ANALYZING THE FOOT BIOMECHANICAL CHARACTERISTICS AND PLANTAR PRESSURE IN BHANGRA DANCERS

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY

in

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By

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2025

DECLARATION

DECLARATION

I, hereby declare that the presented work in the thesis entitled **"Analyzing the Foot Biomechanical Characteristics and Plantar Pressure in Bhangra Dancers"** in the fulfilment of degree of **Doctor of philosophy (Ph. D)** is outcome of research work carried out by me under the guidance of **Dr. Ramesh Chandra Patra**, Assistant Professor, Department of Physiotherapy, School of allied medical sciences of Lovely Professional University, Phagwara, Punjab, India-144411.

The work presented in this thesis, to the best of my knowledge, is my own and does not contain any material that has been accepted for the award of any other degree. I have properly cited and referenced all sources of information, data, and ideas used in this thesis, following the academic conventions and guidelines as prescribed by Lovely Professional University. Any contributions made by others to this research work are acknowledged appropriately in the thesis. Any assistance I received during the course of this research work, including financial support, technical guidance, and intellectual discussions, has been duly acknowledged in the acknowledgments section of this thesis.

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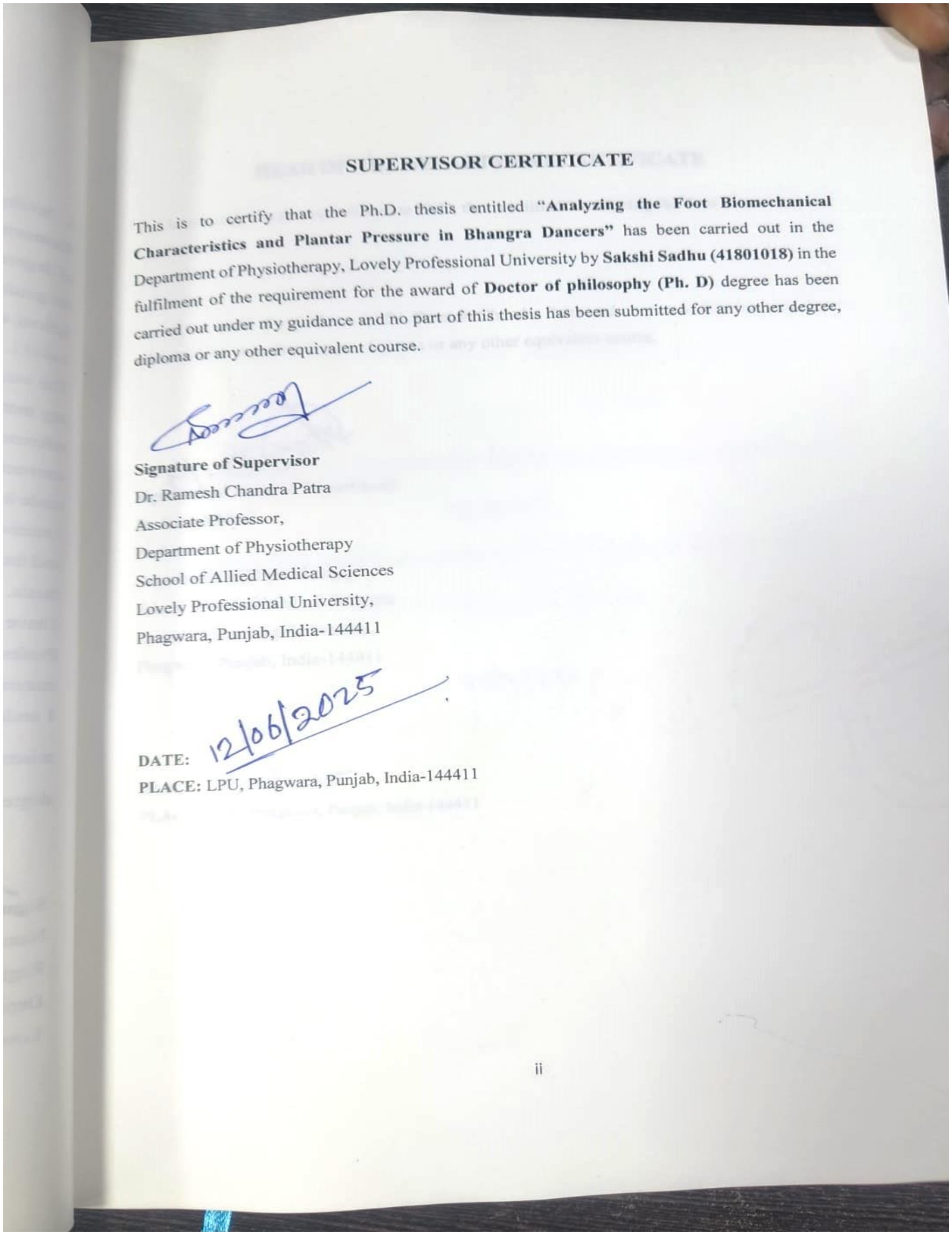

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To my beloved family for their unconditional love and support,
I hope this achievement will fulfil their dreams they have envisioned for me.

-Sakshi Sadhu-

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Sakshi Sadhu (PhD. Scholar)

ABSTRACT

Background: Bhangra, a vibrant and dynamic dance form from Punjab, India, is celebrated for its energetic movements and rhythmic footwork, often performed to the beat of traditional drums like the dhol. This high-intensity dance, while a rich cultural expression, has also become a popular competitive activity worldwide. The nature of Bhangra involves rapid foot movements, jumps, and twists, placing considerable strain on the musculoskeletal system and leading to biomechanical changes and adaptations. As a result, dancers are prone to various injuries, including ankle sprains, knee injuries, lower back pain, and foot-related issues.

Objectives: The objective of this study is to investigate the foot characteristics and plantar pressure of Bhangra dancers compared to non-dancers. By examining these factors, the research aims to understand how the biomechanical demands of Bhangra influence injury risk.

Method: The study used a cross-sectional observational design in the settings of Lovely Professional University, Phagwara, Punjab, India. This study involves 70 Bhangra dancers and 70 non-dancers. Inclusion criteria required participants to be Indian males aged 18-45 years with over 5-10 years of Bhangra dancing experience and to meet specific physical, mental, and cognitive fitness standards. Exclusion criteria included musculoskeletal injuries (past 3 months), neurological conditions, balance issues, and other specified health conditions. Data collection involved demographic information, foot variables, limb variables, plantar pressure variables, gait variables, postural variables, and performance variables.

Result and Discussion: The study examined anatomical and functional differences between Bhangra dancers and non-dancers to predict injury rates and inform intervention protocols. Utilizing IBM SPSS Statistics Version 22 and Microsoft Excel 2016, data from 140 participants (70 dancers and 70 non-dancers) were accurately cleaned and analyzed. Descriptive statistics revealed that dancers had a mean height of 176.45 cm and a mean weight of 70.09 kg, compared to non-dancers with a mean height of 170.94 cm and a mean weight of 64.27 kg. Both groups had similar BMIs, with dancers averaging 22.54 kg/m² and non-dancers averaging 22.01 kg/m². Cardiac assessments showed dancers had a higher mean resting heart rate of 94.33 beats per minute and a mean heart rate of 31.44 beats per 20 seconds, while non-dancers had a higher VO2 max at 37.36 ml/kg/min compared to dancers at 33.30 ml/kg/min.

In our study prominent differences in some foot variables was found between dancers and non-dancers. Descriptive statistics reveal that foot size and truncated foot size show minimal differences between the two groups. However, dancers exhibit significantly higher dorsum height and navicular height compared to non-dancers. Specifically, dancers' dorsum height averages 7.16 cm on the left and 7.01 cm on the right, while non-dancers average 5.99 cm and 6.00 cm, respectively. Similarly, dancers have higher navicular heights, averaging 5.29 cm on the left and 5.46 cm on the right, compared to non-dancers' averages of 4.92 cm and 4.96 cm. The navicular drop test measurements, on the other hand, show no significant difference between the groups. Sensory examinations across both groups were uniform, with all participants scoring the maximum value of 10.00, indicating no variability.

Bhangra dancers and non-dancers show distinct differences in foot angles. Dancers have lower Clarks Angles, reflecting less pronounced arches, the Left Clark Angle for dancers is 26.30° (SD = 7.69) compared to 31.81° (SD = 10.97) for non-dancers, and the Right Clark Angle is 28.16° (SD = 8.53) for dancers versus 32.73° (SD = 10.61) for non-dancers. Dancers also exhibit lower Medial Longitudinal Angles: Left at 146.38° (SD = 7.18) and Right at 147.30° (SD = 7.06), while non-dancers have higher values of 153.10° (SD = 6.51) for the Left and 153.07° (SD = 5.73) for the Right. Dancer's Torsion Angles are slightly higher: Left at 13.48° (SD = 4.20) and Right at 14.26° (SD = 4.29), compared to non-dancer's values of 12.36° (SD = 2.79) and 14.02° (SD = 3.39). Rear-foot Angles are generally higher in dancers, with Left at 5.15° (SD = 11.07) and Right at 3.52° (SD = 10.01), versus non-dancers' values of 1.92° (SD = 11.71) for the Left and 0.83° (SD = 10.87) for the Right. Statistically significant differences were found in Clarks and Medial Longitudinal Angles, with dancers showing lower values. However, no significant differences were observed in Torsion and Rear-foot Angles, except for the Right Clark Angle where dancers had a significantly higher mean.

When comparing Bhangra dancers to non-dancers, significant differences in footprint measurements are evident. Dancers exhibit larger average foot distances across all parameters. For instance, the mean left forefoot distance for dancers is 9.38 cm (SD = 0.89 cm) versus 6.45 cm (SD = 1.98 cm) for non-dancers. The right forefoot distance also differs significantly, with dancers averaging 8.74 cm (SD = 0.71 cm) compared to 6.04 cm (SD = 1.74 cm) in non-dancers. Mid-foot distances show a similar trend; dancers have a mean left mid-foot distance of 3.86 cm (SD = 1.29 cm) and a right mid-foot distance of 3.51 cm (SD = 0.98 cm), while non-dancers have lower means of 2.68 cm (SD = 1.44 cm) and 2.51 cm (SD = 1.18 cm) respectively. Hind-foot distances are also larger in dancers, with a left mean of 5.54 cm (SD = 0.65 cm) and a right mean of 5.14 cm (SD = 0.54 cm), compared to 3.74 cm (SD = 1.17 cm) and 3.65 cm (SD = 1.01 cm) in non-dancers. However, foot indices such as the Staheli Index and Chippaux Smirak Index show minimal differences between the groups. Both indices have similar average values for dancers and non-dancers, with Staheli Indexes around 0.41 and Chippaux Smirak Indexes around 0.69 to 0.70. Dancers have higher arch indices compared to non-dancers, with a left arch index of 0.39 (SD = 0.08) versus 0.32 (SD = 0.04) and a right arch index of 0.38 (SD = 0.07) versus 0.32 (SD = 0.04), indicating that dancers tend to have a higher arch.

When focusing on deviations in foot posture between Bhangra dancers and non-dancers, distinct differences emerge. Bhangra dancers exhibit prominent deviations with a higher prevalence of pronated (39.3%) and highly pronated (7.1%) foot postures, particularly more pronounced in the left foot. In contrast, non-dancers show fewer deviations, with only 19.3% displaying pronated postures and no instances of highly pronated feet. Additionally, Bhangra dancers demonstrate a higher incidence of supinated foot postures (8.6%), especially in the right foot, whereas supination is relatively rare among non-dancers (4.3%). Highly supinated postures are virtually absent in non-dancers, while Bhangra dancers show a slight occurrence (1.4%). These deviations suggest that Bhangra dancing is associated with more significant variations in foot posture compared to non-Bhangra activities.

Bhangra dancers exhibit significantly larger plantar pressure areas, with a left forefoot area of 49.95 cm^2 compared to 44.23 cm^2 in non-dancers, and a hind-foot area of 56.45 cm^2 versus 51.12 cm^2. Their total foot area averages 106.4 cm^2, compared to 95.35 cm^2 for non-dancers. In dynamic measures, Bhangra dancers have a mean step length of 476.89 mm and a step area of 586.92, compared to non-dancers' 513.59 mm and 467.33. They also show a higher length-to-area ratio (7.88) than non-dancers (6.77). Bhangra dancers exhibit a lower Y speed (6.10) compared to non-dancers (7.75). Additionally, postural sway values indicate unique sway characteristics in Bhangra dancers, reflecting their adaptation to dance-related physical demands. These results highlight how Bhangra dancing affects foot pressure distribution, gait dynamics, and postural control.

On comparing Bhangra dancers and non-dancers posture, several variables exhibited distinguished differences. The Left Quadriceps Angle (LQA) differed significantly with Bhangra dancers showing a mean decrease of -4.88 compared to non-dancers, with a t value of -3.99 ($p < 0.001$).

Similarly, the Right Gene Recurvatum (RGR) was significantly greater in Bhangra dancers, with a mean difference of 4.89 and a t value of 4.58 ($p < 0.001$). The Right Forehead Alignment (RFHA) showed a significant difference with Bhangra dancers having a mean difference of -2.88, yielding a t value of -2.55 ($p = 0.01$). Other significant differences were observed in HAA, HAAS, LFHA, LSA, and LGR, suggesting that Bhangra dancing influences various postural and alignment aspects compared to non-dancers.

The correlation analysis among various foot characteristics, limb variables, foot angles and index's, plantar pressure, posture and performance variables in Bhangra dancers reveals intricate relationships that provide awareness into their biomechanics and foot characteristics. Significant findings include the high bilateral symmetry in foot sizes ($r = 0.997$) and truncated foot sizes ($r = 0.998$), with distinguished correlations between weight and BMI ($r = 0.728$) and height and BMI ($r = -0.356$). Dorsum height shows significant correlations with plantar pressure variables, such as the total left foot area (TLFA) ($r = 0.147$) and average pressure (TLFAP) ($r = -0.096$), and is also associated with postural alignment measures like Horizontal Alignment of the Head (HAH) ($r = 0.349$) and Left Shoulder Angle (LSA) ($r = 0.241$). Navicular height reveals moderate to strong correlations with arch indices, including Left Arch Index (LAI) ($r = 0.724$) and Right Arch Index (RAI) ($r = 0.886$), and shows significant positive correlations with average pressures during dynamic walking phases, such as AGPStep1 ($r = 0.379$). These correlations underscore the importance of foot structure in influencing plantar pressure distribution and postural alignment, offering valuable insights for optimizing training interventions and injury prevention strategies for Bhangra dancers.

The regression analysis for the relationship between various biomechanical characteristics of the foot and plantar pressure distribution in Bhangra dancers reveals several insights. Despite the unique biomechanical demands of Bhangra dancing, factors such as age, weight, height, and BMI generally do not show significant effects on most foot variables. For instance, foot size (mean = 25.3 cm) and dorsum height (mean = 10.2 cm) remained largely unaffected by these factors, with p values exceeding 0.05 in most cases. However, exceptions are noted in specific foot angle measurements and posture variables. The right Clark angle, for instance, exhibited a marginally significant relationship with age ($\beta = -0.14$, $p = 0.07$), weight ($\beta = -0.10$, $p = 0.06$), height ($\beta = 0.12$, $p = 0.09$), and BMI ($\beta = -0.08$, $p = 0.05$). Additionally, age (mean = 25.4 years) and weight (mean = 70.1 kg) influenced limb variables like True limb length (mean = 24.5 cm) and Apparent

limb length (mean = 25.1 cm), though these effects were often marginal (p values ranging from 0.04 to 0.09). Posture variables showed that weight had a significant impact on specific angles and indices, such as LTA (mean = 10.5 degrees) and RSA (mean = 12.3 degrees), with weight correlating significantly with LTA ($\beta = 0.15$, $p = 0.03$). These findings suggest that while general predictors may not significantly impact most foot characteristics, specific angles and posture indices may be influenced by certain factors, potentially guiding more targeted interventions or further research into injury prevention and training optimization for Bhangra dancers.

Conclusion: The study highlights distinctive biomechanical adaptations in Bhangra dancers compared to non-dancers. These adaptations include variations in foot characteristics, plantar pressure, and gait. The findings suggest that Bhangra dancing impacts anatomical and functional attributes and emphasizing the need for injury prevention strategies.

Keywords: Bhangra dancers, foot characteristics, plantar pressure, gait analysis, postural alignment, biomechanical adaptations, injury prevention.

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LIST OF ABBREVIATIONS

HAH: Horizontal alignment of the head
HAA: Horizontal alignment of the acromion
HAAS: Horizontal alignment of ASIS
ASIS: Anterior superior iliac spine
LTA: Lateral trunk alignment
LQA: Left quadriceps angle
RQA: Right quadriceps angle
LRA: Left rear-foot angle
RRA: Right rear-foot angle
RFHA: Right forward head angle
RSA: Right shoulder angle
RGR: Right genu recurvatum
LFHA: Left forward head angle
LSA: Left shoulder angle
LGR: Left genu recurvatum
AGP: Average pressure
MP: Maximal pressure
LSTD: Left step duration
RSTD: Right step duration
LSL: Left step length
RSL: Right step length
LTO: Left toe-out
RTO: Right toe-out
LSRD: Left stride duration
RSRD: Right stride duration
LSTL: Left stride length
RSTL: Right stride length
ATFL: Anterior Talofibular Ligament
PTFL: Posterior Talofibular Ligament
FPI: Foot posture index
CFL: Calcaneofibular Ligament
LGCD: Left gait cycle duration
RGCD: Right gait cycle duration
TLFA: Total left foot area
TLFAP: Total left foot average pressure
TLFMP: Total left foot maximum pressure
TLFTH: Total left foot thrust
TLFW: Total left foot weight bearing
TRFA: Total right foot area
TRFAP: Total right foot average pressure
TRFMP: Total right foot maximum pressure
TRFTH: Total right foot thrust
TRFW: Total right foot weight bearing
LSI: Left Staheli Index
RSI: Right Staheli Index
LCSI: Left Chippaux Smirak Index
RCSI: Right Chippaux Smirak Index
LAI: Left Arch Index
RAI: Right Arch Index
LFPIS: Left Foot Posture Index Score
RFPIS: Right Foot Posture Index Score
LCA: Left Clark's angle
RCA: Right Clark's angle
LMLA: Left medial longitudinal angle
RMLA: Right medial longitudinal angle
LTA: Left torsion angle
RTA: Right torsion angle
LRFA: Left rear-foot angle
RRFA: Right rear-foot angle
PSI: Plantar Scan Images

EMG: Electromyography

FPI: Foot Posture Index

CA: Clarke's Angle

CSI: Chippaux Smirak Index

SI: Staheli Index

HST: Harvard Step Test

VO2max: Maximum Oxygen Uptake

VSR: Vertical Sit and Reach

YBT: Y Balance Test

ROM: Range of Motion

FPI: Foot Posture Index

GRF: Ground Reaction Force

CoP: Center of Pressure

MLAA: Medial Longitudinal Arch Angle

ND: Navicular Drop

SEBT: Star Excursion Balance Test

MSD: Musculoskeletal Disorder

WRMSD: Work related Musculoskeletal Disorder

DLCMJ: Double Leg Countermovement Jump

SLJ: Single Leg Jump

BMI: Body Mass Index

p: p value

SEM: Standard Error of Measurement

CI: Confidence Interval

MD: Mean difference

SD: Standard deviation

OPERATIONAL DEFINITIONS

Term	Definition
Foot	The foot is the lower extremity of the leg that supports a person's body weight and facilitates walking and standing.
Biomechanics	Biomechanics involves applying the principles of mechanics to living organism (humans, animals, plants even cells).
Dance	The movement of the body in a rhythmic way, usually to music and within a given space, for the purpose of expressing an idea or emotion, releasing energy, or simply taking delight in the movement itself.
Dancer	One who dances.
Bhangra Dance	Bhangra is a traditional and the most popular folk dance of Punjab.
Plantar Pressure	Foot plantar pressure is the pressure field that acts between the foot and the support surface during everyday locomotor activities.
Injury	It is physiological damage to the living tissue of any organism, whether in humans, in other animals, or in plants.
Static posture	The posture at rest where there is no major change in the primary position such as sitting and standing
Dynamic posture	The posture at motion such as walking, running, jumping, etc., is known as dynamic posture
Gait	The manner or style of walking.
Assessment	Refers to the wide variety of methods or tools that evaluators use to evaluate, measure, and document performance, readiness, learning progress, skill acquisition, or other needs of subjects.
Rehabilitation	Rehabilitation is defined as “a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment”.
Gait analysis	An analysis of all the components and phases of the gait cycle.
Gait cycle	It is a repetitive pattern involving steps and strides.
Step length	Distance between two successive placements of the opposite foot

Stride length	Distance between two successive placements of the same foot. It consists of two step lengths, left and right, each of which is the distance by which the named foot moves forward in front of the other one.
Step time	The time between heel strike of one leg and heel strike of the contralateral leg.
Step width	The Medio-lateral space between the two feet.
Spatial	Relating to the position, area, and size of object.
Temporal	Relating to time duration an object stays in a position.

CHAPTER I

INTRODUCTION

1.1 Overview

The introduction chapter serves as a foundation for the thesis. It establishes the context and significance of the research. In our research this chapter begins with background information of the topic to understand the research problem. In this chapter research problem has been clearly defined and research question has been addressed. Research objectives, hypothesis and significance has been discussed in detail.

1.2 Background

Dancers are considered both athletes and artists (1). Nowadays dancing is not only merely for the statement of social style or cultural significance but people are adapting it as a career and profession (2,3). Countless dance forms are worldwide available and known to have origins for centuries (4) but only few were interested in the stressful aspect of dance (4) . This leads to slow evolution of dance medicine. Over the past decade, dance medicine has seen exponential growth. Dance medicine is defined as "the field of medicine specialized in the evaluation and treatment of performing artists,". Dance medicine has increasingly aligned with sports medicine, evolving into a specialized branch within this domain. This transition can be attributed to the physical and physiological demands that dance places on the body. The complex movements required in dance necessitate extensive muscular and joint flexibility, stability, muscle strength, coordination, and sensorimotor integrity. As a result, understanding the intricate interplay of these demands is crucial for effectively preventing and treating dance-related injuries (5).

Dance demands intense physical exertion, keen concentration and precise technique due to which it poses a risk for multiple types of injuries. There are several risk factors identified in literature including anatomical posture, inadequate training, technical errors, execution speed, psycho-physical state of dancer and environmental conditions such as the floor, footwear, lighting, and temperature etc. Dancing postures can be challenging requiring muscle control and balance, putting dancers at risk of pain and injury (6–9).

Ryan and Stephens in their dance medicine comprehensive guide report that 90% of the dancers experience various types of injuries throughout their careers (10). The available evidences has confirmed that lower limbs are at high risk of injury in dancers (11). Bronner et al. conducted a study confirming that the lower limb injuries make up for 58% of all dance related injuries with 34% of these affecting ankle and foot (12). Christine van Seters et al in their study confirmed that the lower limb injuries were approximately 82.2% in one year in the study population (13). Paul and Kapoor conducted study on Indian classical dancers and study revealed that knee is the most prevalent region to get injured and the reason was associated with the torque from twisting and turning due to different dance positions (14). In a more recent study, Anbarasi et al. found a relationship between the iliotibial band tightness and quadriceps muscle with lower extremity injuries among Bharatanatyam dancers (15). They have discussed the importance of flexibility programs for the prevention of dancing injuries and suggested to incorporate flexibility exercises as the part of their daily routine.

1.2.1 Historical background of dance

The history and origin of dance can be traced back to the earliest expressions of human culture. The roots of dance are deeply embedded in the fabric of human existence, serving as a means of communication, celebration, and storytelling. One of the earliest forms of dance can be found in ancient rituals and ceremonies. Primitive societies engaged in rhythmic movements to connect with the divine, celebrate the changing seasons, or commemorate important events. These early dances were not only a physical expression but also a spiritual and communal experience, fostering a sense of unity among participants. The ancient civilizations of Egypt, Greece, and Rome contributed significantly to the development of dance as an art form. In ancient Egypt, dance was an integral part of religious ceremonies and festivals, with depictions found in hieroglyphs and ancient artwork. In Greece, dance was closely associated with the arts, and prominent philosophers like Plato recognized its educational and therapeutic value (16).

During the Middle Ages in Europe, dance underwent transformations influenced by religious and courtly traditions. The emergence of court dances, such as the pavane and galliard, showcased the refinement of social dancing, becoming an essential skill for the aristocracy. Simultaneously, folk dances thrived as expressions of regional identity and community celebrations. The Renaissance period marked a significant shift in dance as a form of entertainment and self-expression. The emergence of ballet in the courts of Italy and France during the 15th and 16th centuries laid the foundation for a structured and codified dance form. Ballet evolved into a highly stylized art, with formalized positions, movements, and narratives (17). Simultaneously, various folk and traditional dance forms flourished globally, reflecting the rich tapestry of cultural diversity. From the intricate footwork of Indian classical dance to the lively rhythms of African dance, each culture contributed unique movements, costumes, and music to the world of dance. In the 20th century, dance experienced a radical shift with the evolution of modern dance. Pioneers like “Isadora Duncan” and “Martha Graham” rejected the rigid structures of ballet, seeking new ways to express emotion and individuality through movement. This era also saw the rise of social dances like the Charleston, jazz, and swing, reflecting the changing dynamics of society. Contemporary dance, emerged in the latter half of the 20th century, continued to push the boundaries of traditional forms. In the 21st century, dance has become more accessible than ever, thanks to globalization and technological advancements. Dance styles from around the world are shared and adapted, fostering cross-cultural exchanges and collaborations. Dance has also found a prominent place in popular culture, with dance forms like hip-hop influencing music, fashion, and mainstream media (18,19).

The history and origin of Indian classical and traditional dance forms are deeply intertwined with the rich cultural and religious traditions of the Indian subcontinent. There are different classical and traditional dance forms i.e. Bharatanatyam, kathak, Odissi, Manipuri, Kuchipudi, Mohiniyattam, Bhangra etc. and each dance form carries its unique history, mythology, and aesthetic principles, contributing to the diverse tapestry of Indian performing arts (20).

1.2.2 Background and Origin of Bhangra Dance

Bhangra dance is a vibrant and energetic traditional folk dance that originated in the Sialkot district of Majha, Punjab region of South Asia, with strong roots in both Indian and Pakistani culture. It has evolved over the years, blending traditional elements with contemporary influences, and has gained popularity on a global scale. Bhangra is not just a dance but also a celebratory and rhythmic expression of the joyous spirit of the Punjabi people. This form of dance was usually performed as a tradition during the harvesting season to express the happiness of the farmers but later on, this dance form became so viral that now it is being used very commonly because of the form of energy being used in it. This form of dance has its root origin in 1953 during the time of the Maharaja of Patiala. According to Dhillion, the bhangra dance form has its association with Bagga (21).

Bhangra dancers wear vibrant and colorful attire, often featuring traditional Punjabi clothing. This includes bright-colored turbans, long tunic-style shirts (kurta), flowing ghagra or dhoti, and juttis (traditional footwear). Traditional Bhangra music is characterized by the use of Punjabi folk instruments. The dhol (double-headed drum), tumbi (single-stringed instrument), and algoza (double flute) are commonly used to create the distinctive beats of Bhangra music. This dance form involves vigorous kicks, leaps, and bends of the body and it is often accompanied by upraised, thrusting arm or shoulder movements. The movements and gestures of Bhangra mimic the activities and rhythm associated with farming, such as sowing seeds, harvesting crops, and traditional Punjabi folk activities. The bhangra dancing is often accompanied by hand gestures, foot work (Jhumar), singing (Boliyan), energetic movements (Dhamal) (22).

Bhangra dance is a dynamic and culturally rich art form that embodies the exuberance and traditions of the Punjab region (Figure 1). Its evolution from a regional folk dance to a global phenomenon reflects its universal appeal and ability to bring people together in celebration and joy. Whether performed in its traditional form or as part of modern fusions, Bhangra continues to be a symbol of cultural pride and exuberance (23).

Figure 1 displaying the dancing pose of Bhangra dancers

Source: "Jaipuneetsingh, CC BY-SA 4.0 https://creativecommons.org/licenses/by-sa/4.0" (24)

1.2.3 Biomechanics of Dancing

Dance is highly demanding activity that requires exceptional range of motion, strength, coordination and balance. In everyday activities like walking, running, the joints of lower limb move within limited range of motion to facilitate locomotion without placing excessive stress on joints and muscles but dancing often requires extended range of motion to perform movements like high kicks, splits and deep bends. This increased ROM places additional demand on the flexibility of the muscles, tendons and ligaments. These adaptations help dancers to achieve aesthetic lines required in dancing but also increase the risk of injuries like sprain and strain (25) The muscles used in daily activities involves balanced muscle activation to maintain efficiency and prevent fatigue but in compared dancing requires enhanced muscular strength and endurance to perform high intensity activity. The core, lower limb, feet in particular must be exceptionally strong to support the dynamics and explosive movements. This increased strength and endurance help dancers maintain stability and control, but the repetitive high-intensity demands can lead to overuse injuries if not properly managed. Dancing also requires constantly adjusting their balance dynamically, this requires refined proprioception to maintain precise control over the body position and movement. Dancers develop heightened proprioception through extensive training, allowing them to execute intricate footwork, maintain stability during rapid transitions, and perform complex movements with accuracy. This adaptation helps prevent falls and improves movement precision but also demands significant mental and physical coordination (26,27). Dancers often integrate biomechanical adaptations, which allows them to perform with grace. The biomechanics of dancing place unique demands on the spinal posture, hip, knee, and foot mechanics, each requiring specialized adaptations for optimal performance and injury prevention. Dancers often adopt various postures that require hyperextension or unusual spinal alignments, such as the extended spine seen in arabesque positions in ballet. This necessitates increased spinal flexibility, strength, and control to achieve the desired aesthetic lines without causing hyperlordosis or scoliosis. Hip mechanics in dance involve extreme motions such as high leg lifts, splits, and turnout, requiring exceptional hip joint flexibility and stability. Strengthening the hip flexors, extensors, and abductors, along with enhancing ligament flexibility, enables dancers to perform complex movements while mitigating the risk of hip injuries like labral tears or impingement syndromes. Knee mechanics in dance are similarly complex, with the knees handling deep pliés, jumps, and landings. These activities place substantial stress on the knee joint and surrounding structures, increasing the likelihood of patellar tendinitis, meniscus injuries, and ligament strains. Foot mechanics in dance are also markedly different from normal activities. Dancers frequently use non-standard foot positions like pointe and demi-pointe in ballet, which demand significant plantarflexion, robust arches, and altered plantar pressure distribution to withstand repetitive high-impact activities (28). While the biomechanical adaptations in dancers' bodies enhance performance and allow for the execution of complex movements, they also come with potential negative consequences. The repetitive high-intensity demands placed on the spine, feet, hips, and knees can lead to overuse injuries like inflammation of tendons, stress fractures, and chronic joint pain. Among the various parts of the body adapted for dance, the most vulnerable are likely the feet and ankles due to the significant stress and unique demands placed upon them. Dancers frequently use non-standard foot positions, this extended range of motion and high-impact activity can lead to a variety of injuries, including stress fractures, Achilles tendinitis, and chronic ankle instability. The repetitive nature of dance movements, such as jumps and landings, increases the load on the feet and ankles, causing wear & tear on the tendons and ligaments. Additionally, the need for strong and flexible arches to absorb shock and provide stability can lead to conditions like plantar fasciitis. Proper alignment and technique are crucial to minimize these risks, but even with precautions, the constant demands placed on the feet and ankles make them particularly susceptible to overuse injuries and long-term damage (28–30).

1.2.4 Biomechanical assessment and its importance in dance injuries

Biomechanics is a branch using the principles of mechanics, engineering and electronic which helps in analyzing the normal and abnormality in the posture, gait in dynamic and static positions. It helps in preventing the injury occurrence by finding the fault at very beginning and usage the prevention methods as well. Biomechanical assessments help identify dancers at higher risk of specific injuries based on their foot structure and movement patterns. Early identification of risk factors allows for targeted interventions and preventive measures (31) .

Injuries among dancers are quite common because of physical demand and hard training. These injuries range from acute such as strain and sprains to chronic or overuse injuries (32). Injuries can arise from different factors comprising both intrinsic and extrinsic. Intrinsic include biomechanical abnormalities, anatomical discrepancies, ligament laxity, limited range of motion, muscle imbalance, incorrect dance techniques, Overtraining, fatigue, nutritional deficiencies, psychological factors etc. Extrinsic factors include environmental factors, improper footwear, inadequate rest and recovery, inadequate warm up and cool down, dancing surfaces, peer pressure etc. preventing the dance injuries requires addressing both intrinsic and extrinsic factors (33–36). Yiannis Koutedakis, et al. (2008) mentioned in their study that biomechanical analysis helps us to improve performance and also reduce risk of injury. They further stated that there is need to use effective methods for the assessment and training of dancers and there should be usage of advances techniques such as motion-capture, functional analysis of muscles, and strength assessment techniques. These techniques provide valuable understanding into the areas, where dancers require special attention (37) .

1.2.5 Ankle and Foot Anatomical overview

The ankle & foot have important functions in the human body. It helps in supporting the body weight and provides balance. It also provides shock absorption and helps in transferring ground reaction force. The normal biomechanics of ankle & foot complex depend upon static components like joint bony, joint structure, ligament, and fascia and the dynamic component depends upon the muscle and the arthokinematics of tarsal bones (38). The most important function of the ankle & foot complex is maintain body balance, weight transfer to the ground, and maintain stability through various adjustments in standing and walking (39).

The foot and the ankle joint form the complex with Twenty-eight bones, Thirty-three joints, and one hundred and twelve ligaments. It is controlled by twelve extrinsic and twenty-one intrinsic muscles. The foot is divided into forefoot, mid-foot, and rear-foot. The anterior part is forefoot having fourteen phalanges & five metatarsals. There are total of 5 digits in which four digits are having three phalanges each & two in the great toe. The joint between forefoot & mid-foot is called as Lisfranc joint. The mid-foot is made up of five tarsals including three cuneiforms, cuboid and navicular, the joint between the mid-foot & hind-foot is called chopart's joint. This joint is the combination of two joints i.e. "Talonavicular and calcaneocuboid joints". The hind-foot is posterior aspect of the foot complex made up of talus and Calcaneus bone and the articulation between talus and Calcaneus is known as the subtalar joint. The lower end of tibia & fibula forms the mortise-like structure that articulates with talus bone and forms the talocrural or ankle joint (22). The bones and joints of ankle and foot are discussed in Figure 2, Figure 3 and Table 1).

The muscles of ankle and foot are categorized into extrinsic and intrinsic group of muscles (Table 2 and Figure 4). Extrinsic group of muscles originated above the foot in the leg but insert within the foot. Extrinsic muscles are divided into four compartments by fascia i.e. superficial posterior compartment (“gastrocnemius, soleus and Plantaris”), Deep posterior compartment (“tibialis posterior, flexor digitorum longus, and flexor hallucis longus”), anterior compartment (“tibialis anterior, extensor hallucis longus, extensor digitorum longus, and peroneus tertius”) and lateral compartment (“peroneus longus, and peroneus brevis”). There are numerous smaller muscles residing deep within the foot contributing to stabilization and movement of toes, collectively termed as intrinsic muscles of foot. Extensor compartment on top or dorsum of foot and flexor compartment on bottom or ventral aspect of foot. Unlike the muscles there is a fibrous structure known as plantar fascia originating deep within the plantar surface of heel bone and extend to the base of five toes. This structure is contributing to the support of the foot arch by preserving the distance between calcaneus and toes. During walking or dorsiflexion of toes, tension is exerted on this fascia and results in tightening of the fascia. This fascia acts as resilient and impermeable covering for the safety of sole muscles (38,40–43).

There are hundreds of ligaments, both intrinsic and extrinsic providing stability by holding the bones together during static and dynamic posture (Figure 5). The main ligaments are: on the lateral side: “anterior talo-fibular ligament (ATFL), posterior talo-fibular ligament (PTFL), and calcaneo-fibular ligament (CFL)”, which is preventing excessive movement and stabilizing the ankle during different activities. On medial side, deltoid ligament complex is providing stability, including the tibionavicular, tibiocalcaneal, posterior tibiotalar, and anterior tibiotalar ligaments, acts as a robust support system, resisting the forces of eversion. Transverse ligaments, such as the interosseous ligament, contribute to the structural integrity between the tibia and fibula. In the foot, the Lisfranc ligament ensures stability in the tarsometatarsal joint, crucial for weight-bearing activities. Spring ligament serves as cradle to support talar head. Inter-metatarsal ligaments bind neck region of metatarsals together so that they move in sync. The intraosseous ligaments are present in the foot region binding the two adjacent bones (40,43–45).

The ankle & foot is innervated by five nerves (Figure 6), which is having origin from sciatic nerve. At the level of knee its divided into tibial and common peroneal (CPN). Both the nerves further divide and form superficial and deep peroneal nerve. The fifth nerve of which supplies foot is originated from femoral and known as saphenous nerve (46,47).

The ankle & foot biomechanics is important for human movement & stability. The ankle joint is a complex permitting dorsiflexion and plantar flexion as the primary movements. Ligaments, such as ATFL, PTFL and CFL plays pivotal role in stabilization of the joint. Muscles surrounding the joint contributes movement and stability. The arch structure of foot is the fundamental concept in biomechanics. There are three arches in the foot i.e. “the medial longitudinal arch, the lateral longitudinal arch & the transverse arch” (Figure 7). These arches are interconnected and have coordinated movement which allows the foot to adapt to various surfaces and absorb shock during activities. Ligaments, tendons and fascia plays vital role in supporting these arches and maintaining structural integrity of foot (41,42,48).

The medial arch runs along inner side of the foot spanning from heel of the ball of big toe, primarily formed by calcaneus, talus, navicular and three cuneiforms and base of first metatarsal. This arch helps in shock absorption, even weight distribution and provide flexibility during walking and running. The lateral longitudinal arch extends from outer side of the foot and runs parallel to medial longitudinal arch. The components involved in formation of this arch are calcaneus, cuboid and lateral two metatarsals. The function of this arch is similar that of medial longitudinal arch. The transverse arch is perpendicular to longitudinal arches, spanning across the width of the foot, it is formed by cuboid, cuneiforms and bases of all the five metatarsals. This arch is crucial for maintaining overall shape of foot, providing stability during weight bearing activities and assisting in weight distribution (49).

These arches contribute to the overall structure and function of foot, influencing foot type. There are three different types of foot i.e. high arched, neutrally arched, and flat arched (Figure 8). Normal/neutral arched foot have balanced arch and the individual with normal arch have well balanced weight distribution across the foot and the arch provide enough support during supination and pronation. The low arched or flat arched foot individual are categorized as flat foot or pes planus population. This is associated with over pronation of calcaneus results inward rolling of foot during walking and running, leading excessive stress on the inner side of the foot causing problems like shin splits or plantar fascitis. The third category is high arched or pes cavus foot type often linked with under pronation or supination of calcaneus resulting insufficient rolling of foot during normal gait cycle. This leading increase pressure on the outer edge of foot and causes lateral foot pain or stress fractures (50–52).

The foot is the most important component for movement and weight bearing and it offers the central role in maintain balance, force absorption and efficient propulsion during the dance poses. Despite this there is limitation in the literature focusing on the dance injuries and associated risk factors. Therefore, this study aims to investigate the static and dynamic biomechanical characteristics of the foot in Bhangra dancers, focusing on static measures, gait parameters, and plantar pressures. By analyzing these aspects, the study seeks to identify the underlying factors contributing to lower limb injuries, examine the impact of these injuries on dancers' physical structures, and propose effective strategies for injury prevention and rehabilitation to enhance both long-term health and performance.

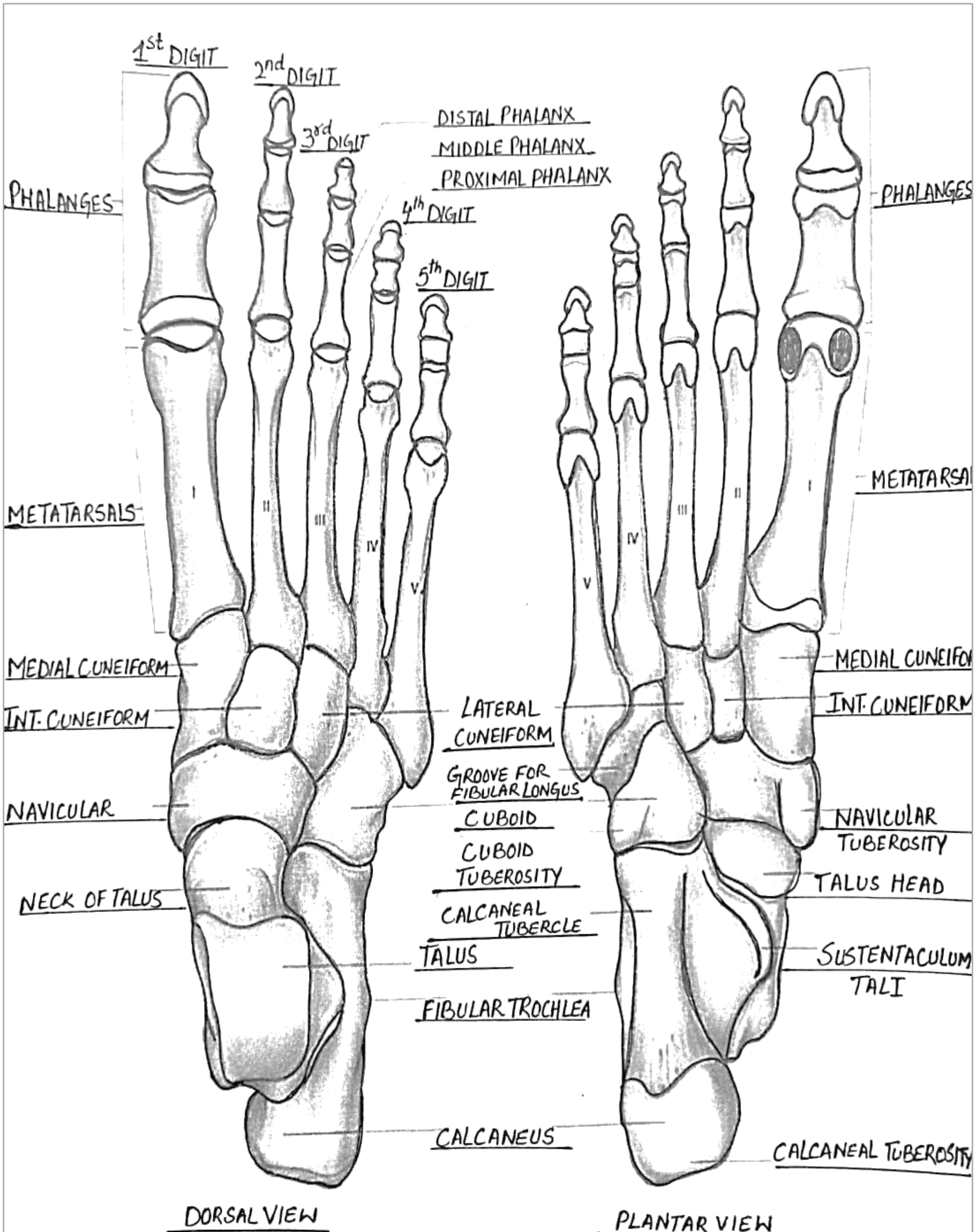


Figure 2 displaying bones of human foot

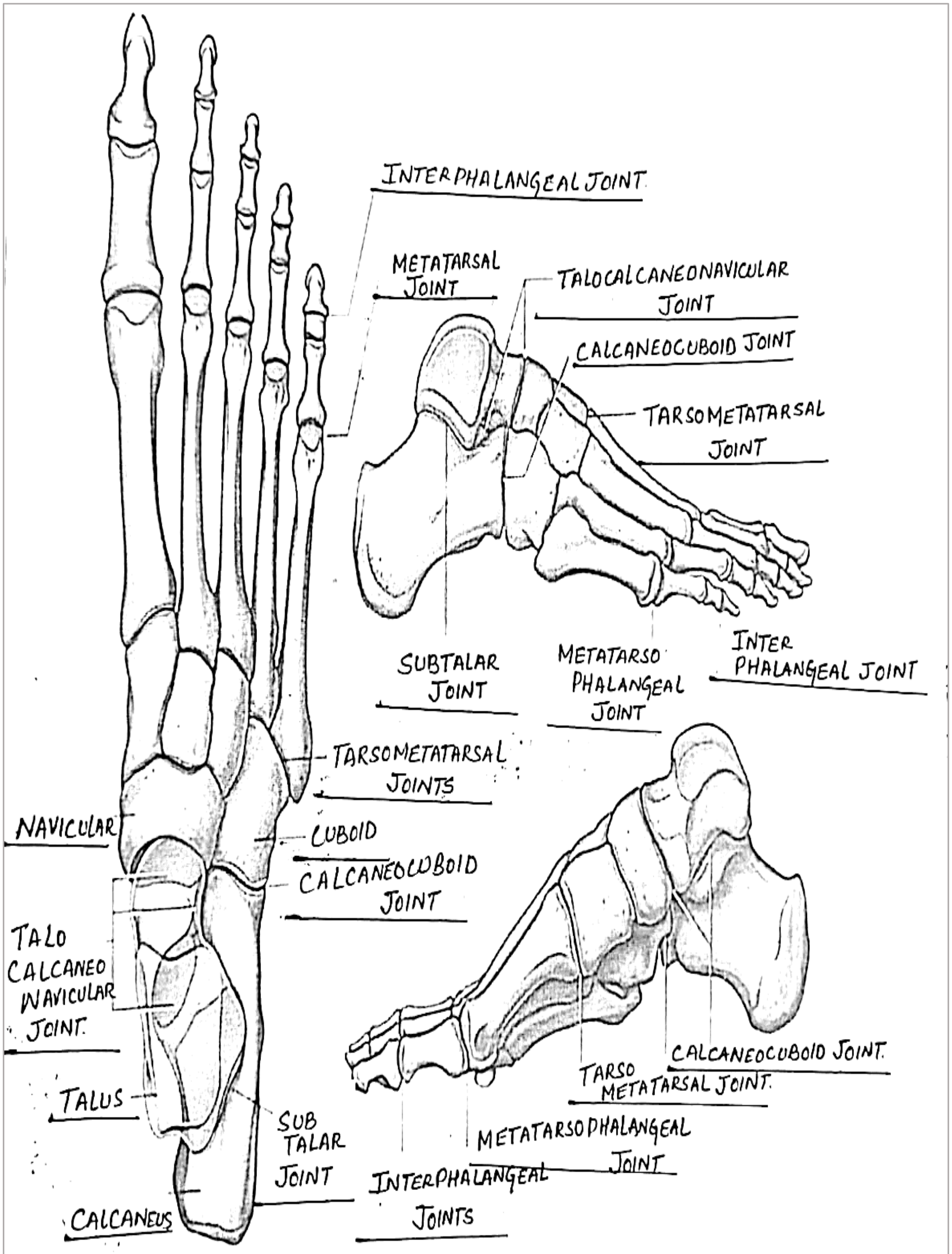


Figure 3 displaying the joints of human foot

Table 1 displaying the description of joints of ankle and foot of humans

Joint	Type	Location	Primary Movements	Associated Planes
Ankle Joint (Talocrural)	Synovial hinge	Between tibia, fibula, and talus	Dorsiflexion (lifting the foot), plantarflexion (pointing the toes)	Sagittal plane
Subtalar Joint	Synovial plane	Between talus and calcaneus	Inversion (sole turns inward), eversion (sole turns outward)	Transverse and frontal planes
Talonavicular Joint	Synovial ball and socket	Between talus and navicular	Inversion, eversion, limited dorsiflexion, and plantarflexion	Transverse, frontal, and sagittal planes
Calcaneocuboid Joint	Synovial plane	Between calcaneus and cuboid	Inversion, eversion, limited dorsiflexion, and plantarflexion	Transverse and frontal planes
Cuneonavicular Joints	Synovial plane	Between cuneiforms and navicular	Limited movement, contribute to foot arch support	Transverse and frontal planes
Intercuneiform Joints	Synovial plane	Between cuneiforms	Limited movement, contribute to foot arch support	Transverse and frontal planes
Cubometatarsal Joints	Synovial plane	Between cuboid and metatarsals	Limited movement, contribute to foot arch support	Transverse and frontal planes

Tarsometatarsal Joints	Synovial plane	Between tarsal and metatarsal bones	Limited movement, contribute to foot arch support	Transverse and frontal planes
Metatarsophalangeal Joints (MTP)	Synovial condyloid	Between metatarsals and phalanges	Flexion & extension, abduction & adduction of toes	Sagittal, frontal & transverse planes
Interphalangeal Joints (IP)	Synovial hinge	Between phalanges	Flexion, extension of the toes	Sagittal plane

Note: MTP: Metatarsal phalangeal, IP: Interphalangeal

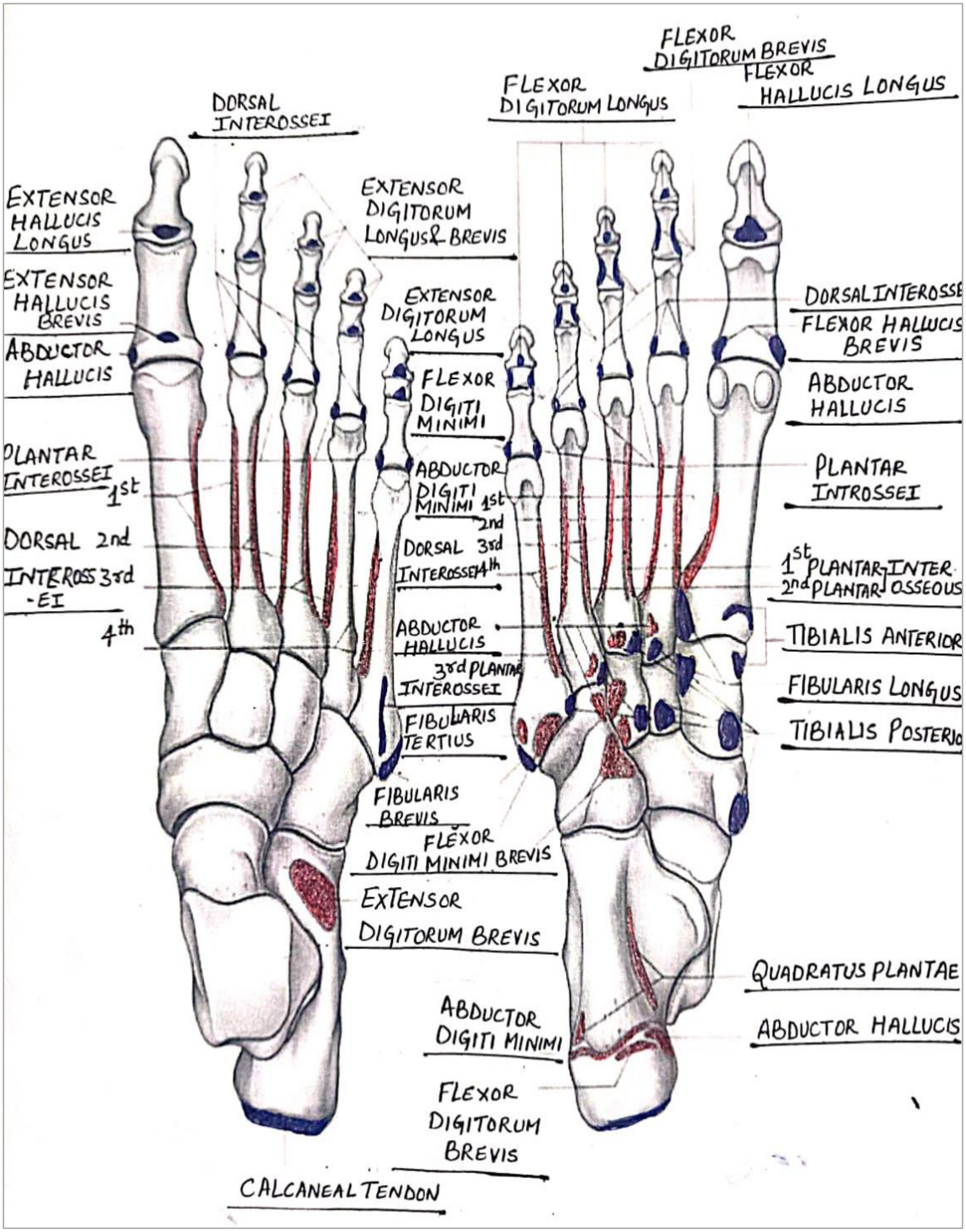


Figure 4 displaying origin (red) & insertion (blue) of muscles of human foot and ankle

Table 2 displaying the description of extrinsic and Intrinsic muscles of ankle and foot

Muscle	Location	Primary Actions
Gastrocnemius	Calf	Plantarflexion of the ankle
Soleus	Calf	Plantarflexion of the ankle
Tibialis Anterior	Front of the shin	Dorsiflexion of the ankle (lifting the foot upward)
Tibialis Posterior	Back of the shin	Inversion of the foot
Peroneus Longus	Outer side of the calf	Eversion of foot, plantarflexion
Peroneus Brevis	Outer side of the calf	Eversion of foot, plantarflexion
Extensor Digitorum Longus	Front of the shin	Dorsiflexion of the ankle, extension of toes
Flexor digitorum Longus	Back of the shin	Plantarflexion of the ankle, flexion of toes
Extensor Hallucis longus	Front of the shin	Dorsiflexion of the ankle, extension of the big toe
Flexor Hallucis Longus	Back of the shin	Plantarflexion of the ankle, flexion of the big toe
Abductor Hallucis	Medial (inner) foot	Abduction of big toe
Flexor Digitorum Brevis	Sole of the foot	Flexion of the toes
Abductor Digiti Minimi	Lateral (outer) foot	Abduction of the little toe (moving it away from the other toes)
Quadratus Plantae	Sole of foot	Assists in flexion of toes
Lumbricals	Sole of foot	Flexion of toes at the metatarsophalangeal joints
Interossei	Sole of the foot	Adduction & abduction of the toes

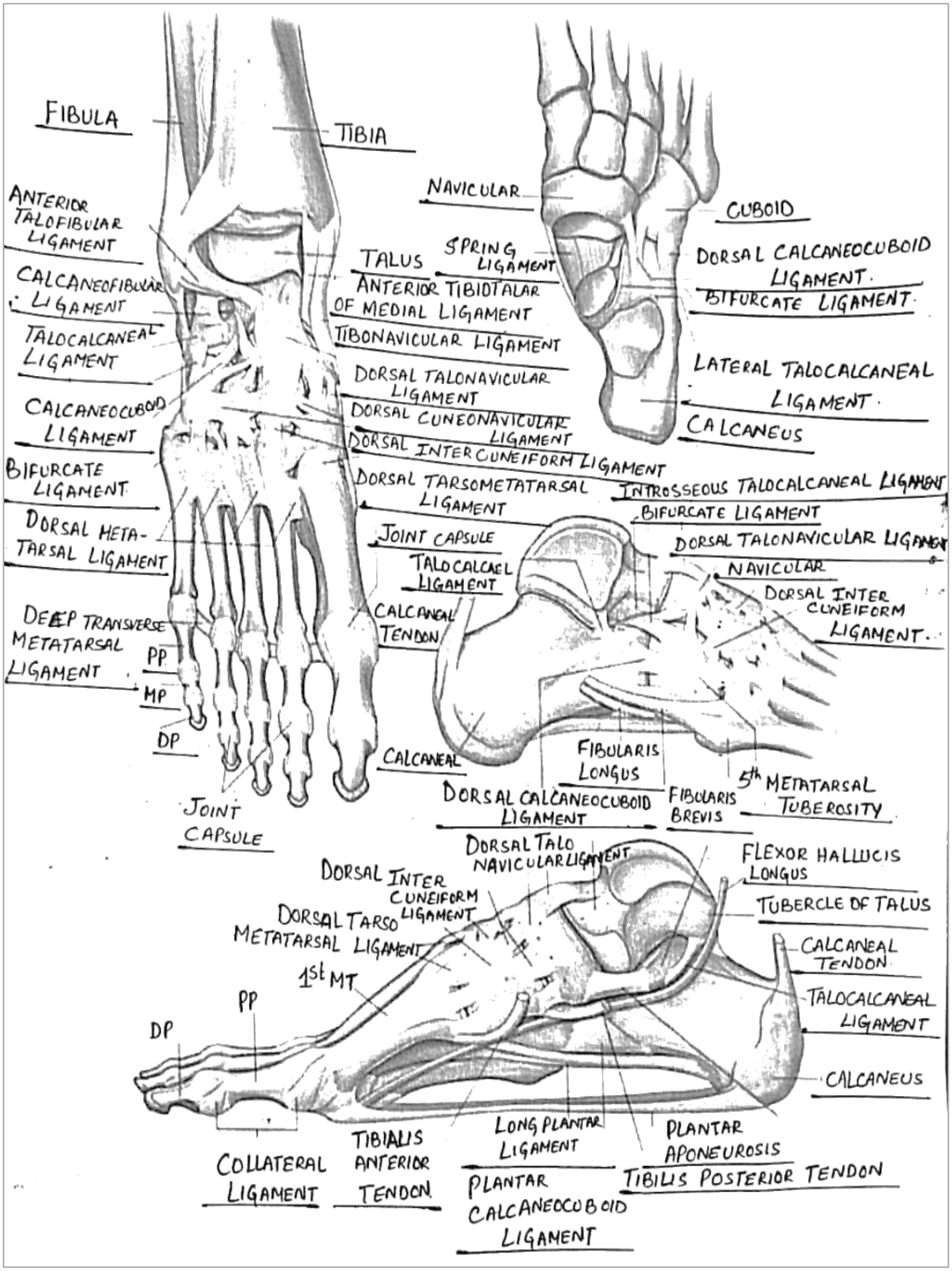


Figure 5 displaying ligaments of human foot and ankle

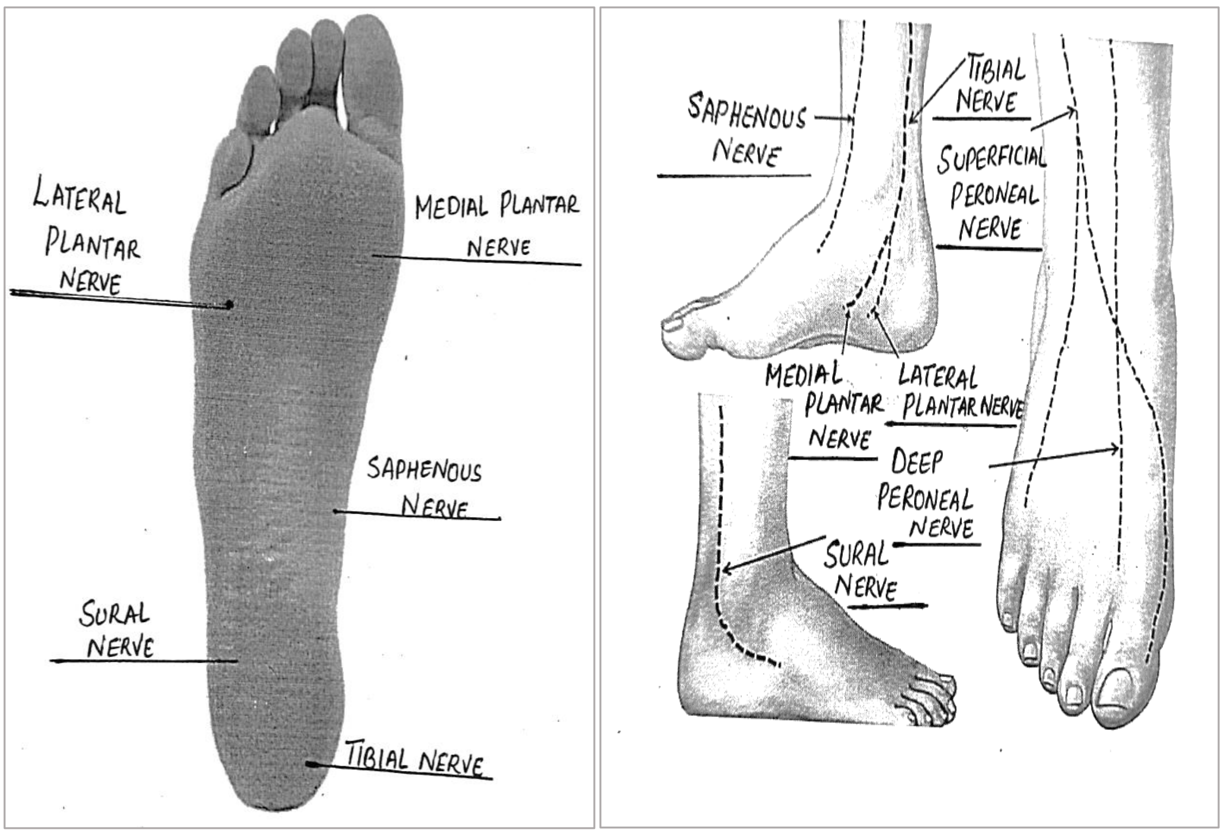


Figure 6 displaying the nerve supply of human foot and ankle

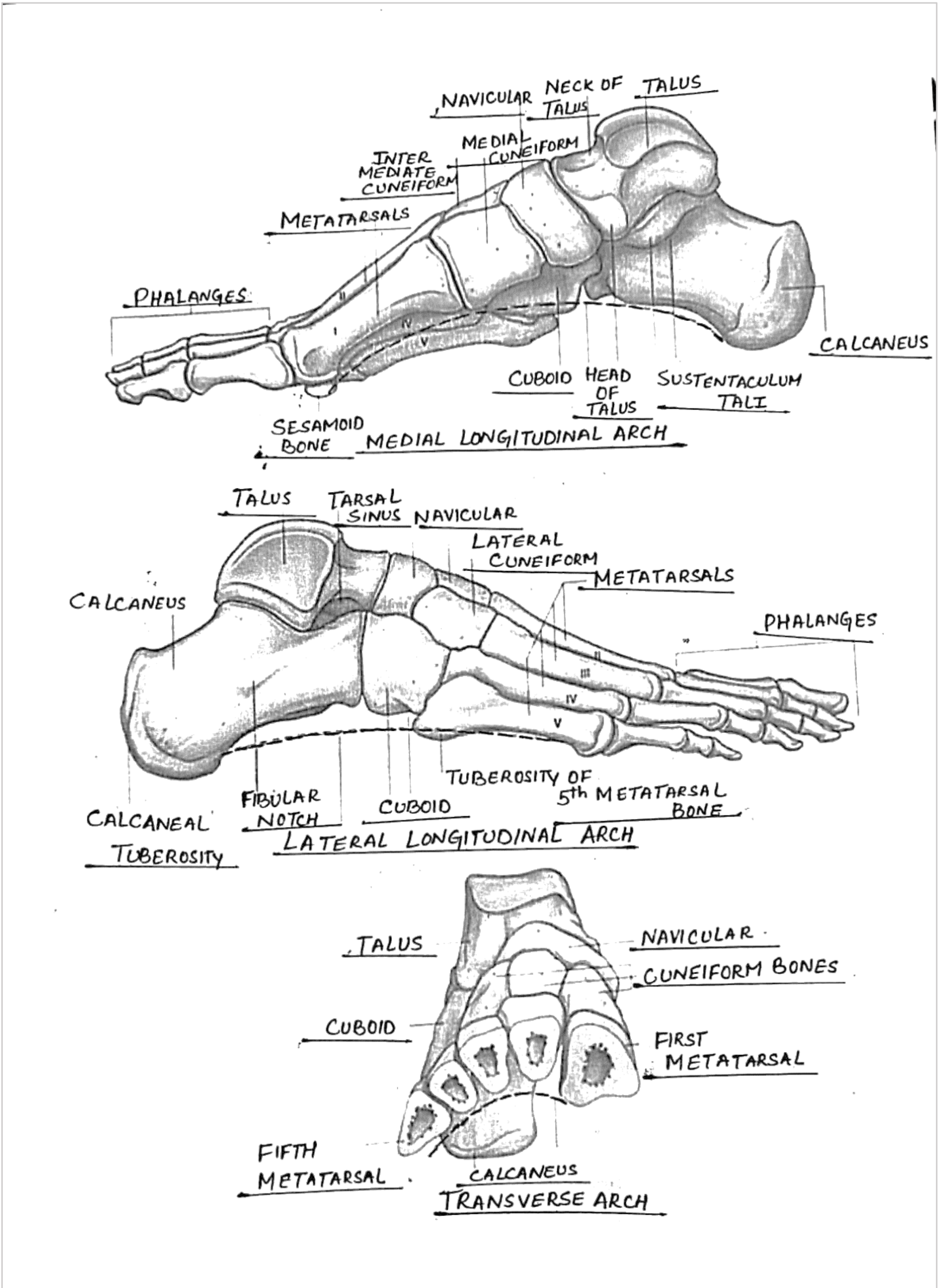


Figure 7 displaying three arches of human foot

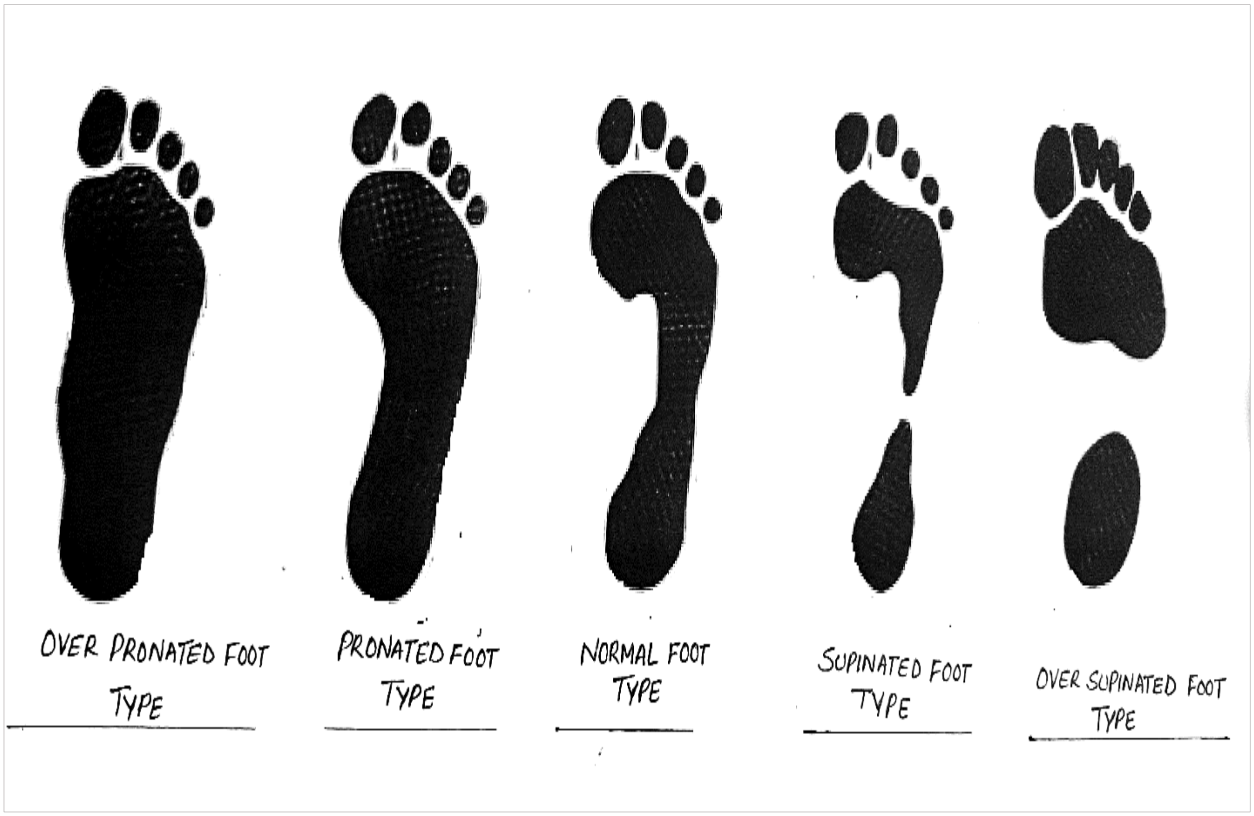


Figure 8 displaying the different foot types

1.3 Research Problem

Bhangra Dance is a dynamic and culturally significant dance form originating from the Punjab region of India. It is characterized by intricate footwork, rhythmic movements, and high-energy performances. Despite its widespread popularity and substantial physical demands, there is major lack of scientific research on the specific effects of Bhangra dancing on foot biomechanical characteristics and plantar pressure distribution. The complexity of Bhangra movements likely induces unique alterations in foot mechanics and pressure distribution, which remain inadequately understood. This dearth of evidence, limits our capacity to optimize dancer health, enhance performance, and devise effective injury prevention strategies.

Addressing this research gap is imperative for several reasons. Firstly, explaining the impact of Bhangra dancing on foot biomechanics can identify distinctive negative stressors and potential injury risk factors inherent to this dance form. Such understandings are critical for designing targeted training regimens that improve dancers' performance while justifying the risk of injuries associated with foot and lower limb stress.

Secondly, the findings can contribute to advancements in sports science and biomechanics by providing a deeper understanding of how much impact a repetitive movement can affect the foot structure and function. This knowledge is essential for designing customized footwear that better supports dancers and athletes engaged in similar high-intensity activities.

Ultimately, investigating the effects of Bhangra dancing on foot biomechanics and plantar pressure distribution will yield valuable data for developing comprehensive injury prevention strategies, refining dance training methodologies, and optimizing footwear design to meet the specific needs of dancers. By addressing this critical knowledge gap, the research aims to make significant contributions to both practical applications in dance and theoretical advancements in biomechanics and sports science.

1.4 Research significance

The significance of conducting this study is in its potential to bring about numerous benefits and contributions to both the scientific community and the Bhangra dance community. This research aims to expand the scientific understanding of how dance movements, particularly those in Bhangra, impact foot biomechanics. It will contribute to the broader field of biomechanics by providing insights into the effects of dynamic, culturally rich dance forms on the human body.

The outcomes of this research can be directly useful to enhance the training and technique of Bhangra dancers. By identifying specific biomechanical characteristics and pressure patterns associated with various dance movements, dance instructors can develop more effective training programs to improve dancers' skills and reduce the risk of injuries. Understanding how Bhangra dancing affects foot biomechanics and plantar pressure can lead to injury prevention strategies. Dancers can learn how to better protect their feet and lower limbs during practice and performances, ultimately promoting their long-term well-being.

Moreover, the study's insights can inform the design of specialized footwear for Bhangra dancers. Customized dance shoes can optimize comfort, support, and performance, addressing the unique demands of this dance form. By conducting scientific research on Bhangra, the study contributes to a deeper understanding and appreciation of this culturally significant dance form. It acknowledges and celebrates the rich cultural heritage of Bhangra while shedding light on its physical aspects.

This research transcends the boundaries of dance science and biomechanics, with the potential to influence sports science, sports medicine, and podiatry by offering insights into the biomechanics of specialized physical activities and their impact on the body. The study can promote the health and well-being of Bhangra dancers by raising awareness of potential foot-related issues and offering evidence-based solutions. Dancers can make informed decisions about their practice and performance routines.

Additionally, this study can serve as an educational resource for dancers, instructors, and researchers interested in the biomechanical aspects of dance. It can lay the foundation for future studies in this area, further advancing our understanding and appreciation of the interplay between dance, culture, and biomechanics.

1.5 Rationale

The rationale for conducting this study are as follows:

- **Cultural Significance and Popularity of Bhangra:** Bhangra is a vibrant and culturally significant dance form that has gained popularity worldwide. Understanding its impact on dancers' foot biomechanics and plantar pressure not only contributes to the scientific knowledge of dance physiology but also respects and celebrates the cultural heritage associated with Bhangra.
- **Dance Performance and Injury Prevention:** Dance performance, including Bhangra, heavily relies on the health and function of the feet. Investigating the biomechanical aspects of the feet can provide valuable insights for optimizing dance performance and reducing the risk of foot-related injuries among dancers.
- **Dance Training and Technique Enhancement:** The outcomes of this study can be applied to dance training plans. By identifying how specific dance movements affect foot biomechanics, instructors can tailor training regimens to enhance dancers' technique, agility, and overall performance.
- **Footwear Design:** Understanding the impact of Bhangra dancing on plantar pressure can inform the design of dance shoes and footwear specifically tailored for this dance form. Customized footwear can enhance comfort, stability, and injury prevention during Bhangra performances.
- **Sports Science and Biomechanics:** The study contributes to the broader field of sports science and biomechanics by exploring the impact of a specialized physical activity (dance) on the human body. The knowledge gained can be valuable not only for dancers but also for athletes in various sports who rely on foot movements.
- **Health and Well-being of Dancers:** Bhangra dancers often engage in intense and physically demanding performances. Understanding how their dance practice affects their foot biomechanics can lead to strategies for preserving foot health and overall well-being.
- **Gap in Existing Research:** There is a visible gap in the scientific literature about the biomechanical aspects of Bhangra dancing. By addressing this gap, the study contributes to the field of dance science.

1.6 Research Questions

- How do biomechanical characteristics of the feet in Bhangra Dancers differ from those of Non-dancers?
- How do different types of Bhangra dance movements, such as jumps, spins, and footwork, affect foot biomechanics and plantar pressure?
- How does Bhangra dance impact the arch structure of the foot and do Bhangra Dancers exhibit differences in foot alignment compared to non-dancers?
- Are there correlations between the duration of Bhangra dance practice and specific foot biomechanical characteristics or plantar pressure patterns?
- To what extent do Bhangra Dancers experience are related to their foot biomechanics and plantar pressure?

1.7 Research Objectives:

General Objectives

- To analyze the static biomechanical characteristics of foot in Bhangra dancers & Non-dancers.
- To analyze dynamic biomechanical features of foot in Bhangra dancers & Non-dancers.
- To analyze the plantar pressure in Bhangra dancers & Non-dancers.
- To compare Plantar pressure and Spatio-temporal variables of gait among the Bhangra dancers & Non-dancers.
- To compare prevalence of alteration in foot and ankle complex static biomechanical measures among the Bhangra dancers and Non-dancer's healthy individuals.

Specific Objectives

- To establish the co-relationship between static biomechanical measures of foot and ankle complex, Spatio-temporal gait parameters, plantar pressure, and injury patterns (frequency, size, and activity).

1.8 Research Hypothesis

Null-Hypothesis (Ho):

- There will not be significant difference in the static foot biomechanical characteristics between Bhangra dancers & Non-dancers with similar demographic characteristics.
- There will not be significant difference in the dynamic foot biomechanical characteristics between Bhangra dancers & Non-dancers with similar demographic characteristics.
- There will not be significant difference in the plantar pressure between Bhangra dancers & Non-dancers with similar demographic characteristics.

Alternate Hypothesis (Ha):

- There will be significant difference in the static foot biomechanical characteristics between Bhangra dancers & Non-dancers with similar demographic characteristics.
- There will be significant difference in the dynamic foot biomechanical characteristics between Bhangra dancers & Non-dancers with similar demographic characteristics.
- There will be significant difference in plantar pressure between Bhangra dancers & Non-dancers with similar demographic characteristics.

FLOWCHART OF RESEARCH

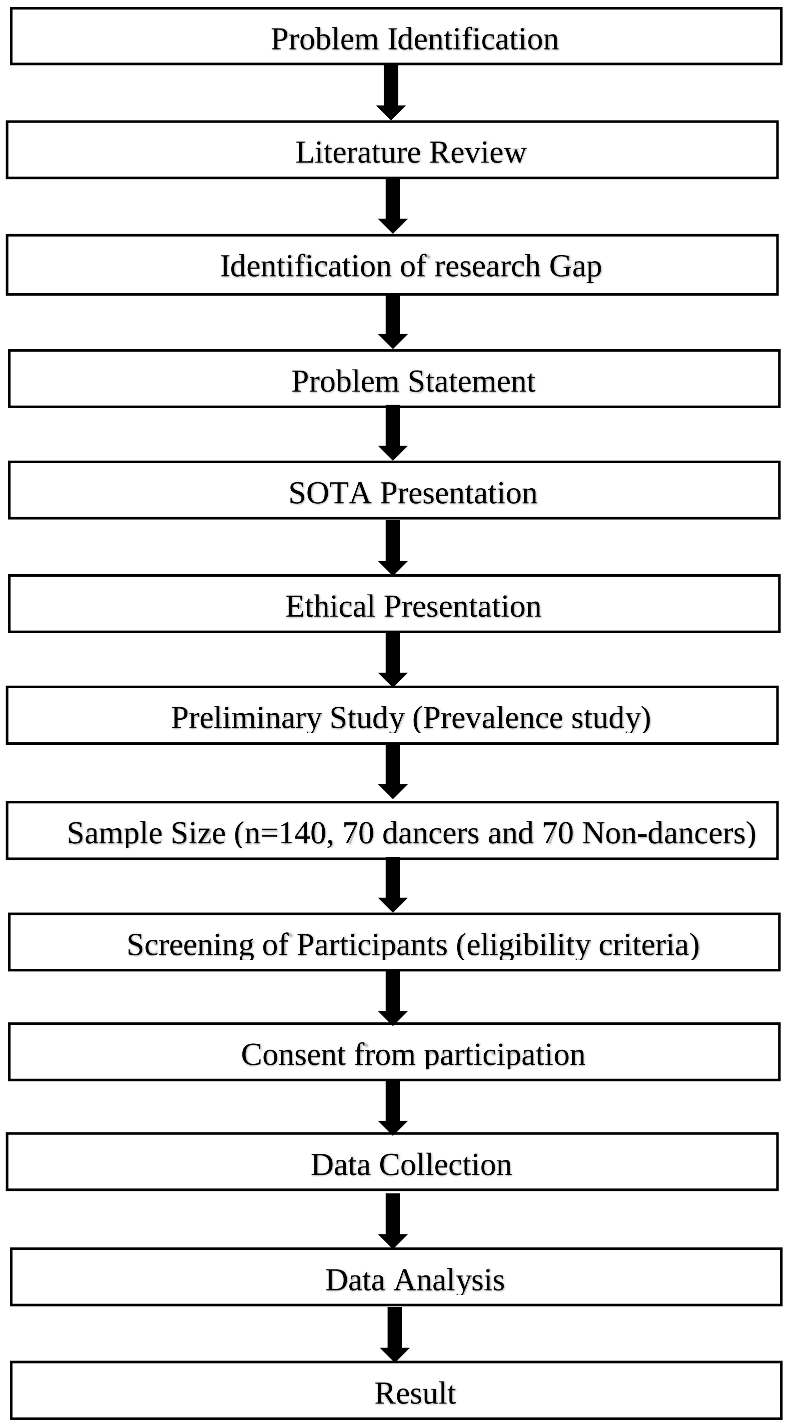


Figure 9 displaying the flow chart of study protocol

CHAPTER II

REVIEW OF LITERATURE

2.1 Overview

This chapter presents a comprehensive literature review focused on dancers, addressing the prevalence of injuries, biomechanical changes, ergonomic shifts due to excessive practice, assessment methods for biomechanical evaluation, and available treatment options. The review includes research studies published between 1980 and 2024, sourced from reputable databases such as Scopus, Web of Science, Medline, PubMed, Ingenta, and the Cochrane Library. Keywords used in the search included dance, dancers, foot, ankle, knee, hip, lower limb, musculoskeletal disorders, injury, biomechanics, kinetics, kinematics, risk factors, epidemiology, assessment, prevention, strength, power, and flexibility. Various keyword combinations and Boolean operators were used to refine the search, yielding 10,40,000 results. After screening, the most relevant studies were selected to form the basis of this literature review. Good quality with sufficient sample peer-reviewed articles published from 1980 to 2024 and involving dancers across various dance forms additionally those addressing biomechanical changes, injury prevalence, and musculoskeletal issues were included for literature review and others were excluded. This process ensures the review focuses on high-quality, relevant research that provides valuable insights into health, performance, and injury prevention strategies for dancers.

This chapter is divided into several sections:

2.2 Review on association of work and musculoskeletal disorders.

2.3 Review on the prevalence rate of injury among the dancers of different dance forms.

2.4 Review on risk factors responsible for causing the injuries in the dancers of different dance forms.

2.5 Review on the most common part injured among the dancers of different dance forms.

2.6 Review on the changes in the static and dynamic foot biomechanical characteristics in dancers of different dance forms.

2.7 Review on the changes in the gait variables in the dancers of different dance forms.

2.8 Review on the association of different biomechanical characteristics in dancers.

2.9 Review on the overview of dance medicine and the assessment methods used to identify the changes.

2.10 Review on the reliability & validity of assessment methods and tools used in our study.

2.2 Review on association of work and musculoskeletal disorders

The nature of the dance requires repetitive movement, and several research support the fact that repetitive movement leads to musculoskeletal disorder (MSD) and if the MSD is due to work then it is considered a work related musculoskeletal disorder (WMSD). There is a strong evidential support to the fact that there is a significant relationship between occupation and musculoskeletal disorder. A survey was conducted to explore the link between the ergonomic & psychosocial work hazards and risks of musculoskeletal disorders in definite body parts across the different occupations. The study was conducted in Taiwan among the general employees involving 8,937 males and 7,052 females aged between 20-65 years. It found that neck and shoulder issues were more common among professional and skilled workers, while back region, hands, & wrist issues were prevalent among manual workers. The study concluded that the different types of work-related hazards have the risk of different types of MSD and These findings underscore the need for tailored health prevention programs addressing both ergonomic and psychosocial factors to mitigate the risk of MSDs across different occupational groups, enhancing occupational health strategies comprehensively (53). There is association between work-related hazards and the risk of various types of musculoskeletal disorders (MSDs) and it is significant area of concern in occupational health and safety. Several work-related factors can be contributor for the development of MSDs in different parts of body. A review aimed at examining the work related musculoskeletal disorders (WRMSDs) and its associated risk factors. This study was conducted among professional drivers to find the relationship between the two components. The results findings revealed strong evidence of link between awkward postures, lifting tasks, manual material handling, stress due to, demands and expectations of job demand, and agony due to work. The review suggested the need of targeted interventions to address WRMSDs (54).

Another study supported the fact that same thing doing repeatedly leads to adaptation and this leads to injury, this study was conducted in Chinese electronics manufacturing factories with the aim to understand musculoskeletal disorders among workers and their connection to work-related factors. The research, found that 40.6% of workers experienced musculoskeletal issues in the past year, with common problems in the shoulders, upper, and lower back region. Factors like awkward posture, lifting heavy weights, repetitive tasks, prolonged sitting, monotonous work, and exposure to cold increased the risk of these disorders. Female workers and those with more than 5 years of job tenure were more susceptible. Additionally, vibrations led to increased pain in the upper back, wrist/hand, and elbow. Surprisingly, regular physical exercise appeared protective against most musculoskeletal disorders, except for some areas like the upper back, leg, and knee. The study suggests tailored preventive measures addressing these issues, emphasizing ergonomic training, posture improvement, reducing prolonged sitting, and encouraging physical activity in the workplace among electronics manufacturing workers in China (55).

A longitudinal study conducted with the time frame of fifteen years with the aim to investigate the work related musculoskeletal injuries among professional dancers. This research investigated the prevalence, injury rate, severity, mechanism. The key findings of this study revealed that the female dancers were fifteen times more likely to have bone injury than the male dancers, while male dancers were experienced eight to fifteen times more laceration and contusion injuries than female dancers. The study also addressed that there was time loss and absentee from the work places due to injury as well dancers miss their performances. The findings suggested that the cause of the injury was associated with the actions such as repetitive movements, jumping, stomping or revolving (56).

2.3 Review on prevalence rate of injury among the dancers of different dance forms

This section discusses about the injury rate among dancers. It has been already proven in the literature that dancers are prone for injuries. The dancing is a physical demanding activity which poses a risk of musculoskeletal injuries among dancers therefore the injury prevalence among dancers is significantly high and it is of concern among the dancing community. The rate of injuries among dancers of different forms varies based on dance style, intensity, and individual factors. Due to the physical demand dancers often injured themselves and injury can be acute or chronic. The acute or traumatic injuries are basically resultant of high jumping, stomping but the chronic injuries or overuse injuries are due to incorrect posture, techniques, lack of warm-up & cool-down, environmental factors or individual factors. An umbrella research was recently conducted on the injury epidemiology among the ballet dancers and artistic dancers. This review assessed 12 systematic reviews and found that the rate of injury ranging from 26-84 percent in artistic dancers and 42-34.3 percent in the ballet dancers. The incidence was below 5/1000 dance hours for both the groups, mainly affecting the lower extremities & the lower back (57). Similar review aimed to conclude the prevalence, incidence, and pattern of injury and risk factors was conducted among Irish dancers. Eleven studies were included in this review, estimating prevalence of injuries range from 72.2- 92.6 percent, with the foot & ankle being the most commonly affected area. Incidence, on the other hand, was only reported varied between 3.4 and 10.6 injuries per 1000 hours of dance. The risk factors identified were year of dancing, poor sleep, psychological stress due to competition (58). Another study provided valuable insights into pain & injury incidence among elite adolescent Irish dancers, as well as the associated biopsychosocial risk factors. The study involved 37 championship-level dancers who provided data on pain, injury, dancing sessions, practice time, general health, sleeping habits, eating habits, and psychological factors. Baseline physical screenings assessed endurance, fitness, flexibility, balance & functional movement. The analysis revealed that 84% of dancers experienced pain or injury, with the lower limbs, especially the foot & ankle, being the most commonly affected areas. Key factors associated with pain and injury included having multiple troublesome body parts, dancing while in pain, and high levels of anger. The study suggests that the high risk of pain or injury in elite adolescent Irish dance may be due to factors such as inadequate technique progression, unique choreography, and a demanding competition schedule (59). A similar prevalence study was conducted among the Chinese dancers. In this study a total of 293 participants shared their own dance-injury incidences, revealing that young dancers (aged 15-24 years) exhibited a significantly higher injury-rate and 12 months' prevalence compared to their younger dancers (aged 10-14 years). The knee, lower back, and ankles were identified as most commonly injured regions. The findings underscore the vulnerability of young Chinese dance practitioners to dance related injuries(60). Another study conducted among the Chinese pre-professional dancers using self-reporting injury monitoring tool. The results of this study indicated injury incidences of 64.9% with the incidence of 5.51 injuries per 1000 hours. The main injury regions were knees, lower back, feet, & groin (61). A survey was conducted among 110 individuals who engage in dancing as a profession or as a recreational activity. The findings revealed the prevalence of musculoskeletal injuries among dancers is notably high. Specifically, professional dancers were found to have a significant incidence of ankle sprains, accounting for 69.8% of their reported injuries. These ankle sprains were primarily attributed to the execution of pirouettes, which constituted 67.9% of the reported cases (62). On the other hand, non-professional dancers reported a lower percentage of ankle sprains, specifically 42.1%, with the main cause being repetitive movements, accounting for 28.1% of the cases. Gender differences were observed in the study, with women experiencing a higher proportion of ankle sprains, reaching 90%, while men reported a lower percentage of muscle sprains, amounting to 54.5%. It is worth noting that both genders frequently encountered injuries related to the ankle joint, with women accounting for 67.6% of such cases and men representing 40.9%. By identifying the mechanisms underlying these injuries and considering the duration of dance practice, valuable insights can be gained that may contribute to development of more effective therapeutic interventions aimed at improving well-being and performance of dancers (63). Another survey was conducted to assess the occurrence of injuries in traditional dancers in Sri Lanka, with a specific focus on university undergraduates. The research encompassed a total of 293 participants from four local universities, and the findings unveiled an injury rate of 64.84%, with the male population exhibiting the highest rate at 36.87%. Kandyan dancing was the most prevalent form of dance, accounting for 45.1% of the participants, and reported the maximum number of injuries, Surprisingly, only 10.6% of the participants sought physiotherapy following their injuries. This study sheds light on the significant prevalence of dancing-related injuries within the Sri Lankan traditional dance community (64).

This research endeavours to examine the occurrence of musculoskeletal pain and injuries in Indian dancers of Mumbai & Mangalore, specifically focusing on comparing pain tolerance between dancers and individuals who do not engage in dance. A total of fifty-one traditional and western dancers, as well as 164 recreational dancers, took part in this study. To assess dance-related pain and injury profiles, an indigenous questionnaire, which had been validated by physical therapists and dancers, was utilized. The results revealed that the most prevalent sites of pain were back (42.5%), knee (28.3%), & ankle (18.6%). Furthermore, stress was identified as the primary perceived cause of pain, accounting for 34.4% of cases. It was found that 43.30% of dancers consistently engaged in warm-up exercises, while only 20% stretched after dancing. Interestingly, no significant difference in pain sensitivity between dancers & non-dancers ($p = 0.159$), and this remained unaffected by the level of training or gender (65). This study explores the prevalence of injuries in Bharatanatyam dancers in Udupi district of India. Among 101 surveyed dancers, 10.8% reported injuries, with 0.65 injuries/1,000 hours of dancing. Ankle (27.2%) and knee (27.2%) were common injury sites, and 36.4% continued to dance despite injuries. Over half sought medical help. The study highlights a vulnerability to lower extremity and back injuries, particularly on hard surfaces. Further investigation into impact of training factors on injury occurrence is recommended (66). The prevalence of ankle instability among thirty-six Kathak dancers aged 18-35 in Jalgaon district was estimated by using Functional Ankle Instability scale. Results showed that 58.33% of

Kathak dancers exhibited functional ankle instability. The study emphasizes the importance of educating dancers, instructors, and medical staff about identifying and addressing ankle instability early on, potentially reducing the incidence of ankle sprains and the development of functional instability over time (67).

2.4 Review on risk factors responsible for causing the injuries in the dancers of different dance forms

Dance is a sport and requires lot of high intensity and long hours of practice sessions, involving repetition of similar type of movement and this cause constant stress on particular part of the body. Leading to overuse injuries among dancers. There are several other reasons or risk factors identified that leads to injury among dancers. The risk factors have been categorised into intrinsic and extrinsic factors, supported by a literature conducted among young dancers between age group of 8-16 years to find association of internal and external components with the injury rate in these dancers. Total of 1336 dancers participated and the risk factors included for the study were range of motion, structure, technique, discipline. In this study total of 61 different types of injuries were identified, which includes knee injuries, foot or ankle injuries, back injuries and others. The result revealed positive association between the factors included and the injury incidence, therefore the study concluded not to overlook the dancer's injuries precautions should be taken to avoid such circumstances in the future. This study advised to implement screening of kinematics and anatomical structures as well supported the fact to use the proper techniques with time controlled practice sessions (68). This is further supported by a review stating overuse as the common risk factors for low back pain among dancers. Literature review of articles published in last ten years between 2002-2023 involving every dance form, inclusion of 15-40-year age group was done. The result concluded that in kathak back pain is mainly due to pronated barefoot stamping, in Bharatanatyam and ballet dancers the posture adapted cause tightening of back extensors and shortening of hamstring muscles and results in back pain. The study suggests to implement rehabilitation programs at earliest in the daily regime (69). An open ended online survey was conducted among the nineteen ballet dancers of Australia age ranging from 12-19 with the purpose of knowing the perspectives and experience of dancers concerning dance related injuries. The dancers revealed a pattern of pain and multiple injuries, often concealed or ignored due to fear. The dancers were keenly aware of the profound physical and psycho-social impact of these injuries on themselves and their peers. Risk factors and injury prevention strategies emerged from their narratives, highlighting the need for proactive measures. Notably, the dancers expressed reservations about the effectiveness and in formativeness of available treatments. The study concludes that while adolescent ballet dancers grapple with various injuries, there exists a necessity for support mechanisms to encourage injury disclosure, active participation in prevention strategies, and facilitated access to treatment. The recommendations underscore the importance of increased understanding by health professionals regarding ballet-specific concerns and advocate for enhanced education for dance teachers to better support their students. The call for clinical trials seeks to validate proposed injury risks and assess the efficacy of prevention strategies and treatments, providing a roadmap for future research and improved care in the realm of adolescent ballet (70). A study highlights the prevalent issue of the musculoskeletal injuries among modern & contemporary dancers. The investigation involved a comprehensive review of 18 prospective studies. The overall injury rate in modern and contemporary dancers was determined to be 0.82 (95%CI: 0.74~0.90). The study categorized injuries based on trauma, overuse, anatomical location ("ankle & foot, lower extremity, joint and ligaments, muscle and tendons"), and time-loss. Notably, lower limb injuries, particularly to foot and ankle, was the most common part to get injury. The majority of injuries resulted from overuse mechanisms, predominantly affecting muscle tendons and joint ligaments. The study found no significant differences in injury prevalence related to sex, age, or education program, but identified Body mass index and history of injury as statistically significant risk factors for injuries in dancers. In conclusion, the findings underscore the substantial prevalence of musculoskeletal injuries in this dance genre, emphasizing the importance of understanding risk factors such as BMI and injury history for effective injury prevention strategies (71). In the realm of pre-professional ballet, where lower extremity injuries are a prevalent concern during jumping and landing activities, a cohort study was conducted regarding the potential injury risk in adolescent dancers. 255 participants were included and these were evaluated for double leg countermovement jump (DL-CMJ) & single leg jump (SLJ) on force plates. Visible asymmetries in the eccentric, concentric, and landing phases of DL-CMJ, as well as left limb–dominant jump height asymmetry in SLJ, were associated with a significant rise in injury risk. Sex-specific differences were observed, with DL-CMJ asymmetries not significant for boys but linked to increased injury risk for girls. The findings suggest that higher asymmetries, particularly in the take-off phase and involving a left limb dominance, may signify a relative right limb deficit, thus elevating the risk of injuries in elite pre-professional ballet dancers. This study underscores the importance of understanding asymmetry in kinetic variables as a potential predictor of injury risk in the ballet domain, with nuanced differences between male and female dancers (72).

2.5 Review on the most common part injured among the dancers of different dance forms

Dancers employ their bodies as instruments to convey emotions, stories, and cultural expressions. The intricate choreography and demanding routines, however, expose them to an inherent risk of musculoskeletal injuries. These injuries, stemming from overuse, repetitive movements, or sudden strain, often manifest in specific areas of the body. The intensity of training and performance schedules is a major contributing factor to these injuries. The lower extremities emerge as most common site of injury among dancers. Whether in the graceful pirouettes of ballet or the rhythmic footwork of various cultural dance forms, the legs, knees, and ankles bear the brunt of the physical stress. The repetitive nature of jumps, spins, and complex footwork contributes to the vulnerability of these areas. Dancers experience high ankle injury rates due to the repetitive nature of dance movements predisposes classical ballet dancers to potential musculoskeletal stresses in the ankle. Incidence of ankle injuries varies between 4.7% and 54% among dancers. The ankle serves as the connection between the leg and the foot, establishing lower extremity stability. Proper training, conditioning, and awareness are vital for ankle health. Understanding ankle anatomy and biomechanics is essential for dancers’ performance and injury prevention (73). A study reviewed musculoskeletal injuries in Indian classical dancers and the finding revealed that lower back and lower extremities are commonly affected. In Bharatanatyam, back injuries were predominant around 42.5 %, followed by knee region (28.30 %) and then ankle (18.64%). Kathak dancers experienced 47 % back injuries, 16 % knee injuries, and 20% ankle injuries. Overall, 80% of injuries were low back pain. The study acknowledged challenges in pinpointing injury causes, identifying Bharatanatyam as the most prevalent modality (74).

Tolarsky's findings indicate that 60 to 80 percent of dance-related injuries involve lower limb and among all ankle & foot injuries being more prevalent. Micheli's study on ballet injuries found that 24.1% involved the foot or ankle, while Milan reported that 13 to 15 percent of ballet injuries were due to foot issues. In a cross-sectional retrospective analysis by Noon et al. (2010) involving 69 female Irish dancers aged 8 to 23 years, 217 injuries were documented. The most frequent injuries included stress fractures (29.9%), patellofemoral pain syndrome (11.1%), severe conditions (6.0%), ankle sprains (5.1%), posterior tibialis tendonitis (4.6%), and plantar fasciitis

(4.6%). Lower extremity injuries were predominant, with the remaining injuries occurring in the lumbosacral spine and pelvis. Additionally, 79.7% of dancers reported multiple injuries, and injury frequency increased with proficiency level, while the average age of dancers decreased as proficiency level rose (75).

2.6 Review on the changes in the static and dynamic foot biomechanical characteristics in dancers of different dance forms

Dancers are at high risk of overuse injury because of repetitive movements causing change in the normal mechanics as a compensatory adaptation but this put them more under risk of injury, supported by the study conducted in three groups one group was of dancers having average experience of thirteen years, second group including dance students with 0.3 year of dancing experience and the third group purely of non-dancers with no dancing experience and on comparison the kinematic characters the findings showed, there was substantial difference between the groups, dancers had minimum knee & hip angles as compared to students and non-dancers. The ankle angle were not significant but on comparing knee angular velocities dancers demonstrated greater knee angular velocity as compared to students and non-dancers so the results suggested that training of professional dancers may had influence on mechanics of dancers (76). A similar study was with the aim to explore the performance ballet dancers compared to non-dancers was conducted. This study investigates mechanics of lower limb landings and the associated risk of injury. The main findings are the dancers demonstrated greater range of motion in sagittal plane during landing and it was accompanied by increased motion in coronal and frontal plane. This combination may elevate the risk of injury among dancers so the study suggested that even though there is greater flexibility among the dancers but dancers should be cautious of the potential impact on their lower limbs during landings. The study suggested, it is crucial to consider the overall biomechanics to ensure their safety and well-being. The study underscores the significance of understanding these kinematic differences, given the elevated prevalence of lower extremity overuse injuries among adolescent ballet dancers (77). Another study explores the subtle interplay between plantar sensory feedback, Range of motion of joints, and balance in female ballet dancers as compared to non-dancers. This cross-sectional study researched on 11 ballet dancers and 10 non-dancers, reveals intriguing findings. ballet dancers exhibit an inferior cutaneous threshold for the fifth metatarsal head, suggesting a localized difference in plantar sensitivity. Additionally, ballet dancers showcase superior joint ROM and dynamic balance, as evidenced by significantly higher scores in the Y-Balance test. Non-dancing athletes demonstrate heightened correlations between plantar sensitivity and dynamic balance for specific foot regions, emphasizing the importance of plantar sensation in maintaining equilibrium. Furthermore, certain joint movements exhibit stronger associations between ROM and dynamic balance in non-dancing athletes. The finding revealed that dancers and non-dancers exhibit difference in range of motion, plantar sensation, balance so this results in compromising situation resulting in high prevalence rate of injury among dances as compared to non-dancers (78). Dancers' extensive training and extreme ankle postures increase their susceptibility to ankle sprains. A study using ground reaction force (GRF) and center of pressure (CoP) measurements found that dancers exhibited greater medial shear force, reduced velocity in pre-swing phase, delayed peak velocity during mid-stance, & straight trajectory at push-off compared to non-dancers. These alterations in gait patterns suggest a higher risk of ankle sprains due to the demanding nature of dancing. (79). Another study comparing unipedal balance between professional ballet dancers and non-dancers found that dancers had smaller postural sway parameters after completing ten 360° turns, indicating better balance in this condition. However, dancers showed higher center of pressure (CoP) velocities with eyes closed compared to other conditions, and overall, the results did not support the notion that ballet dancers possess superior general balance abilities compared to untrained individuals (80). Another study with the objective to test dynamic balance in Thai classical dancers. The research involved 25 Thai classical dancers & 25 non-dancers who underwent the modified Sensory Organization Test. The results indicated that Thai classical dancers consistently achieved higher equilibrium scores in all balance testing conditions. In conclusion, Thai classical dancers exhibited superior postural stability during various challenging postural tests, emphasizing their enhanced ability to maintain balance under diverse conditions (81). Other than the ankle, low back region is also an area for concern among dancers as the high prevalence rate, a cross-sectional study aimed to comparing stability of lumbopelvic in dancers. The findings indicated substantial differences in stability between two groups, and dynamic balance. In conclusion, dancers demonstrated superior lumbo-pelvic motor control, dynamic stability, and lumbar movements, excluding extension, compared to non-dancers. These findings suggest potential implications for sports performance, injury prevention, and rehabilitation for attaining overall physical well-being of dancers (82). In an observational research changes in ankle dorsiflexion, FPI, and pronation was compared between flamenco dancers &non- dancers. the results determined substantial difference between the two groups. The study suggests to induce the modification as a preventive measure in dancers to prevent risk of injuries in the foot & lower limb (83).

The foot and ankle region of a dancer is notably susceptible to injuries. This study aims to investigate potential deviations in the foot posture of Kathak dancers. Utilizing the foot posture index as a clinical diagnostic tool, we quantified the static posture of the foot. The research involved 100 healthy young Kathak dancers meeting specific inclusion criteria from various dance schools in Delhi. Assessment of foot posture included the foot posture index, navicular drop, and arch index. The results revealed that 3% exhibited a supinated foot, 7% had a normal foot, 25% displayed a pronated foot, and 65% had an excessively pronated foot. Additionally, 5% showed a cavus foot, while 78% had a planus foot. Notably, the study concludes that Kathak dancers commonly exhibit a pronated foot posture, suggesting a potential predisposition to foot, knee, and back-related issues (84). The subjects underwent assessments for deviations in foot posture using the FPI, MLAA, ND, Rearfoot angle, and Forefoot angle. The results indicated that approximately 92.5% of Kathak dancers exhibited pronated feet, with the majority showing an increase in Rear-foot angle (approximately 90%), Forefoot angle (approximately 75%), and Navicular drop (approximately 97%), along with a decrease in Medial Longitudinal Arch angle (approximately 95%). In conclusion, the study suggests that over time, Kathak dancers tend to develop postural deviations in their feet, particularly hyperpronation. If left untreated, these changes may lead to degenerative alterations in the foot and ankle, resulting in instability and increased susceptibility to foot and ankle injuries, as well as shin pain (85). Kathak, a classical dance form originating from North India, demands intricate footwork and rapid turns, exposing dancers to a heightened risk of foot injuries. Another study supporting the deviation in foot characteristics was focused on evaluating foot deviations, associated injuries, and their impact on functional activity among Kathak dancers. This study had the objective of raising awareness about foot positioning as a risk factor for injuries. The research involved 100 subjects selected based on specific criteria, and various measures, including foot posture and function indexes, were employed. Results indicated that the mean FPI for both left & right feet was within the normal range, suggesting no significant deviations in foot positioning during Kathak performances. However, the overall foot functional index score revealed a mean and standard deviation of 9.76 and 10.39, respectively. This suggests that while foot posture remained normal, dancers experienced severe pain that significantly restricted their activity patterns and impeded their dance performance. In conclusion, the study emphasizes the importance of addressing foot function and pain management among Kathak dancers to enhance their overall performance and prevent injuries associated with the rigorous footwork and turns inherent in this classical dance form (86). Ankle and foot issues extend beyond the general population to impact dancers and athletes, with Bharatanatyam, an ancient classical dance in India, being no exception. This study involved 50 female Bharatanatyam dancers and utilized plantar scan images to analyze foot arches, while FPI scale was employed to assess ankle and foot deviations. AutoCAD 2010 software was used to measure parameters such as Staheli index, Chippaux index, Clarke's angle, and Arch index from PSI. The findings revealed a significant trend, with 70% of Bharatanatyam dancers exhibiting flattened arches, 20% displaying high arches, and accompanying ankle and foot deviations. The repetitive loading on the ankle & foot during practice session, initiated from a young age increase stress on foot arches leading to flattened arches and subsequent pronation and supination. Additionally, body mass index and physical activity were identified as influential factors in ankle & foot issues. Sedentary dancers exhibited a higher prevalence of flat foot arches and pronated feet. The study suggests that regular diagnosis and assessment, appropriate warmup and stretching, footwear modifications, are essential measures to mitigate and prevent ankle and foot deformities in dancers (87). Another study added to the evidence by exploring the relationship between FPI & ROM of rear foot angle and forefoot angle (FFA) in experienced Odissi dancers. Fifty-four professional female Odissi dancers. The results indicated a significant positive correlation between FPI and FFA, as well as FPI and rear foot angle. Additionally, a positive correlation was observed between rear foot angle and FFA. This understanding contributes valuable insights into the nuanced dynamics of foot positioning in the context of Odissi dance (88). Postural control demands attention to maintain balance, and even minor biomechanical alterations can disrupt whole intricate process. A study focused on evaluating static and dynamic balance of the contemporary dancers with altered foot posture. The methodology involved assessing altered foot posture by using Navicular drop test, followed by evaluating static & dynamic balance by using flamingo balance test star excursion balance test. Results revealed that among the participants, 21 had a pronated foot, 8 had a neutral foot, and 1 had a supinated foot. A robust correlation was observed between foot posture and static balance. SEBT analysis demonstrated that the balance was affected differently in various directions for dancers with different foot alterations. Specifically, dancers with a supinated foot showed changes in anterior and antero-medial directions, while those with a pronated foot displayed in posterior, postero-lateral, and lateral directions. In conclusion, the study suggests that contemporary dancers, particularly those with a pronated foot, are more susceptible to balance challenges, implying a higher risk of future injuries (89).

2.7 Review on the changes in the gait variables in dancers of different dance forms

Dance is a highly demanding physical activity that significantly affects the musculoskeletal system. Different dance forms, with their unique movement techniques and postures, can lead to specific adaptations in gait patterns among dancers. Understanding these adaptations is crucial for injury prevention and enhancing the performance and health of dancers. This review synthesizes findings from various studies examining changes in gait variables among dancers of different dance forms. A study comparing the gait patterns of dance students and non-dancers found significant differences. These altered gait characteristics, influenced by intense dance activities, may increase the risk of ankle sprains (90). Another research comparing plantar pressure during the stance phase of gait between ballet dancers & non-dancers revealed higher pressure peaks in the medial edge of the forefoot for dancers. Additionally, dancers showed higher total foot loading and longer foot loading duration in the rear-foot. These differences are attributed to the long-term, intensive training routines of professional dancers, which alter their gait patterns (91). Specific movement and compensatory strategies in dancing alter the relationships between lower limb segments during walking. The female dancers exhibited larger knee flexion in the swing phase and greater hip abduction in the pre-swing phase compared to controls. Male dancers showed larger dorsiflexion in the final stance and a greater range of motion in total pelvic tilt, this was revealed in a study which assessed kinematics of lower extremity and pelvis in professional ballet dancers during normal walking (92). An investigation into the gait patterns of non-professional dancers who practiced dance for many years found no significant differences in most gait variables compared to non-dancers, except for the double support phase and step width. However, notable variations were observed in pelvic tilt, ankle dorsiflexion, knee internal rotation, and foot progression, suggesting compensatory mechanisms developed from long-term dance practice (93). Bharatanatyam dancers performs complex poses, exhibit distinct gait kinematics associated with a high prevalence of low-back pain. This was revealed in a study conducted among Bharatanatyam dancers with low-back pain. Dancers showed greater spine extension, anterior pelvic tilt, and lesser pelvic rotation compared to those without pain. These kinematic changes highlight the need for targeted exercise programs to neutralize excess deviations at the pelvis and spine, potentially reducing pain and improving strength (94). Another study added to the evidence of changes in gait variables in dancers using electromyography (EMG) to examine muscle activation during gait in dancers found and no significant differences in muscle activation patterns compared to existing studies. The activation peaks occurred at similar points in the gait cycle, indicating that muscle activation in these dancers is not markedly different from normal patterns, despite slight variations in gait (95). Research on China Classic Dancers revealed significant differences in plantar pressure distribution compared to non-dancers. Dancers exhibited lower maximum forces and peak pressures in most regions, with notable load transfers from the lateral forefoot, mid-foot, and heel to the medial forefoot. These findings suggest distinct gait patterns, necessitating further research in sports biomechanics and injury prevention. The review highlights the significant impact of various dance forms on gait variables, revealing unique adaptations and compensatory mechanisms in dancers (75).

2.8 Review on the association of different biomechanical characteristics in dancers

Dancers often face overuse injuries due to repetitive actions, and alterations in foot posture can exacerbate this risk. Variations such as overpronation or supination may disrupt the biomechanical chain, impacting lower extremity alignment and increasing susceptibility to injuries in the ankles, knees, and hips. Furthermore, changes in foot posture affect plantar pressure distribution, potentially leading to conditions like plantar fasciitis or metatarsal stress fractures. The biomechanical consequences of altered foot posture during weight-bearing activities play a pivotal role in injury development. Recognizing individual variability in foot structure is crucial, and a multidisciplinary approach involving physiotherapists, podiatrists, and dance instructors is essential. Implementing targeted exercises, orthotics, and appropriate footwear can mitigate the impact of foot posture on injury risk, fostering a comprehensive strategy for injury prevention in the unique context of dance. A study conducted to compare the foot characteristics in Bharatanatyam dancer’s minimum of 8 years of experience. Results indicated that dancers exhibited a lower medial longitudinal arch height, wider mid-foot, and wider forefoot, suggesting an over-pronated foot during walking. Moreover, dancers showed a 37% increase in total plantar peak pressure, with 24% higher pressure on the mid-foot and 13% higher on the forefoot. These findings underscore the greater plantar loading and over-pronation during walking, providing insights into the prevalent ankle and foot pain among dancers. The study offering valuable information on foot function and guiding strategies for the prevention and management of foot pain (62). A study investigates the relationship between angle of turnout, foot posture, and lower-limb musculoskeletal injuries in twelve professional contemporary dancers by using Foot Posture Index, researchers found a tendency toward pronated foot posture in the turnout position. Significant correlations were observed between the FPI and angle of turnout and between reported injuries and changes in foot posture during turnout for the right. All dancers had a history of spine or lower limb injuries, with nine reporting injuries in the past year. The study suggests that turnout may lead to pronation and is linked to increased lower-limb injury risk (96).

2.9 Review on the overview of dance medicine and the assessment methods used to identify the changes

Dance is a beautiful form of expression that transcends cultural boundaries. It's an art that allows individuals to communicate emotions, stories, and ideas through movement and rhythm. There are various styles of dance across the world, each with its unique techniques, music, and cultural significance. Dance is not about physical movements alone, it also helps in conveys feelings and forming the association and connectivity between the audience. The diversity in the dance reflects the richness of the human creativity. There are different forms of dances from traditional dance forms to modern hip-hop and contemporary. Dance is not confined or bounded to the stage it can be social and physical activity or used as a form of therapy. It promotes physical and mental fitness both, boosts confidence, helps in forming bonds.

The person who possess this unique ability to express themselves through movement and rhythm is known as dancer. Dancers dedicated themselves to master the skills for several years from the very young age. They use their body as an instrument to convey their emotions, stories and ideas, to keep this essence intact dancers undergo extensive training to refine their skills the dancer need to continuously work on their flexibility, strength, coordination and artistic expressions. The nature of the dance requires repetitive movement, extreme flexibility and strenuous activity, which contributes to injuries.

Dance injuries encompass a wide spectrum of physical issues that dancers face during their practice session or performance. The injury can be acute or overuse. Acute injuries mostly result from any direct trauma to the part, sudden fall or unbalanced force application. Overuse injuries results from repetitive movements leading to the stress in the part and ultimately leads to failure. Common dance injuries often involve lower extremities including ankle, feet, knee and hip due to demanding nature of dance movements. Treatment for dance injuries usually involves a multidisciplinary approach. Dancers often seek care from healthcare professionals specializing in dance medicine or sports medicine. Treatment may include rest, physical therapy, specific exercises to strengthen and rehabilitate affected areas, use of orthotics or braces, and in some cases, surgery for severe injuries.

Dance medicine plays a crucial role in supporting dancers' physical and mental well-being, allowing them to continue pursuing their passion while minimizing the impact of injuries on their artistry and livelihood. It is also known as dance medicine and science or dance medicine and rehabilitation, is a specialized field that focuses on the prevention, diagnosis, treatment, and rehabilitation of dance-related injuries and conditions. It combines elements of sports medicine, physical therapy, biomechanics, and dance-specific knowledge to address the unique physical demands and challenges faced by dancers. This field not only focuses on treating injuries but also aims to promote overall wellness and longevity in a dancer's career. Through evidence-based practices and research, dance medicine specialists strive to improve the health and performance of dancers while ensuring they can sustain their careers with reduced risk of injury. Professionals in dance medicine, including physicians, physical therapists, athletic trainers, and specialists, work closely with dancers to optimize their health, enhance performance, and prevent injuries. They understand the specific stresses that dance places on the body, such as repetitive movements, extreme flexibility, and high-impact jumps, which can lead to overuse injuries or acute trauma. Dance medicine professionals offer a range of services, including injury assessment, personalized conditioning and strengthening programs, rehabilitation after injuries, nutritional guidance, mental health support, and techniques to improve technique and prevent future injuries. They also educate dancers about proper warm-up routines, safe training practices, and injury prevention strategies.

Preventing dance injuries is a crucial focus in the dance community. Dancers, instructors, and healthcare professionals emphasize injury prevention through proper warm-ups, cross-training, maintaining good nutrition, adequate rest, technique refinement, and recognizing the body's limits to avoid overexertion. Prompt attention to injuries, proper rehabilitation, and a balanced approach to training are essential for dancers to recover effectively and minimize the risk of re-injury. Through education, awareness, and proactive measures, dancers strive to maintain their physical well-being and prolong their careers in this demanding art form.

2.11 Review on the reliability & validity of assessment methods and tools used in our study

In order to guarantee accurate and significant results, it is important to use reliable as well as valid tools and methods for our research. This section present the reliability measures of different tools used in our study. Understanding these aspects aids in minimize measurement error and enhance the credibility of research findings. In our study tape measurement has been used to determine the foot size, truncated foot size, limb length and girth of thigh and girth and it has been supported by the study which tested the validity and reliability of using a tape measure for leg length measurements by comparing them to x-ray measurements and assessing intertester consistency. The True and apparent limb length was measured by using measuring tape. The Pearson correlation coefficients for measuring tape is having high validity, with values of 0.98 for comparisons between the two therapists and between each therapist and the x-ray measurements. The intraclass correlation coefficients also indicated excellent reliability, with values of 0.99 for both intertester comparisons and comparisons between each therapist and the x-ray measures. These results confirm that tape measure leg length assessments are both accurate and reliable, providing strong support for their clinical use (97). Another study added the evidence in which foot length and truncated measurements has been measured by tape measurements in 850 participants. In a study arch height ratio normative values were determined and the results indicated that the dorsal arch height measurement while standing was shown to be valid, and the measurements showed good intra- and interrater reliability (98). The reliability of feiss line to be used as a clinical tool has been tested in 43 healthy young subjects. Results showed high reliability with an intertester of 0.94 and an intratester of 0.91. The data support the Navicular position test (feiss line) as a reliable measure of navicular bone position during rest and loading. This high reliability suggests that the test could be useful in future studies investigating the impact of arch type on lower limb injury risk (99).

FPI-6 was used in our investigation to measure foot posture, the test-retest & interrater reliability of the FPI-6 for evaluating foot posture in both adults and older adults was determined in a study revealing fair to high interrater reliability and considerable to fair test-retest reliability for adults, so the study suggested FPI is a helpful instrument for evaluating adults' foot posture. (100). Another study used radiographic measures as the reference standard to test and compare the validity & diagnostic accuracy of FPI & Clarke's angle for detecting flexible flatfoot in teenagers. The intrarater reliability for FPI was determined as 0.96 and the intra-rater reliability of 0.99 was for CA, according to the results. Therefore, FPI-6 & Clarke Angle are both reliable and accurate methods for identifying flat foot (101).

In our study we used several other measures of foot such as the navicular drop, medial longitudinal arch angle, chippaux smirak & staheli index and a study had assessed their reliability. The results determined strong intrarater and interrater reliability (>0.880). Additionally, there were significant inter-correlations between the footprint parameters (0.838–0.881) (102). In comparison to the talar-first metatarsal angle for foot issues, a study evaluated the diagnostic accuracy and reliability of the CSI and SI and results revealed maximum accuracy of 0.73 and 0.68 respectively. The greatest intra-observer reliability was demonstrated by CSI, which was 0.95 for supinated feet and 0.97 for flat feet. All of the indices demonstrated moderate to high inter-observer reliability. (103). Another study supported this by testing the intra & interrater reliability of navicular drop test across different postures. In forty healthy volunteers, the test was performed in three posture combinations: standing/standing, sitting/sitting, and sitting/standing and found largest drop observed in the sitting/standing posture. The study recommends using this posture for navicular drop tests to assess flat feet effectively (104). A study evaluated the intra and inter-examiner reliability of the measures included torsion, leg length discrepancy, medial talonavicular joint bulge, arch angle, rearfoot angle and foot type. The results showed that the intraclass reliability ranged from 0.65 to 0.97. Overall, the findings indicate that these lower extremity measures are reliable (105). The dynamic functionality of foot can be also predicted by using longitudinal arch angle. A study results confirmed that it is a useful component of physical examinations of the feet and ankles (106).

Using one and three step gait protocols, the validity of WinTrack system for monitoring plantar pressures & temporal gait characteristics was assessed. The one-step approach demonstrated good reliability with ICC values ranging from 0.75-0.88. For a wider range of metrics, the three-step approach showed even higher reliability, ranging between 0.75 and 0.90. (107). Kinovea software reliability has been tested in comparison to AutoCAD for obtaining coordinate data, as well as to assess the intra & interrater reliability of Kinovea across four different viewing angles. The results demonstrated that Kinovea is a valid and reliable tool for accurate measurement at distances up to 5 meters and within the 90° to 45° angle range. However, for the best results, an angle of 90° is recommended (108).

A review provided an overview of current motion and posture analysis systems. These advancements are particularly beneficial for postural issues. The evolution of these technologies aims to standardize measurements, offering practical tools for early diagnosis of musculoskeletal conditions and tracking patient progress. This review describes these technologies and their applications, serving as a valuable resource for researchers, clinicians, orthopedists, physical therapists, and sports coaches seeking to incorporate new diagnostic, therapeutic, and preventive tools into their practice (109).

The study evaluated and compared the validity and reliability of two methods of the Harvard step test (HST) for predicting maximum oxygen uptake (VO2max) in healthy college students. The traditional HST (THST), using a step height of 50.8 cm, was compared with the Multi-Height step based on knee joint angle (KJAHST). Results indicated a correlation coefficient (r) of 0.818 between VO2max values predicted by THST and those measured in the laboratory, while KJAHST showed a higher correlation coefficient of 0.905. This suggests both methods are valid for predicting VO2max, with KJAHST demonstrating greater accuracy and reliability (110). In addition, the study assessed the reliability of the Vertical Sit & Reach (VSR) test as a self-assessment tool for flexibility in adolescent females. Conducted with 43 female students averaging 21.2 years of age, the VSR test demonstrated high intra-individual reliability ($r = 0.98$). Systematic bias analysis revealed a statistically significant average improvement of 1.14 cm in test performance across repeated measurements, reinforcing its consistency. The low standard error of measurement (SEM = 0.139 cm) further confirmed precise measurement consistency, validating the VSR test as a reliable tool for self-assessing hamstring and low-back flexibility in adolescent females (111). Additionally, the study evaluated submaximal fitness tests using perceptual scales, which included activities like the Multistage Fitness Testing, Crunch Testing, Push-up Testing, and Trunk Flexion Testing. These tests showed high reliability with Intraclass Correlation Coefficients above 0.8, except for the submaximal Crunch Test. Criterion validity analyses revealed strong correlations between submaximal and maximal tests, particularly for cardiorespiratory fitness and flexibility assessments. However, these submaximal tests may not be as suitable for assessing muscular endurance capacity. Overall, the findings suggest submaximal tests based on perceptual scales are valid tools for assessing certain fitness components, offering practical alternatives to maximal tests in various settings (112). The study also compared four methods for measuring vertical jump performance in 52 physically active men. All 4 methods demonstrated excellent reliability with coefficients exceeding 0.97. However, while the other three methods showed high validity correlations with VJPT, they exhibited poorer accuracy, with significant differences in vertical jump height scores observed among methods. JUMPAIR emerged as a cost-effective option for measuring vertical jump performance, emphasizing simplicity and accuracy when adjusted appropriately (113). Moreover, dynamic stability tests were explored using the Y Balance Test (YBT) as a practical, low-cost alternative for assessing postural control. The YBT, involving unilateral balance while reaching in three directions (anterior, posteromedial, and posterolateral), demonstrated predictive value for injury in adults. However, limited research has explored its effectiveness in adolescents. This study aimed to evaluate reliability, along with stability over a one-month period in early adolescent females (114).

CHAPTER III

METHODOLOGY

3.1 Overview

The chapter methodology provides the detailed overview of the material and method used in this study which includes research design, population, sampling method, sample-size, inclusion & exclusion criteria, study location, outcome measures, procedure. Our study was conducted in the clinical settings of "Department of Physiotherapy of Lovely Professional University Phagwara". The study was conducted in several steps. Firstly, the topic was finalized in State of Art (SOTA) followed by the ethical clearance and clinical rail registration. The subjects were selected by purposive sampling based on the inclusion & exclusion criteria. Total of 140 subjects were included 70 Dancers (Group A) and 70 Non dancers (Group B). Both the Group participants were made aware about the study protocol and clinical significance by explaining the whereabouts of the study. After the explanation, the participants signed the consent form, and only those participants were included who agreed to participate in the study. After the consent, the information sheet of the participants was filled having the sections of demographic information and clinical examination part. The participants were tested for all the outcomes included in this study related to static foot measures, gait parameters, and plantar pressure. The result was analyzed with the help of IBM SPSS software version 22.

3.2 Research design: Cross-Sectional/Observational type research

The study design of the study was a cross-sectional observational research design involving collection of data from a specific population at a single point in time. This method aims to gather information about different variables or characteristics within a population without altering or intervening in their natural settings or behaviors. Our study involves two groups, Group A Including Bhangra dancers and Group B involving Non dancers.

3.3 Study Population: Indian Bhangra dancer

The study population denotes the entire group of individuals or elements that possess specific characteristics and are the focus of a research investigation. It represents the larger collective from which a sample, a smaller subset, is drawn to conduct the study. The study population for this study was Indian Bhangra dancers, actively engaged in performing Bhangra dance.

3.4 Sampling Method

In this study, a convenient sampling was used. Convenience sampling is a form of non-probability sampling process that focuses on taking the data from the readily accessible participants of the society. The samples of both the groups Group A or Bhangra Dancers and Group B or Non-Dancer samples was randomly taken from the dance academies and nearest areas.

3.5 Sample-Size

Sample size of our study was calculated by using G-power version 3.1 (G*Power was developed in Germany. The software is associated with Heinrich Heine University Düsseldorf, which is located in Düsseldorf, Germany) (115) and the total estimated sample came out was 128 ie. 64 (Bhangra Dancers) and 64 (Non- Dancers) for effect-size (d) 0.5 and power (1-β) 0.80 and error probability of 0.05 (Figure 10). The dropout for our study was take as 10-15% i.e. 13, So total sample size is 128+13=141. Final sample estimated was 70 (Bhangra Dancers) and 70 (Non-Dancers).

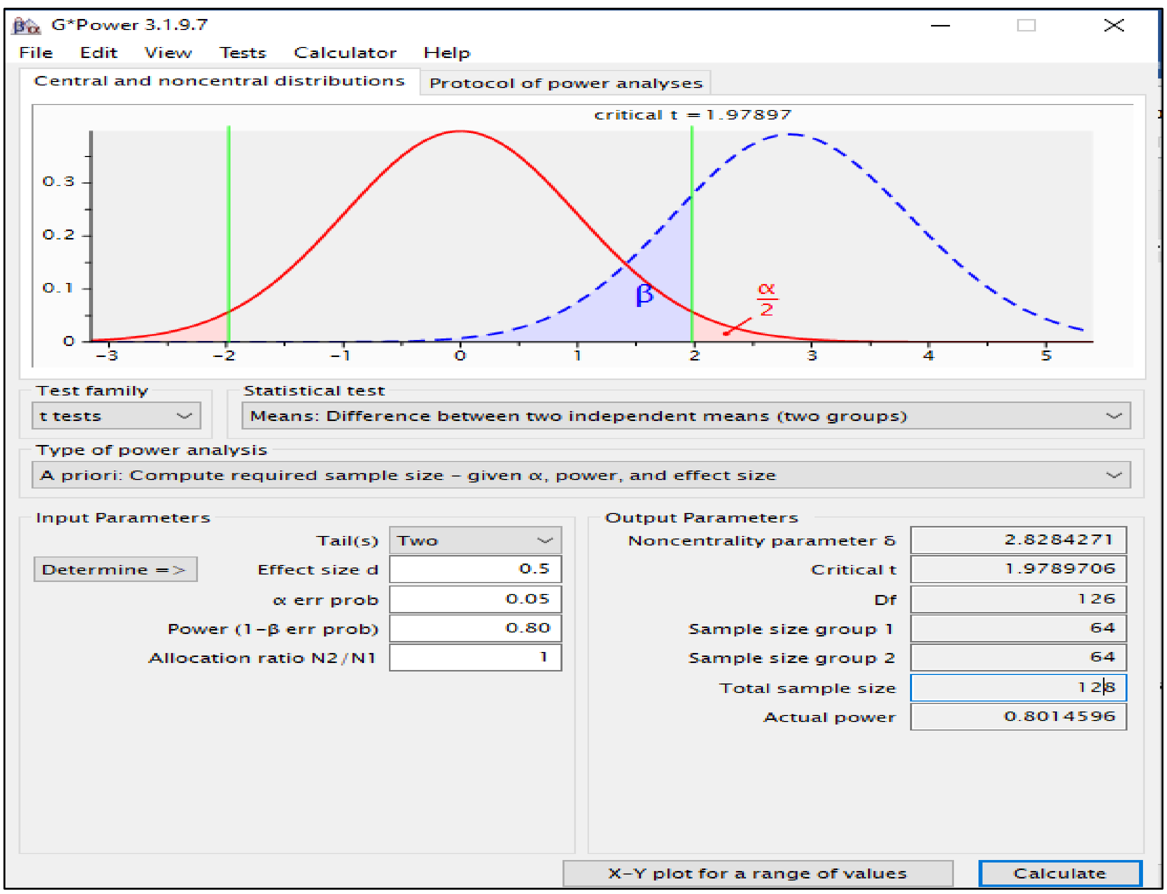


Figure 10 displaying sample size calculation by G*Power version 3.1

3.6 Selection criteria:

The selection criteria for participant inclusion in the study investigating the foot characteristics and plantar pressure of Bhangra dancers are meticulously defined in table 3. Eligible participants for both the groups fulfilled certain inclusion criteria, such as being Indian Male Bhangra dancers for Group A and Non Dancers for Group B within the age range of 18 to 45 years, Group A having an extensive dancing background of more than 5-10 years. Both the group participants were physically, mentally, cognitively fit which was determined by Physical Activity Readiness Questionnaire (PARQ), World Health Organization Wellbeing Index-5, and Montreal Cognitive Assessment (MOCA) scale. Exclusion criteria encompass individuals involved in dance forms other than Bhangra, having any visible deformity and those with recent musculoskeletal injuries within the past three months, neurological conditions, balance or coordination issues associated with ankle, knee, or hip instability cases, diabetic peripheral neuropathy, collagen vascular diseases, known cardiac conditions, or osteoporosis.

Table 3 displaying the description of inclusion & exclusion criteria for study

A. Inclusion-Criteria for Group A and Group B:
➢ **Indian Bhangra Dancers for Group A** ➢ **Non Dancers for Group B** ➢ **18-45 years** ➢ **Having Dancing experience of more than 5-10 years for Group A** ➢ **Gender Male** ➢ **Physical fit and Healthy bhangra dancers (assessed by PARQ)** ➢ **Mentally fit (assessed by WHO wellbeing Index-5)** ➢ **Cognitively fit (assessed by MOCA scale)**
B. Exclusion-Criteria for Group A and Group B:
➢ **Any other dance form (History assessment)** ➢ **Recent Musculoskeletal injury (3months) (History assessment)** ➢ **Visible deformity in posture or any part of the body** ➢ **Diagnosed neurological condition (History assessment)** ➢ **Diagnosed Balance and coordination issues (ankle, knee, hip instability cases) (History assessment)**

- **Diagnosed case of any systemic disorder (diabetes, hypertension, hypotension, hyper or hypo thyroidism, diabetic peripheral neuropathy, obesity etc.) (History assessment)**
- **Diagnosed case of collagen vascular disease (History assessment)**
- **Diagnosed case of cardiac diseases (History assessment)**
- **Diagnosed case of osteoporosis (History assessment)**

3.7 Study setting:

We carried out our study in the clinical settings of Department of Physiotherapy, School of allied health sciences, Lovely Professional University, Phagwara, Punjab, India. The study setup was in Exercise Science Laboratory, room number 309, block 4.

3.8 Tools and Instrument:

The comprehensive list of tools and equipment outlined for this study has been given in the table 4. This inventory comprises essential items such as a consent form and information sheet for ethical compliance and participant information. Data recording tools like pens/pencils ensure accurate data capture. Equipment like the pulse oximeter, thermometer, and sphygmomanometer are employed for assessing vital signs, while the stadiometer and weighing machine aid in height and weight measurements. Various tools, including ruler for foot measurements (foot size, truncated length, arch height, navicular height, and drop), inch tape for limb measurements, and tools such as the foot posture index, monofilament for foot sensation assessment, and goniometer for ankle range of motion evaluation, contribute to detailed foot analysis. Specialized devices like the baropodometer (Wintrack device) for plantar pressure assessment, digital cameras, Gait-On running gait analysis software, Kinovea software for angle assessments, refractive markers for reference, stamp pads for footprints, and a 50.8 cm stepper for the Harvard step test, yoga mat for the V-sit & reach test, setup for Y balance test, & the Vertec vertical jump tester collectively facilitate a comprehensive examination encompassing foot characteristics, movement, balance, flexibility, and fitness indices. These tools and resources was carefully selected and employed in the study, ensure their reliability and validity before using them for the study.

Table 4 displaying the description of tools and instruments used in study

Instruments used in study
➢ Consent form and Information sheet
➢ Pen/Pencil to record the data
➢ Pulse oximeter, thermometer, Sphygmomanometer for assessing Vitals
➢ Stadiometer for height measurement
➢ Weighing machine for weight assessment
➢ Ruler for foot measurements (foot size, truncated length, arch height, navicular he and drop)
➢ Inch tape for limb length and girth measurement
➢ Foot Posture Index (FPI-6) for assessing foot posture
➢ Monofilament (10 gm force) for assessing sensation of foot
➢ Baropodometer (Wintrack device) for assessment of plantar pressure
➢ Digital Camera's for recording
➢ Gait-On running gait analysis software for assessing posture
➢ Kinovea Software for angle assessment (torsion angle, Medial longitudinal arch an
➢ Refractive markers for Reference
➢ Stamp pad for footprint to measure (Clarke's angle, Chippaux-Smirak index, Stah Planter Arch Index)
➢ 50.8 cm Stepper for Harvard step test to estimate fitness index
➢ Yoga mat for V-sit and reach test for flexibility
➢ Set up for Y balance test for assessment of Balance
➢ Vertec vertical jump tester for assessment of vertical jump

3.9 Outcome Measure/Variables

3.9.1 Foot Size

The foot size was determined by positioning the participant barefoot on a level surface, ensuring an equal weight distribution between both feet and a relaxed stance against the wall ensuring the heels of both feet are in close approximation with wall. The farthest point of the big toe was marked and the distance was measured between the two points to determine foot length (Figure 11).

3.9.2 Truncated foot length

In our study truncated foot length was measured by positioning the participant barefoot on the levelled surface against the wall in relaxed stance, a point was marked on the ruler at the level of head of first metatarsal. The procedure was repeated for both the foot and record the measurements (Figure 11).

3.9.3 Navicular height & navicular drop

Navicular height & drop was determined by firstly, locating the position of navicular tubercle by palpation and marking it in non-weight-bearing position and measure the height from the ground then participants were then instructed to bear 50% of weight and once again the navicular tuberosity was palpated and marked. The height was again measured and the difference gives us the navicular drop. A displacement greater than 10mm from the neutral position is suggested to have excessive medial longitudinal collapse of abnormal pronation.

3.9.4 Arch height index (AHI)

To determine arch height index, firstly we measured height of dorsum of foot at mid-point of the total length of foot. The AHI is calculated by dividing this height measurement by truncated foot length. If the ratio is greater than 0.356 the foot is considered high arched, and a ratio of less than 0.275 is considered a low-arched foot (Figure 11).

$$\text{Arch height index score} = \frac{\text{dorsum height at 50 \% of foot length}}{\text{Truncated foot length}}$$

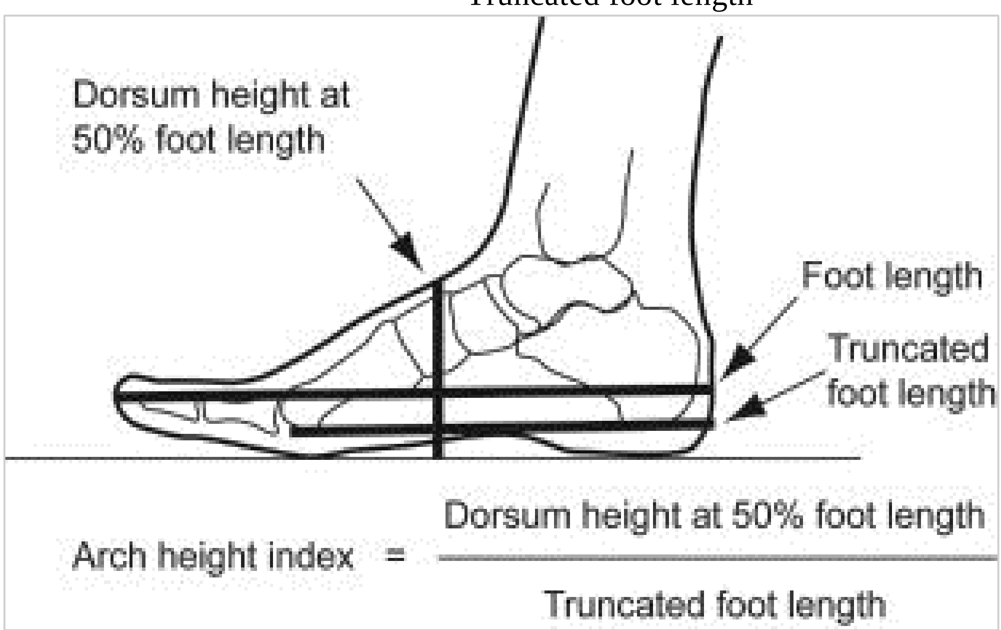


Figure 11 displaying the calculation of foot arch height index

3.9.5 Feiss Line

The feiss line was analyzed by locating and marking three points, one point is medial malleoli, second point is navicular tuberosity and third point is head of first metatarsal then a line is drawn from medial malleoli to the first metatarsal. The position of the navicular tuberosity determines a high arch, normal arch or low arch foot. The navicular tuberosity above the line means high arched foot and position of navicular tuberosity below line determines low arched foot and on the line determines normal arched foot (Figure 12).

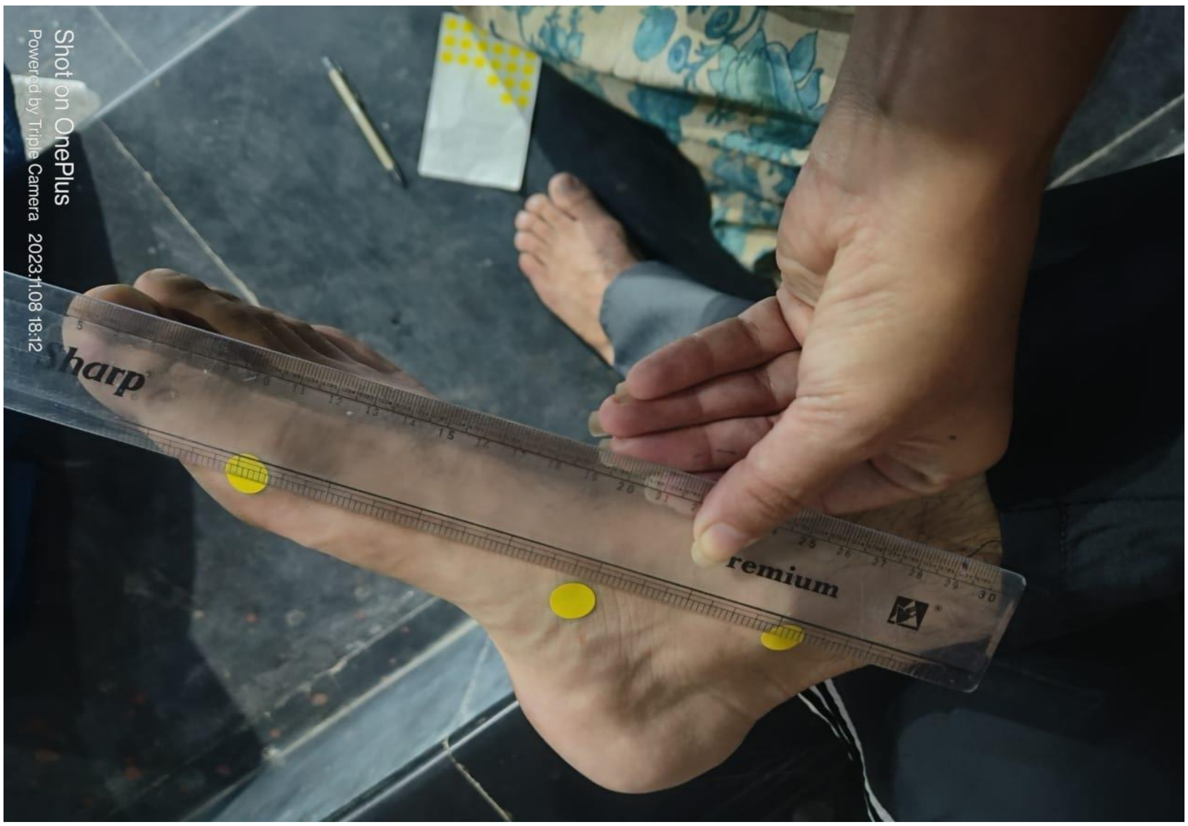


Figure 12 displaying feiss line assessment of participant

3.9.6 Medial Longitudinal arch angle (MLAA)

The MLLA is a good & reliable test to determine the type of foot. It was measured by drawing the line from center of medial malleoli to navicular tuberosity and from navicular tuberosity another line joining to the head of the first metatarsal head. This is forming an obtuse angle called LAA and it normally ranges between 131^0 and 152^0. The Values less than 131^0 determine low arched foot and values greater than 152^0 state high arched foot (Figure 13).

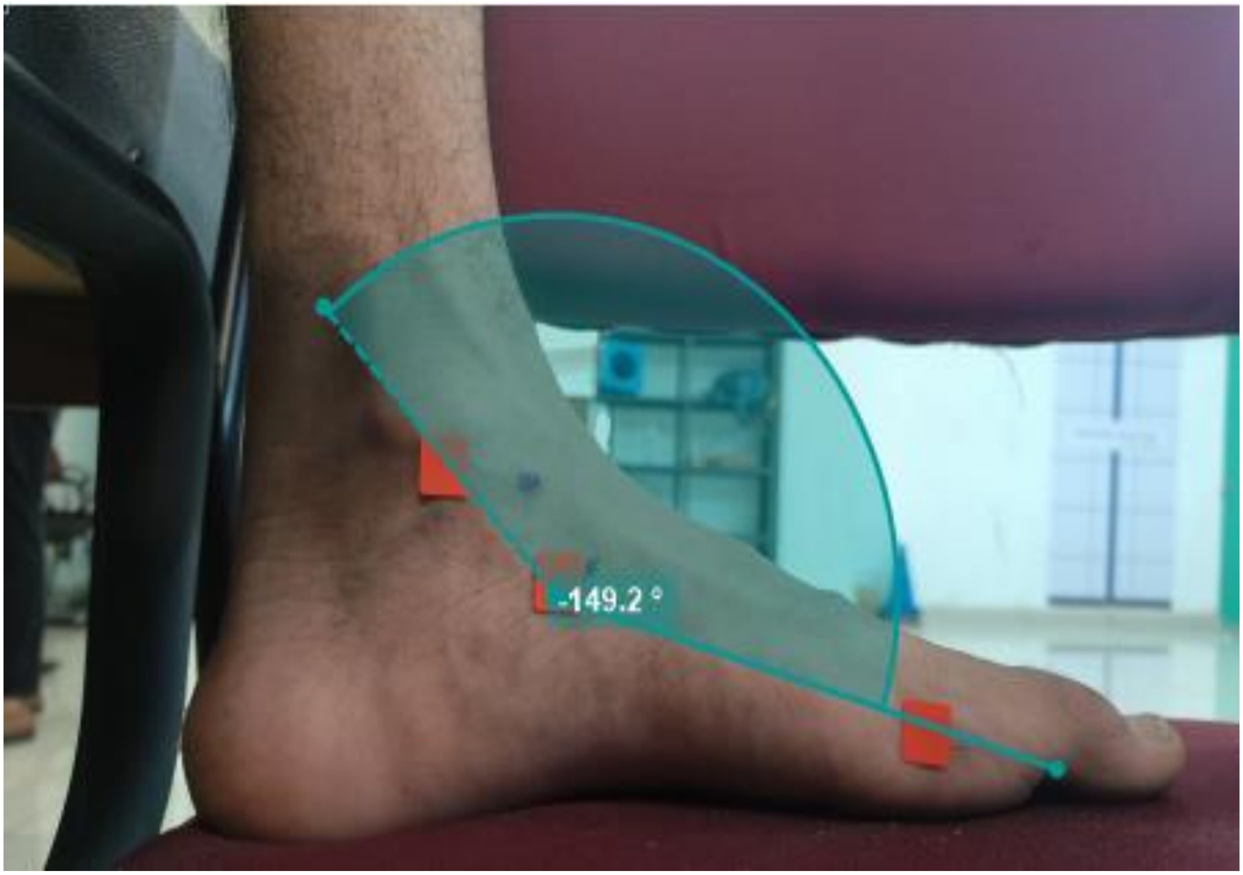


Figure 13 displaying the medial longitudinal arch angle (MLAA)

3.9.7 Foot posture index (FPI)

FPI is a valid clinical tool which is used to assess static foot measures as well it is also valid to determine the structure of the foot. This index was determined by observation assessment. The participants were made to stand barefooted in relaxed position with equal weight distribution between both feet. The six items were tested to get the total score of foot posture index are i.e. talar head position, symmetry of supra and infra lateral malleolar curvature, inversion or eversion of the Calcaneum bone, prominence in region of talo navicular joint, the height of medial longitudinal arch, and abduction or adduction of forefoot (table 5 and Figure 14). The six palpations and observation assessment series were conducted with the score ranging from -2 to 2. Zero scores are considered as neutral-foot, positive score for pronated foot and negative score for Supinated foot. The FPI thus has a score of -12 (highly Supinated) to +12 (highly pronated). For assessment of FPI ensure the individual is barefoot and relaxed in either a sitting or standing position. Adequate lighting should be available for accurate observation. Total six components are assessed three for forefoot and three for rear foot. Procedure, interpretation of FPI is discussed below:

Rear foot assessment

a. Talar-Head Palpation:

The head of talus is located within the ankle joint. A gentle pressure is applied Apply gentle pressure while palpating to assess alignment. The score is assigned between -2 to +2 based on the observed curvature as mentioned in table 5.

b. Supra & Infra Lateral Malleolar Curvature:

The curvature around the lateral malleolus (both above and below) is examined. The score is assigned between -2 to +2 based on the observed curvature as mentioned in table 5.

c. Calcaneal Palpation:

The calcaneus bone alignment is felt in relation to the subtalar joint. The score is assigned between -2 to +2 based on the observed curvature as mentioned in table 5.

Forefoot assessment

d. Talocalcaneal Axis:

The positioning and alignment of the talus and calcaneus bones is evaluated and the score is assigned between -2 to +2 based on the observed curvature as mentioned in table 5.

e. Medial Longitudinal Arch:

The height & alignment of the medial longitudinal arch is evaluated and the score is assigned between -2 to +2 based on the observed curvature as mentioned in table 5.

f.Forefoot to Rear Foot Alignment:

The alignment between the forefoot and rear-foot is assessed and the score is assigned between -2 to +2 based on the observed curvature as mentioned in table 5.

Totaling Scores and Interpretation:

Sum up the scores obtained from all six components to derive the overall Foot Posture Index (FPI-6). Higher total scores suggest greater deviations from normal foot posture, while lower scores indicate a closer alignment to the expected foot posture.

Table 5 displaying the description of foot posture index used in study

Variable	-2	-1	0	+1	+2
Talar head palpation	Talar head palpable on lateral side/but not on medial side	Talar head palpable on lateral/slightly palpable on medial side	Talar head equally palpable on lateral and medial side	Talar head slightly palpable on lateral side/palpable on medial side	Talar head not palpable on lateral side/but palpable on medial side
Supra and infra lateral malleoli curvature	Curve below the malleolus either straight or convex	Curve below the malleolus concave, but flatter/more than the curve above the malleolus	Both infra and supra malleolar curves roughly equal	Curve below the malleolus more concave than curve above malleolus	Curve below the malleolus markedly more concave than curve above malleolus
Calcaneal frontal plane position	More than an estimated 5º inverted (varus)	Between vertical and an estimated 5º inverted (varus)	Vertical	Between vertical and an estimated 5º everted (valgus)	More than an estimated 5º everted (valgus)
Prominence in region of TNJ	Area of TNJ markedly concave	Area of TNJ slightly, but definitely concave	Area of TNJ flat	Area of TNJ bulging slightly	Area of TNJ bulging markedly

Congruence of medial longitudinal arch	Arch high and acutely angled towards the posterior end of the medial arch	Arch moderately high and slightly acute posteriorly	Arch height normal and concentrically curved	Arch lowered with some flattening in the central position	Arch very low with severe flattening in the central portion - arch making ground contact
Abduction/adduction of forefoot on rear-foot (view from behind)	No lateral toes visible. Medial toes clearly visible	Medial toes clearly more visible than lateral	Medial and lateral toes equally visible	Lateral toes clearly more visible than medial	No medial toes visible. Lateral toes clearly visible.

Figure 14 displaying six components of foot posture index

3.9.8 Rear-foot angle

In this assessment test four locations were palpated and marked on the participants (Figure 15):

A. Base of Calcaneus (1)

B. Achilles tendon attachment point (2)

C. Center of Achilles tendon at the height of medial malleoli (3)

D. Center of posterior aspect of calf (15 cm above marker three) (4)

A picture was clicked and examined I the posterior view of posture. Gait-On analysis software was used for this purpose. Two lines were drawn, one joining base of calcaneus and Achilles tendon attachment and other was formed by joining centre of Achilles tendon and centre of calf. An angle is formed between these two lines. The normal values of this angle lies between 4° valgus to 4° varus. The angle ≥ 5° valgus represents a pronated foot type and ≥ 5° varus a Supinated foot.

Figure 15 displaying Rear-foot angle measured by Gait-On Software

3.9.9 Tibial Torsion measurement:

The tibial torsion angle was measured by instructing the participant to lie prone on the couch with knee flexed at 90 degrees. Two pencils were used as reference lines. One line placed parallel to the condyles of tibia and other line passing through two malleoli. The angle formed by bisection of these two lines is measured in software after pictorial analyses. The standard angle ranges from 0° to 30°. A TTA exceeding 30° indicates excessive external tibial torsion, whereas a TFA below 0° signifies internal tibial torsion. (Figure 16).

Figure 16 displaying the tibial torsion angle of the participant

3.9.10 Sensory examination of the foot:

The sensory examination of foot was done for all the participants. The participants were instructed to lie on the couch comfortable in supine and relaxed position. The subject was made aware about the procedure and sensation of monofilament. The participants were asked to close the eyes and instructed to provide the response about the sensation felt. The test was performed by using the monofilament of 10 gm force. Total of 10 sites were examined and scored accordingly. The site description is given in the Figure 17.

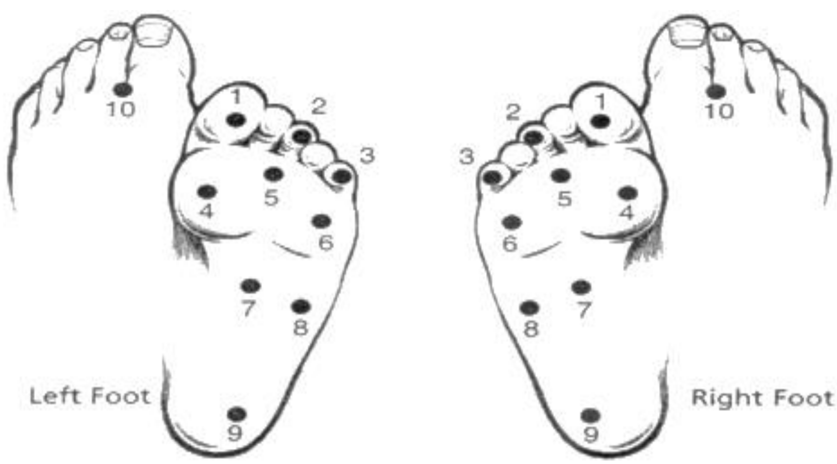


Figure 17 displaying the sensory testing sites on the dorsum and plantar surface of foot

3.9.11 Clarke's angle

Clarks angle is formed by angle between 1st medial tangential line joining medial edge of 1st metatarsal head & heel and second line joins the 1st metatarsal head to top of the MLA. It was determined by taking the foot print on A4 sheet of both feet of the participants in full weight bearing position. The picture was scanned and by help of the kinovea it was measured. If calculated number is <41 degree then flatfoot is present (Figure 18 a &19).

3.9.12 Chippaux-Smirak index (CSI)

This was also determined by the foot print method. This is ratio of minimum width of midfoot arch region to maximum width at metatarsals. Based on CSI index, if someone is having flatfoot then the calculated number is < 45 (Figure 18 b &19).

3.9.13 Staheli index

Foot print also gave us the Staheli index. This is ratio between minimum width of midfoot & maximum width of rear-foot region. If flatfoot is present, then the calculated number is > 0.8 (Figure 18 c &19).

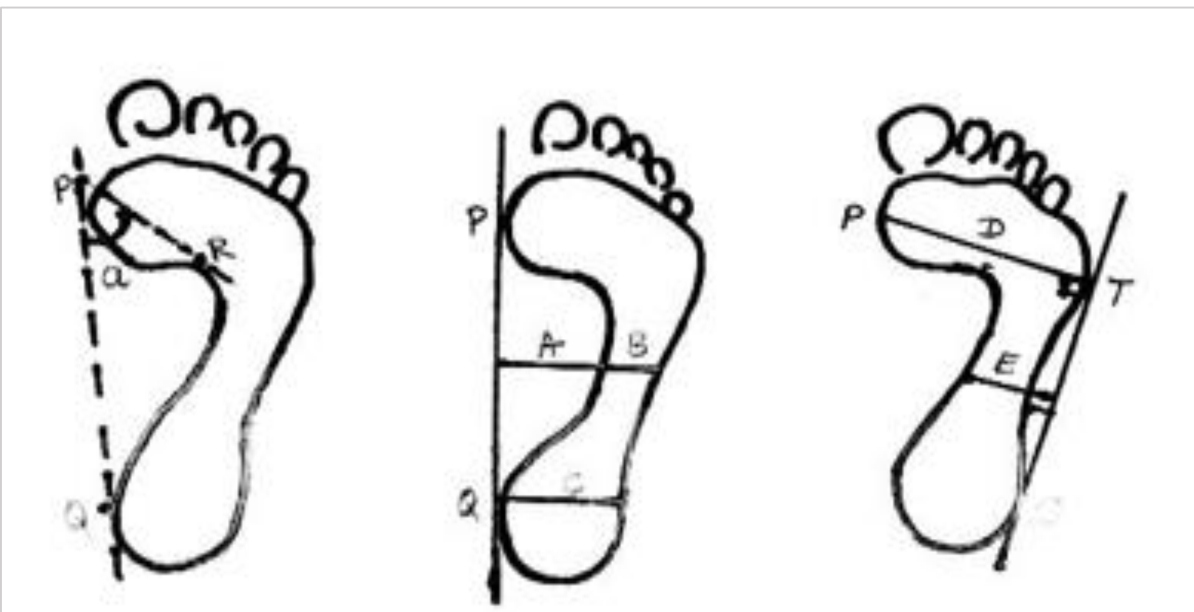


Figure 18 displaying Foot print parameters a. Clarks angle,

b. Staheli Plantar Arch Index, C. Chippaux Smirak Index

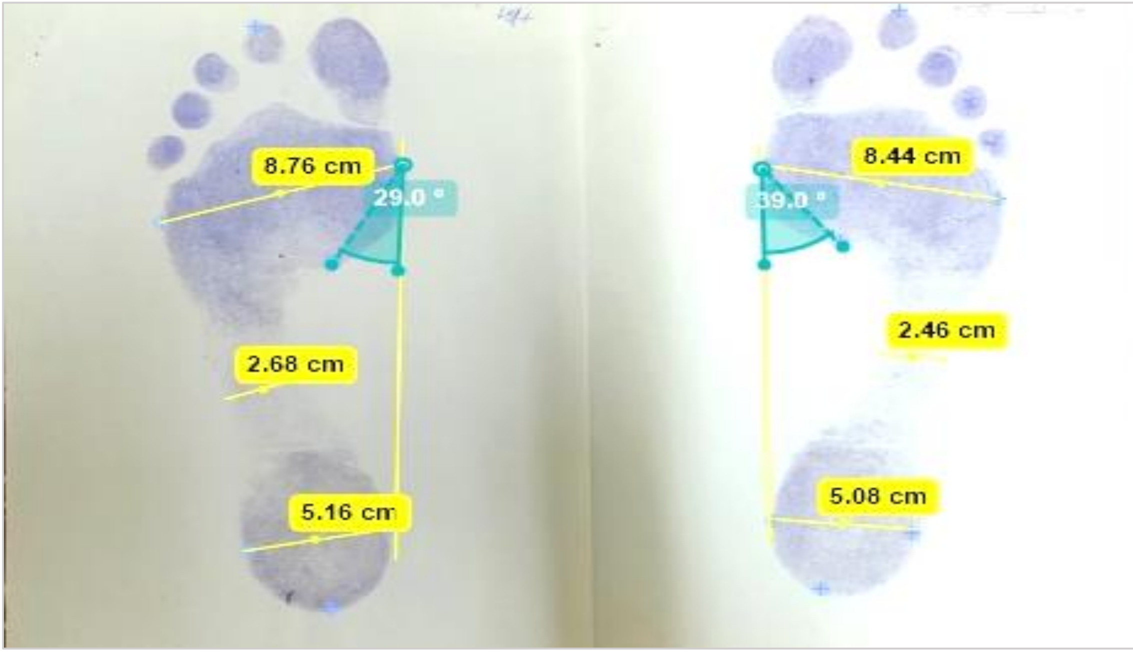


Figure 19 displaying foot print analysis measurements (Clarks angle, Forefoot distance, Midfoot distance and Hindfoot distance)

3.9.14 True Limb length

True limb length was determined by instructing the participant to lie comfortably on the couch, inch tape was used to measure length from anterior superior iliac spine (ASIS) to medial malleolus. The length was measured in centimeters.

3.9.15 Apparent Limb length

Apparent limb length was also measured with inch tape in centimeters, the participants were instructed to lie down comfortably on couch. The length was measured from umbilicus to medial malleolus.

3.9.16 Thigh Girth measurement

The participant was positioned in supine (lying on their back) ensuring the leg being measured is relaxed and extended. The midpoint of the thigh was identified usually halfway between the hip (ASIS) and the knee joint. Inch tape was wrapped around the thigh at the identified point. Ensuring the tape is snug but not too tight, maintaining even tension around the thigh. The measurement was recorded in centimeters.

3.9.17 Calf Girth measurement

The participant was positioned in supine (lying on their back) ensuring the leg being measured is relaxed and extended. The widest part of the calf muscle was identified, the measuring tape was wrapped around this point, ensuring it is snug against the skin without compressing or indenting the calf muscle. The measurement was recorded in centimeters.

3.9.18 Postural assessment

The postural assessment of participants was done by the pictorial method. The markers were placed at the different locations of the participants and pictures were clicked in anterior, posterior, left lateral and right lateral views (Figure 20 a, b, c, & d). Then these pictures were assessed with the help of Gait-On software and the final report was generated for readings.

Figure 20 displaying postural assessment of participant "a) Anterior view b) Posterior view c) left lateral view d) Right lateral view"

3.9.19 Plantar pressure

The plantar pressure of the participants was recorded with the help of baropodometer (wintrack) in static as well as dynamic posture (Figure 21, 22, 23, 24, 25). "The Win-Track platform (Medicapteurs Technology, France) is a valid and reliable tool for these assessment barefooted. The platform has a dimension of 1610 mm × 652 mm × 30 mm (length/width/height). It has a thickness of 9 mm, and it has a total of 12288 sensors of resistive type. Each sensor has a dimension of 7.8 × 7.8 mm^2, with an acquisition frequency of up to 200 images/s". The Wintrack data accusation software allows the clinician to upload the assessment data to a computer on which it is installed, and it automatically identifies the footstep and calculates the parameters in three modes static, dynamic, and postural. The Wintrack system for static posture of participants were instructed to stand on the platform for at least thirty seconds, static and postural analysis was recorded. For dynamic analysis the participants were instructed to walk on the platform with at least three steps on the platform with dominant and non-dominant foot and complete six laps at least provides the clinician with quantitative information about the patient's static loading, plantar pressure, postural instability, and spatiotemporal gait parameters.

The variables recorded were:

i. Foot area (static)
ii. Average pressure (static)
iii. Maximum pressure (static)
iv. Thrust (static)
v. Distribution (static)
vi. Deviations (x and y axis)
vii. Speed (x and y axis)
viii. Foot area (step 1, 2, and 3)
ix. Average pressure (step 1, 2, and 3)
x. Maximum pressure (step 1, 2, and 3)
xi. Cadence (dynamic)
xii. Step duration left (dynamic)
xiii. Step duration Right (dynamic)
xiv. Stride duration Left (dynamic)
xv. Stride duration Right (dynamic)
xvi. Angle of the toe-out left (dynamic)
xvii. Angle of the toe-out Right (dynamic)

Figure 21 displaying wintrack assessment of participant

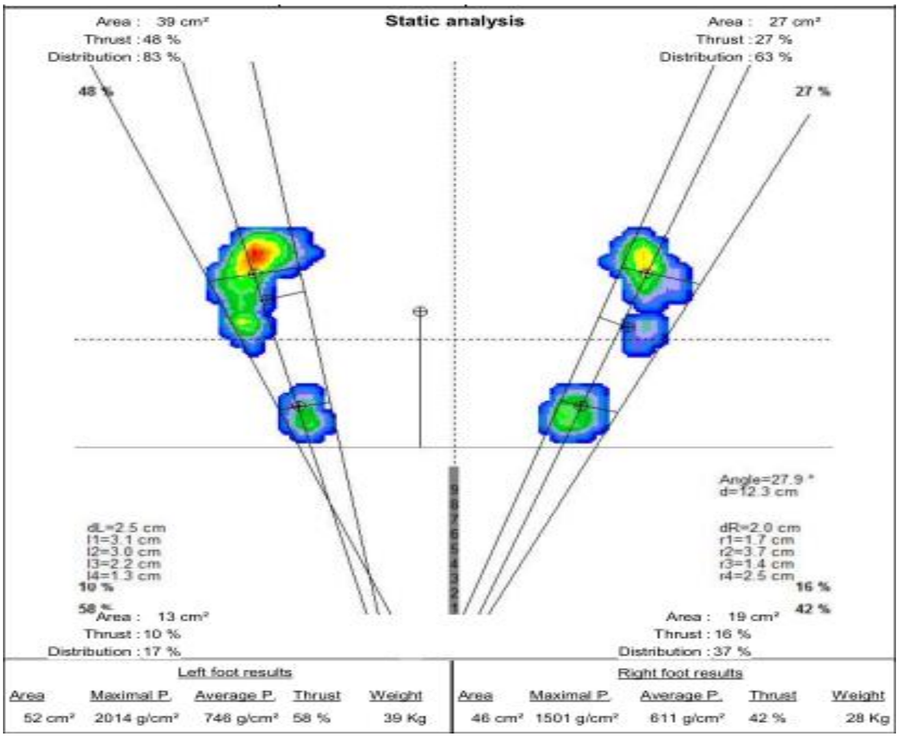


Figure 22 displaying wintrack reading for static analysis of plantar pressure

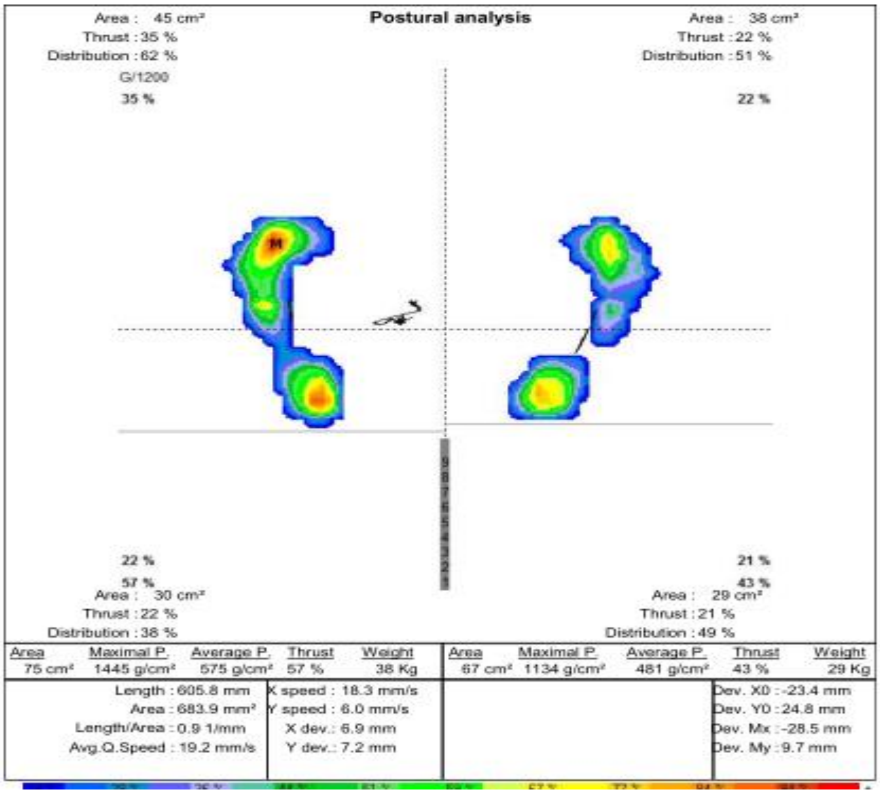


Figure 23 displaying the wintrack reading for postural analysis

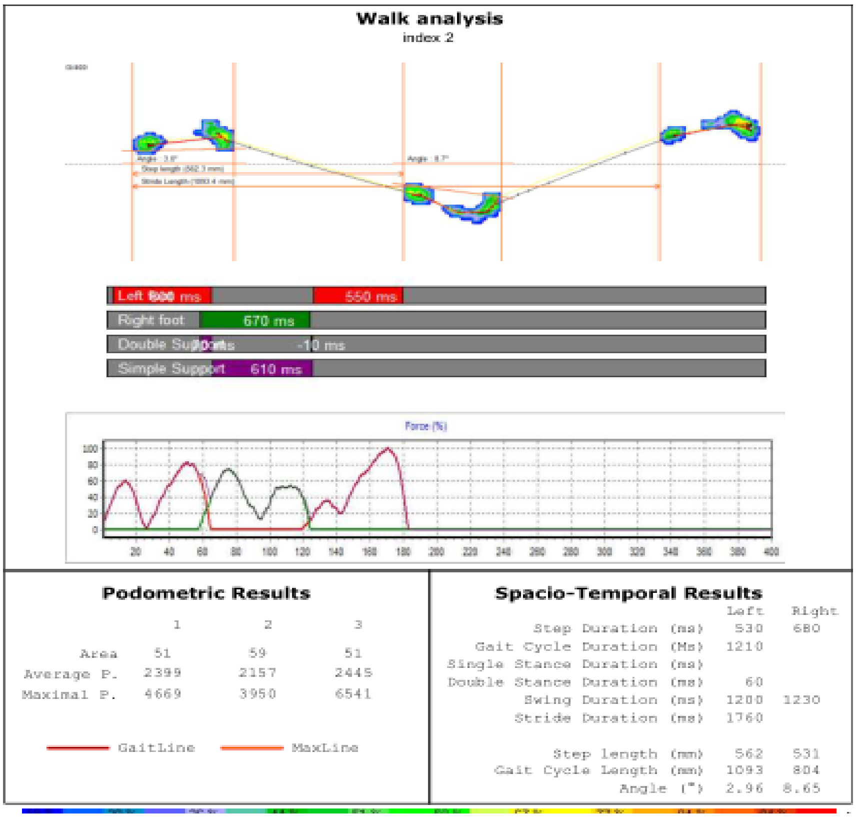


Figure 24 displaying the wintrack readings of walk analysis (left foot)

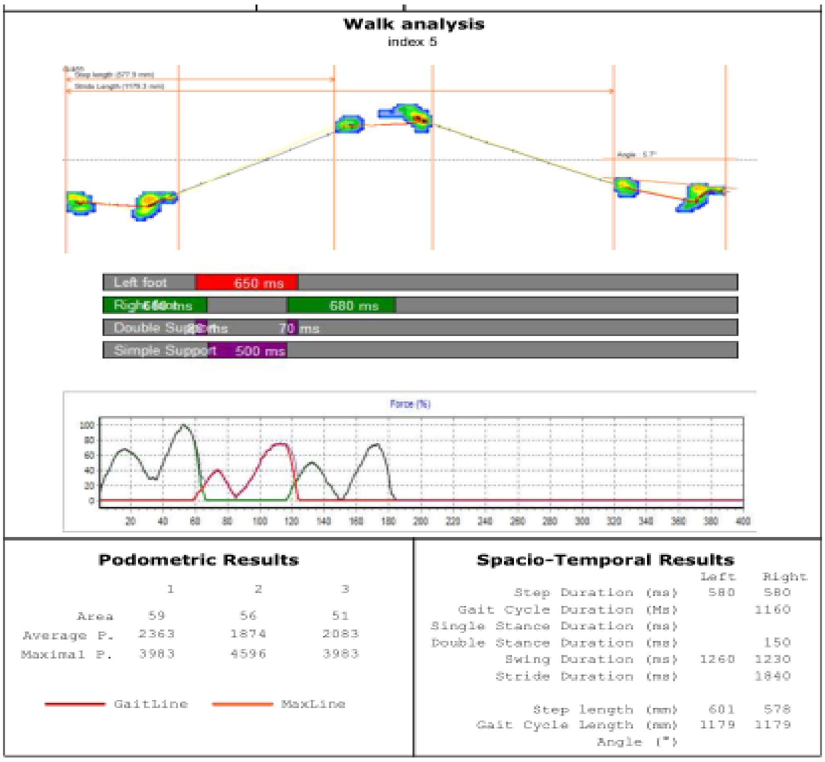


Figure 25 displaying wintrack reading of walk analysis (right foot)

3.8.20 Fitness testing:

The fitness of participants was estimated by battery of reliable and valid tests. Total of six tests were used including Harvard step test for endurance testing and fitness index calculation, V sit and reach test for flexibility of lower limbs, vertical jump test to estimate leg power of participants, Y balance test for both lower limbs to estimate balance, crunches and pushup for core strength.

3.8.20.1 Harvard step test: The participants heat rate was recorded with the help of pulse oximeter. They were instructed to ascend and descend the 50.8 cm step at the one step per second place. The participants were told to stop the test as they feel like giving up or they can continue the test up to five minutes. After they finish chair was provided to sit down and the pulse rate was recorded three times every minute (Figure 26). After completing the test, the participant sits down on a chair to allow for recovery. The participant's pulse is measured three times every minute following the completion of the test, at the 1st, 2nd and 3rd min after stopping the test. The Vo2 max and Maximum heart rate was calculated by the OMNI calculator and The fitness index (also called the "Harvard Fitness Index") was determined by using the formula:

$$\text{Fitness Index} = \frac{100 \times \text{Duration of exercise in seconds}}{\text{Sum of 3 pulse readings}}$$

The fitness index is usually categorized as follows: Excellent: > 90, Good: 80-89, Average: 65-79, Below average: 55-64, Poor: < 55. A higher fitness index indicates better cardiovascular fitness.

Figure 26 displaying participant performing Harvard fitness testing

3.8.20.2 V sit and reach test: The inch tape was fixed on the floor and the participants were made to sit with the legs extended with the 12-inch (30.48 cm) distance between the two legs, forming a "V" shape. The participants were instructed to bend and reach to the measuring tape and it was repeated three time and the readings were recorded (Figure 27). The measurement is taken at the point where the participant's fingertips reach along the measuring tape The score is determined by the best distance reached of the three attempts. This is usually recorded in inches or centimeters. A positive score indicates that the participant has reached beyond the baseline (i.e., their fingers passed the 0-point or the start of the tape). A negative score indicates that the participant could not reach the baseline (i.e., their fingers were behind the starting point). The classification of the results varies by age and gender, but a general guideline for adults is as follows: Excellent: ≥ 16 inches (40.64 cm), Good: 11–15 inches (27.94–38.1 cm), Average: 6–10 inches (15.24–25.4 cm), Below average: 1–5 inches (2.54–12.7 cm), Poor: ≤ 0 inches (0 cm or less)

Figure 27 displaying participant performing v sit and reach test

3.8.20.3 Vertical jump test: The participants were made to stand upright with feet shoulder-width apart, arms overhead or hands on hips next to the vertical jump device. The initial reading was noted and the final reading was noted when the participants bend the knees and swing the arms, then jump as high as possible. The difference between initial and final readings gives us the estimation of leg power. The peak power is estimated from a vertical jump test by using the following formula:

Peak Power (watts) = $\frac{(Height\ Jump\ X\ BodyMass\ X\ 9.81)}{0.2}$

- **Height_{jump}** is the vertical jump height (in meters)
- **Body Mass** is the participant’s body weight (in kilograms)
- **9.81** is the acceleration due to gravity (m/s^2)
- **0.2** is a constant that adjusts the formula for practical estimation

3.8.20.4 Y balance test: Y shape was created on the floor. The participants were made to stand on one leg at the center of the Y shape and told to reach with the opposite foot as far as possible along each of the three directions (anterior, posteromedial, and posterolateral) and return back to the starting position. The furthest distance reached in each direction for both lower limbs was recorded (Figure 28).

Score Formula: Y Balance Score = $\frac{Anterior+Posteromedial+Posterolateral}{Leg\ Length}\ X\ 100$

Figure 28 displaying participant performing Y balance test

3.8.20.5 Crunches: The participant was instructed to lie on a mat on flat surface with knees flexed with feet flat on the ground both the hands behind the head or crossed over the chest. The participants then lift the upper body by contracting the abdominal muscles while keeping the lower back on the floor. Number of repetitions and time in seconds was recorded for every participant and Performance and efficacy of crunches was estimated by using the following formula:

$$\text{Crunches performance: } \frac{Total\ Numbers\ of\ repetitions}{Total\ time\ in\ seconds}$$

- A higher values indicates better performance (more crunches in less time)

$$\text{Crunches efficacy: } \frac{Total\ time\ in\ seconds}{Numbers\ of\ repetitions}$$

- A lower value indicates better efficiency (less time per crunch)

3.8.20.6 Pushup: The participants were instructed to assume a plank position with hands shoulder width apart and body straight from head to heels. They then lower the body by bending the elbows until the chest touches or nearly touches the ground. The participant then pushed back up to the starting position, by keeping the body in a straight line throughout the movement. They were advised to perform the designated number of repetitions while maintaining proper form. Number and time in seconds was recorded (Figure 29). Performance and efficacy of push-ups was estimated by using the following formula:

$$\text{Push-up performance: } \frac{Total\ Numbers\ of\ repetitions}{Total\ time\ in\ seconds}$$

- A higher values indicates better performance (more Push-up in less time)

$$\text{Push-up efficacy: } \frac{Total\ time\ in\ seconds}{Numbers\ of\ repetitions}$$

- A lower value indicates better efficiency (less time per Push-up)

Figure 29 displaying participant performing push-up

3.10 Procedure

After topic was finalized, the state of art clearance was obtained in the Lovely Professional University, Phagwara, Punjab-144411. The ethical approval of the study was obtained from Genebandhu independent ethical committee on 20/04/2023 under reference number **Ref-*ECG005/2023*.** After ethical approval study was registered under Clinical Trail registry of India on 08/05/2023 bearing registration number ***CTRI/2023/05/052343.*** The enrollment of the participants started after the CTRI registration. The participants were enrolled on the basis of inclusion and exclusion criteria, ensuring the reliability and integrity of the research. The initial screening involved checks for visible deformities and inquiries into the medical history of control group participants, specifically focusing on past injuries, systemic disorders, or metabolic diseases. This thorough examination aimed to exclude individuals whose conditions might impact the study's outcomes. The observational group underwent the same screening process, maintaining consistency across both groups. Following this initial screening, participants from both groups were assessed for physical, mental, and cognitive well-being using three standardized tools: The Physical Activity Readiness Questionnaire (PARQ), the World Health Organization's Five Well-Being Index (WHO-5), and the Montreal Cognitive Assessment (MOCA) scale. The PARQ was employed to determine if individuals could safely engage in physical activity by identifying potential health risks that could arise from physical exertion. The WHO-5 Index provided a status of current mental well-being, general mood and overall mental health. The MOCA scale assessed cognitive function which includes memory testing, attention, language, & executive functions. Only participants who met the necessary scores on these assessments were included in the study, ensuring that the sample was both healthy and capable of providing reliable data.

The comprehensive testing parameters were divided into seven distinct parts to capture a wide array of relevant data. The first part included demographic assessment, which involved collecting basic demographic data such as age, height, weight, and BMI. Additionally, information on hand dominance and leg dominance was recorded, as these factors could influence physical performance and foot characteristics. Resting heart rate was also measured to provide a baseline for participants' cardiovascular health. These measurements were critical in understanding the general health and physical readiness of the participants.

The second part of the testing involved detailed foot measurements to assess various aspects of foot structure and function. This included measuring foot size, truncated foot length, arch height and the Feiss line which was used to evaluate the arch of the foot. Navicular height & navicular drop were measured to assess the vertical movement of the navicular bone, which is crucial for understanding foot mechanics. Foot posture index was also recorded to get detailed analysis of structure and function of the foot.

The third part of the assessment was conducted on a couch, where participants were instructed to lie down for a series of measurements and assessments. Photos were taken to document tibial torsion, which can influence gait and posture. True limb length and apparent limb length were measured to identify any discrepancies that could affect biomechanics. Thigh girth and calf girth were recorded to assess muscle mass and distribution, providing additional context to the physical characteristics of the participants. A foot sensory assessment was also conducted to evaluate sensation and responsiveness of the feet, which is important for balance and coordination.

The fourth part of the testing involved static and dynamic plantar pressure assessment using the Wintrack system. This advanced technology allowed for a detailed analysis of the pressure distribution on the feet during both static standing and dynamic movements. By capturing data on how pressure is distributed across the foot, researchers could gain understandings into the biomechanics and potential issues related to foot function.

The fifth part of the assessment focused on fitness, encompassing a range of physical tests designed to evaluate overall fitness levels. This included the Harvard step test, which measures cardiovascular fitness and endurance, and the vertical jump test, which assesses lower body power. Additionally, participants performed crunches and push-ups to evaluate core and upper body strength, respectively. The V sit & reach test was used to measure flexibility, while the Y balance test assessed dynamic balance and stability. These fitness assessments provided a comprehensive overview of the participants' physical capabilities and helped identify any differences between the observational & control group.

The sixth part of the testing involved a thorough postural assessment, conducted in multiple views including anterior, posterior, left lateral, and right lateral. This assessment aimed to identify any postural abnormalities or asymmetries that could influence physical performance and overall health. By capturing detailed information on posture, researchers could analyze the relationship between postural alignment and various physical and cognitive parameters.

The final part of the assessment was foot print analysis, which involved taking detailed imprints of the participants' feet. This analysis provided additional data on foot structure and pressure distribution, complementing the static and dynamic plantar pressure assessments. By examining the footprints, researchers could identify variations in arch height, foot shape, and weight distribution, contributing to a comprehensive understanding of foot mechanics.

3.11 Statistical Analysis

In this section, the statistical methods and analysis utilized to investigate research question posed in our study has been discussed. The primary objective of this analyses is to exact meaningful insights and validate hypothesis by applying appropriate statistical techniques. By leveraging both descriptive and inferential statistics, we aim to thoroughly understand the pattern and relationship within the data. This section begins with an overview of the data presentation process including data cleaning preliminary examination to ensure integrity and reliability of the dataset.

The data was analyzed using SPSS version 22 (developed by IBM in the United States, headquartered in Armonk, New York). and Microsoft excel 2016 (developed by Microsoft, a company based in the United States). The statistical analysis of our study begins with the normality testing to ensure usage of parametric or non-parametric test for our study. After normality testing descriptive statistics provides summary of the key characteristics of the data set including measure of central tendency (mean, median & mode) and the variability (standard deviation & range). These statics offers a preliminary understanding of the data distribution and highlights any anomalies or outliers. After descriptive analysis, inferential statistics is used to delve into hypothesis testing and confidence interval estimation to draw conclusion about population from the sample. For comparison within group paired student T test was used and for comparison between Bhangra dancer & Non-dancer group, Independent T test was used. Karl Pearson and regression analysis was employed to assess relationship and differences between variables.

Multivariate analysis was used to explore more complex interactions among the multiple variables simultaneously. Multiple regression, factor analysis and cluster analysis are utilized to cover deeper insights and patterns within the data.

Normality testing

Normality testing was used to determine whether the data set is well modeled by normal distribution. Several statistical tests and methods are available for testing normality and for our study we assessed by Shapiro-Wilk test using formula:

$$w = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

where:

- W is the test statistic.
- $x_{(i)}$ are ordered sample values.
- $\bar{x}$ is sample mean.
- a_i are constants generated from means, variances, and covariance of the order statistics of a sample of size n from a normal distribution.

Mean & standard deviation

The mean is the sum of the observations divided by number of observations. It is the measure of central tendency. Mean of all the variables was evaluated using the formula:

$$\frac{1}{n}\Sigma_{i=1}^{n}x_i$$

where:

x̄ is mean

n is number of observations

xi is i-th observation

Standard Deviation

The standard deviation (SD) measures the amount of dispersion in the dataset. Low standard deviations indicate that the values tend to be close to mean, while a high standard deviation indicates that the values are spread out over a wider range. Along with the mean standard deviation was evaluated by using formula:

$$\text{For Population: } \sigma = \sqrt{\frac{1}{N}\Sigma_{i=1}^{N}(X_i - \mu)^2}$$

$$\text{For Sample: } s = \sqrt{\frac{1}{n-1}\Sigma_{i=1}^{n}(x_i - \bar{x})^2}$$

Where:

- σ is population standard deviation
- s is sample standard deviation
- N is number of observations in the population
- n is number of observation in the sample
- μ is population mean
- x̄ is sample mean
- xi is i-th observation

Hypothesis testing

The hypothesis was tested to confirm whether there was difference between the biomechanical static and dynamic foot characteristics of bhangra dancer as compared to non-dancers. hypothesis was tested by using Independent T test (Unpaired T test) to confirm whether there is significant difference between the foot characteristics of dancer group & non-dancer group. Paired T test was also used to assess whether there is difference between the left & right side of the same participant from both the groups. The formula used for paired T test & Unpaired T test was:

Paired t test:

$$t = \frac{\bar{d}}{sd \, / \, \sqrt{n}}$$

Where

- $\bar{d}$ is mean difference between the two observations
- Sd is standard deviation of differences
- n is the number of pair's

Unpaired t test:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where:

- $\bar{x}1$ is mean of first group
- $\bar{x}2$ is mean of second group
- S1 is standard deviation of first group
- S2 is standard deviation of second group
- n1 is sample size of first group
- n2 is sample size of second group

Correlation

Correlation measures strength & direction of a linear relationship between two variables. The most common measure of correlation is the Pearson correlation coefficient. In our study we measured the correlation between the different variables to find the positive or negative association between the different variables. The formula used to measure the correlation is:

$$\gamma = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \Sigma_{i=1}^{n}(y_i - \bar{y})^2}}$$

Where

- γ is Pearson correlation coefficient

- xi and yi are individual sample points indexed with i
- $\bar{x}$ and $\bar{y}$ are mean of variables x and y
- n is number of observations

Regression

Regression analysis is used for modelling and analyzing relationship between dependent variable & one or more independent variables. Simple Linear regression evaluates the one dependent variable (Y) & one independent variable (X) and multiple linear regression evaluates relationship between dependent variable (Y) and multiple independent variables (X_1, X_2………., X_p). In our study both simple and multiple linear regression was analyzed. The formula used to calculate **Simple Linear Regression** and **Multiple Linear Regression** are as follows:

Simple Linear Regression Equation:

$$\mathrm{Y = b0 + b1X + \epsilon}$$

Where:

- Y = Dependent variable (outcome)
- X = Independent variable (predictor)
- $b0$= Intercept (constant)
- $b1$= Slope coefficient (change in Y for one-unit change in X)
- ϵ = Error term (residuals)

Multiple Linear Regression Equation: $\mathrm{Y = b0 + b1X1 + b2X2 + \cdots + bpXp + \epsilon}$

Where:

- X1, X2, ..., Xp = Independent variables
- b1, b2, ……..., bp = Regression coefficients for each independent variable

CHAPTER IV

RESULT

4.1 Overview

The data was collected and result of this study was analyzed with the help of the IBM statistical package of social sciences Version 22 and Microsoft excel 2016. The descriptive and interferential data was determined. The correlation was examined within the variables used in the study. The linear and multiple regression analysis was evaluated between dependent and independent variables. Total sample of the study 128 and 10-15% of Drop out = 141 (70 dancers and 70 Non Dancers) was part of our study.

After completing the data collection process, the subsequent step involved a meticulous assessment and analysis to derive meaningful insights and conclusions from the collected data. Initially, the data underwent a thorough cleaning and preparation phase and excel file was prepared. All collected data were accurately entered into a SPSS statistical software program. During the data cleaning process, any errors or inconsistencies were identified and corrected, duplicate entries were removed, and missing data were handled appropriately through imputation methods or exclusion of incomplete cases. Qualitative data were assigned numerical or categorical codes to facilitate the analysis.

Descriptive statistics was calculated to summarize the data. This involved determining the mean, median, mode, standard deviation, and range for continuous variables, as well as frequencies and percentages for categorical variables. Visual representations of the data, such as histograms, bar charts were created to understand the distribution and identify any outliers.

Normality of the data was assessed using the Shapiro-Wilk test and Q-Q plots. The data was found to be normally distributed so the parametric tests were used for hypothesis testing and correlation.

Inferential statistical methods were applied to test the research hypotheses. Appropriate statistical tests, such as t-tests for comparing means between two groups, Karl Pearson correlation, Regression analysis, both simple and multiple, was performed.

The results were interpreted with a focus on statistical significance, effect sizes, and confidence intervals. P values were compared to determine whether to reject or accept null hypothesis. Finally, results were reported in a clear and detailed manner. Summary tables and graphs were created to present the key findings succinctly. A detailed explanation of the results was provided, including discussions on statistical significance, effect sizes, and confidence intervals. The findings were compared to the initial research hypotheses, and limitations of the study that might affect the results or their interpretation were acknowledged. Conclusions were drawn based on the results, and their implications for theory, practice, or further research were discussed. To ensure the reliability of the findings, cross-validation techniques were employed where applicable, and the results were subjected to peer review by experts in the field

4.2 Normality testing:

The normality of dataset was tested by using Shapiro wilk normality test. The Shapiro-Wilk test statistics (W values) for the variables Age, Weight, Height, and BMI was 0.853, 0.976, 0.982, 0.983. These statistics represent the Shapiro-Wilk test results (W values) for different variables. These values indicate how closely the distribution of each variable matches normal distribution. Generally, values closer to 1 suggest a distribution that is closer to normal. However, it's important to also consider the corresponding p values to determine statistical significance and confirm the normality of the distributions. Normality testing indicates Age may deviate significantly from normality but Weight, Height, and BMI may have distributions that are relatively close to normal, with BMI potentially being the closest to normality among the variables as given in table 6.

Table 6 displaying Normality testing using Shapiro- Wilk Normality test

Variables	Normality value	Sig.
Age (years)	.853	.000
Weight (kg)	.976	.013
Height (cm)	.982	.064
BMI (kg/cm^2)	.983	.074

4.3 Descriptive statistics of demographic variables of the participants

Total of 140 participants were included in our study, 70 were Bhangra dancers and 70 non dancers. The table 7 and Graph 1 provides a summary of descriptive statistics for a sample of 140 individuals, presenting data on four variables: age in years, weight in kgs, height in cm, and BMI in kg/m^2.

The age of participants ranged from 18 -38 years, with a mean age of 22.26 years. This indicates that the sample is relatively young, with the majority of individuals being in their early twenties. The standard deviation of 3.38 years suggests moderate variability in the age of participants, while the variance of 11.43 years squared reflects the dispersion of age values around the mean.

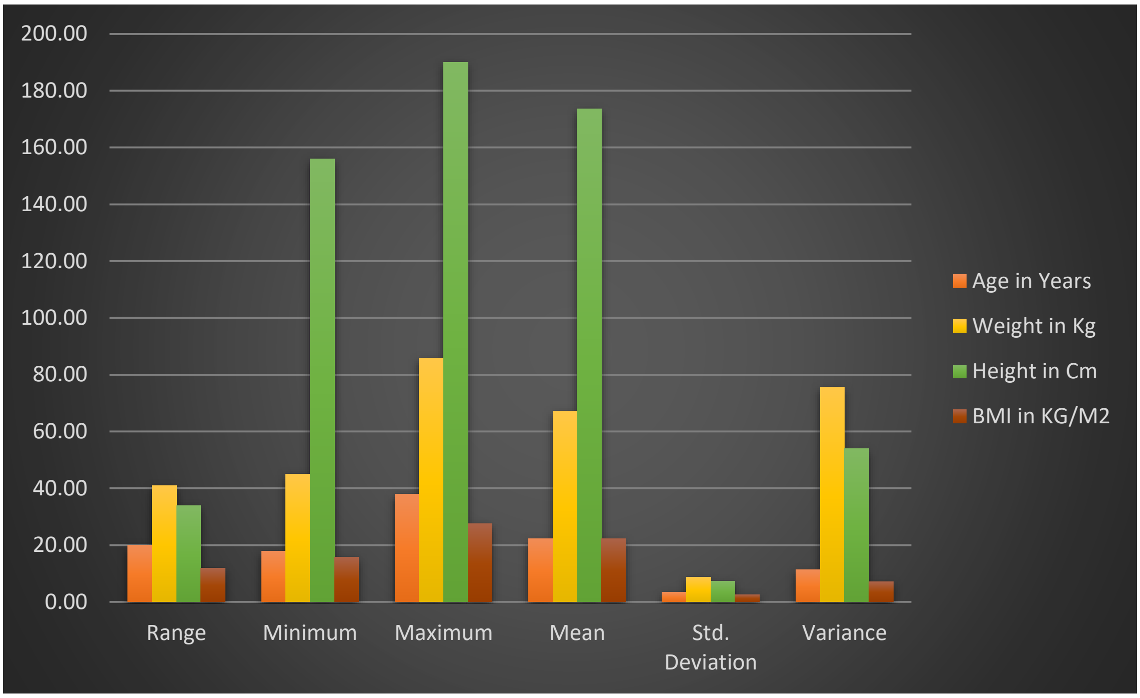
The weight of participant's ranged from 45 kg to 86 kg, covering a range of 41 kg. The mean weight is 67.18 kg, indicating that the average participant has a weight within the healthy range for adults. The standard deviation is 8.70 kg, showing a higher variability compared to age, which is also reflected in the variance of 75.70 kg squared. This suggests that the sample includes individuals with a wide variety of body weights.

Participants' heights ranged from 156 cm to 190 cm, a 34 cm span, with an average height of 173.70 cm. The standard deviation is 7.35 cm, indicating moderate variability in height among the participants. The variance of 53.96 cm squared further highlights this dispersion. The mean height suggests that the sample population is slightly taller than average, which could be of interest depending on the demographic being studied.

BMI values in the sample ranged from 15.70 to 27.64, with a mean BMI of 22.28 kg/m². This mean suggests that, on average, the participants fall within the normal weight range according to standard BMI classifications. The standard deviation of 2.66 kg/m² indicates some variability in body mass relative to height, while the variance of 7.07 kg/m² squared underscores this spread. The BMI range and mean suggest that while the sample includes individuals from underweight to overweight categories, the average participant maintains a healthy BMI.

Table 7 displaying descriptive statistics of Demographic variables of participants (N=140)

Variables	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Age (years)	20.00	18.00	38.00	22.26	3.38	11.43
Weight (kg)	41.00	45.00	86.00	67.18	8.70	75.70
Height (cm)	34.00	156.00	190.00	173.70	7.35	53.96
BMI (kg/cm^2)	11.94	15.70	27.64	22.28	2.66	7.07



Graph 1 displaying demographic description of the participants included in the study

4.3.1 Age description

Two groups were included in our study Bhangra dancer group and Non-dancer group with each group having 70 participants (N=70). Table 8 and Graph 2 summarize the descriptive statistics for dancers & Non-dancers. In our study the dancers had the mean age of 22.01 years, with a standard deviation (SD) of 3.32 years and a standard error of the mean (SEM) of 0.40 years. This indicates that the dancers have moderate amount of variability in their ages. In comparison, the mean age of the Non-dancers is 22.51 years, with a standard deviation of 3.45 years and a standard error of the mean of 0.41 years. The difference in age between the two groups is minimal, with both groups exhibiting similar variability.

4.3.2 Weight description

The mean weight for dancers is 70.09 kg, with a SD of 7.10 kg and a SEM of 0.85 kg. This suggests that dancers had low variability in their weights. On the other hand, the mean weight for Non-dancers is 64.27 kg, with a SD of 9.21 kg and a SEM of 1.10 kg. Non-dancers weigh less on average, with greater variability in their weights compared to dancers.

4.3.3 Height description

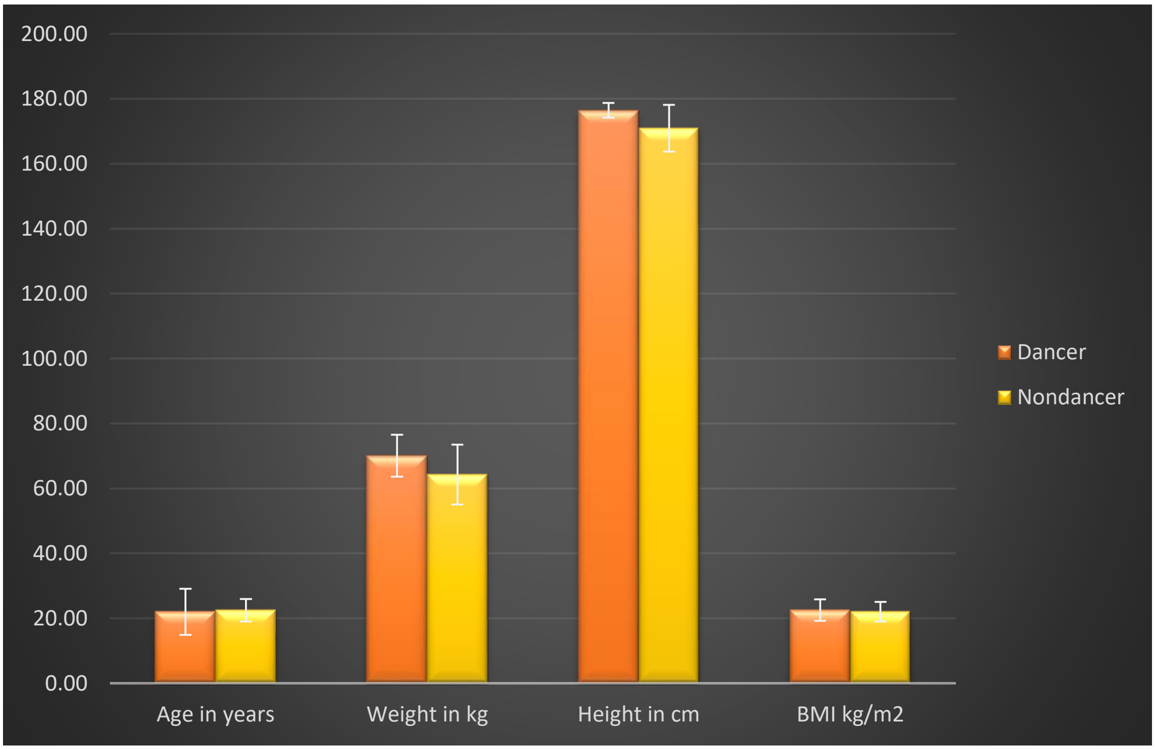
Dancers have a mean height of 176.45 cm, with a SD of 6.49 cm and a standard error of the mean of 0.78 cm. This indicates that dancers have moderate variability in height. Non-dancers, in contrast, have a mean height of 170.94 cm, with a SD of 7.16 cm and a standard error of the mean of 0.86 cm. Non-dancers are shorter on average, with similar variability in height compared to dancers.

4.3.4 Body Mass Index (BMI) description

The mean BMI for dancers is 22.54 kg/m², with a SD of 2.28 kg/m² and a standard error of the mean of 0.27 kg/m². This suggests that dancers have a slightly higher BMI on average, with lower variability in BMI. Non-dancers have a mean BMI of 22.01 kg/m², with a SD of 2.99 kg/m² and a standard error of the mean of 0.36 kg/m². Non-dancers have a slightly lower BMI on average, with greater variability in BMI.

Table 8 displaying the description of demographic variables of Dancers and Non-dancer group

Variables	Group	Mean	Std. Deviation	Std. Error Mean
Age (years)	Dancer	22.01	3.32	0.40
	Non-dancer	22.51	3.45	0.41
Weight (kg)	Dancer	70.09	7.10	0.85
	Non-dancer	64.27	9.21	1.10
Height (cm)	Dancer	176.45	6.49	0.78
	Non-dancer	170.94	7.16	0.86
BMI (kg/m²)	Dancer	22.54	2.28	0.27
	Non-dancer	22.01	2.99	0.36



Graph 2 displaying mean and standard deviation of demographic variables of Dancers and Non-dancers

4.4 Inferential statistical of the demographic variables of the participants

In our study on comparing the mean of demographic variables between two groups by using Levene's test to assesses the equality of variances between groups (table 9), indicating significant differences in variances for Weight and BMI ($p = 0.01$ and $p < 0.001$, respectively), but no significant differences for Age and Height ($p = 0.37$ and $p = 0.23$, respectively). The t-test for Equality of Means shows significant differences in mean values for Weight ($p < 0.001$, Mean Difference = 5.81, 95% CI [3.06, 8.56]) and Height ($p < 0.001$, Mean Difference = 5.51, 95% CI [3.23, 7.80]), indicating these variables vary significantly between the groups. In contrast, there are no significant mean differences observed for Age ($p = 0.38$, Mean Difference = -0.50, 95% CI [-1.63, 0.63]) and BMI ($p = 0.24$, Mean Difference = 0.53, 95% CI [-0.36, 1.42]), despite differences in variance for BMI. These findings suggest that while there are notable differences in Weight and Height between the groups, Age and BMI do not differ significantly on average, despite some variability in BMI measurements.

Table 9 displaying comparison of mean of demographic variables of both the groups

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Age (years)	0.82	0.37	-0.87	0.38	-0.5	0.57
Weight (kg)	7.86	0.01	4.18	0	5.81	1.39
Height (cm)	1.46	0.23	4.78	0	5.51	1.15
BMI (kg/cm^2)	8.97	0	1.18	0.24	0.53	0.45

4.5 Descriptive Statistics of Dominance (Hand and leg) of the participants

4.5.1 Hand Dominance

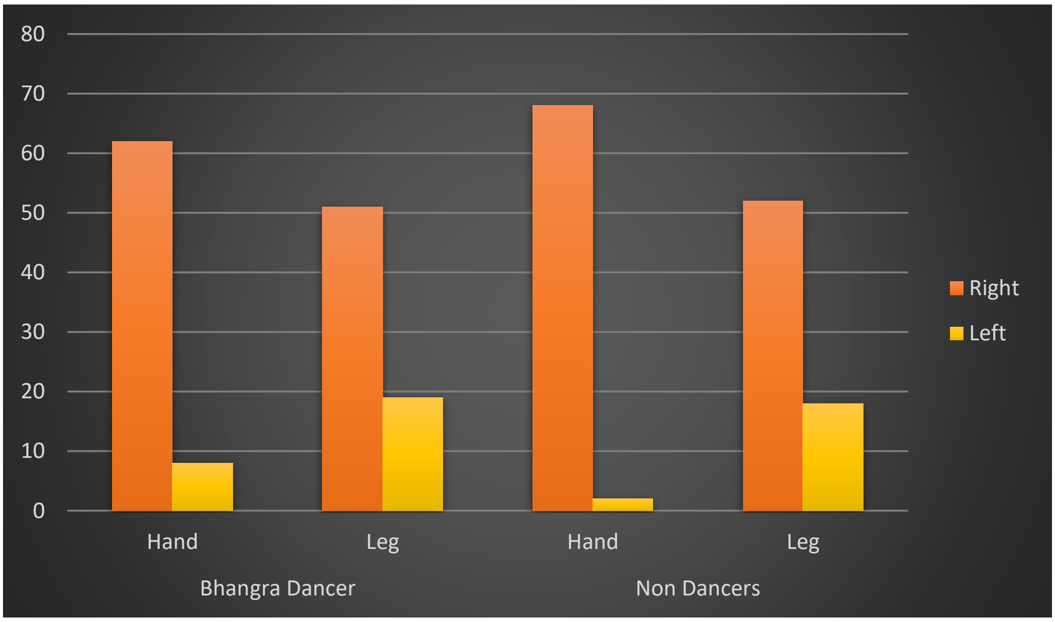
In the dancer group out of 70 participants, 62 were right-handed (88.57%), while 8 participants (11.43%) were left-handed. This indicates a greater diversity in hand dominance among dancers compared to non-dancers. In contrast, the non-dancer group, the majority of participants exhibited right-hand dominance, with 68 out of 70 participants being right-handed, which constitutes 97.14% of the sample. Only 2 participants, or 2.86%, were left-handed. This high prevalence of right-hand dominance is consistent with general population trends (table 10 and Graph 3).

4.5.2 Leg Dominance

In the dancer group, out of 70 participants, 51 participants (72.86%) being right-legged and 19 participants (27.14%) being left-legged. In the non-dancer group, 52 participants (74.29%) were right-legged, while 18 participants (25.71%) were left-legged. The dancer group had a slightly higher percentage of left-legged individuals compared to the non-dancer group, both groups predominantly displayed right-leg dominance. The higher occurrence of left-leg dominance in the dancer group might be related to the specific physical demands and training regimens associated with dancing, which often require greater ambidexterity and balance (table 10 and Graph 3).

Table 10 displaying the descriptive statistics of dominance (hand and leg) of the participants

	Bhangra Dancer (N=70)		Non Dancers (N=70)	
Side	**Hand**	**Leg**	**Hand**	**Leg**
Right	62 (88.57%)	51 (72.86%)	68 (97.14%)	52 (74.29%)
Left	8 (11.43%)	19 (27.14%)	2 (2.86%)	18 (2.71%)



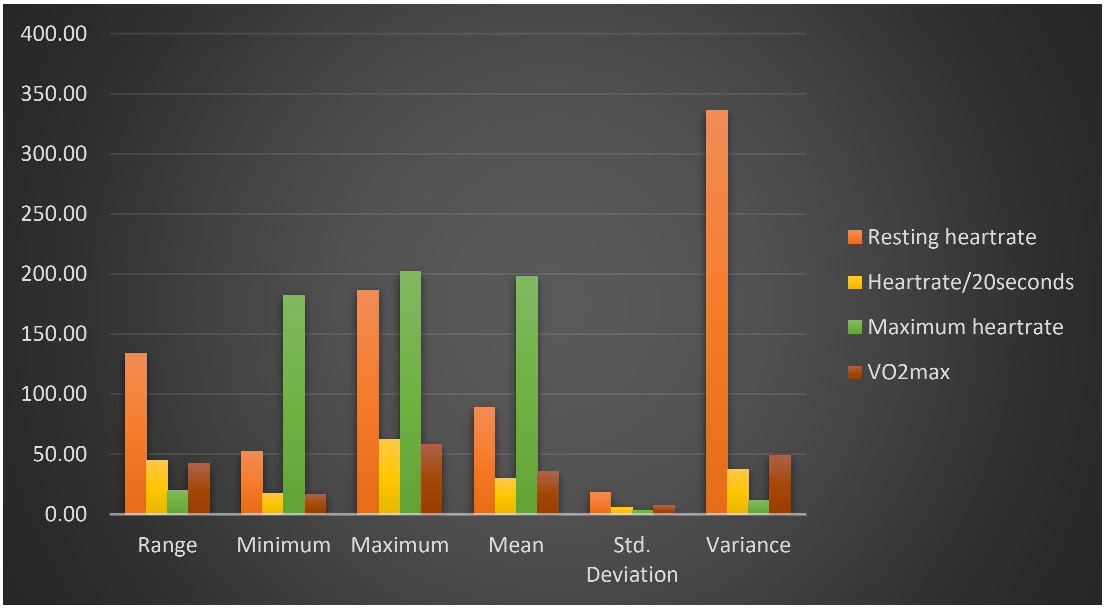
Graph 3 displaying the descriptive statistics of dominance (hand and leg) of the participants

4.6 Descriptive statistics of physiological variables of the participants

In our study four physiological variables were measured in a sample of 140 individuals as summarised in table 11 and graph 4. These variables include Resting Heart Rate, Heart Rate per 20 Seconds, Maximum Heart Rate, and VO2max. For Resting Heart Rate, the values range from 52 to 186 beats per minute, with a mean of 89.01 and a SD of 18.33, indicating substantial variability around the average. The variance for this measure was 335.88. For Heart Rate per 20 Seconds, the range spans from 17.33 to 62, with a mean of 29.67 and a SD of 6.11, suggesting a moderate spread of values, reflected in the variance of 37.32. The Maximum Heart Rate shows a narrower range from 182 to 202 beats per minute, with a high mean of 197.74 and a low SD of 3.38, indicating values are closely clustered around the mean; the variance here is 11.43. Finally, VO2max values vary between 16.45 and 58.57, with a mean of 35.33 and a SD of 7.01, highlighting a moderate level of dispersion, as evidenced by the variance of 49.18. Overall, these statistics provide a detailed overview of the distribution and variability of each variable within the sample.

Table 11 displaying the descriptive statistics of physiological variables of both groups

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Resting heart rate	134.00	52.00	186.00	89.01	18.33	335.88
Heartrate/20sec	44.67	17.33	62.00	29.67	6.11	37.32
Max. heartrate	20.00	182.00	202.00	197.74	3.38	11.43
VO2max	42.12	16.45	58.57	35.33	7.01	49.18



Graph 4 displaying descriptive statistics of physiological variables of participants

4.6.1 Resting heart rate:

The resting heartrate values indicate the average number of heart beats per minute while the subjects are at rest. For the dancer group, the mean resting heartrate is 94.33 beats per minute with a SD of 19.26, implying some variability around the mean. The standard error of the mean (SEM) is 2.30, which measures the precision of the sample mean as an estimate of the population mean. In contrast, the non-dancer group has a lower mean resting heartrate of 83.70 beats per minute, with a SD of 15.76 and a SEM of 1.88. This suggests that, on average, dancers have a higher resting heartrate compared to non-dancers, but the variability within each group is relatively comparable (table 12 & graph 5).

4.6.2 Heartrate per 20 seconds:

This variable measures the number of heartbeats over a 20-second period. Dancers have a mean heartrate of 31.44 beats per 20 seconds, with a SD of 6.42, and a SEM of 0.77. Non-dancers have a lower mean heartrate of 27.90 beats per 20 seconds, with a SD of 5.25 and a SEM of 0.63. The higher mean in the dancer group suggests that, even in shorter time intervals, dancers tend to have a higher heartrate compared to non-dancers (table 12 & graph 5).

4.6.3 Maximum heart rate:

The maximum heartrate represents the highest number of heart beats per minute recorded during the study. For dancers, the mean maximum heartrate is 197.99 beats per minute, with a SD of 3.32 and a SEM of 0.40. Non-dancers have a very similar mean maximum heartrate of 197.49 beats per minute, with a slightly higher SD of 3.45 and a SEM of 0.41. These results indicate that both groups reach similar maximum heartrates, with minimal variation within each group (table 12 & graph 5).

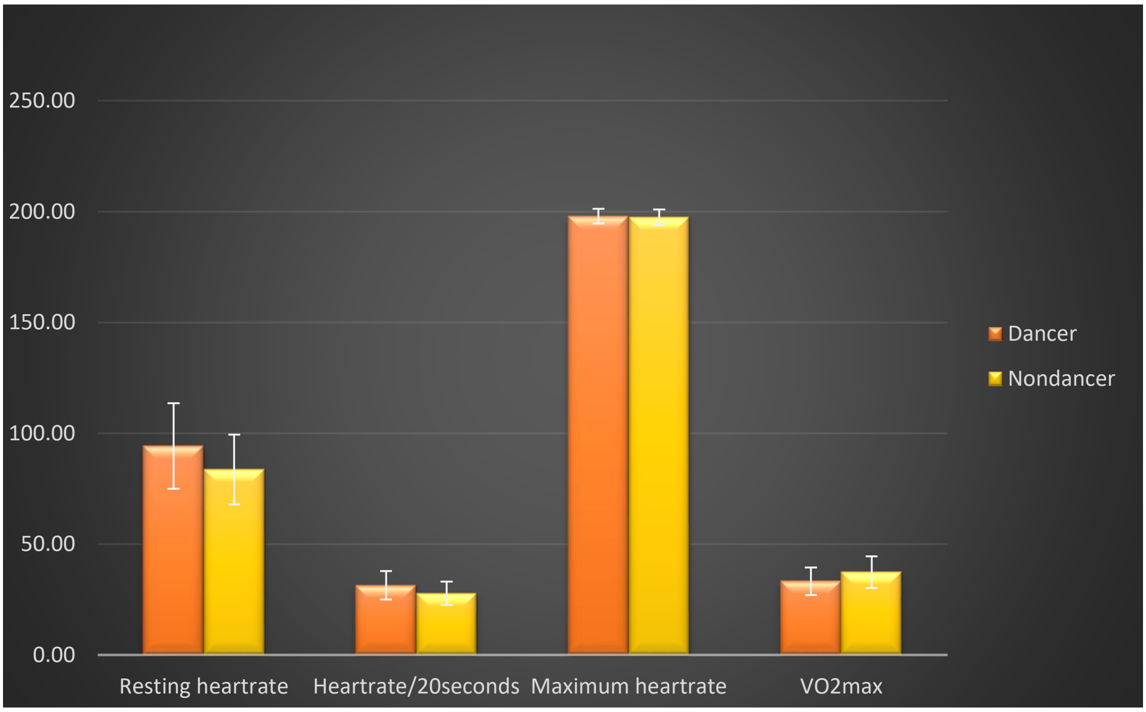
4.6.4 VO2 Max:

VO2max is a measure of the maximum volume of oxygen that an individual can use during intense exercise and is an indicator of cardiovascular fitness. Dancers have a mean VO2max of 33.30 ml/kg/min, with a SD of 6.26 and a SEM of 0.75. Non-dancers have a higher mean VO2max of 37.36 ml/kg/min, with a SD of 7.18 and a SEM of 0.86. This suggests that non-dancers, on average, have a higher cardiovascular fitness level compared to dancers, with a slightly greater variability in their fitness levels (table 12 & graph 5).

Table 12 displaying the description of physiological variables of Dancers and Non-dancer group

Variables	Group	Mean	Std. Deviation	Std. Error Mean
Resting	Dancer	94.33	19.26	2.30
Heart rate	Non-dancer	83.70	15.76	1.88
Heartrate/20sec	Dancer	31.44	6.42	0.77

	Non-dancer	27.90	5.25	0.63
Maximum heart rate	Dancer	197.99	3.32	0.40
	Non-dancer	197.49	3.45	0.41
VO2max	Dancer	33.30	6.26	0.75
	Non-dancer	37.36	7.18	0.86



Graph 5 displaying descriptive statistics of physiological variables of both groups

4.7: Inferential statistics of physiological variables of the participants

The table 13 presents statistical analyses comparing bhangra dancers and non-dancers on four physiological variables: resting heartrate, heartrate per 20 seconds, maximum heartrate, and VO2max. The F and Sig. values indicate no significant difference in the variances between the groups for all variables. The t-test results reveal significant differences in resting heartrate ($t = 3.57$, $p = 0.00$), heartrate per 20 seconds ($t = 3.57$, $p = 0.00$), and VO2max ($t = -3.57$, $p = 0.00$), with dancers exhibiting higher resting heartrates and short-interval heartrates, while non-dancers have higher VO2max. However, there is no significant difference in the maximum heart rate ($t = 0.87$, $p = 0.38$). The mean differences reinforce these findings, showing that dancers have a higher resting heartrate by 10.63 beats per minute and a higher heartrate per 20 seconds by 3.54 beats, whereas non-dancers have a higher VO2max by 4.06 ml/kg/min (table 13).

Table 13 displaying comparison of mean of cardiac variables of both the groups

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Resting heartrate	1.62	0.20	3.57	**0.00**	10.63	2.97
Heartrate/20seconds	1.62	0.20	3.57	**0.00**	3.54	0.99
Maximum heartrate	0.82	0.37	0.87	0.38	0.50	0.57
VO2max	0.01	0.93	-3.57	**0.00**	-4.06	1.14

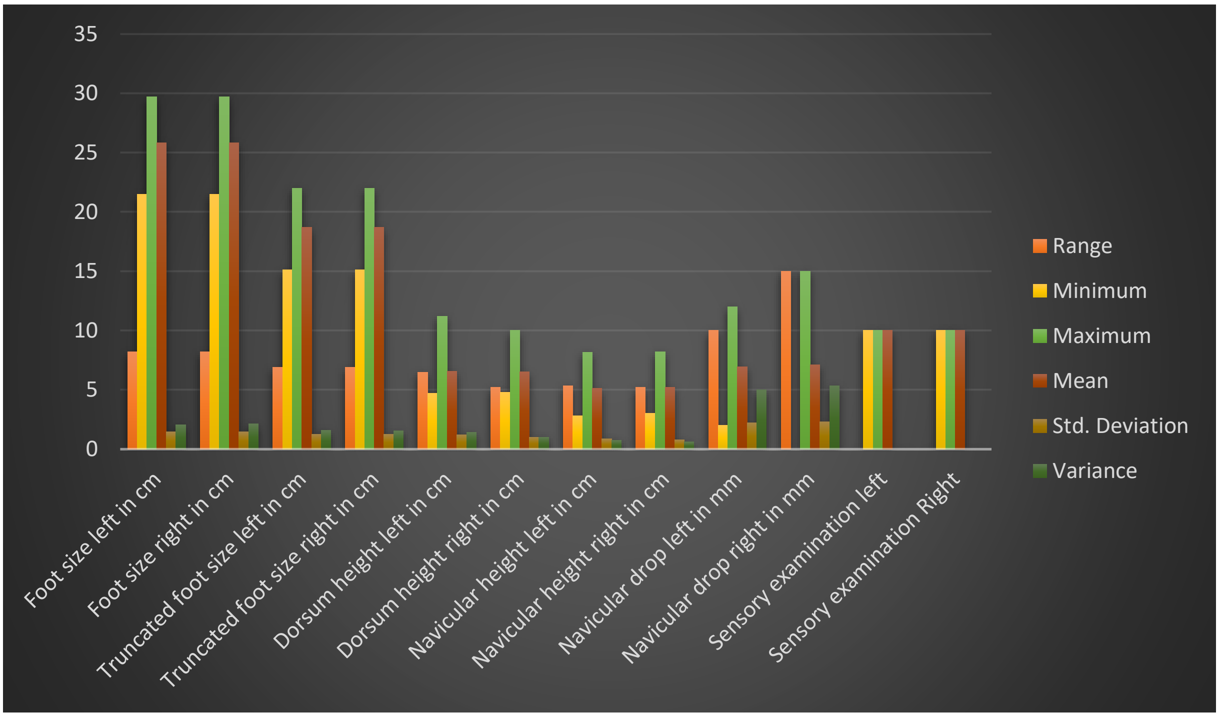
4.8 Descriptive statistics of foot variables of the participants (N=140)

In our study detailed measurements providing a comprehensive profile of foot characteristics within the sample of 140 individuals were studied given (table 14 & graph 6). They are essential for understanding biomechanical complexities, aiding in the development of tailored footwear solutions and informing clinical approaches to foot health and orthopedic care. The measurements encompass both left and right feet and include foot size, truncated foot size, dorsum height, navicular height, and navicular drop.

The Foot size, averaging 25.83 cm with a SD of 1.44 cm for both feet, provides a baseline for foot dimensions within the sample. Truncated foot size, a more constrained measure, averages 18.70 cm for the left foot and 18.68 cm for the right, indicating a narrower range in comparison to the overall foot size. Dorsum height, ranging from 4.70 cm to 11.20 cm, averages 6.57 cm for the left foot and 6.51 cm for the right foot. This measurement highlights the vertical elevation of the foot's dorsum, crucial for understanding arch support and foot mechanics. Navicular height, varying from 2.80 cm to 8.16 cm, shows an average of 5.11 cm for the left foot and 5.21 cm for the right foot. This metric is essential for assessing the height of the navicular bone, a key indicator in foot arch analysis. Navicular drop, measuring the difference in height when weight is applied, ranges from 2.00 mm to 15.00 mm, with averages of 6.95 mm for the left foot and 7.11 mm for the right foot. The sensory measurements for both left and right sides are consistently at the maximum value of 10.00, resulting in a range of 0.00, a SD of 0.00, and a variance of 0.00. This indicates no variability, with all participants having the maximum sensory score.

Table 14 displaying the descriptive statistics of foot variables of participants (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Foot size left (cm)	8.20	21.50	29.70	25.83	1.44	2.07
Foot size right (cm)	8.20	21.50	29.70	25.82	1.45	2.11
Truncated foot size left (cm)	6.90	15.10	22.00	18.70	1.25	1.57
Truncated foot size right (cm)	6.90	15.10	22.00	18.68	1.24	1.53
Dorsum height left (cm)	6.50	4.70	11.20	6.57	1.19	1.42
Dorsum height right (cm)	5.20	4.80	10.00	6.51	1.01	1.02
Navicular height left (cm)	5.36	2.80	8.16	5.11	0.86	0.73
Navicular height right (cm)	5.20	3.00	8.20	5.21	0.79	0.62
Navicular drop left (mm)	10.00	2.00	12.00	6.95	2.23	4.98
Navicular drop right (mm)	15.00	0.00	15.00	7.11	2.32	5.37
Sensory examination left	0.00	10.00	10.00	10.00	0.00	0.00
Sensory examination Right	0.00	10.00	10.00	10.00	0.00	0.00



Graph 6 displaying the descriptive statistics of foot variables of participants (N=140)

4.8.1 Foot Size

The left foot, dancers have an average foot size of 25.79 cm (SD = 1.72 cm, SE = 0.21 cm), while non-dancers have a slightly larger average of 25.87 cm (SD = 1.10 cm, SE = 0.13 cm). The right foot shows a similar trend, with dancers averaging 25.77 cm (SD = 1.74 cm, SE = 0.21 cm) and non-dancers averaging 25.87 cm (SD = 1.10 cm, SE = 0.13 cm). These measurements indicate minimal difference in foot size between the two groups (table 15 & graph 7).

4.8.2 Truncated foot size

The truncated foot size, which provides a narrower measurement range, shows that for the left foot, dancers have an average size of 18.67 cm (SD = 1.44 cm, SE = 0.17 cm), while non-dancers average 18.72 cm (SD = 1.05 cm, SE = 0.13 cm). For the right foot, dancers average 18.65 cm (SD = 1.41 cm, SE = 0.17 cm) compared to non-dancers' 18.71 cm (SD = 1.04 cm, SE = 0.12 cm) (table 15 & graph 7).

4.8.3 Dorsum height

Dorsum height varies more distinctly between dancers and non-dancers. For the left foot, dancers have an average dorsum height of 7.16 cm (SD = 1.29 cm, SE = 0.15 cm), compared to 5.99 cm (SD = 0.71 cm, SE = 0.08 cm) for non-dancers. The right foot follows this pattern, with dancers averaging 7.01 cm (SD = 1.02 cm, SE = 0.12 cm) and non-dancers averaging 6.00 cm (SD = 0.71 cm, SE = 0.09 cm). These differences highlight the impact of dance on foot arch height (table 15 & graph 7).

4.8.4 Navicular Height

Navicular height, an important indicator of arch height, also shows variation between the groups. For the left foot, dancers have an average navicular height of 5.29 cm (SD = 1.01 cm, SE = 0.12 cm), while non-dancers average 4.92 cm (SD = 0.62 cm, SE = 0.07 cm). The right foot averages are 5.46 cm (SD = 0.86 cm, SE = 0.10 cm) for dancers and 4.96 cm (SD = 0.62 cm, SE = 0.07 cm) for non-dancers. These findings suggest that dancers generally have higher navicular bones (table 15 & graph 7).

4.8.5 Navicular drop

Navicular drop, measures the descent of the navicular bone underweight, shows subtle differences. For the left foot, dancers average a navicular drop of 6.88 mm (SD = 2.45 mm, SE = 0.29 mm) compared to 7.01 mm (SD = 2.01 mm, SE = 0.24 mm) for non-dancers. For the right foot, the averages are 7.21 mm (SD = 2.63 mm, SE = 0.31 mm) for dancers and 7.02 mm (SD = 1.97 mm, SE = 0.24 mm) for non-dancers. These measurements indicate a slightly greater navicular drop in dancers' right feet (table 15 & graph 7).

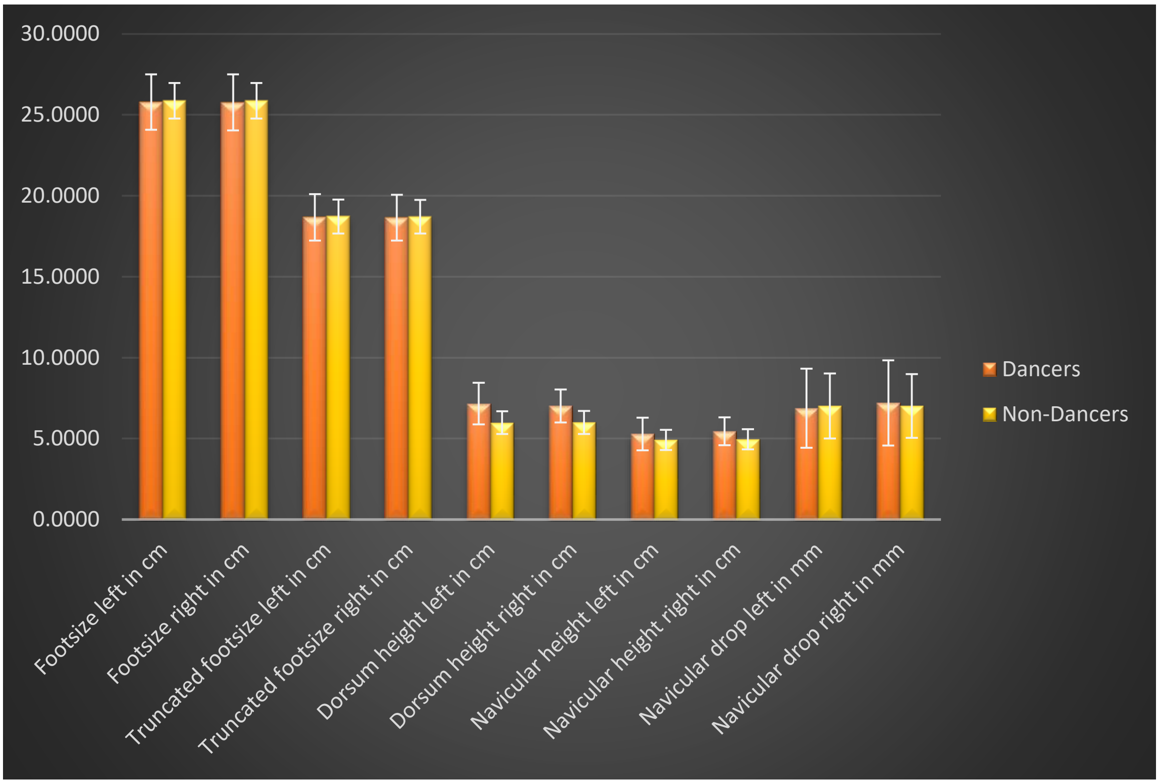
4.8.6 Sensory examination of foot

Sensory examination of left and right foot indicated. both variables show identical characteristics across their distributions. Specifically, the data range from a minimum of 10.00 to a maximum of 10.00, indicating no variability within the dataset. The mean for both variables is precisely 10.00, and their SD and variance are both 0.00, reflecting no deviation from this mean value across the entire sample. This uniformity suggests that every observation in both cases is exactly 10.00, with no variation or spread in values observed within the dataset (table 15 & graph 7).

Table 15 displaying descriptive statistics of foot characteristics of Dancers and Non- Dancers

Variable	Group	Mean	Std. Deviation	Std. Error Mean
FSL (cm)	Bhangra Dancer	25.79	1.72	0.21
	Non-dancer	25.87	1.10	0.13
FSR (cm)	Bhangra Dancer	25.77	1.74	0.21
	Non-dancer	25.87	1.10	0.13
TFSL (cm)	Bhangra Dancer	18.67	1.44	0.17
	Non-dancer	18.72	1.05	0.13
TFSR (cm)	Bhangra Dancer	18.65	1.41	0.17
	Non-dancer	18.71	1.04	0.12
DHL (cm)	Bhangra Dancer	7.16	1.29	0.15
	Non-dancer	5.99	0.71	0.08
DHR (cm)	Bhangra Dancer	7.01	1.02	0.12
	Non-dancer	6.00	0.71	0.09
NHL (cm)	Bhangra Dancer	5.29	1.01	0.12
	Non-dancer	4.92	0.62	0.07
NHR (cm)	Bhangra Dancer	5.46	0.86	0.10
	Non-dancer	4.96	0.62	0.07
NDL (mm)	Bhangra Dancer	6.88	2.45	0.29
	Non-dancer	7.01	2.01	0.24
NDR (mm)	Bhangra Dancer	7.21	2.63	0.31
	Non-dancer	7.02	1.97	0.24
SELF (10 points)	Bhangra Dancer	10.00	0.00	0.00
	Non-dancer	10.00	0.00	0.00
SERF (10 points)	Bhangra Dancer	10.00	0.00	0.00
	Non-dancer	10.00	0.00	0.00

Note: FSL: Foot size left, FSR: Foot size right, TFSL: Truncated foot size left, TFSR: Truncated foot size right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular Drop right, SELF: Sensory Examination of left foot, SERF: sensory examination of right foot



Graph 7 displaying the descriptive statistics of foot characteristics of Dancers and Non- Dancers

4.9 Inferential statistics for foot characteristics within the groups comparing left and right

4.9.1 Bhangra Dancer Group

The table 16 displays the paired differences for various foot measurements in the dancer group. For the difference in foot size between the left and right feet, the mean difference is 0.02 cm with a SD of 0.13 and a SEM of 0.02. The 95% confidence interval ranges from -0.01 to 0.05. The t value is 1.35, and the p value is 0.18, indicating no significant difference between left & right foot sizes. The difference in truncated foot size between the left and right feet has a mean difference of 0.02 cm, a SD of 0.09, and a SEM of 0.01. The 95% confidence interval ranges from 0.00 to 0.04. The t value is 1.75, and the p value is 0.09, which is close to but not below the threshold for significance. For dorsum height, the difference between the left and right feet shows a mean of 0.15 cm with a SD of 0.86 and a SEM of 0.10. The 95% confidence interval ranges from -0.06 to 0.35. The t value is 1.43, and the p value is 0.16, indicating no significant difference. The navicular height difference between the left and right feet has a mean of -0.17 cm, a SD of 0.92, and a SEM of 0.11. The 95% confidence interval ranges from -0.38 to 0.05. The t value is -1.52, and the p value is 0.13, indicating no significant difference. The navicular drop difference between the left and right feet shows a mean of -0.32 mm, a SD of 2.95, and a SEM of 0.35. The 95% confidence interval ranges from -1.03 to 0.38. The t value is -0.92, and the p value is 0.36, indicating no significant difference.

The Feiss line data indicates a significant prevalence of pronated foot alignment among bhangra dancers. Specifically, 35 out of 70 dancers (50.00%) had below-normal Feiss line measurements on the left foot, which signifies a pronated foot. On the right foot, 28 dancers (40.00%) also exhibited pronation. This trend is reinforced bilaterally, with 19 dancers (27.14%) having below-normal measurements (table 18).

Table 16 displaying comparison of mean of foot variables within the Dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	t	Sig.(2-tailed)
FSL FSR	0.02	0.13	0.02	1.35	0.18
TFSL TFSR	0.02	0.09	0.01	1.75	0.09
DHL DHR	0.15	0.86	0.1	1.43	0.16
NHL NHR	-0.17	0.92	0.11	-1.52	0.13
NDL NDR	-0.32	2.95	0.35	-0.92	0.36

Note: FSL: Foot size left, FSR: Foot size right, TFSL: Truncated foot size left, TFSR: Truncated foot size right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular Drop right

4.9.2 Non-dancer Group:

In non-dancer group foot characteristics of left and right side were compared (table 17). For foot size, the mean difference between the left and right foot was found to be minimal, with an average difference of 0.02 cm. This small difference was statistically non-significant (t = 1.35, p = 0.18), indicating a lack of substantial asymmetry in foot size among non-dancers. Similarly, truncated foot size showed a mean difference of 0.02 cm (t = 1.75, p = 0.09), again suggesting no significant left-right asymmetry. The dorsum height measurements exhibited a slightly larger mean difference of 0.15 cm (t = 1.43, p = 0.16). Despite this difference, it did not reach statistical significance, implying no systematic asymmetry in dorsum height between the left and right feet among non-dancers. Navicular height showed a mean difference of -0.17 cm (t = -1.52, p = 0.13), suggesting a slight tendency for the right navicular to be higher, though this difference was not statistically significant. Navicular drop, on the other hand, displayed a mean difference of -0.32 mm (t = -0.92, p = 0.36), indicating no significant asymmetry in this aspect between the left and right feet., The feiss line was also compared and this group shows a much lower prevalence of pronated feet. On the left foot, 11 out of 70 individuals (15.71%) had below-normal Feiss line measurements, and on the right foot, 10 individuals (14.29%). Bilaterally, only 5 participants (7.14%) showed below-normal measurements. This suggests that non-dancers generally have a more typical foot alignment with fewer instances of pronation (table 18).

Table 17 displaying comparison of mean of foot variables within the Non-Dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)
FSL FSR	0	0.02	0	0	1
TFSL TFSR	0.01	0.07	0.01	1.34	0.18
DHL DHR	-0.02	0.13	0.02	-1.08	0.28
NHL NHR	-0.04	0.15	0.02	-2.05	**0.04**
NDL NDR	0	1.2	0.14	-0.02	0.98

Note: FSL: Foot size left, FSR: Foot size right, TFSL: Truncated foot size left, TFSR: Truncated foot size right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular Drop right

Table 18 displaying data of both the groups for Feiss line variable

Group	Side	Normal	Below	Above
Group 1	Left	32	35	3
	Right	41	28	1
	Bilateral	23	19	0
Group 2	Left	56	11	3
	Right	57	10	3
	Bilateral	51	5	3

4.10 Inferential statistics of foot characteristics between the two groups (Bhangra Dancers and Non- Dancers)

The table 19 presents the results of Levene's Test for Equality of Variances and t-tests for Equality of Means, comparing various foot characteristics between Bhangra dancers and non-dancers. The analysis reveals several significant differences in foot characteristics between dancers and non-dancers, where the p value is less than 0.05.

For foot size (left and right), the variability between the groups is significantly different, indicated by F-values of 15.34 and 16.45, respectively. However, the differences in the mean foot sizes are not statistically significant, with p values of 0.74 for the left foot and 0.68 for the right foot. The mean differences are -0.08 cm for the left foot and -0.10 cm for the right foot, indicating no considerable difference in foot size between dancers and non-dancers.

For truncated foot size (left and right), the variability is also significantly different, with F-values of 6.21 (left) and 6.33 (right). The differences in the mean truncated foot sizes are not significant, with p values of 0.81 for the left foot and 0.78 for the right foot. The mean differences are -0.05 cm (left) and -0.06 cm (right), showing no notable difference between the groups.

Dorsum height measurements reveal significant variability between the groups, with F-values of 13.54 (left) and 5.47 (right). The mean differences are highly significant, with p values of 0.00 for both feet. The mean differences are 1.17 cm (left) and 1.01 cm (right), suggesting difference in the dorsum height of dancers compared to non-dancers.

Navicular height shows significant variability, with F-values of 6.00 (left) and 5.50 (right). The mean differences are statistically significant, with p values of 0.01 (left) and 0.00 (right). The mean differences are 0.37 cm (left) and 0.50 cm (right), indicating that navicular heights are different in both the groups.

Navicular drop measurements indicate significant variability with F-values of 6.01 (left) and 6.26 (right). However, the differences in mean navicular drop are not significant, with p values of 0.73 (left) and 0.63 (right). The mean differences are -0.13 mm (left) and 0.19 mm (right), suggesting no substantial difference in navicular drop between the groups.

In comparing the Feiss line data (table 18), Bhangra dancers show a higher incidence of pronation compared to non-dancers. In Group 1, 50% of dancers exhibit below-normal Feiss line measurements on the left foot and 40% on the right, with 27.14% bilaterally, indicating significant pronation. In contrast, Group 2 has only 15.71% of non-dancers with below-normal measurements on the left foot and 14.29% on the right, with just 7.14% bilaterally. This suggests that Bhangra dancers are more prone to foot pronation, likely due to the specific stresses of dancing, whereas non-dancers generally have more stable foot alignment.

Table 19 displaying mean difference and significance of foot variables between the two groups

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
FSL (cm)	15.34	0.00	-0.34	0.74	-0.08	0.24
FSR (cm)	16.45	0.00	-0.42	0.68	-0.10	0.25
TFSL (cm)	6.21	0.01	-0.24	0.81	-0.05	0.21
TFSR (cm)	6.33	0.01	-0.28	0.78	-0.06	0.21
DHL (cm)	13.54	0.00	6.66	**0.00**	1.17	0.18
DHR (cm)	5.47	0.02	6.79	**0.00**	1.01	0.15
NHL (cm)	6.00	0.02	2.59	**0.01**	0.37	0.14
NHR (cm)	5.50	0.02	3.91	**0.00**	0.50	0.13
NDL (mm)	6.01	0.02	-0.35	0.73	-0.13	0.38
NDR (mm)	6.26	0.01	0.48	0.63	0.19	0.39

Note: FSL: Foot size left, FSR: Foot size right, TFSL: Truncated foot size left, TFSR: Truncated foot size right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular Drop right

4.11 Descriptive statistics of limb measurements of the participants (N=140)

In our study the descriptive statistics given in table 20 and graph 8 reveal that the measurements for true and apparent limb length, as well as thigh and calf girth, exhibit moderate variability, with the apparent foot lengths showing slightly higher variability compared to the true foot lengths. The thigh and calf measurements are consistent between the left and right sides, reflecting similar distributions in these measurements.

The true limb length of the left foot, the measurements range from 79.00 cm to 110.00 cm, yielding a range of 31.00 cm. The mean true limb length is 94.21 cm, with a SD of 5.68 cm, indicating moderate variability around the mean. The variance is 32.28, reflecting the overall dispersion of the data. Similarly, the true limb length of the right foot spans the same range (79.00 cm to 110.00 cm), with a slightly higher mean of 94.31 cm. The SD is 5.74 cm, and the variance is 32.95, showing a similar spread to the left foot.

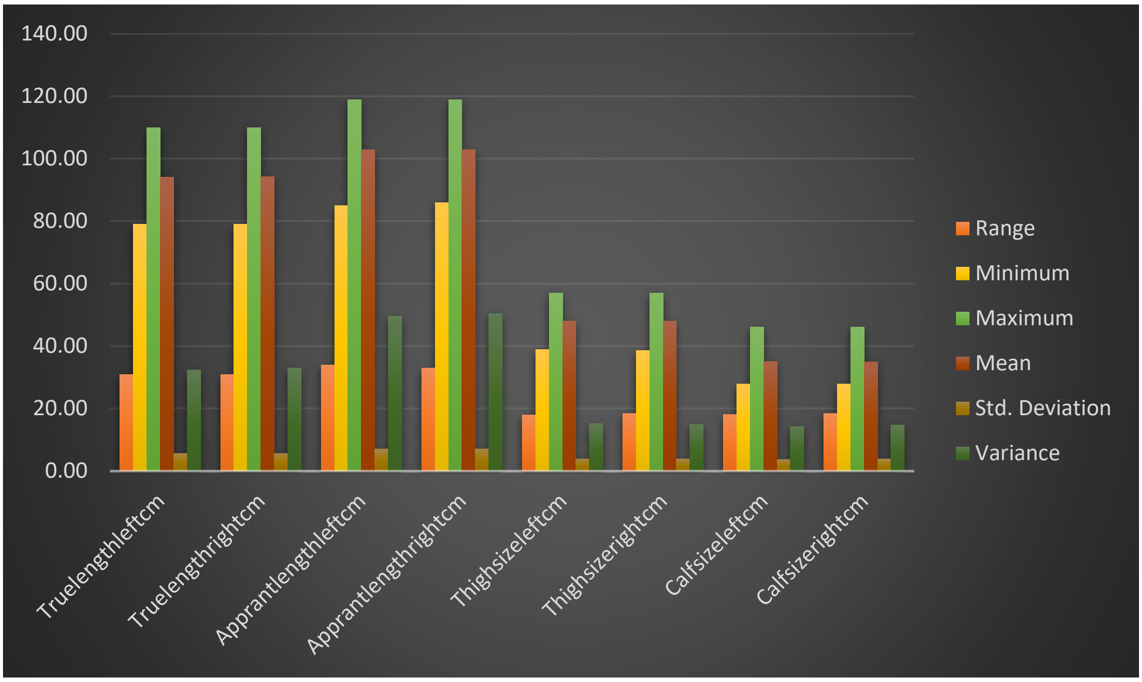
In terms of apparent length, the left foot measurements range from 85.00 cm to 119.00 cm, with a range of 34.00 cm. The mean apparent limb length is 102.88 cm, and the SD is 7.05 cm, indicating higher variability compared to the true length. The variance is notably higher at 49.65. The apparent limb length of the right foot shows a similar pattern, with measurements ranging from 86.00 cm to 119.00 cm, a mean of 102.90 cm, a SD of 7.10 cm, and a variance of 50.42.

For thigh girth, the left thigh measurements range from 39.00 cm to 57.00 cm, with a mean of 48.08 cm. The SD is 3.90 cm, and the variance is 15.25, indicating some variability in thigh girth. The right thigh measurements are similar, ranging from 38.60 cm to 57.00 cm, with a mean of 48.11 cm, a SD of 3.87 cm, and a variance of 14.95, suggesting consistent measurements between the left and right thighs.

The calf girth measurements show that the left calf ranges from 27.80 cm to 46.00 cm, with a mean of 35.05 cm. The SD is 3.78 cm, and the variance is 14.32. The right calf measurements have a similar range from 27.80 cm to 46.20 cm, a mean of 35.03 cm, a SD of 3.84 cm, and a variance of 14.71, indicating a slight increase in variability compared to the left calf.

Table 20 displaying descriptive statistics of limb variables of participants (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
True limb length left (cm)	31.00	79.00	110.00	94.21	5.68	32.28
True limb length right (cm)	31.00	79.00	110.00	94.31	5.74	32.95
Apparent limb length left (cm)	34.00	85.00	119.00	102.88	7.05	49.65
Apparent limb length right (cm)	33.00	86.00	119.00	102.90	7.10	50.42
Thigh Girth left (cm)	18.00	39.00	57.00	48.08	3.90	15.25
Thigh Girth right (cm)	18.40	38.60	57.00	48.11	3.87	14.95
Calf Girth left (cm)	18.20	27.80	46.00	35.05	3.78	14.32
Calf Girth right (cm)	18.40	27.80	46.20	35.03	3.84	14.71



Graph 8 displaying the descriptive statistics of limb measurements of participants (N=140)

4.12 Descriptive statistics of limb measurements of Bhangra Dancers and Non- Dancers

The table provides the means, SDs, and standard errors for various measurements comparing dancers and non-dancers. These statistics offer insights into the differences between the two groups across different physical attributes.

4.12.1 True limb length Measurements

For the true limb length of the left foot, dancers have a mean of 96.13 cm with a SD of 5.57 cm and a standard error of 0.67 cm. Non-dancers have a lower mean of 92.29 cm, with a SD of 5.15 cm and a standard error of 0.62 cm. Similarly, the true limb length of the right foot shows that dancers have a mean of 96.10 cm (SD = 5.61 cm, standard error = 0.67 cm), while non-dancers have a mean of 92.52 cm (SD = 5.33 cm, standard error = 0.64 cm). These results indicate that dancers have longer true foot lengths compared to non-dancers.

4.12.2 Apparent limb length Measurements

The apparent limb length of the left foot for dancers has a mean of 105.32 cm, with a SD of 6.94 cm and a standard error of 0.83 cm. Non-dancers have a mean of 100.44 cm, with a SD of 6.30 cm and a standard error of 0.75 cm. For the right foot, dancers have a mean apparent limb length of 105.28 cm (SD = 6.92 cm, standard error = 0.83 cm), while non-dancers have a mean of 100.53 cm (SD = 6.49 cm, standard error = 0.78 cm). This suggests that dancers also have longer apparent foot lengths compared to non-dancers.

4.12.3 Thigh girth Measurements

In terms of thigh girth, the left thigh for dancers has a mean of 48.22 cm, a SD of 3.17 cm, and a standard error of 0.38 cm. Non-dancers have a mean of 47.95 cm, a SD of 4.55 cm, and a standard error of 0.54 cm. The right thigh measurements are similar, with dancers having a mean of 48.27 cm (SD = 3.06 cm, standard error = 0.37 cm) and non-dancers having a mean of 47.95 cm (SD = 4.55 cm, standard error = 0.54 cm). The results show that dancers and non-dancers have comparable thigh sizes, with slight differences.

4.12.4 Calf Girth Measurements

For calf size, the left calf for dancers has a mean of 36.12 cm, with a SD of 3.56 cm and a standard error of 0.43 cm. Non-dancers have a lower mean of 33.98 cm, with a SD of 3.73 cm and a standard error of 0.45 cm. The right calf shows similar patterns, with dancers having a mean of 36.12 cm (SD = 3.65 cm, standard error = 0.44 cm) and non-dancers having a mean of 33.95 cm (SD = 3.73 cm, standard error = 0.45 cm). This indicates that dancers have larger calf sizes compared to non-dancers.

The data reveals that dancers tend to have longer true and apparent foot lengths and larger calf sizes compared to non-dancers, while the thigh sizes are relatively similar between the two groups. These differences might be attributed to the physical demands and training associated with dancing, which could influence the development of these physical characteristics.

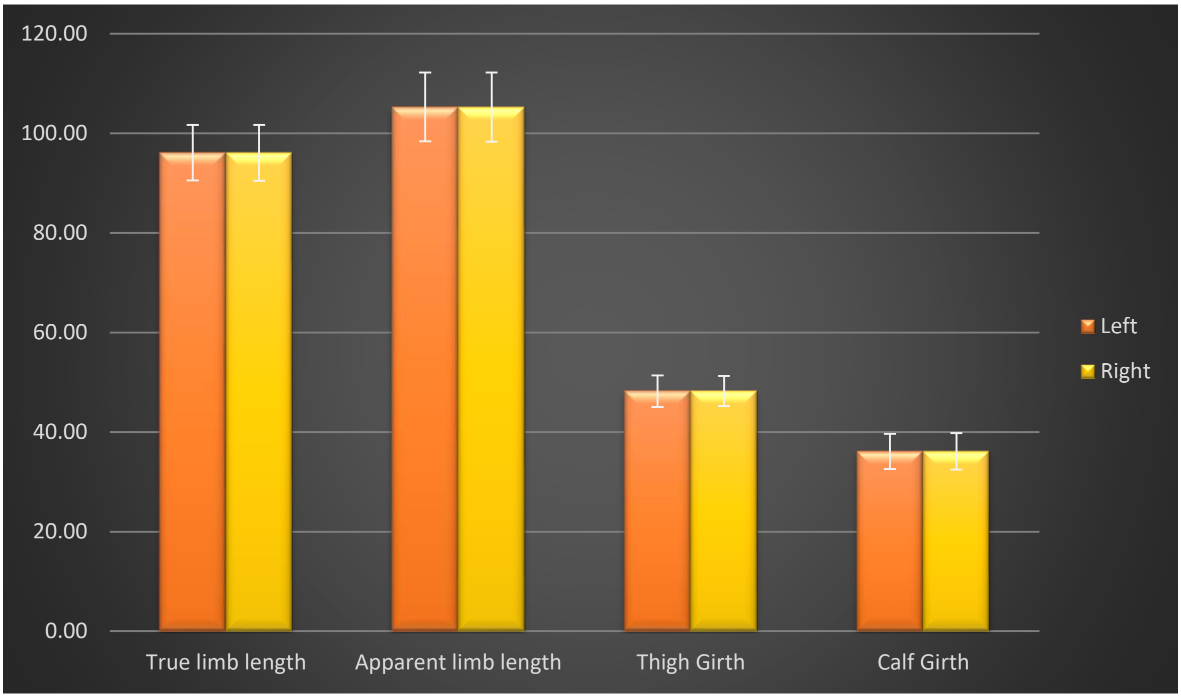
4.13 Inferential statistics of limb measurements within each group (Bhangra Dancers and Non dancers)

4.13.1 Bhangra Dancer group

On comparing the left and right limb measurements of the bhangra dancers as described in Table 21 and graph 9. The mean value of true limb length for the left side was 96.13 cm with a SD of 5.57 cm, while the right side had a mean of 96.10 cm with a SD of 5.61 cm. The mean difference between the left and right true lengths was negligible at 0.03 cm with a SD of 0.44 cm. The t-test yielded a t value of 0.51 with a significance level (Sig. 2-tailed) of 0.61, indicating no statistically significant difference between the true lengths of the left and right limbs. For apparent limb length, the left side had a mean of 105.32 cm and a SD of 6.94 cm, while the right side had a mean of 105.28 cm with a SD of 6.92 cm. The mean difference was minimal at 0.04 cm with a SD of 1.05 cm. The t-test produced a t value of 0.97 with a significance level of 0.34, again suggesting no statistically significant difference in the apparent limb length between the left and right limbs. Thigh size measurements showed a mean of 48.22 cm on the left side with a SD of 3.17 cm, and a mean of 48.27 cm on the right side with a SD of 3.06 cm. The mean difference was -0.06 cm with a SD of 0.43 cm. The t value was -0.64 with a significance level of 0.53, indicating no significant difference in the thigh size between the left and right sides. The calf size was measured with a mean of 36.12 cm on both the left and right sides, with SDs of 3.56 cm and 3.65 cm, respectively. The mean difference was 0.01 cm with a SD of 0.41 cm. The t-test resulted in a t value of 0.14 and a significance level of 0.89, showing no significant difference in the calf size between the left and right limbs. The results indicate that there are no significant differences in the true limb length, apparent length, thigh size, or calf size between the left and right limbs in Bhangra dancers, suggesting symmetrical limb development in these measurements.

Table 21 displaying comparison of mean of measurements of left and right limb within the bhangra dancer group

Variables	Mean ± SD	MD ± SD	t	Sig. (2-tailed)
True limb length left cm	96.13 ± 5.57	0.03 ± 0.44	0.51	0.61
True limb length right cm	96.1 ± 5.61			
Apparent limb length left cm	105.32 ± 6.94	0.04 ± 1.05	0.97	0.34
Apparent limb length right cm	105.28 ± 6.92			
Thigh girth left cm	48.22 ± 3.17	-0.06 ± 0.43	-0.64	0.53
Thigh girth right cm	48.27 ± 3.06			
Calf girth left cm	36.12 ± 3.56	0.01 ± 0.41	0.14	0.89
Calf girth right cm	36.12 ± 3.65			



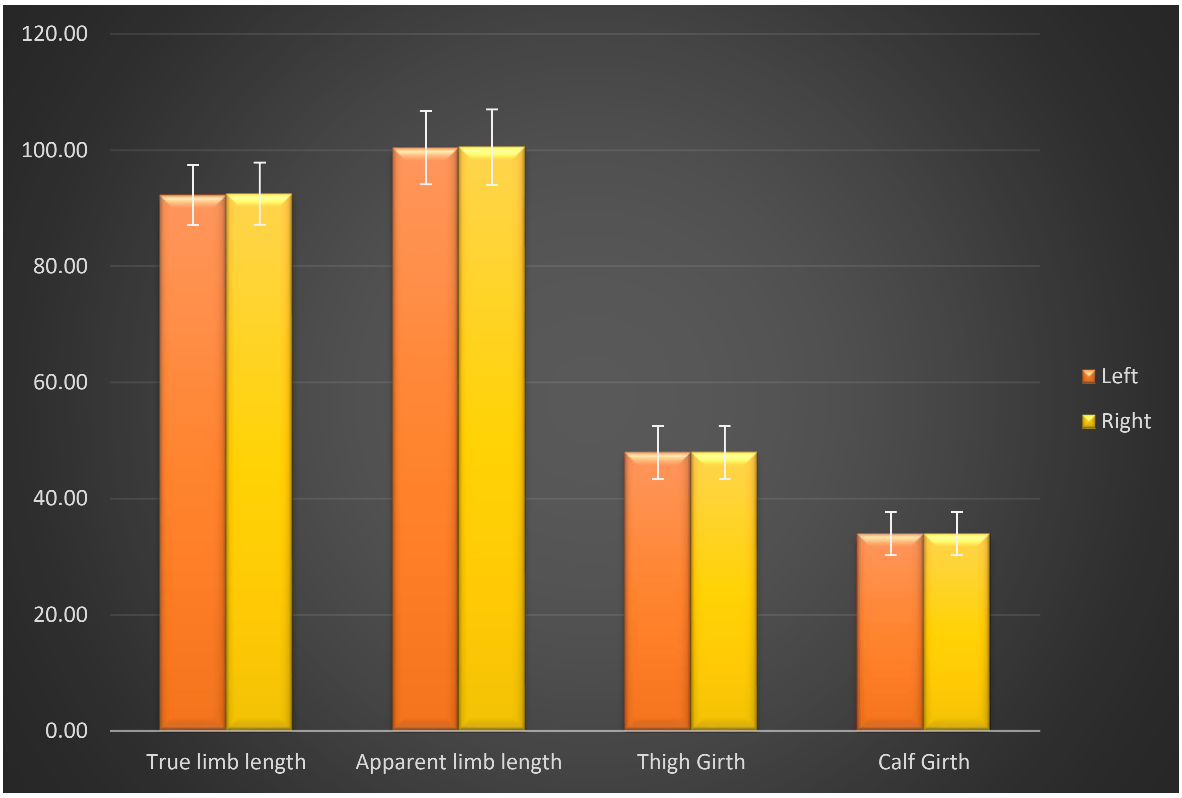
Graph 9 displaying the comparison of mean of measurements of left and right limb within the bhangra dancer group

4.13.2 Non- dancer Group

The Table 22 and graph 10 presents the comparison of limb measurements between the left and right sides of the body in Non-dancers, analysing true limb length, apparent limb length, thigh girth, and calf girth. The mean value for true limb length of the left side is 92.29 cm with SD 5.15 cm, while the right side has a mean of 92.52 cm with SD 5.33 cm. The mean difference between the left & right true lengths is -0.23 cm with SD 1.54 cm. The t-test yields a t value of -1.27 with significance level (Sig. 2-tailed) of 0.21, indicating no statistically significant difference between true lengths of the left & right limbs. The apparent limb length of the left side has a mean of 100.44 cm and a SD of 6.30 cm, while the right side has a mean of 100.53 cm with SD 6.49 cm. The mean difference is -0.09 cm with SD 0.31 cm. The t-test produces a t value of -0.68 with significance level of 0.50, suggesting no statistically significant difference in the apparent limb length between the left & right limbs. Thigh girth measurements show a mean of 47.95 cm on both the left & right sides, with SD 4.55 cm. The mean difference is 0.00 cm with SD 0.73 cm. The t value is -0.03 with significance level of 0.98, indicating no significant difference in the thigh size between the left & right sides. The calf girth is measured with a mean of 33.98 cm on the left side and 33.95 cm on the right side, both with SD 3.73 cm. The mean difference is 0.03 cm with SD 0.36 cm. The t-test results in a t value of 0.67 and a significance level of 0.51, showing no significant difference in the calf size between the left & right limbs. The results indicate that there are no significant differences in true limb length, apparent limb length, thigh girth, or calf girth between the left & right limbs in non-dancers, suggesting symmetrical limb development in these measurements.

Table 22 displaying comparison of mean of measurements of left & right limb within the Non-dancer group

Variables	Mean ± SD	Mean difference ± SD	t	Sig. (2-tailed)
True limb length left cm	92.29 ± 5.15	-0.23 ± 1.54	-1.27	0.21
True limb length right cm	92.52 ± 5.33			
Apparent limb length left cm	100.44 ± 6.30	-0.09 ± 0.31	-0.68	0.50
Apparent limb length right cm	100.53 ± 6.49			
Thigh girth left cm	47.95 ± 4.55	0.00 ± 0.73	-0.03	0.98
Thigh girth right cm	47.95 ± 4.55			
Calf girth left cm	33.98 ± 3.73	0.03 ± 0.36	0.67	0.51
Calf girth right cm	33.95 ± 3.73			



Graph 10 displaying the comparison of mean of measurements of left & right limb within the bhangra dancer group

4.14 Inferential statistics of limb measurements between the groups (Bhangra Dancers and Non dancers)

The table 23 provides statistical analysis results comparing limb measurements between two groups. For the true limb length of the left foot, the variance is not significantly different ($F = 0.98$, $p = 0.32$), and the mean difference is statistically significant ($t = 4.23$, $p < 0.05$) with a mean difference of 3.84 cm (standard error = 0.91 cm). Similarly, for the true limb length of the right foot, the variance is also not significantly different ($F = 0.39$, $p = 0.53$), and the mean difference is significant ($t = 3.87$, $p < 0.05$) with a mean difference of 3.58 cm (standard error = 0.93 cm).

For the apparent limb length of the left foot, the variance is not significantly different ($F = 1.87$, $p = 0.17$), and the mean difference is statistically significant ($t = 4.35$, $p < 0.05$) with a mean difference of 4.88 cm (standard error = 1.12 cm). For the apparent limb length of the right foot, the variance is not significantly different ($F = 0.84$, $p = 0.36$), and the mean difference is significant ($t = 4.19$, $p < 0.05$) with a mean difference of 4.75 cm (standard error = 1.13 cm).

In terms of thigh girth, the left thigh shows a significant difference in the variance ($F = 16.22$, $p < 0.05$), but the mean difference is not statistically significant ($t = 0.41$, $p = 0.68$) with a mean difference of 0.27 cm (standard error = 0.66 cm). Similarly, the right thigh also shows a significant difference in the variance (F = 15.44, p < 0.05), but the mean difference is not significant (t = 0.50, p = 0.62) with a mean difference of 0.33 cm (standard error = 0.66 cm).

For calf girth, the left calf does not have a significantly different variance (F = 0.09, p = 0.76), and the mean difference is significant (t = 3.48, p < 0.05) with a mean difference of 2.14 cm (standard error = 0.62 cm). The right calf also shows no significant difference in the variance (F = 0.05, p = 0.83), and the mean difference is significant (t = 3.47, p < 0.05) with a mean difference of 2.16 cm (standard error = 0.62 cm).

These results indicate that for the majority of the limb measurements, there is statistical significant differences in means between the two groups, whereas for thigh girth, despite differences in variance, the means do not differ significantly.

Table 23 displaying Inferential statistics of limb measurements between the groups (Bhangra Dancers and Non dancers)

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
True limb length left (cm)	0.98	0.32	4.23	**0.00**	3.84	0.91
True limb length right (cm)	0.39	0.53	3.87	**0.00**	3.58	0.93
Apparent limb length left (cm)	1.87	0.17	4.35	**0.00**	4.88	1.12
Apparent limb length right (cm)	0.84	0.36	4.19	**0.00**	4.75	1.13
Thigh size left (cm)	16.22	0.00	0.41	0.68	0.27	0.66
Thigh size right (cm)	15.44	0.00	0.50	0.62	0.33	0.66
Calf size left (cm)	0.09	0.76	3.48	**0.00**	2.14	0.62
Calf size right (cm)	0.05	0.83	3.47	**0.00**	2.16	0.62

4.15 Descriptive statistics of foot angles of the participants (N=140)

The descriptive statistics for various foot angles measured in 140 participants, including the Left Clarks angle (LCA), Right Clarks angle (RCA), Left Medial Longitudinal angle (LMLA), Right Medial Longitudinal angle (RMLA), Left Torsion angle (LTA), Right Torsion angle (RTA), Left Rear-foot angle (LRFA), and Right Rear-foot angle (RRFA) is provided in table 24 and graph 11.

4.15.1 Left Clarks Angle (LCA)

The LCA ranges from 8.70 degrees to 58.60 degrees, with a mean of 29.05 degrees and a SD of 9.83 degrees, resulting in a variance of 96.65. This indicates a moderate level of variability in the left foot arch angle among the participants.

4.15.2 Right Clarks Angle (RCA)

The RCA has a broader range of 47.60 degrees, spanning from 9.20 degrees to 56.80 degrees. The mean RCA is 30.44 degrees with a higher SD of 9.86 degrees, resulting in a variance of 97.29. This suggests a smaller variability in the right foot arch angle compared to the left.

4.15.3 Left Medial Longitudinal Angle (LMLA)

The LMLA values range from 128.10 degrees to 178.50 degrees, with a mean of 149.74 degrees and a SD of 7.61 degrees, leading to a variance of 57.96. The relatively lower SD and variance indicate that the left medial longitudinal arch angle is more consistent among participants.

4.15.4 Right Medial Longitudinal Angle (RMLA)

The RMLA ranges from 129.10 degrees to 171.20 degrees, with a mean of 150.19 degrees and a SD of 7.03 degrees, resulting in a variance of 49.39. Similar to the LMLA, the right medial longitudinal arch angle shows relatively low variability.

4.15.5 Left Torsion Angle (LTA)

The LTA ranges from 6.20 degrees to 25.50 degrees, with a mean of 12.92 degrees and a SD of 3.60 degrees, giving a variance of 12.95. This indicates that the left torsion angle has moderate variability among the participants.

4.15.6 Right Torsion Angle (RTA)

The RTA has a range of 19.80 degrees, with values from 6.60 degrees to 26.40 degrees. The mean RTA is 14.14 degrees, with SD 3.85 degrees and a variance of 14.84, showing slightly higher variability compared to the left torsion angle.

4.15.7 Left Rear-foot Angle (LRFA)

The LRFA has a wide range of 103.70 degrees, spanning from -72.90 degrees to 30.80 degrees. The mean LRFA is 3.54 degrees with SD 11.47 degrees, resulting in a variance of 131.56. This significant variability indicates diverse rear-foot positioning among participants.

4.15.8 Right Rear-foot Angle (RRFA)

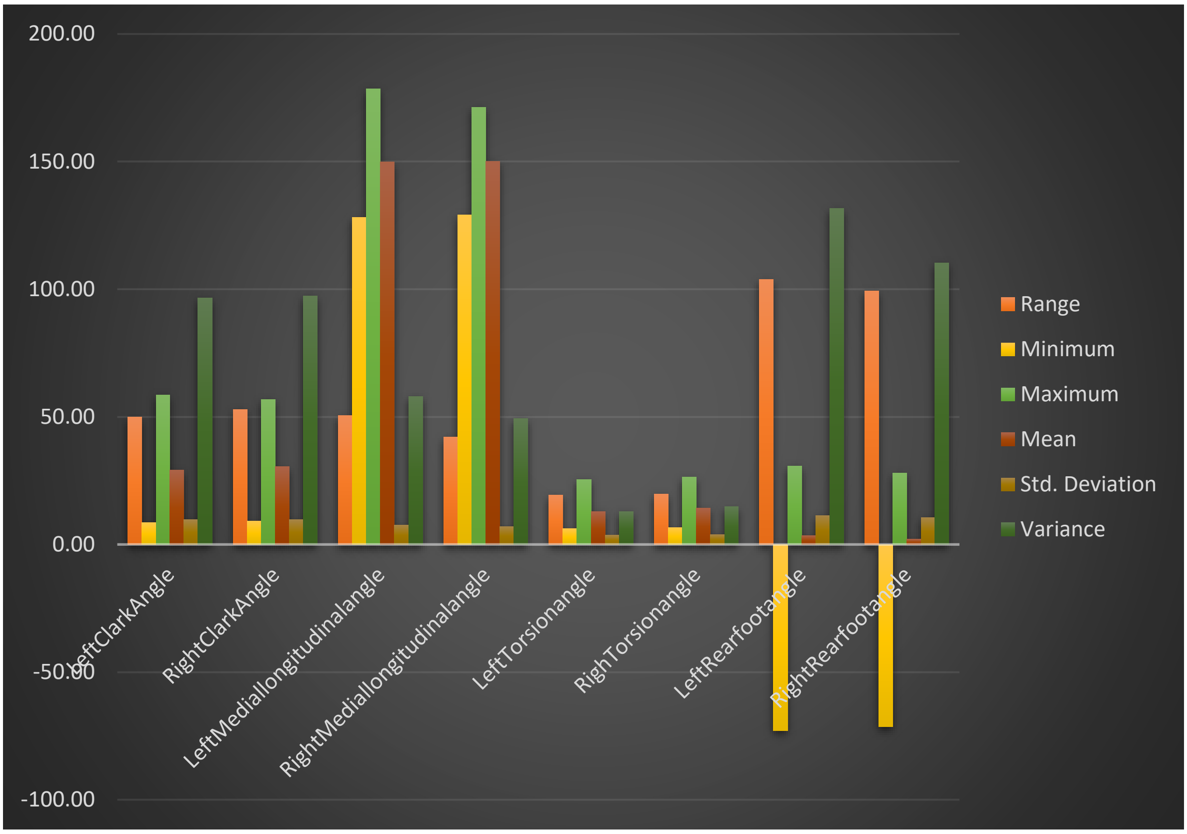
The RRFA ranges from -71.30 degrees to 28.00 degrees, with a mean of 2.17 degrees and a SD of 10.50 degrees, giving a variance of 110.27. Similar to the LRFA, the right rear-foot angle shows considerable variability.

The descriptive statistics reveal varying levels of variability across different foot angles in the participants. Notably, the Clarks angles and rear-foot angles exhibit higher variability, whereas the medial longitudinal and torsion angles are more consistent across the sample. These measurements provide valuable insights into the structural and functional aspects of foot biomechanics in the population studied.

Table 24 displaying descriptive statistics of foot angles of the participants (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
LCA (degree)	49.90	8.70	58.60	29.05	9.83	96.65
RCA (degree)	47.60	9.20	56.80	30.44	9.86	97.29
LMLA (degree)	50.40	128.10	178.50	149.74	7.61	57.96
RMLA (degree)	42.10	129.10	171.20	150.19	7.03	49.39
LTA (degree)	19.30	6.20	25.50	12.92	3.60	12.95
RTA (degree)	19.80	6.60	26.40	14.14	3.85	14.84
LRFA (degree)	103.70	-72.90	30.80	3.54	11.47	131.56
RRFA (degree)	99.30	-71.30	28.00	2.17	10.50	110.27

Note: LCA: Left Clarks angle, RCA: Right Clarks angle, LMLA: Left Medial Longitudinal angle, RMLA: Right Medial Longitudinal angle, LTA: Left Torsion angle, RTA: Left Torsion angle, LRFA: Left Rear-foot angle, RRFA: Right Rear-foot angle



Graph 11 displaying the descriptive statistics of foot angles of the participants (N=140)

4.16 Descriptive statistics of foot angles of Bhangra dancers and Non dancers

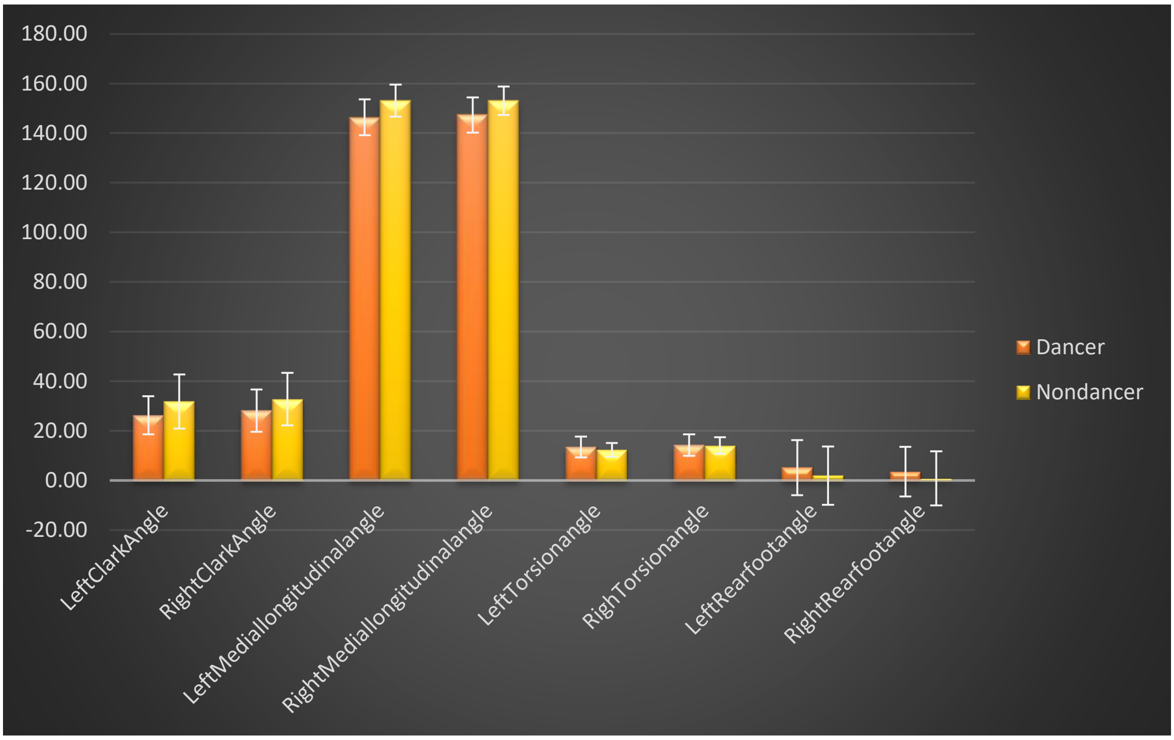
The descriptive statistics for various foot angles measured in two groups of participants: 70 Bhangra dancers and 70 non-dancers. The mean Left Clark angle for dancers is 26.30 degrees with SD 7.69 degrees and a standard error of 0.92 degrees. For non-dancers, the mean is 31.81 degrees with SD 10.97 degrees and a standard error of 1.31 degrees. This indicates that non-dancers tend to have a higher Left Clark angle with greater variability. The mean Right Clark angle for dancers is 28.16 degrees, with SD 8.53 degrees and a standard error of 1.02 degrees. Non-dancers have a significantly higher mean of 32.73 degrees, with SD 10.61 degrees and a standard error of 1.26 degrees. This suggests a difference in the Right Clark angle between dancers and non-dancers, with non-dancers exhibiting more variability. Dancers have a mean Left Medial Longitudinal angle of 146.38 degrees with SD 7.18 degrees and a standard error of 0.86 degrees. Non-dancers show a higher mean of 153.10 degrees, with SD 6.51 degrees and a standard error of 0.78 degrees. The higher mean in non-dancers indicates a more pronounced medial longitudinal arch. The mean Right Medial Longitudinal angle for dancers is 147.30 degrees, with SD 7.06 degrees and a standard error of 0.84 degrees. For non-dancers, the mean is 153.07 degrees, with SD 5.73 degrees and a standard error of 0.68 degrees. Non-dancers again show a higher mean, suggesting a more pronounced right medial longitudinal arch. The Left Torsion angle for dancers has a mean of 13.48 degrees, with SD 4.20 degrees and a standard error of 0.50 degrees. Non-dancers have a mean of 12.36 degrees, with SD 2.79 degrees and a standard error of 0.33 degrees. The dancers exhibit slightly higher torsion angles with greater variability. Dancers have a mean Right Torsion angle of 14.26 degrees, with SD 4.29 degrees and a standard error of 0.51 degrees. Non-dancers have a mean of 14.02 degrees, with SD 3.39 degrees and a standard error of 0.40 degrees. The values are similar, indicating comparable right torsion angles in both groups. The mean Left Rear-foot angle for dancers is 5.15 degrees, with SD 11.07 degrees and a standard error of 1.32 degrees. For non-dancers, the mean is 1.92 degrees, with SD 11.71 degrees and a standard error of 1.40 degrees. This suggests that dancers have a higher mean rear-foot angle but both groups exhibit high variability. The mean Right Rear-foot angle for dancers is 3.52 degrees, with SD 10.01 degrees and a standard error of 1.20 degrees. Non-dancers have a mean of 0.83 degrees, with SD 10.87 degrees and a standard error of 1.30 degrees. Again, dancers have a slightly higher mean rear-foot angle with substantial variability in both groups.

The results show notable differences between Bhangra dancers and non-dancers in several foot angles. Dancers tend to have lower medial longitudinal arch angles and higher torsion angles, while non-dancers exhibit higher variability in the Clark angles and medial longitudinal angles. The rear-foot angles show high variability in both groups, with dancers having slightly higher means. These findings highlight the distinct biomechanical characteristics of the feet in Bhangra dancers compared to non-dancers.

Table 25 displaying descriptive statistics of foot angles of Bhangra dancers and Non-dancers

Variables	Group	Mean	Std. Deviation	Std. Error Mean
LCA (degree)	Dancer	26.30	7.69	0.92
	Non-dancer	31.81	10.97	1.31
RCA (degree)	Dancer	28.16	8.53	1.02
	Non-dancer	32.73	10.61	1.26
LMLA (degree)	Dancer	146.38	7.18	0.86
	Non-dancer	153.10	6.51	0.78
RMLA (degree)	Dancer	147.30	7.06	0.84
	Non-dancer	153.07	5.73	0.68
LTA (degree)	Dancer	13.48	4.20	0.50
	Non-dancer	12.36	2.79	0.33
RTA (degree)	Dancer	14.26	4.29	0.51
	Non-dancer	14.02	3.39	0.40
LRFA (degree)	Dancer	5.15	11.07	1.32
	Non-dancer	1.92	11.71	1.40
RRFA (degree)	Dancer	3.52	10.01	1.20
	Non-dancer	0.83	10.87	1.30

Note: LCA: Left Clarks angle, RCA: Right Clarks angle, LMLA: Left Medial Longitudinal angle, RMLA: Right Medial Longitudinal angle, LTA: Left Torsion angle, RTA: Left Torsion angle, LRFA: Left Rear-foot angle, RRFA: Right Rear-foot angle



Graph 12 displaying the comparison of descriptive statistics of foot angles of Bhangra dancers and Non-dancers

4.17 Inferential statistics of foot angles within the groups (Bhangra Dancers and Non-dancers

4.17.1 Bhangra dancers

The inferential statistical comparisons of left & right foot angles of Bhangra dancers are discussed in Table 26. The analysis includes mean values, SDs, mean differences, t values, and significance levels.

For the Clark Angles, the mean for the left angle is 26.30 degrees with SD 7.69 degrees, while the mean for the right angle is 28.16 degrees with SD 8.53 degrees. The mean difference is -1.86 degrees, and the t value is -2.46 with significance level of 0.02. This indicates that the Left Clark Angle is significantly lower than the Right Clark Angle within Bhangra dancers.

Regarding the Medial Longitudinal Angles, the mean for the left angle is 146.38 degrees with SD 7.18 degrees, and the mean for the right angle is 147.30 degrees with SD 7.06 degrees. The mean difference is -0.92 degrees, and the t value is -1.21 with significance level of 0.23. This suggests no significant difference between left & right Medial Longitudinal Angles.

For the Torsion Angles, the mean for the left angle is 13.48 degrees with SD 4.20 degrees, while the mean for the right angle is 14.26 degrees with SD 4.29 degrees. The mean difference is -0.78 degrees, and the t value is -1.48 with significance level of 0.14, indicating no significant difference between left & right Torsion Angles.

Finally, for the Rear-foot Angles, the mean for the left angle is 5.15 degrees with SD 11.07 degrees, and the mean for the right angle is 3.52 degrees with SD 10.01 degrees. The mean difference is 1.63 degrees, and the t value is 1.43 with significance level of 0.16. This suggests no significant difference between left & right Rear-foot Angles.

The results indicate a significant difference between left & right Clark Angles, with the Left Clark Angle being significantly lower within Bhangra dancers. However, no significant differences are observed between the Left & right Medial Longitudinal Angles, Torsion Angles, or Rear-foot Angles within this group.

Table 26 displaying inferential statistics of foot angles of bhangra dancer group

Variables	Mean ± SD	Mean difference ± SD	t	Sig. (2 tailed)
LCA (degree)	26.30 ± 7.69	-1.86 ± 6.35	-2.46	**0.02**
RCA (degree)	28.16 ± 8.53			
LMLA (degree)	146.38 ± 7.18	-0.92 ± 6.36	-1.21	0.23
RMLA (degree)	147.30 ± 7.06			
LTA (degree)	13.48 ± 4.20	-0.78 ± 4.41	-1.48	0.14
RTA (degree)	14.26 ± 4.29			
LRFA (degree)	5.15 ± 11.07	1.63 ± 9.55	1.43	0.16
RRFA (degree)	3.52 ± 10.01			

Note: LCA: Left Clarks angle, RCA: Right Clarks angle, LMLA: Left Medial Longitudinal angle, RMLA: Right Medial Longitudinal angle, LTA: Left Torsion angle, RTA: Left Torsion angle, LRFA: Left Rear-foot angle, RRFA: Right Rear-foot angle

4.17.2 Non-dancers

The results of inferential statistical comparison of left & right foot angles of non-dancers has been summarized in table 27.

For the Clark Angles, the mean for the left angle is 31.81 degrees with SD 10.97 degrees, while the mean for the right angle is 32.73 degrees with SD 10.61 degrees. The mean difference is -0.92 degrees, and the SD of this difference is 7.05 degrees. The t value is -1.09 with significance level of 0.28, indicating that that there is no statistically significant difference between Clark Angles of the left & right sides of non-dancers.

The Medial Longitudinal Angles, the mean for the left angle is 153.10 degrees with SD 6.51 degrees, and the mean for the right angle is 153.07 degrees with SD 5.73 degrees. The mean difference is 0.03 degrees, with SD 5.79 degrees. The t value is 0.04 with significance level of 0.97, suggesting no significant difference between left & right Medial Longitudinal Angles.

The mean for the left torsion angle is 12.36 degrees with SD 2.79 degrees, while the mean for the right angle is 14.02 degrees with SD 3.39 degrees. The mean difference is -1.66 degrees, and the SD of this difference is 3.92 degrees. The t value is -3.55 with significance level of 0.00, indicating that the Left Torsion Angle is significantly lower than the Right Torsion Angle within non-dancers.

Finally, for the Rear-foot Angles, the mean for the left angle is 1.92 degrees with SD 11.71 degrees, and the mean for the right angle is 0.83 degrees with SD 10.87 degrees. The mean difference is 1.10 degrees, and the SD of this difference is 9.89 degrees. The t value is 0.93 with significance level of 0.36, suggesting no significant difference between left & right rearfoot Angles.

The results indicate significant differences between the Left & right Clark Angles and between the Left & right Torsion Angles within non-dancers. The Left Clark Angle is significantly higher, and the Left Torsion Angle is significantly lower. However, no significant differences were observed between the Left & right Medial Longitudinal Angles or the Left & right Rear-foot Angles within this group.

Table 27 displaying inferential statistics of foot angles of Non-dancer group

Variables	Mean ± SD	Mean difference ± SD	t	Sig.(2 tailed)
LCA (degree)	31.81± 10.97	-0.92 ± 7.05	-1.09	0.29
RCA (degree)	32.73 ± 10.61			
LMLA (degree)	153.10 ± 6.51	0.03 ± 5.79	0.04	0.97
RMLA (degree)	153.07 ± 5.73			
LTA (degree)	12.36 ± 2.79	-1.66 ± 3.92	-3.55	**0.00**
RTA (degree)	14.02 ± 3.39			
LRFA (degree)	1.92 ± 11.71	1.10 ± 9.89	0.93	0.36
RRFA (degree)	0.83 ± 10.87			

Note: LCA: Left Clarks angle, RCA: Right Clarks angle, LMLA: Left Medial Longitudinal angle, RMLA: Right Medial Longitudinal angle, LTA: Left Torsion angle, RTA: Left Torsion angle, LRFA: Left Rear-foot angle, RRFA: Right Rear-foot angle

4.18 Inferential statistics of foot angles between the two groups (Bhangra Dancers and Non dancers)

The inferential statistics indicate significant differences between Bhangra dancers and non-dancers in several foot angles. The table 28 presents the results of inferential statistical comparisons between various foot angles of Bhangra dancers and non-dancers, including significance values, mean differences, and standard error differences.

The Left Clark Angle results show F-value of 10.75 with significance level of 0.00, indicating unequal variances. The t value is -3.44 with significance level of 0.00. The mean difference is -5.51 degrees with a standard error difference of 1.60 degrees. These findings indicate that the Left Clark angle is significantly lower in Bhangra dancers compared to non-dancers. For the Right Clark Angle, F-value of 28.65 with significance level of 0.00 indicates unequal variances. The t value is 5.81 with significance level of 0.00. The mean difference is 11.33 degrees with a standard error difference of 1.95 degrees, showing that the Right Clark angle is significantly higher in Bhangra dancers compared to non-dancers. The findings indicate that Bhangra dancers exhibit significantly different Clark Angles compared to non-dancers.

The Left Medial Longitudinal Angle results show F-value of 1.78 with significance level of 0.18, indicating equal variances. The t value is -5.80 with significance level of 0.00. The mean difference is -6.72 degrees with a standard error difference of 1.16 degrees, suggesting that the Left Medial Longitudinal angle is significantly lower in Bhangra dancers. Similarly, for the Right Medial Longitudinal Angle, F-value of 1.44 with significance level of 0.23 indicates equal variances. The t value is -5.31 with significance level of 0.00. The mean difference is -5.77 degrees with a standard error difference of 1.09 degrees, indicating that the Right Medial Longitudinal angle is significantly lower in Bhangra dancers.

The Left Torsion Angle results show F-value of 7.27 with significance level of 0.01, indicating unequal variances. The t value is 1.86 with significance level of 0.07. The mean difference is 1.12 degrees with a standard error difference of 0.60 degrees. Although the p value is slightly above 0.05, there is a trend towards a higher Left Torsion angle in Bhangra dancers. For the Right Torsion Angle, F-value of 2.17 with significance level of 0.14 indicates equal variances. The t value is 0.37 with significance level of 0.71. The mean difference is 0.24 degrees with a standard error difference of 0.65 degrees, showing no significant difference in the the Right Torsion angle between the groups.

The Left Rear-foot Angle results show F-value of 0.32 with significance level of 0.57, indicating equal variances. The t value is 1.67 with significance level of 0.10. The mean difference is 3.23 degrees with a standard error difference of 1.93 degrees, suggesting a trend towards a higher Left Rear-foot angle in Bhangra dancers, though it is not statistically significant. For the Right Rear-foot Angle, F-value of 0.06 with significance level of 0.81 indicates equal variances. The t value is 1.52 with significance level of 0.13. The mean difference is 2.69 degrees with a standard error difference of 1.77 degrees, indicating no significant difference in the Right Rear-foot angle between the groups.

The results reveal significant differences between Bhangra dancers and non-dancers in several foot angles. Specifically, Bhangra dancers have significantly lower Left & right Medial Longitudinal angles and significantly higher Right Clark angles. The Left Clark angle is also significantly lower in dancers. Trends suggest higher Left Torsion and Left Rear-foot angles in dancers, though these differences are not statistically significant. No significant differences were observed in the Right Torsion and Right Rear-foot angles between the two groups.

Table 28 displaying Inferential statistics of foot angles between the two groups (Bhangra dancer group and Non dancer group)

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
LCA (degree)	10.75	**0.00**	-3.44	0.00	-5.51	1.60
RCA (degree)	28.65	**0.00**	5.81	0.00	11.33	1.95
LMLA (degree)	1.78	0.18	-5.80	0.00	-6.72	1.16
RMLA (degree)	1.44	0.23	-5.31	0.00	-5.77	1.09
LTA (degree)	7.27	**0.01**	1.86	0.07	1.12	0.60
RTA (degree)	2.17	0.14	0.37	0.71	0.24	0.65
LRFA (degree)	0.32	0.57	1.67	0.10	3.23	1.93
RRFA (degree)	0.06	0.81	1.52	0.13	2.69	1.77

Note: LCA: Left Clarks angle, RCA: Right Clarks angle, LMLA: Left Medial Longitudinal angle, RMLA: Right Medial Longitudinal angle, LTA: Left Torsion angle, RTA: Left Torsion angle, LRFA: Left Rear-foot angle, RRFA: Right Rear-foot angle

4.19 Descriptive statistics of foot print variables and Indices of the participants (N= 140)

The descriptive statistics shows moderate to minimal variability across different measurements, indicating consistent patterns within the sample (table 29 and graph 13). These measurements provide valuable insights into foot characteristics, which could be crucial for further analysis and interpretation in relevant studies.

4.19.1 Left Forefoot Distance

The left forefoot distance ranges from 4.31 cm to 12.14 cm, resulting in a range of 7.83 cm. The mean left forefoot distance is 7.92 cm, indicating the average measurement among the participants. The SD is 2.12 cm, which shows the extent of variability around the mean. The variance, which is the square of the SD, is 4.50 cm^2, indicating the degree of dispersion in the data.

4.19.2 Right Forefoot Distance

The right forefoot distance has a range of 7.30 cm, with values spanning from a minimum of 3.09 cm to a maximum of 10.39 cm. The mean value is 7.39 cm, slightly lower than the left forefoot distance. The SD is 1.90 cm, reflecting less variability compared to the left forefoot distance. The variance is 3.59 cm^2, which is slightly lower than that of the left forefoot distance.

4.19.3 Left Midfoot Distance

For the left midfoot distance, the range is 7.79 cm, with measurements between 0.66 cm and

8.45 cm. The mean is 3.27 cm, showing that the average left midfoot distance is lower than the forefoot distances. The SD is 1.48 cm, indicating moderate variability, and the variance is 2.20 cm^2.

4.19.4 Right Midfoot Distance

The right midfoot distance has a range of 5.61 cm, with values from 0.44 cm to 6.05 cm. The mean is 3.01 cm, which is close to the left midfoot distance. The SD is 1.19 cm, suggesting less variability, and the variance is 1.42 cm^2, indicating less dispersion compared to the left midfoot distance.

4.19.5 Left Hindfoot Distance

The left hindfoot distance ranges from 1.91 cm to 7.07 cm, with a range of 5.16 cm. The mean value is 4.64 cm, indicating the average left hindfoot distance among participants. The SD is 1.30 cm, reflecting moderate variability, and the variance is 1.70 cm^2.

4.19.6 Right Hindfoot Distance

The right hindfoot distance has a range of 4.82 cm, with measurements between 2.01 cm and 6.83 cm. The mean is 4.40 cm, slightly lower than the left hindfoot distance. The SD is 1.10 cm, indicating less variability, and the variance is 1.21 cm^2, which is lower compared to the left hindfoot distance.

4.19.7 Left Staheli Index

The left Staheli Index has a range of 0.72, with values between 0.12 and 0.84. The mean value is 0.41, indicating the average index among participants. The SD is 0.13, showing slight variability, and the variance is 0.02, reflecting minimal dispersion in the data.

4.19.8 Right Staheli Index

The right Staheli Index has a range of 0.77, with values from 0.09 to 0.86. The mean value is 0.41, similar to the left Staheli Index. The SD is 0.13, indicating slight variability, and the variance is 0.02, showing minimal dispersion.

4.19.9 Left Chippaux Smirak Index

The left Chippaux Smirak Index has a range of 1.15, with values between 0.19 and 1.34. The mean is 0.70, indicating the average index among participants. The SD is 0.23, reflecting moderate variability, and the variance is 0.05, indicating some degree of dispersion.

4.19.10 Right Chippaux Smirak Index

The right Chippaux Smirak Index has a range of 1.23, with measurements between 0.15 and 1.38. The mean value is 0.68, slightly lower than the left index. The SD is 0.20, showing moderate variability, and the variance is 0.04, indicating slight dispersion.

4.19.11 Left Arch Index

The left arch index ranges from 0.24 to 0.74, with a range of 0.50. The mean value is 0.35, indicating the average left arch index among participants. The SD is 0.07, showing slight variability, and the variance is 0.01, reflecting minimal dispersion in the data.

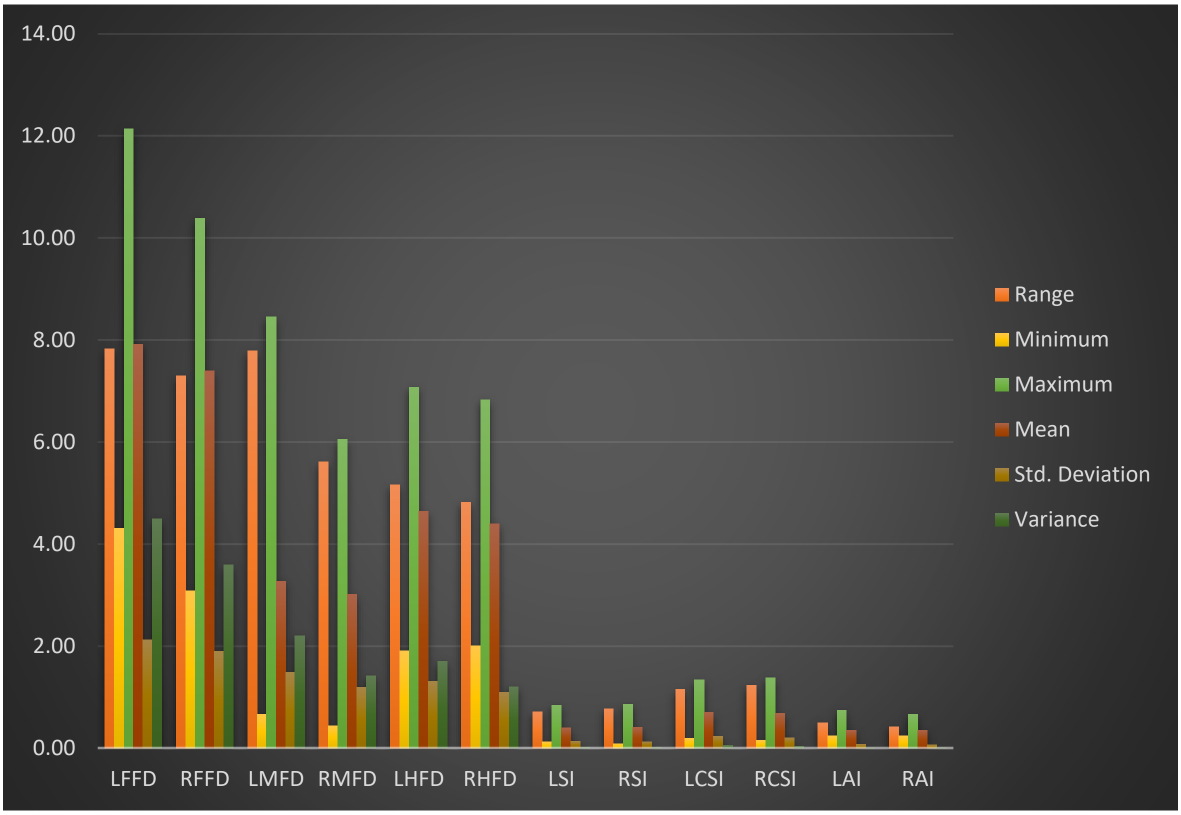
4.19.12 Right Arch Index

The right arch index has a range of 0.42, with values between 0.24 and 0.66. The mean value is 0.35, similar to the left arch index. The SD is 0.06, indicating slight variability, and the variance is 0.00, showing minimal dispersion.

Table 29 displaying descriptive statistics of foot print variables and Indices of the participants (N= 140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
LFFD	7.83	4.31	12.14	7.92	2.12	4.50
RFFD	7.30	3.09	10.39	7.39	1.90	3.59
LMFD	7.79	0.66	8.45	3.27	1.48	2.20
RMFD	5.61	0.44	6.05	3.01	1.19	1.42
LHFD	5.16	1.91	7.07	4.64	1.30	1.70
RHFD	4.82	2.01	6.83	4.40	1.10	1.21
LSI	0.72	0.12	0.84	0.41	0.13	0.02
RSI	0.77	0.09	0.86	0.41	0.13	0.02
LCSI	1.15	0.19	1.34	0.70	0.23	0.05
RCSI	1.23	0.15	1.38	0.68	0.20	0.04
LAI	0.50	0.24	0.74	0.35	0.07	0.01
RAI	0.42	0.24	0.66	0.35	0.06	0.00

Note: LFFD: Left Forefoot distance, LMFD: Left Midfoot distance, LHFD: Left Hindfoot distance, RFFD: Right forefoot distance, RMFD: Right Midfoot distance, RHFD: Right Hindfoot distance, LSI: Left Staheli Index, RSI: Right Staheli Index, LCSI: Left Chippaux Smirak Index, RCSI: Right Chippaux Smirak Index, LAI: Left Arch Index, RAI: Right Arch Index



Graph 13 displaying the descriptive statistics of foot print variables and Indices of the participants (N= 140)

4.20 Descriptive statistics of foot print variables and Indices of the participants of two groups (Bhangra dancer group and Non-dancer group

The Table 30 and graph 14 displays the descriptive statistics of both the groups, bhangra dancers have a mean left forefoot distance of 9.38 cm with SD 0.89 cm and a SEM of 0.11 cm. In contrast, non-dancers have a mean left forefoot distance of 6.45 cm, a SD of 1.98 cm, and a SEM of 0.24 cm. This indicates that dancers tend to have a significantly larger left forefoot distance compared to non-dancers. For the right forefoot distance, dancers show a mean of 8.74 cm, a SD of 0.71 cm, and a SEM of 0.09 cm. Non-dancers have a lower mean right forefoot distance of 6.04 cm, with SD 1.74 cm and a SEM of 0.21 cm. This again suggests that dancers have larger forefoot distances than non-dancers. The mean left midfoot distance for dancers is 3.86 cm with SD 1.29 cm and a SEM of 0.15 cm. Non-dancers have a mean of 2.68 cm, a SD of 1.44 cm, and a SEM of 0.17 cm. This shows that dancers have a greater left midfoot distance compared to non-dancers. Dancers have a mean right midfoot distance of 3.51 cm, a SD of 0.98 cm, and a SEM of 0.12 cm. Non-dancers, on the other hand, have a mean of 2.51 cm, a SD of 1.18 cm, and a SEM of 0.14 cm. This difference highlights that dancers have a larger right midfoot distance. The left hindfoot distance for dancers is 5.54 cm with SD 0.65 cm and a SEM of 0.08 cm. Non-dancers have a mean of 3.74 cm, a SD of 1.17 cm, and a SEM of 0.14

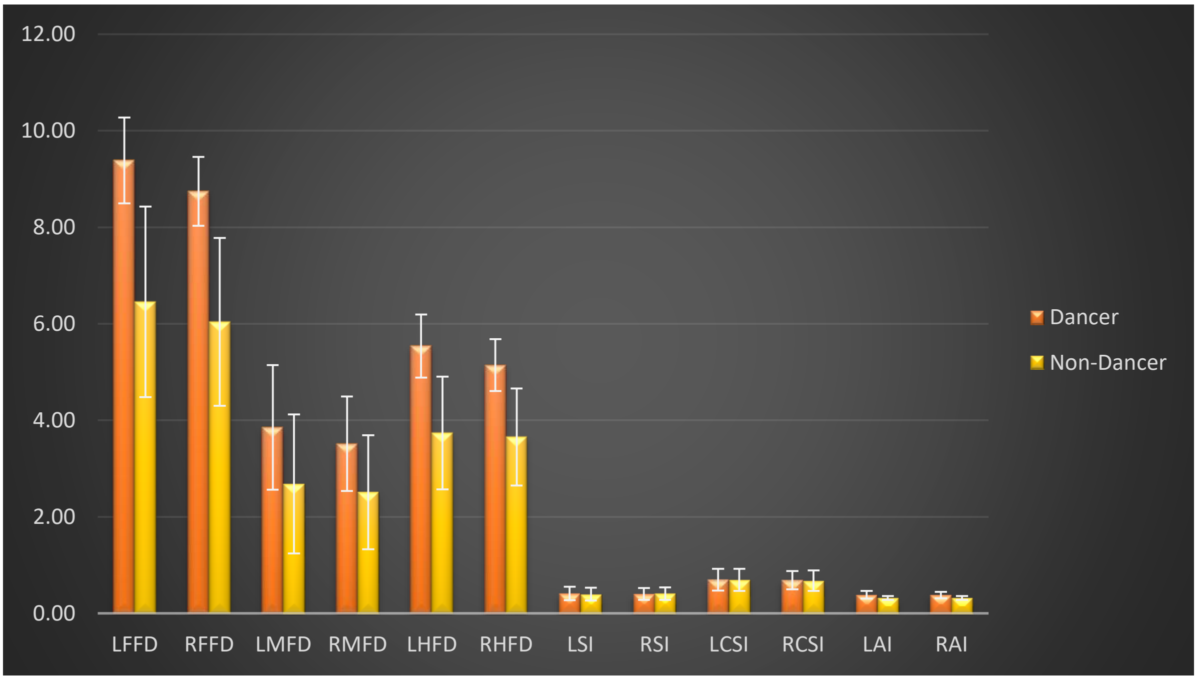
cm. This indicates a significant difference, with dancers having a larger left hindfoot distance. For the right hindfoot distance, dancers exhibit a mean of 5.14 cm, a SD of 0.54 cm, and a SEM of 0.06 cm. Non-dancers have a mean of 3.65 cm, a SD of 1.01 cm, and a SEM of 0.12 cm. This difference suggests that dancers have a larger right hindfoot distance compared to non-dancers. Dancers have a mean left Staheli Index of 0.41 with SD 0.14 and a SEM of 0.02. Non-dancers have a mean of 0.40, a SD of 0.13, and a SEM of 0.02. The small difference indicates that the left Staheli Index is quite similar between the two groups. The mean right Staheli Index for dancers is 0.40 with SD 0.12 and a SEM of 0.01. Non-dancers have a mean of 0.41, a SD of 0.13, and a SEM of 0.02. This indicates that the right Staheli Index is also quite similar between dancers and non-dancers. Dancers have a mean left Chippaux Smirak Index of 0.70 with SD 0.23 and a SEM of 0.03. Non-dancers have a mean of 0.69, a SD of 0.23, and a SEM of 0.03. This indicates a very small difference between the two groups. The mean right Chippaux Smirak Index for dancers is 0.69 with SD 0.19 and a SEM of 0.02. Non-dancers have a mean of 0.68, a SD of 0.21, and a SEM of 0.03. This again suggests a very small difference between the two groups. Dancers have a mean left arch index of 0.39 with SD 0.08 and a SEM of 0.01. Non-dancers have a lower mean of 0.32, a SD of 0.04, and a SEM of 0.00. This indicates that dancers tend to have a higher left arch index. For the right arch index, dancers show a mean of 0.38, a SD of 0.07, and a SEM of 0.01. Non-dancers have a mean of 0.32, a SD of 0.04, and a SEM of 0.00. This difference suggests that dancers have a higher right arch index compared to non-dancers.

Table 30 displaying descriptive statistics of foot print variables and Indices of the participants of two groups (Bhangra dancer group and Non-dancer group

Variables	Group	Mean	Std. Deviation	Std. Error Mean
LFFD (cm)	Dancer	9.38	0.89	0.11
	Non-dancer	6.45	1.98	0.24
RFFD (cm)	Dancer	8.74	0.71	0.09
	Non-dancer	6.04	1.74	0.21
LMFD (cm)	Dancer	3.86	1.29	0.15
	Non-dancer	2.68	1.44	0.17
RMFD (cm)	Dancer	3.51	0.98	0.12
	Non-dancer	2.51	1.18	0.14
LHFD (cm)	Dancer	5.54	0.65	0.08
	Non-dancer	3.74	1.17	0.14

RHFD (cm)	Dancer	5.14	0.54	0.06
	Non-dancer	3.65	1.01	0.12
LSI	Dancer	0.41	0.14	0.02
	Non-dancer	0.40	0.13	0.02
RSI	Dancer	0.40	0.12	0.01
	Non-dancer	0.41	0.13	0.02
LCSI	Dancer	0.70	0.23	0.03
	Non-dancer	0.69	0.23	0.03
RCSI	Dancer	0.69	0.19	0.02
	Non-dancer	0.68	0.21	0.03
LAI	Dancer	0.39	0.08	0.01
	Non-dancer	0.32	0.04	0.00
RAI	Dancer	0.38	0.07	0.01
	Non-dancer	0.32	0.04	0.00

Note: LFFD: Left Forefoot distance, LMFD: Left Midfoot distance, LHFD: Left Hindfoot distance, RFFD: Right forefoot distance, RMFD: Right Midfoot distance, RHFD: Right Hindfoot distance, LSI: Left Staheli Index, RSI: Right Staheli Index, LCSI: Left Chippaux Smirak Index, RCSI: Right Chippaux Smirak Index, LAI: Left Arch Index, RAI: Right Arch Index



Graph 14 displaying descriptive statistics of foot print variables and Indices of the participants of two groups (Bhangra dancer group and Non-dancer group

4.21 Inferential statistics of foot print variables and Indices within the groups (Bhangra dancer group and Non-dancer group

4.21.1 Bhangra Dancer

On comparing the left & right foot print variables and indices in Bhangra dancers, it reveals significant differences between left & right foot distances for forefoot, midfoot, and hindfoot, with the left foot generally showing larger values. However, indices such as the Staheli Index, Chippaux Smirak Index, and Arch Index do not show significant differences between the left & right sides. The mean values, SDs, mean differences, SD differences, t-values, and significance levels for various foot characteristics is discussed in table 31.

The mean left forefoot distance for Bhangra dancers is 9.38 cm with SD 0.89 cm. The mean difference between left & right forefoot distance is 0.64 cm, with SD this difference being 0.75 cm. The t-test yields a t value of 7.14 with significance level of 0.00, indicating a highly significant difference between left & right forefoot distances in Bhangra dancers. This suggests that the left forefoot distance is significantly larger compared to the right forefoot distance in this group. In comparison the mean right forefoot distance for Bhangra dancers is 8.74 cm with SD 0.71 cm.

The mean left midfoot distance for Bhangra dancers is 3.86 cm with SD 1.29 cm and the mean right midfoot distance is 3.51 cm with SD 0.98 cm. The mean difference between left & right midfoot distances is 0.34 cm, with SD 0.95 cm. The t-test yields a t value of 3.01 with significance level of 0.00, indicating a significant difference between left & right midfoot distances in Bhangra dancers. This suggests that the left midfoot distance is significantly larger compared to the right. The mean left hindfoot distance for Bhangra dancers is 5.54 cm with SD 0.65 cm and the mean right hindfoot distance is 5.14 cm with SD 0.54 cm. The mean difference between left & right hindfoot distances is 0.40 cm, with SD 0.60 cm. The t-test yields a t value of 5.50 with significance level of 0.00, indicating a highly significant difference between left & right hindfoot distances in Bhangra dancers. This suggests that the left hindfoot distance is significantly larger compared to the right hindfoot distance.

The mean left & right Staheli Index for Bhangra dancers is 0.41 and 0.40 with SD 0.14 and 0.12. The mean difference between the left & right Staheli Index is 0.01, with SD 0.11. The t-test yields a t value of 0.68 with significance level of 0.50, indicating no significant difference between left & right Staheli Index in Bhangra

The mean of left & right Chippaux Smirak Index for Bhangra dancers is 0.70 and 0.69 with SD 0.23 and 0.19. The mean difference between the left & right Chippaux Smirak Index is

0.01, with SD 0.17. The t-test yields a t value of 0.66 with significance level of 0.51, indicating no significant difference between left & right

The mean value for left arch index for Bhangra dancers is 0.39 with SD 0.08 and The mean right arch index for Bhangra dancers is 0.38 with SD 0.07. The mean difference between the left & right arch index is 0.01, with SD 0.05. The t-test yields a t value of 1.33 with significance level of 0.19, indicating no significant difference between left & right arch index in Bhangra dancers.

Table 31displaying inferential statistics of foot print variables and Indices within the bhangra dancer group

Variables	Mean	Std. Deviation	Mean difference	Std. Deviation	t	Sig. (2-tailed)
LFFD (cm)	9.38	0.89	0.64	0.75	7.14	**0.00**
RFFD (cm)	8.74	0.71				
LMFD (cm)	3.86	1.29	0.34	0.95	3.01	**0.00**
RMFD (cm)	3.51	0.98				
LHFD (cm)	5.54	0.65	0.40	0.60	5.50	**0.00**
RHFD (cm)	5.14	0.54				
LSI	0.41	0.14	0.01	0.11	0.68	0.50
RSI	0.40	0.12				
LCSI	0.70	0.23	0.01	0.17	0.66	0.51
RCSI	0.69	0.19				
LAI	0.39	0.08	0.01	0.05	1.33	0.19
RAI	0.38	0.07				

Note: LFFD: Left Forefoot distance, LMFD: Left Midfoot distance, LHFD: Left Hindfoot distance, RFFD: Right forefoot distance, RMFD: Right Midfoot distance, RHFD: Right Hindfoot distance, LSI: Left Staheli Index, RSI: Right Staheli Index, LCSI: Left Chippaux Smirak Index, RCSI: Right Chippaux Smirak Index, LAI: Left Arch Index, RAI: Right Arch Index

4.21.2 Non dancer

On comparing the left & right foot measurements for non-dancers, the results revealed significant difference between left & right forefoot distances, with the left forefoot distance being larger. However, there are no significant differences between the left & right midfoot, hindfoot distances, and various indices such as the Staheli Index, Chippaux Smirak Index, and Arch Index (table 32).

The mean left forefoot distance for non-dancers is 6.45 cm with SD 1.98 cm, while the mean right forefoot distance is 6.04 cm with SD 1.74 cm. The mean difference between the left & right forefoot distances is 0.41 cm, with SD this difference being 0.70 cm. The t-test yields a t value of 4.94 with significance level of 0.00, indicating a highly significant difference between left & right forefoot distances. This suggests that the left forefoot distance is significantly larger compared to the right forefoot distance in non-dancers.

The mean left midfoot distance for non-dancers is 2.68 cm with SD 1.44 cm, while the mean right midfoot distance is 2.51 cm with SD 1.18 cm. The mean difference between the left & right midfoot distances is 0.17 cm, with SD 0.91 cm. The t-test yields a t value of 1.58 with significance level of 0.12, indicating that the difference between the left & right midfoot distances in non-dancers is not statistically significant.

The mean left hindfoot distance for non-dancers is 3.74 cm with SD 1.17 cm, while the mean right hindfoot distance is 3.65 cm with SD 1.01 cm. The mean difference between the left & right hindfoot distances is 0.09 cm, with SD 0.59 cm. The t-test yields a t value of 1.24 with significance level of 0.22, indicating that the difference between the left & right hindfoot distances in non-dancers is not statistically significant.

The mean left Staheli Index for non-dancers is 0.40 with SD 0.13, while the mean right Staheli Index is 0.41 with SD 0.13. The mean difference between the left & right Staheli Index is -0.01, with SD 0.12. The t-test yields a t value of -0.64 with significance level of 0.52, indicating no significant difference between left & right Staheli Index in non-dancers.

The mean left Chippaux Smirak Index for non-dancers is 0.69 with SD 0.23, while the mean right Chippaux Smirak Index is 0.68 with SD 0.21. The mean difference between the left & right Chippaux Smirak Index is 0.02, with SD 0.21. The t-test yields a t value of 0.68 with significance level of 0.50, indicating no significant difference between left & right Chippaux Smirak Index in non-dancers.

The mean left arch index for non-dancers is 0.32 with SD 0.04, while the mean right arch index is 0.32 with SD 0.04. The mean difference between the left & right arch index is 0.00, with SD 0.01. The t-test yields a t value of -1.18 with significance level of 0.24, indicating no significant difference between left & right arch index in non-dancers.

Table 32 displaying inferential statistics of foot print variables and Indices within the Non-dancer group

Variables	Mean	Std. Deviation	Mean Difference	Std. Deviation	t	Sig. (2-tailed)
LFFD (cm)	6.45	1.98	0.41	0.70	4.94	**0.00**
RFFD (cm)	6.04	1.74				
LMFD (cm)	2.68	1.44	0.17	0.91	1.58	0.12
RMFD (cm)	2.51	1.18				
LHFD (cm)	3.74	1.17	0.09	0.59	1.24	0.22
RHFD (cm)	3.65	1.01				
LSI	0.40	0.13	-0.01	0.12	-0.64	0.52
RSI	0.41	0.13				
LCSI	0.69	0.23	0.02	0.21	0.68	0.50
RCSI	0.68	0.21				
LAI	0.32	0.04	0.00	0.01	-1.18	0.24
RAI	0.32	0.04				

Note: LFFD: Left Forefoot distance, LMFD: Left Midfoot distance, LHFD: Left Hindfoot distance, RFFD: Right forefoot distance, RMFD: Right Midfoot distance, RHFD: Right Hindfoot distance, LSI: Left Staheli Index, RSI: Right Staheli Index, LCSI: Left Chippaux Smirak Index, RCSI: Right Chippaux Smirak Index, LAI: Left Arch Index, RAI: Right Arch Index

4.22 Inferential statistics of foot print variables and Indices between the groups (Bhangra dancer group and Non-dancer group

The Table 33 provides a comprehensive analysis of differences in various foot measurements between dancers and non-dancers. The analysis of the left forefoot distance shows a significant difference between dancers and non-dancers. With F-value of 72.18 and a significance level of 0.00, the variances between the groups are unequal. The t-test yields a t value of 11.32 with significance level of 0.00, indicating a highly significant difference. The mean difference is 2.93 cm, with a standard error difference of 0.26 cm. This result confirms that dancers have a significantly larger left forefoot distance compared to non-dancers. For right forefoot distance, the F value is 94.02 with significance level of 0.00, indicating unequal variances. The t value is 12.05 with significance level of 0.00, showing a highly significant difference. The mean difference is 2.70 cm, and the standard error difference is 0.22 cm. This suggests that dancers have a significantly larger right forefoot distance than non-dancers.

The left midfoot distance analysis reveals F-value of 1.82 with significance level of 0.18, indicating equal variances. The t-test yields a t value of 5.07 with significance level of 0.00, indicating a significant difference. The mean difference is 1.17 cm, with a standard error difference of 0.23 cm. This indicates that dancers have a significantly larger left midfoot distance compared to non-dancers and for the right midfoot distance, the F value is 2.22 with significance level of 0.14, suggesting equal variances. The t value is 5.47 with significance level of 0.00, indicating a significant difference. The mean difference is 1.00 cm, and the standard error difference is 0.18 cm. This shows that dancers have a significantly larger right midfoot distance than non-dancers.

The left hindfoot distance analysis indicates F-value of 25.39 with significance level of 0.00, showing unequal variances. The t value is 11.26 with significance level of 0.00, indicating a highly significant difference. The mean difference is 1.80 cm, with a standard error difference of 0.16 cm. This result confirms that dancers have a significantly larger left hindfoot distance compared to non-dancers. The right hindfoot distance, the F value is 30.48 with significance level of 0.00, indicating unequal variances. The t value is 10.95 with significance level of 0.00, showing a highly significant difference. The mean difference is 1.49 cm, and the standard error difference is 0.14 cm. This indicates that dancers have a significantly larger right hindfoot distance than non-dancers.

The left Staheli Index analysis shows F-value of 0.07 with significance level of 0.80, indicating equal variances. The t value is 0.57 with significance level of 0.57, suggesting no significant difference. The mean difference is 0.01, with a standard error difference of 0.02. This indicates that the left Staheli Index is not significantly different between dancers and non-dancers. The right Staheli Index, the F value is 0.66 with significance level of 0.42, indicating equal variances. The t value is -0.25 with significance level of 0.80, suggesting no significant difference. The mean difference is -0.01, with a standard error difference of 0.02. This indicates that the right Staheli Index is not significantly different between dancers and non-dancers.

The left Chippaux Smirak Index analysis shows F-value of 0.39 with significance level of 0.53, indicating equal variances. The t value is 0.14 with significance level of 0.89, suggesting no significant difference. The mean difference is 0.01, with a standard error difference of 0.04. This indicates that the left Chippaux Smirak Index is not significantly different between dancers and non-dancers. For the right Chippaux Smirak Index, the F value is 1.35 with significance level of 0.25, indicating equal variances. The t value is 0.27 with significance level of 0.79, suggesting no significant difference. The mean difference is 0.01, with a standard error difference of 0.03. This indicates that the right Chippaux Smirak Index is not significantly different between dancers and non-dancers.

The left arch index analysis indicates F-value of 7.64 with significance level of 0.01, showing unequal variances. The t value is 6.16 with significance level of 0.00, indicating a highly significant difference. The mean difference is 0.07, with a standard error difference of 0.01. This result confirms that dancers have a significantly higher left arch index compared to non-dancers. The right arch index, the F value is 4.37 with significance level of 0.04, indicating unequal variances. The t value is 6.14 with significance level of 0.00, showing a highly significant difference. The mean difference is 0.06, and the standard error difference is 0.01. This indicates that dancers have a significantly higher right arch index than non-dancers.

Table 33 displaying inferential statistics of foot print variables and Indices between the groups (Bhangra dancer group and Non-dancer group

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
LFFD (cm)	72.18	0.00	11.32	**0.00**	2.93	0.26
RFFD (cm)	94.02	0.00	12.05	**0.00**	2.70	0.22
LMFD (cm)	1.82	0.18	5.07	**0.00**	1.17	0.23
RMFD (cm)	2.22	0.14	5.47	**0.00**	1.00	0.18
LHFD (cm)	25.39	0.00	11.26	**0.00**	1.80	0.16
RHFD (cm)	30.48	0.00	10.95	**0.00**	1.49	0.14
LSI	0.07	0.80	0.57	0.57	0.01	0.02
RSI	0.66	0.42	-0.25	0.80	-0.01	0.02
LCSI	0.39	0.53	0.14	0.89	0.01	0.04
RCSI	1.35	0.25	0.27	0.79	0.01	0.03
LAI	7.64	0.01	6.16	**0.00**	0.07	0.01
RAI	4.37	0.04	6.14	**0.00**	0.06	0.01

Note: LFFD: Left Forefoot distance, LMFD: Left Midfoot distance, LHFD: Left Hindfoot distance, RFFD: Right forefoot distance, RMFD: Right Midfoot distance, RHFD: Right Hindfoot distance, LSI: Left Staheli Index, RSI: Right Staheli Index, LCSI: Left Chippaux Smirak Index, RCSI: Right Chippaux Smirak Index, LAI: Left Arch Index, RAI: Right Arch Index

4.23 Descriptive statistics of Foot Posture Index of the participants of Bhangra Dancer Group

The table 34 and Graph 15 displays the of the foot postures of 70 Bhangra dancers for both the left & right feet. The data is categorized into five distinct foot postures: Normal, Pronated, Highly Pronated, Supinated, and Highly Supinated, resulting in a total of 140 foot observations.

Out of the 70 Bhangra dancers, 28 (40%) have a normal foot posture in their left foot, while

33 (47.1%) have a normal foot posture in their right foot. Combined, there are 61 instances (43.6%) of normal foot posture out of the 140 foot observations. This indicates that a slightly higher number of dancers have a normal posture in their right foot compared to their left foot. Overall, normal foot posture is the most common among Bhangra dancers.

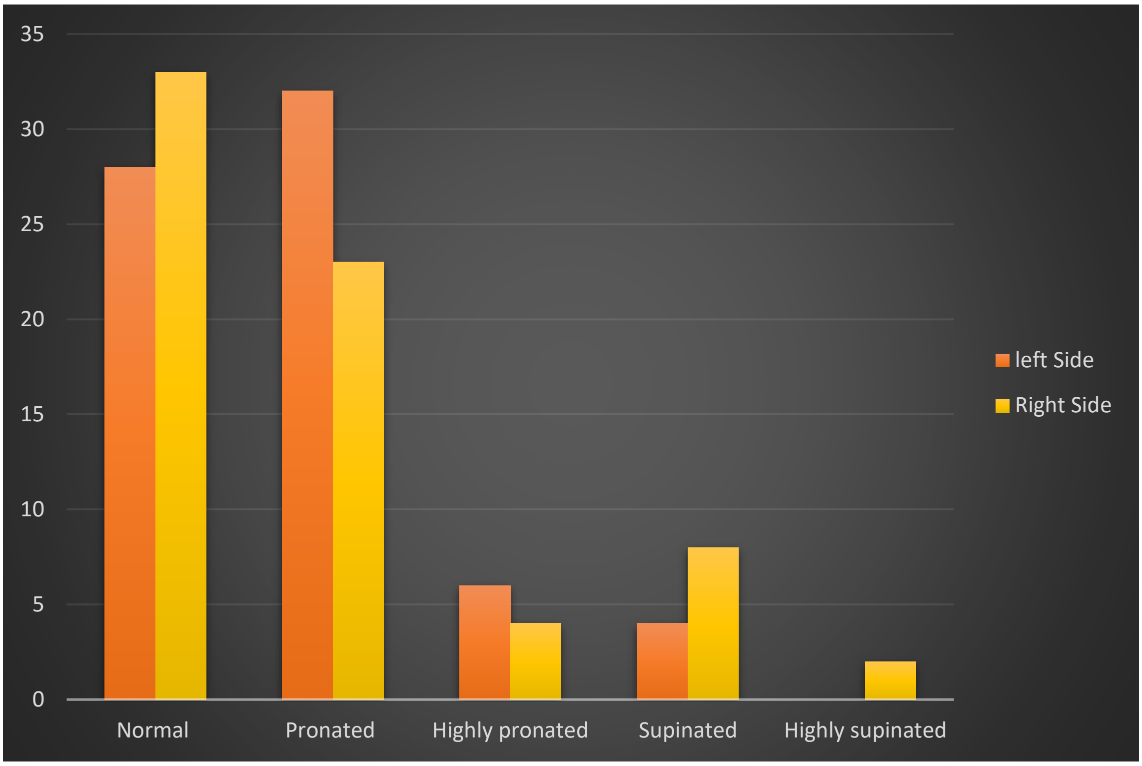
For the left foot, 32 dancers (45.7%) exhibit a pronated foot posture, while for the right foot, 23 dancers (32.9%) exhibit a pronated foot posture. Together, there are 55 instances (39.3%) of pronated foot posture out of the 140 observations. The data shows that more dancers have a pronated posture in their left foot compared to their right foot. Pronated foot posture is the second most common type among Bhangra dancers. Highly pronated foot posture is observed in 6 dancers (8.6%) for the left foot and in 4 dancers (5.7%) for the right foot. The total number of highly pronated instances is 10 (7.1%) out of 140 observations, indicating that highly pronated posture is relatively rare among Bhangra dancers.

For the supinated foot posture, 4 dancers (5.7%) have this posture in their left foot, while 8 dancers (11.4%) have it in their right foot. Combined, there are 12 instances (8.6%) of supinated foot posture out of the 140 observations. Supinated posture is more common in the right foot compared to the left. Highly supinated foot posture is the least common, with no instances (0%) observed in the left foot and 2 instances (2.9%) in the right foot. The total number of highly supinated instances is 2 (1.4%) out of 140 observations.

The findings reveal that normal foot posture is the most prevalent among Bhangra dancers, accounting for 43.6% of the foot observations. Pronated posture follows, representing 39.3%. Highly pronated, supinated, and highly supinated postures are significantly less common, with 7.1%, 8.6%, and 1.4% of the observations, respectively. Notably, normal and supinated postures are more frequent in the right foot, while pronated and highly pronated postures are more common in the left foot.

Table 34 displaying foot posture category of bhangra dancer group

Foot posture	left Side	Right Side	Total
Normal	28	33	61
Pronated	32	23	55
Highly pronated	6	4	10
Supinated	4	8	12
Highly supinated	0	2	2
Total	70	70	140



Graph 15 displaying the foot posture category of bhangra dancer group

The provided data (table 35 and graph 16) also discuss about the distribution of foot postures among Bhangra dancers, categorized into unilateral (one foot affected) and bilateral (both feet affected) occurrences. The foot postures are divided into five categories: Normal, Pronated, Highly Pronated, Supinated, and Highly Supinated.

Out of the total observations, 43 dancers (70.5%) exhibit a unilateral normal foot posture, while 18 dancers (29.5%) exhibit a bilateral normal foot posture. In total, there are 61 instances of normal foot posture, representing 43.6% of the overall foot postures observed. This indicates that normal foot posture is predominantly unilateral among Bhangra dancers.

For the pronated foot posture, 39 dancers (70.9%) exhibit a unilateral pronated foot posture, while 16 dancers (29.1%) exhibit a bilateral pronated foot posture. The total number of pronated foot posture instances is 55, accounting for 39.3% of the overall foot postures. Similar to normal foot posture, pronated foot posture is more common unilaterally.

Highly pronated foot posture is observed unilaterally in 7 dancers (70%) and bilaterally in 3 dancers (30%). The total number of highly pronated instances is 10, making up 7.1% of the overall foot postures. This posture is relatively rare among Bhangra dancers.

Supinated foot posture is observed unilaterally in 11 dancers (91.7%) and bilaterally in 1 dancer (8.3%). There are a total of 12 instances of supinated foot posture, representing 8.6%

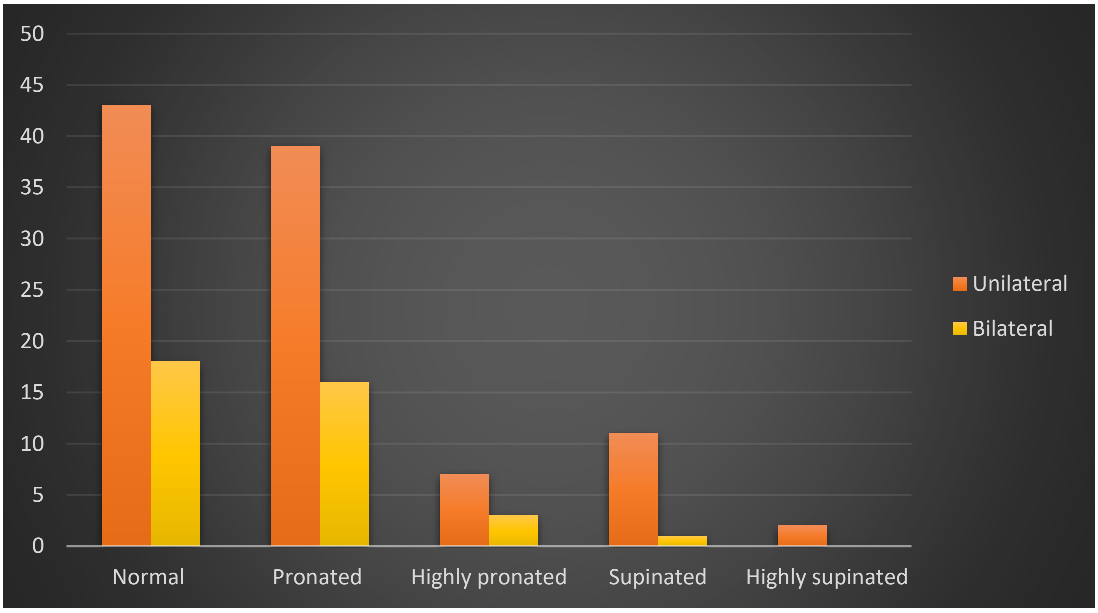
of the overall foot postures. Supinated foot posture is predominantly unilateral among Bhangra dancers.

Highly supinated foot posture is the least common, with 2 dancers (100%) exhibiting a unilateral highly supinated foot posture and no instances of bilateral highly supinated foot posture. The total number of highly supinated instances is 2, accounting for 1.4% of the overall foot postures

The findings reveal that normal and pronated foot postures are the most prevalent among Bhangra dancers, together accounting for 82.9% of the observed foot postures. Both normal and pronated postures are more commonly unilateral. Highly pronated, supinated, and highly supinated foot postures are less common, representing 7.1%, 8.6%, and 1.4% of the observations, respectively. Supinated posture is also predominantly unilateral, whereas highly supinated posture is exclusively unilateral among the dancers.

Table 35 displaying unilateral and bilateral foot posture of bhangra dancer group

Foot posture	Unilateral	Bilateral	total
Normal	43	18	61
Pronated	39	16	55
Highly pronated	7	3	10
Supinated	11	1	12
Highly supinated	2	0	2



Graph 16 displaying unilateral and bilateral foot posture of bhangra dancer group

4.24 Descriptive statistics of Foot Posture Index of the of the participants of Non-dancer group

The table 36 and graph 17 illustrates the distribution of various foot postures among 70 Non-dancers, with data collected for both the left & right feet, resulting in a total of 140 observations. The foot postures are categorized as normal, pronated, highly pronated, supinated, and highly supinated.

Among the non-dancers, 51 left feet and 56 right feet were classified as having a normal foot posture. This totals to 107 feet out of the 140 observed. Consequently, 76.4% of the feet exhibited a normal foot posture. This high percentage indicates that the majority of non-dancers have a foot posture that falls within the typical range, suggesting a balanced distribution of weight across the foot.

The pronated foot posture was observed in 16 left feet and 11 right feet, making a combined total of 27 feet. This accounts for 19.3% of the total observations. Pronated foot posture is characterized by the inward rolling of the foot's arch, which can affect the dancer's gait and potentially lead to issues such as flat feet. The relatively high percentage of pronation suggests that a significant number of non-dancers might be prone to such conditions.

There were no instances of highly pronated foot posture among the non-dancers. Both left & right feet showed zero cases, representing 0% of the total observations. Highly pronated feet, which show an extreme inward roll, are absent in this sample, suggesting that while pronation is present, it does not reach severe levels among these dancers.

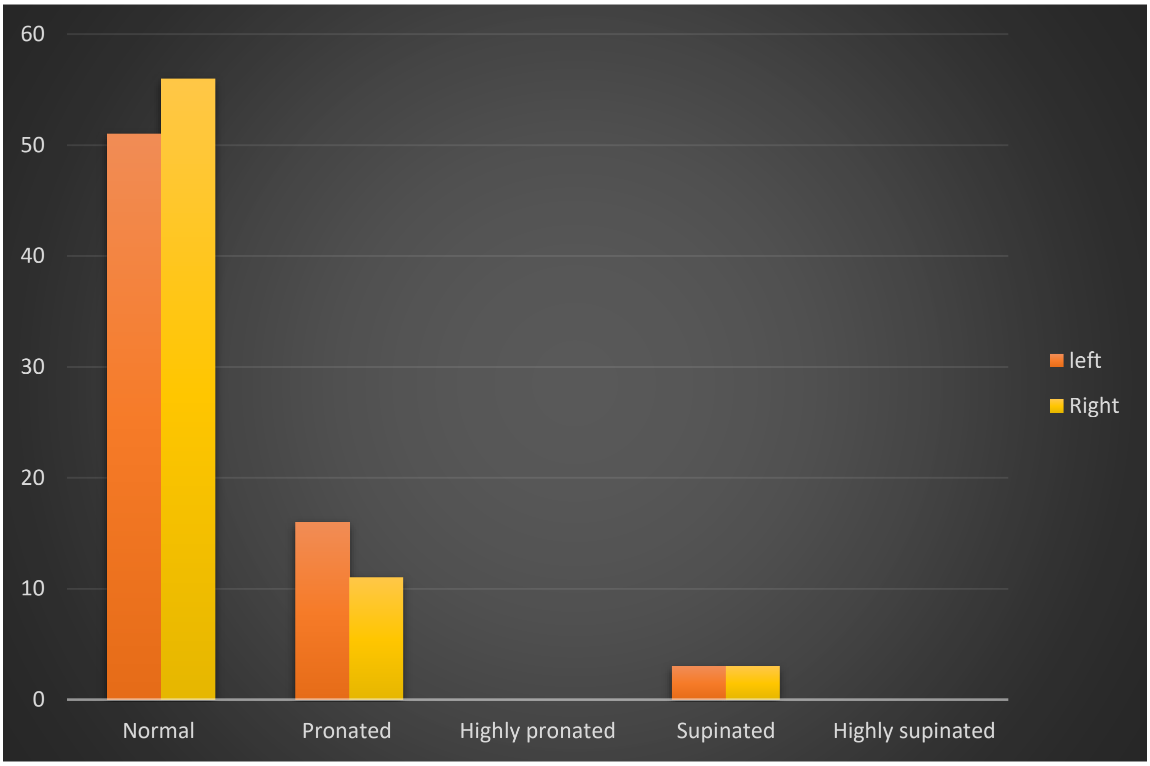
Supinated foot posture, where the arch of the foot rolls outward, was seen in 3 left feet and 3 right feet, resulting in a total of 6 feet. This represents 4.3% of the total observations. Supination can lead to uneven weight distribution on the outer edges of the feet, which might affect balance and stability. The relatively low prevalence indicates that supination is less common among the non-dancers compared to pronation.

Similarly, there were no cases of highly supinated foot posture among the non-dancers, with both left & right feet showing zero instances. This accounts for 0% of the total observations. Highly supinated feet, which excessively roll outward, are not found in this sample, indicating that extreme cases of supination are also absent among these dancers.

The foot posture among non-dancers reveals that a majority of them (76.4%) have normal foot posture. A significant minority (19.3%) exhibit pronation, which might suggest a tendency toward flat feet or related issues. Supination is relatively rare, affecting only 4.3% of the dancers. There are no cases of highly pronated or highly supinated feet, indicating that extreme deviations in foot posture are not present in this group of non-dancers.

Table 36 displaying foot posture category of Non dancer group

Foot posture	left	Right	Total
Normal	51	56	107
Pronated	16	11	27
Highly pronated	0	0	0
Supinated	3	3	6
Highly supinated	0	0	0
Total	70	70	140



Graph 17 displaying the foot posture category of Non-dancer group

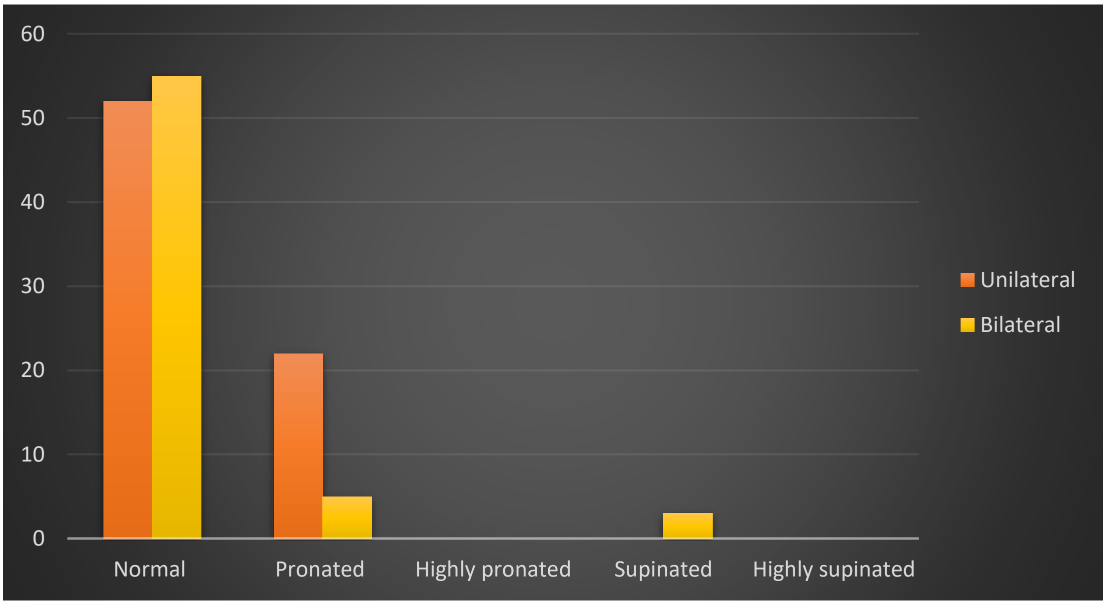
The table 37 and graph 18 provides a detailed analysis of foot posture among non-dancers, distinguishing between unilateral and bilateral conditions. The majority of the non-dancers exhibit a normal foot posture, with 52 individuals displaying unilateral normal posture and 55 individuals showing bilateral normal posture, resulting in a total of 107 dancers. This represents a significant portion, accounting for 76.4% of the entire sample.

There are 22 dancers with unilateral pronation and 5 with bilateral pronation, totaling 27 dancers. This indicates that 19.3% of the Non-dancers have a pronated foot posture. There show no occurrences of highly pronated foot posture.

For the supinated foot posture, there are no cases of unilateral supination, but there are 3 non bhangra dancers with bilateral supination, accounting for 2.1% of the total sample. Overall, the data reveals that the most common foot posture among non-dancers is normal, followed by pronated foot posture. The absence of highly pronated and highly supinated conditions suggests these are not prevalent in the non-dancer population.

Table 37 displaying foot posture category of Non-dancer group

Foot posture	Unilateral	Bilateral	Total
Normal	52	55	107
Pronated	22	5	27
Highly pronated	0	0	0
Supinated	0	3	3
Highly supinated	0	0	0



Graph 18 displaying unilateral and bilateral foot posture of bhangra dancer group

4.25 Inferential statistics of Foot Posture Index within the groups (Bhangra dancer group and Non-dancer group

4.25.1 Bhangra Dancer Group

The Table 38 compares various Foot Posture Index (FPI) parameters between the left & right feet of Bhangra dancers, highlighting both similarities and notable differences in foot posture characteristics. For the Talar Head Position (LTHP and RTHP**),** the left foot shows a mean of 0.91 compared to 0.56 for the right foot. This significant difference is supported by a t value of 3.31 ($p = 0.00$), indicating that the talar head is positioned differently between the left & right feet. This suggests potential asymmetry in weight distribution or foot alignment during dance movements. Supra and Infra lateral Malleolar Curvature (LSILMC and RSILMC)**,** both sides exhibit means of 0.66 and 0.49, respectively, with t-values of 1.76 (p = 0.08) and 1.76 (p = 0.08). These results suggest no significant differences in malleolar curvature between the left & right feet among the dancers, indicating relative symmetry in this aspect of foot posture. Similarly, Calcaneal Frontal Plane Position (LCFPP and RCFPP) also shows comparable means of 0.69 and 0.49, with t-values of 1.81 (p = 0.08) and 1.81 (p = 0.08), respectively. This suggests that the frontal plane position of the calcaneus is similar between the left & right feet, with no significant asymmetries detected. In terms of Medial Longitudinal Arch (LCMLA and RCMLA) congruence, both sides exhibit means of 0.61 and 0.49, with t-values of 1.35 (p = 0.18) and 1.35 (p = 0.18). These results indicate no statistically significant differences in arch congruence between the left & right feet, suggesting similar structural alignment across both sides. The Bulge near the Talo-navicular Joint (LBTNJ and RBTNJ)**,** the left foot shows a mean of 0.73 compared to 0.50 for the right foot, with a t value of 2.44 (p = 0.02). This significant difference suggests a more pronounced bulge presence near the talo-navicular joint in the left foot compared to the right foot among the dancers studied. For the Abduction/Adduction of the Forefoot on the Rear Foot (LAAFR and RAAFR), the left foot exhibits a mean of 0.90 compared to 0.54 for the right foot, with a t value of 3.83 (p = 0.00). This significant difference indicates asymmetry in forefoot movement between the left & right feet, highlighting potential differences in foot mechanics during dance activities.

Finally, the Total Score (LTS and RTS)**,** reflecting an aggregate measurement across all FPI parameters, shows a mean of 4.50 for the left foot compared to 3.06 for the right foot, with t-values of 3.09 (p = 0.00). This significant overall difference suggests that the left foot has a higher total FPI score, indicating more pronounced deviations from neutral foot posture compared to the right foot.

The result shows while some foot posture parameters show symmetrical characteristics between the left & right feet of Bhangra dancers (e.g., malleolar curvature, calcaneal position, arch congruence), significant asymmetries are observed in talar head position, bulge near the talo-navicular joint, forefoot movement, and overall FPI score. These findings highlight the importance of assessing and addressing asymmetries to optimize foot function and reduce injury risks in dance-specific movements and performances.

Table 38 displaying inferential statistics of Foot Posture Index within the Bhangra dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	MD	t	Sig. (2-tailed)
LTHP	0.91	0.85	0.10	0.36	3.31	**0.00**
TTHP	0.56	0.90	0.11			
LSILMC	0.66	0.70	0.08	0.17	1.76	0.08
RSILMC	0.49	0.79	0.09			
LCFPP	0.69	0.77	0.09	0.20	1.81	0.08
RCFPP	0.49	0.81	0.10			
LCMLA	0.61	0.73	0.09	0.13	1.35	0.18
RCMLA	0.49	0.79	0.09			
LBTNJ	0.73	0.85	0.10	0.23	2.44	**0.02**
RBTNJ	0.50	0.88	0.11			
LAAFR	0.90	0.73	0.09	0.36	3.83	**0.00**
RAAFR	0.54	0.88	0.11			
LTS	4.50	3.42	0.41	1.44	3.09	**0.00**
RTS	3.06	4.13	0.49			

Note: LTHP: Left talar head position, RTHP: Right talar head position, LSILMC: Left Supra and infra lateral malleolar curvature, RSILMC: Right Supra and infra lateral malleolar curvature, LCFPP: Left Calcaneal frontal plane position, RCFPP: Right Calcaneal frontal plane position, LBTNJ: Left Bulge in the region of the talo-navicular joint, RBTNJ: Right Bulge in the region of the talo-navicular joint, LCMLA: Left Congruence of the medial longitudinal arch, RCMLA: Right Congruence of the medial longitudinal arch, LAAFR: Left Abduction/adduction of the forefoot on the rear foot, RAAFR: Right Abduction/adduction of the forefoot on the rear foot, LTS: Left Total Score, RTS: Right Total Score

4.25.2 Non-Dancer Group

The Table 39 provides a comprehensive comparison of Foot Posture Index (FPI) parameters between the left & right feet of a Non-dancer group, offering understandings into various aspects of foot posture crucial for understanding asymmetries and biomechanical implications. In the Talar Head Position (LTHP and RTHP), the left foot shows a mean of 0.63 with SD 0.75 and a standard error of 0.09. The mean difference (MD = 0.19) results in a t value of 1.93 (p = 0.06), indicating a marginal difference that does not reach statistical significance. In comparison, the Right Talar Head Position (RTHP) on the right foot has a mean of 0.44 and a SD of 0.65, though the specific t-test result is not provided, suggesting a potential difference between the left & right sides in talar head positioning. Supra and Infra lateral Malleolar Curvature (LSILMC and RSILMC), both sides exhibit means of 0.54 and 0.51, respectively, with t-values of 0.32 (p = 0.75). These results indicate no significant differences in malleolar curvature between the left & right feet, suggesting symmetry in this aspect of foot posture among the non-dancer group. Similarly, Calcaneal Frontal Plane Position (LCFPP and RCFPP) shows means of 0.79 and 0.80, respectively, with t-values of -0.18 (p = 0.85). This suggests no significant differences in calcaneal frontal plane position between the left & right feet, indicating comparable alignment in this area. However, Congruence of the Medial Longitudinal Arch (LCMLA and RCMLA) reveals a mean of 0.37 for the left foot compared to 0.57 for the right foot, with a significant t value of -2.49 (p = 0.02). This significant difference indicates asymmetry in arch congruence between the left & right feet among non-dancers, suggesting a more pronounced variation in arch alignment. Regarding Bulge near the Talo-navicular Joint (LBTNJ and RBTNJ) and Abduction/Adduction of the Forefoot on the Rear Foot (LAAFR and RAAFR), both measurements show means and t-values that do not reach statistical significance, indicating no significant asymmetries in these parameters between the left & right feet. Finally, the Total Score (LTS and RTS), reflecting the overall FPI assessment, shows means of 3.79 and 3.57 for the left & right feet, respectively, with a t value of 0.65 (p = 0.52). This indicates no significant overall difference in foot posture between the left & right sides among non-dancers based on the total score. The results highlights various aspects of foot posture among Non-dancers, showing symmetry in most parameters such as malleolar curvature and calcaneal position.

Table 39 displaying inferential statistics of Foot Posture Index within the Non-dancer groups

Variables	Mean	Std. Deviation	Std. Error Mean	MD	t	Sig. (2-tailed)
LTHP	0.63	0.75	0.09	0.19	1.93	0.06
TTHP	0.44	0.65	0.08			
LSILMC	0.54	0.56	0.07	0.03	0.32	0.75
RSILMC	0.51	0.56	0.07			
LCFPP	0.79	0.59	0.07	-0.01	-0.18	0.85
RCFPP	0.80	0.60	0.07			
LCMLA	0.37	0.54	0.06	-0.20	-2.49	**0.02**
RCMLA	0.57	0.58	0.07			

LBTNJ	0.60	0.65	0.08	0.10	1.22	0.23
RBTNJ	0.50	0.61	0.07			
LAAFR	0.86	0.64	0.08	0.11	1.09	0.28
RAAFR	0.74	0.76	0.09			
LTS	3.79	2.70	0.32	0.21	0.65	0.52
RTS	3.57	2.59	0.31			

Note: LTHP: Left Talar head position, RTHP: Right Talar head position, LSILMC: Left Supra and infra lateral malleolar curvature, RSILMC: Right Supra and infra lateral malleolar curvature, LCFPP: Left Calcaneal frontal plane position, RCFPP: Right Calcaneal frontal plane position, LBTNJ: Left Bulge in the region of the talo-navicular joint, RBTNJ: Right Bulge in the region of the talo-navicular joint, LCMLA: Left Congruence of the medial longitudinal arch, RCMLA: Right Congruence of the medial longitudinal arch, LAAFR: Left Abduction/adduction of the forefoot on the rear foot, RAAFR: Right Abduction/adduction of the forefoot on the rear foot, LTS: Left Total Score, RTS: Right Total Score

4.26 Inferential statistics of Foot Posture Index between the groups (Bhangra dancer group and Non-dancer group

The table 38 compares various foot characteristics between Bhangra dancers and non-dancers. The measurements include both left & right sides of the foot for each characteristic. The mean, SD, F-value, significance (Sig.), t-value, and significance of the t-test (Sig. 2-tailed) are provided for each group.

4.26.1 Left Talar Head Position (LTHP)

Bhangra dancers have a mean LTHP of 0.91 with SD 0.85, while non-dancers have a mean of 0.63 with SD 0.75. The mean difference is 0.29, with an F-value of 0.32 and a significance of 0.57. The t-test shows a t value of 2.12 and a significance of 0.04, indicating a significant difference between groups.

4.26.2 Right Talar Head Position (RTHP)

The mean RTHP for Bhangra dancers is 0.56 with SD 0.90, compared to 0.44 and 0.65 for non-dancers. The mean difference is 0.11, with an F-value of 7.31 and a significance of 0.01. The t-test shows a t value of 0.86 and a significance of 0.39, indicating no significant difference.

4.26.3 Left Supra and Infra Lateral Malleolar Curvature (LSILMC)

Bhangra dancers have a mean LSILMC of 0.66 with SD 0.70, while non-dancers have a mean of 0.54 with SD 0.56. The mean difference is 0.11, with an F-value of 1.49 and a significance of 0.23. The t-test shows a t value of 1.07 and a significance of 0.29, indicating no significant difference.

4.26.4 Right Supra and Infra Lateral Malleolar Curvature (RSILMC)

The mean RSILMC for Bhangra dancers is 0.49 with SD 0.79, compared to 0.51 and 0.56 for non-dancers. The mean difference is -0.03, with an F-value of 9.57 and a significance of 0.00. The t-test shows a t value of -0.25 and a significance of 0.81, indicating no significant difference.

4.26.5 Left Calcaneal Frontal Plane Position (LCFPP)

Bhangra dancers have a mean LCFPP of 0.69 with SD 0.77, while non-dancers have a mean of 0.79 with SD 0.59. The mean difference is -0.10, with an F-value of 4.24 and a significance of 0.04. The t-test shows a t value of -0.86 and a significance of 0.39, indicating no significant difference.

4.26.6 Right Calcaneal Frontal Plane Position (RCFPP)

The mean RCFPP for Bhangra dancers is 0.49 with SD 0.81, compared to 0.80 and 0.60 for non-dancers. The mean difference is -0.31, with an F-value of 15.34 and a significance of 0.00. The t-test shows a t value of -2.60 and a significance of 0.01, indicating a significant difference between groups.

4.26.7 Left Congruence of the Medial Longitudinal Arch (LCMLA)

Bhangra dancers have a mean LCMLA of 0.73 with SD 0.85, while non-dancers have a mean of 0.60 with SD 0.65. The mean difference is 0.13, with an F-value of 2.17 and a significance of 0.14. The t-test shows a t value of 1.01 and a significance of 0.32, indicating no significant difference.

4.26.8 Right Congruence of the Medial Longitudinal Arch (RCMLA)

The mean RCMLA for both groups is the same at 0.50. The SD for Bhangra dancers is 0.88, compared to 0.61 for non-dancers. The mean difference is 0.00, with an F-value of 7.06 and a significance of 0.01. The t-test shows a t value of 0.00 and a significance of 1.00, indicating no significant difference.

4.26.9 Left Bulge in the Region of the Talo-Navicular Joint (LBTNJ)

Bhangra dancers have a mean LBTNJ of 0.61 with SD 0.73, while non-dancers have a mean of 0.37 with SD 0.54. The mean difference is 0.24, with an F-value of 3.77 and a significance of 0.05. The t-test shows a t value of 2.24 and a significance of 0.03, indicating a significant difference.

4.26.10 Right Bulge in the Region of the Talo-Navicular Joint (RBTNJ)

The mean RBTNJ for Bhangra dancers is 0.49 with SD 0.79, compared to 0.57 and 0.58 for non-dancers. The mean difference is -0.09, with an F-value of 5.71 and a significance of 0.02.

The t-test shows a t value of -0.73 and a significance of 0.47, indicating no significant difference.

4.26.11 Left Abduction/Adduction of the Forefoot on the Rear Foot (LAAFR)

Bhangra dancers have a mean LAAFR of 0.90 with SD 0.73, while non-dancers have a mean of 0.86 with SD 0.64. The mean difference is 0.04, with an F-value of 1.08 and a significance of 0.30. The t-test shows a t value of 0.37 and a significance of 0.71, indicating no significant difference.

4.26.12 Right Abduction/Adduction of the Forefoot on the Rear Foot (RAAFR)

The mean RAAFR for Bhangra dancers is 0.54 with SD 0.88, compared to 0.74 and 0.76 for non-dancers. The mean difference is -0.20, with an F-value of 2.46 and a significance of 0.12. The t-test shows a t value of -1.44 and a significance of 0.15, indicating no significant difference.

4.26.13 Left Total Score (LTS)

Bhangra dancers have a mean LTS of 4.50 with SD 3.42, while non-dancers have a mean of 3.79 with SD 2.70. The mean difference is 0.71, with an F-value of 4.47 and a significance of 0.04. The t-test shows a t value of 1.37 and a significance of 0.17, indicating no significant difference.

4.26.14 Right Total Score (RTS)

The mean RTS for Bhangra dancers is 3.06 with SD 4.13, compared to 3.57 and 2.59 for non-dancers. The mean difference is -0.51, with an F-value of 21.05 and a significance of 0.00. The t-test shows a t value of -0.88 and a significance of 0.38, indicating no significant difference.

The finding reveals that several foot characteristics, such as the Left Talar Head Position, Right Calcaneal Frontal Plane Position, and Left Bulge in the Region of the Talo-Navicular Joint, show significant differences between Bhangra and non-dancers. However, many characteristics, including various arches and navicular bulge positions, do not show significant differences. These results highlight the specific areas where Bhangra dancing may impact foot posture and alignment compared to non-dancers.

Table 40 displaying inferential statistics of Foot Posture Index between the groups (Bhangra dancer group and Non-dancer group

Variables	Group	Mean	SD	MD	F	Sig.	t	Sig. (2-tailed)
LTHP	Bhangra Dancer	0.91	0.85	0.29	0.04	0.32	0.57	2.12
	Non Dancer	0.63	0.75					
TTHP	Bhangra Dancer	0.56	0.90	0.11	0.39	7.31	0.01	0.86
	Non Dancer	0.44	0.65					
LSILMC	Bhangra Dancer	0.66	0.70	0.11	0.29	1.49	0.23	1.07
	Non Dancer	0.54	0.56					
RSILMC	Bhangra Dancer	0.49	0.79	-0.03	0.81	9.57	0.00	-0.25
	Non Dancer	0.51	0.56					
LCFPP	Bhangra Dancer	0.69	0.77	-0.10	0.39	4.24	0.04	-0.86
	Non Dancer	0.79	0.59					
RCFPP	Bhangra Dancer	0.49	0.81	-0.31	0.01	15.34	0.00	-2.60
	Non Dancer	0.80	0.60					
LCMLA	Bhangra Dancer	0.73	0.85	0.13	0.32	2.17	0.14	1.01
	Non Dancer	0.60	0.65					
RCMLA	Bhangra Dancer	0.50	0.88	0.00	1.00	7.06	0.01	0.00
	Non Dancer	0.50	0.61					
LBTNJ	Bhangra Dancer	0.61	0.73	0.24	0.03	3.77	0.05	2.24
	Non Dancer	0.37	0.54					
RBTNJ	Bhangra Dancer	0.49	0.79	-0.09	0.47	5.71	0.02	-0.73
	Non Dancer	0.57	0.58					

LAAFR	Bhangra Dancer	0.90	0.73	0.04	0.71	1.08	0.30	0.37
	Non Dancer	0.86	0.64					
RAAFR	Bhangra Dancer	0.54	0.88	-0.20	0.15	2.46	0.12	-1.44
	Non Dancer	0.74	0.76					
LTS	Bhangra Dancer	4.50	3.42	0.71	0.17	4.47	0.04	1.37
	Non Dancer	3.79	2.70					
RTS	Bhangra Dancer	3.06	4.13	-0.51	0.38	21.05	0.00	-0.88
	Non Dancer	3.57	2.59					

Note: LTHP: Left Talar head position, RTHP: Right Talar head position, LSILMC: Left Supra and infra lateral malleolar curvature, RSILMC: Right Supra and infra lateral malleolar curvature, LCFPP: Left Calcaneal frontal plane position, RCFPP: Right Calcaneal frontal plane position, LBTNJ: Left Bulge in the region of the talo-navicular joint, RBTNJ: Right Bulge in the region of the talo-navicular joint, LCMLA: Left Congruence of the medial longitudinal arch, RCMLA: Right Congruence of the medial longitudinal arch, LAAFR: Left Abduction/adduction of the forefoot on the rear foot, RAAFR: Right Abduction/adduction of the forefoot on the rear foot, LTS: Left Total Score, RTS: Right Total Score

4.27 Descriptive statistics of posture variables of the participants (Bhangra dancer group and Non- Dancer group) (N=140)

The table 41 and graph 19 provides a summary of the descriptive statistics for various angular measurements related to postural alignment and anatomical angles of 140 participants (70 Bhangra Dancers and 70 Non Bhangra Dancers). These measurements are crucial for understanding the alignment and potential asymmetries in the human body, particularly in the context of clinical and sports assessments. The table includes the following statistical parameters for each measurement: Range, Minimum, Maximum, Mean, SD, and Variance. These parameters are critical for comprehending the distribution and central tendency of the data.

4.27.1 Horizontal Alignment of the Head (HAH)

The HAH shows a range of 15.80 degrees, with values spanning from -8.20 to 7.60 degrees. The mean value is -0.11 degrees, indicating a slight inclination towards the negative direction. The SD of 2.95 degrees suggests moderate variability around the mean, with a variance of 8.73.

4.27.2 Horizontal Alignment of the Acromion (HAA)

The HAA has a range of 11.10 degrees, with a minimum of -5.80 degrees and a maximum of 5.30 degrees. The mean is 0.26 degrees, showing a slight positive alignment. The SD is 2.05 degrees, and the variance is 4.22, indicating relatively low variability in this measurement.

4.27.3 Horizontal Alignment of ASIS (HAAS)

The HAAS ranges from -10.70 to 5.30 degrees, with a total range of 16.00 degrees. The mean is -0.62 degrees, with SD 2.41 degrees and a variance of 5.82, showing moderate variability.

4.27.4 Lateral Trunk Alignment (LTA)

For LTA, the range is 17.30 degrees, with values between -4.30 and 13.00 degrees. The mean is 0.86 degrees, and the SD is 2.71 degrees. The variance stands at 7.35, indicating moderate variability.

4.27.5 Quadriceps Angles (LQA and RQA)

The left quadriceps angle (LQA) has a range of 43.10 degrees, from -4.20 to 38.90 degrees, with a mean of 13.44 degrees. The SD is 7.61 degrees, and the variance is 57.98. The right quadriceps angle (RQA) shows a higher range of 52.70 degrees, from -10.90 to 41.80 degrees, a mean of 11.11 degrees, a SD of 9.46 degrees, and a variance of 89.57, indicating higher variability compared to the left side.

4.27.6 Rear-foot Angles (LRA and RRA)

The left rear-foot angle (LRA) has the largest range of 103.70 degrees, spanning from -72.90 to 30.80 degrees, with a mean of 3.54 degrees, a SD of 11.47 degrees, and a variance of 131.56. The right rear-foot angle (RRA) also shows a wide range of 99.30 degrees, from -71.30 to 28.00 degrees, a mean of 2.17 degrees, a SD of 10.50 degrees, and a variance of 110.27.

4.27.7 Forward Head Angles (RFHA and LFHA)

The right forward head angle (RFHA) ranges from 36.20 to 70.50 degrees, with a mean of 53.57 degrees, a SD of 6.81 degrees, and a variance of 46.35. The left forward head angle (LFHA) ranges from 39.50 to 83.90 degrees, with a mean of 54.88 degrees, a SD of 6.88 degrees, and a variance of 47.27.

4.27.8 Shoulder Angles (RSA and LSA)

The right shoulder angle (RSA) has a range of 73.30 degrees, from 16.20 to 89.50 degrees, with a mean of 54.54 degrees, a SD of 15.45 degrees, and a variance of 238.79. The left shoulder angle (LSA) shows a similar range of 71.20 degrees, from 14.00 to 85.20 degrees, a mean of 55.58 degrees, a SD of 15.30 degrees, and a variance of 233.99.

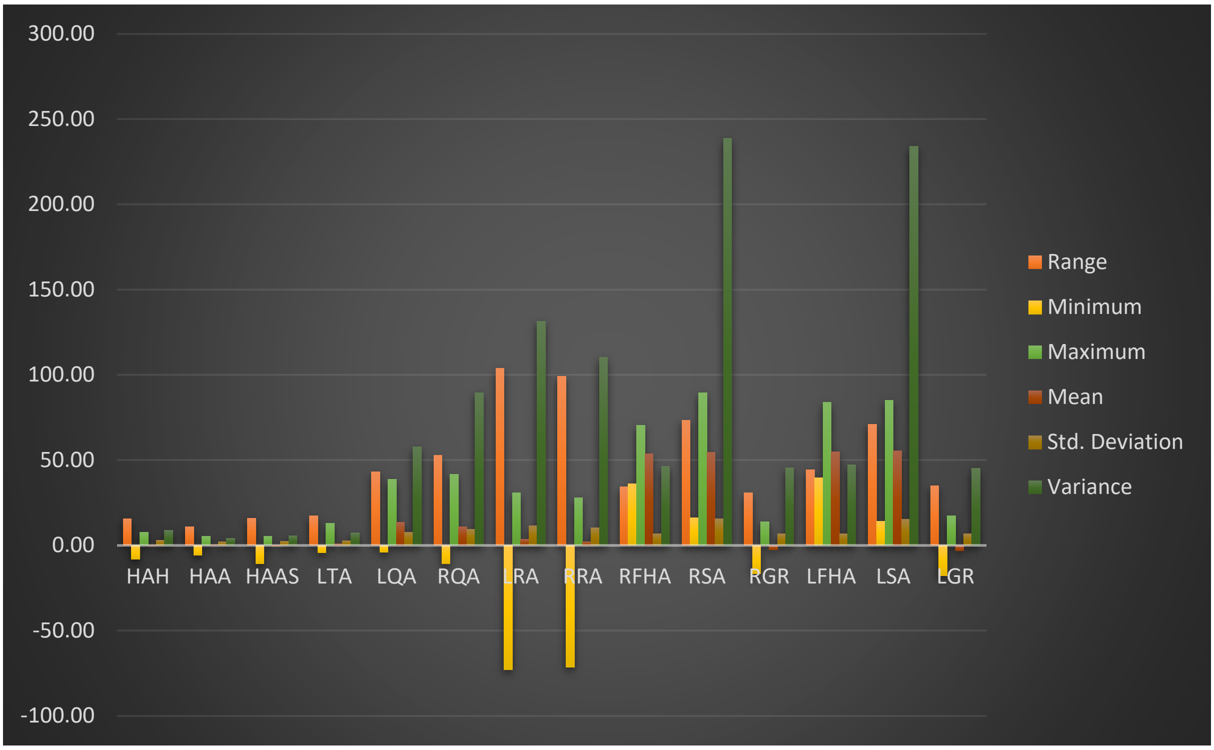
4.27.9 Genu Recurvatum (RGR and LGR)

The right genu recurvatum (RGR) ranges from -16.80 to 13.90 degrees, with a mean of -2.70 degrees, a SD of 6.75 degrees, and a variance of 45.59. The left genu recurvatum (LGR) has a range of 35.10 degrees, from -17.90 to 17.20 degrees, a mean of -3.17 degrees, a SD of 6.72 degrees, and a variance of 45.15.

Table 41 displaying descriptive statistics of posture variables of the participants (Bhangra dancer group and Non- Dancer group) (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
HAH	15.80	-8.20	7.60	-0.11	2.95	8.73
HAA	11.10	-5.80	5.30	0.26	2.05	4.22
HAAS	16.00	-10.70	5.30	-0.62	2.41	5.82
LTA	17.30	-4.30	13.00	0.86	2.71	7.35
LQA	43.10	-4.20	38.90	13.44	7.61	57.98
RQA	52.70	-10.90	41.80	11.11	9.46	89.57
LRA	103.70	-72.90	30.80	3.54	11.47	131.56
RRA	99.30	-71.30	28.00	2.17	10.50	110.27
RFHA	34.30	36.20	70.50	53.57	6.81	46.35
RSA	73.30	16.20	89.50	54.54	15.45	238.79
RGR	30.70	-16.80	13.90	-2.70	6.75	45.59
LFHA	44.40	39.50	83.90	54.88	6.88	47.27
LSA	71.20	14.00	85.20	55.58	15.30	233.99
LGR	35.10	-17.90	17.20	-3.17	6.72	45.15

Note: HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, LRA: Left Rear-foot angle, RRA: right Rear-foot angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum



Graph 19 displaying descriptive statistics of posture variables of the participants (N=140)

4.28 Descriptive statistics of posture variables of the groups (Bhangra dancer group and Non-Dancer group)

The table 42 and graph 20 summarizes the descriptive statistics of posture variables both the groups, Bhangra dancers have a mean HAH of 0.11 degrees with SD 2.97 degrees and a SEM of 0.36. Non-dancers, on the other hand, show a mean HAH of -0.33 degrees, a SD of 2.94 degrees, and a SEM of 0.35. This suggests that Bhangra dancers tend to have a slightly more positive head alignment compared to non-dancers, although the difference is minor.

For HAA, Bhangra dancers exhibit a mean of 0.68 degrees, a SD of 1.99 degrees, and a SEM of 0.24. In contrast, non-dancers had a mean HAA of -0.15 degrees, a SD of 2.05 degrees, and a SEM of 0.25. This indicates that Bhangra dancers generally have a more positive acromion alignment compared to their non-dancing counterparts.

The mean HAAS for Bhangra dancers is -0.21 degrees, with SD 2.17 degrees and a SEM of 0.26. Non-dancers show a mean of -1.02 degrees, a SD of 2.58 degrees, and a SEM of 0.31. This data suggests that Bhangra dancers have a less negative alignment of the ASIS compared to non-dancers.

Bhangra dancers had a mean LTA of 0.77 degrees, a SD of 2.58 degrees, and a SEM of 0.31. Non-dancers had a slightly higher mean LTA of 0.95 degrees, with SD 2.85 degrees and a SEM of 0.34. This indicates that there is a slight difference in lateral trunk alignment, with non-dancers showing a slightly greater inclination.

The left quadriceps angle (LQA) for Bhangra dancers has a mean of 11.00 degrees, a SD of 7.24 degrees, and a SEM of 0.87. Non-dancers exhibit a mean LQA of 15.88 degrees, with SD 7.23 degrees and a SEM of 0.86, indicating higher quadriceps angle in non-dancers. For the right quadriceps angle (RQA), Bhangra dancers had a mean of 7.07 degrees, a SD of 7.93 degrees, and a SEM of 0.95. Non-dancers show a higher mean of 15.14 degrees, with SD 9.19 degrees and a SEM of 1.10, indicating significant differences in right quadriceps angles between the two groups.

The left rear-foot angle (LRA) for Bhangra dancers has a mean of 5.15 degrees, a SD of 11.07 degrees, and a SEM of 1.32. Non-dancers had a mean of 1.92 degrees, with SD 11.71 degrees and a SEM of 1.40. This suggests that Bhangra dancers tend to have a higher LRA. For the right rear-foot angle (RRA), Bhangra dancers exhibit a mean of 3.52 degrees, a SD of 10.01 degrees, and a SEM of 1.20. Non-dancers had a lower mean RRA of 0.83 degrees, with SD 10.87 degrees and a SEM of 1.30.

The right forward head angle (RFHA) in Bhangra dancers has a mean of 52.13 degrees, a SD of 7.28 degrees, and a SEM of 0.87. Non-dancers show a mean of 55.01 degrees, with SD 6.01 degrees and a SEM of 0.72, indicating a greater forward head angle in non-dancers. The left forward head angle (LFHA) for Bhangra dancers is 53.24 degrees, with SD 6.80 degrees and a SEM of 0.81. Non-dancers had a mean of 56.51 degrees, with SD 6.60 degrees and a SEM of 0.79.

The right shoulder angle (RSA) in Bhangra dancers has a mean of 56.82 degrees, a SD of 15.34 degrees, and a SEM of 1.83. Non-dancers show a mean of 52.26 degrees, with an identical SD and standard error mean, indicating similar variability but a higher mean shoulder angle in Bhangra dancers. The left shoulder angle (LSA) for Bhangra dancers has a mean of 62.45 degrees, a SD of 15.09 degrees, and a SEM of 1.80. Non-dancers show a lower mean of 48.70 degrees, with SD 12.16 degrees and a SEM of 1.45.

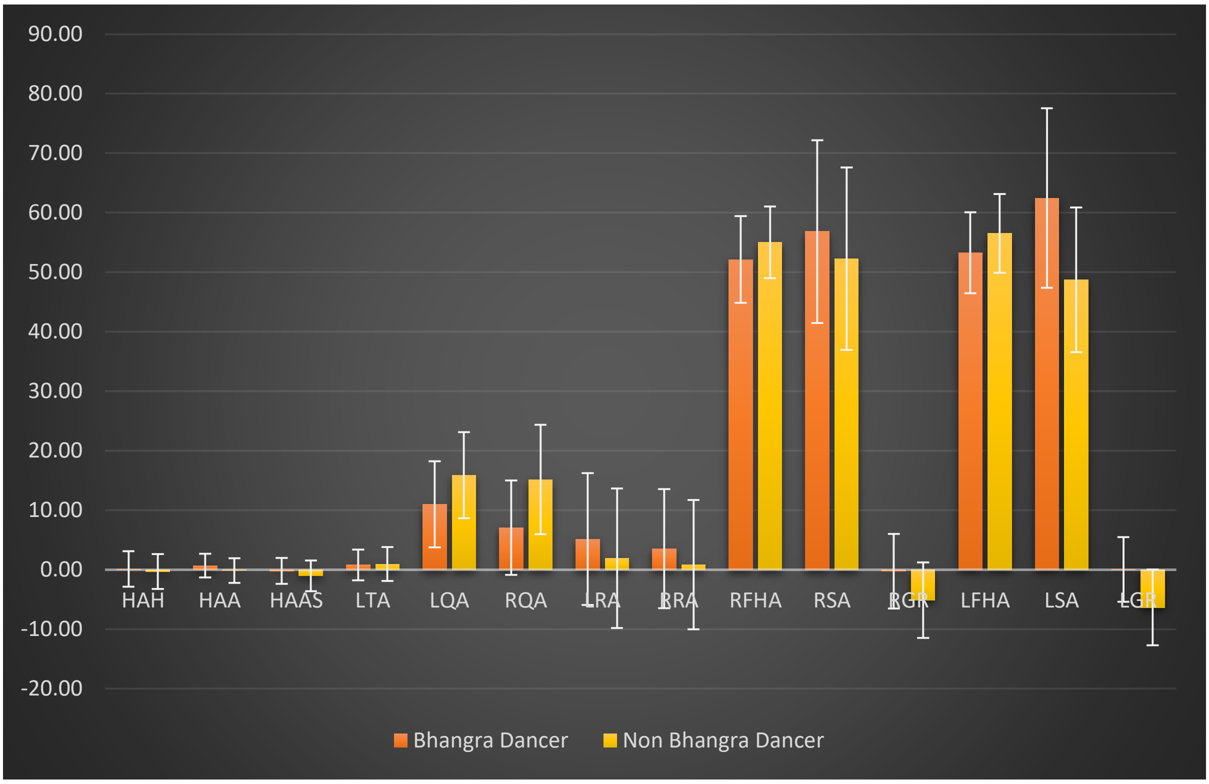
The right genu recurvatum (RGR) in Bhangra dancers has a mean of -0.25 degrees, a SD of 6.28 degrees, and a SEM of 0.75. Non-dancers show a more negative mean of -5.14 degrees, with a similar SD and standard error mean, indicating greater hyperextension in non-dancers. The left genu recurvatum (LGR) for Bhangra dancers has a mean of 0.02 degrees, a SD of 5.44 degrees, and a SEM of 0.65. Non-dancers exhibit a more negative mean of -6.35 degrees, with SD 6.38 degrees and a SEM of 0.76.

Overall, the results indicate significant differences in postural and alignment measurements between Bhangra dancers and non-dancers. Bhangra dancers generally show better alignment and less deviation in various postural angles, suggesting that the physical demands and movements specific to Bhangra dancing may contribute to these differences.

Table 42 displaying descriptive statistics of posture variables of the groups (Bhangra dancer group and Non- Dancer group)

Variables	Group	Mean	Std. Deviation	Std. Error Mean
HAH	Bhangra Dancer	0.11	2.97	0.36
	Non-Dancer	-0.33	2.94	0.35
HAA	Bhangra Dancer	0.68	1.99	0.24
	Non-Dancer	-0.15	2.05	0.25
HAAS	Bhangra Dancer	-0.21	2.17	0.26
	Non-Dancer	-1.02	2.58	0.31
LTA	Bhangra Dancer	0.77	2.58	0.31
	Non-Dancer	0.95	2.85	0.34
LQA	Bhangra Dancer	11.00	7.24	0.87
	Non-Dancer	15.88	7.23	0.86
RQA	Bhangra Dancer	7.07	7.93	0.95
	Non-Dancer	15.14	9.19	1.10
LRA	Bhangra Dancer	5.15	11.07	1.32
	Non-Dancer	1.92	11.71	1.40
RRA	Bhangra Dancer	3.52	10.01	1.20
	Non-Dancer	0.83	10.87	1.30
RFHA	Bhangra Dancer	52.13	7.28	0.87
	Non-Dancer	55.01	6.01	0.72
RSA	Bhangra Dancer	56.82	15.34	1.83
	Non-Dancer	52.26	15.34	1.83
RGR	Bhangra Dancer	-0.25	6.28	0.75
	Non-Dancer	-5.14	6.35	0.76
LFHA	Bhangra Dancer	53.24	6.80	0.81
	Non-Dancer	56.51	6.60	0.79
LSA	Bhangra Dancer	62.45	15.09	1.80
	Non-Dancer	48.70	12.16	1.45
LGR	Bhangra Dancer	0.02	5.44	0.65
	Non-Dancer	-6.35	6.38	0.76

Note: HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, LRA: Left Rear-foot angle, RRA: Right Rear-foot angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum



Graph 20 displaying descriptive statistics of posture variables of the groups (Bhangra dancer group and Non- Dancer group)

4.29 Inferential statistics of posture variables within the group (Bhangra dancer group and Non- Dancer group)

4.29.1 Bhangra Dancer Group

The provided tables 43 offer an overview of the alignment measures in a group of Bhangra dancers, evaluated through descriptive statistics and one-sample t-tests. Each measure is compared to a specific reference value to ascertain whether the sample mean significantly differs from the reference value.

The horizontal alignment measures include the horizontal alignment of the head (HAH), horizontal alignment of the acromion (HAA), horizontal alignment of the ASIS (HAAS), and lateral trunk alignment (LTA). For the horizontal alignment of the head (HAH), the mean value is 0.11 with SD 2.97 and a SEM of 0.36. The t-test results show a mean difference of 0.11, a t value of 0.31, and p value of 0.75, indicating no significant difference from the reference value of 0. This suggests that the horizontal alignment of the head is, on average, close to zero, with a high variability among dancers. In contrast, the horizontal alignment of the acromion (HAA) has a mean value of 0.68, a SD of 1.99, and a SEM of 0.24. The t-test results reveal a mean difference of 0.68, a t value of 2.85, and p value of 0.01, indicating a significant difference from the reference value of 0. This implies that the acromion alignment is slightly elevated compared to zero, with moderate variability. The horizontal alignment of the ASIS (HAAS) shows a mean value of -0.21, with SD 2.17 and a SEM of 0.26. The t-test results, with a mean difference of -0.21, a t value of -0.81, and p value of 0.42, indicate no significant difference from the reference value of 0. This suggests that the ASIS alignment is slightly below zero, but this difference is not statistically significant.

For the lateral trunk alignment (LTA), the mean value is 0.77, the SD is 2.58, and the SEM is 0.31. The t-test results show a mean difference of 0.77, a t value of 2.48, and p value of 0.02, indicating a significant difference from the reference value of 0. This indicates that there is a slight lateral deviation in the trunk alignment, which is statistically significant.

The reference value for Quadriceps angle is 15^0, the left quadriceps angle (LQA) has a mean value of 11.00, with SD 7.24 and a SEM of 0.87. The t-test results show a mean difference of -4.00, a t value of -4.63, and p value of 0.00, indicating a significant difference from the reference value of 15. This suggests that the left quadriceps angle is significantly lower than the reference value. The right quadriceps angle (RQA) shows a mean value of 7.07, with SD 7.93 and a SEM of 0.95. The t-test results reveal a mean difference of -7.93, a t value of -8.36, and p value of 0.00, indicating a significant difference from the reference value of 15. This suggests that the right quadriceps angle is significantly lower than the reference value.

The reference value for the forward head angle measures is 50 degrees, the right forward head angle (RFHA) has a mean value of 52.13, with SD 7.28 and a SEM of 0.87. The t-test results show a mean difference of 2.13, a t value of 2.45, and p value of 0.02, indicating a significant difference from the reference value of 50. This suggests that the right forward head angle is slightly higher than the reference value. The left forward head angle (LFHA) shows a mean value of 53.24, with SD 6.80 and a SEM of 0.81. The t-test results reveal a mean difference of 3.24, a t value of 3.99, and p value of 0.00, indicating a significant difference from the reference value of 50. This suggests that the left forward head angle is significantly higher than the reference value.

The reference value for Shoulder Angle is 52^0, the right shoulder angle (RSA) has a mean value of 56.82, with SD 15.34 and a SEM of 1.83. The t-test results show a mean difference of 4.82, a t value of 2.63, and p value of 0.01, indicating a significant difference from the reference value of 52. This suggests that the right shoulder angle is significantly higher than the reference value. The left shoulder angle (LSA) shows a mean value of 62.45, with SD 15.09 and a SEM of 1.80. The t-test results reveal a mean difference of 10.45, a t value of 5.79, and p value of 0.00, indicating a significant difference from the reference value of 52. This suggests that the left shoulder angle is significantly higher than the reference value.

The reference value for Genu Recurvatum is -10 degrees, for the right genu recurvatum (RGR) has a mean value of -0.25, with SD 6.28 and a SEM of 0.75. The t-test results show a mean difference of 9.75, a t value of 12.99, and p value of 0.00, indicating a significant difference from the reference value of -10. This suggests that the right genu recurvatum is significantly higher than the reference value. The left genu recurvatum (LGR) shows a mean value of 0.02, with SD 5.44 and a SEM of 0.65. The t-test results reveal a mean difference of 10.02, a t value of 15.40, and p value of 0.00, indicating a significant difference from the reference value of -10. This suggests that the left genu recurvatum is significantly higher than the reference value.

In summary, the Bhangra dancers show significant deviations from reference values in several alignment measures. The head and trunk alignments exhibit minor deviations with varying degrees of significance. The quadriceps angles are significantly lower than the reference values, while the forward head and shoulder angles are significantly higher. Additionally, both genu recurvatum measures are significantly higher than the reference value of -10. These findings highlight specific postural characteristics and deviations in Bhangra dancers, which may be pertinent for understanding their biomechanics and informing training or corrective strategies.

Table 43 displaying inferential statistics of posture variables of Bhangra dancer group (Compared with normative values)

Variables	Mean	Std. Deviation	Std. Error Mean	Mean difference	t	Sig. (2-tailed)
			Test Value = 0			
HAH	0.11	2.97	0.36	0.11	0.31	0.75
HAA	0.68	1.99	0.24	0.68	2.85	0.01
HAAS	-0.21	2.17	0.26	-0.21	-0.81	0.42
LTA	0.77	2.58	0.31	0.77	2.48	0.02
			Test Value = 15			
LQA	11.00	7.24	0.87	-4.00	-4.63	0.00
RQA	7.07	7.93	0.95	-7.93	-8.36	0.00
			Test Value = 50			

RFHA	52.13	7.28	0.87	2.13	2.45	**0.02**
LFHA	53.24	6.80	0.81	3.24	3.99	**0.00**
			Test Value = 52			
RSA	56.82	15.34	1.83	4.82	2.63	**0.01**
LSA	62.45	15.09	1.80	10.45	5.79	**0.00**
			Test Value = -10			
RGR	-.25	6.28	.75	9.75	12.99	**0.00**
LGR	.02	5.44	.65	10.02	15.39	**0.00**

Note: HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right Genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum

The provided table 44 reveals significant insights into the alignment measures of a group of Bhangra dancers. Each measure is assessed against a reference value to understand the prevalence of specific postural characteristics within the group.

For the horizontal alignment measures, the horizontal alignment of the head (HAH) has a reference value of 0°, with only 11 out of 70 participants (15.71%) meeting this reference. The majority of the dancers (84.29%) do not align horizontally at the head, indicating a significant deviation in head posture. The horizontal alignment of the acromion’s (HAA) is even more striking, with only 1 participant (1.43%) meeting the reference value of 0°, suggesting that nearly all dancers had a significant deviation in shoulder alignment. Similarly, for the horizontal alignment of the ASIS (HAAS), only 6 participants (8.57%) meet the reference value, indicating substantial variability in pelvic alignment. The lateral trunk alignment (LTA) also shows a deviation, with only 4 participants (5.71%) meeting the reference value of 0°.

Regarding the quadriceps angle measures, a significant majority of dancers had quadriceps angles close to the reference values. For the left quadriceps angle (LQA), 53 participants (75.71%) meet the reference value of 15°, while for the right quadriceps angle (RQA), 57 participants (81.43%) meet the same reference. This suggests that most dancers have quadriceps angles within the normal range.

The rear-foot angle measures display considerable variability. For both the left rear-foot angle (LRA) and the right rear-foot angle (RRA), 33 participants (47.14%) meet the reference value of (-) 5° to (+) 5°, indicating that nearly half of the dancers had rear-foot angles within the normal range, while the other half shows deviations.

When it comes to the forward head and shoulder angles, a substantial portion of dancers exhibit higher values than the reference. The right forward head angle (RFHA) has a reference value of > 50°, with 37 participants (52.86%) meeting this reference. Similarly, the left forward head angle (LFHA) shows 47 participants (67.14%) exceeding the reference value of 50°. The right shoulder angle (RSA) and left shoulder angle (LSA) also exhibit significant deviations, with 44 participants (62.86%) and 56 participants (80.00%) respectively exceeding the reference value of 52°.

Lastly, the Genu recurvatum measures reveal that this condition is relatively uncommon among the dancers. For the right genu recurvatum (RGR), only 8 participants (11.43%) meet the reference value of < (-) 10°, and for the left genu recurvatum (LGR), only 3 participants (4.29%) meet this reference. This indicates that most dancers do not exhibit hyperextension of the knee beyond -10°.

In conclusion, the Bhangra dancers show significant deviations from reference values in various alignment measures. Most dancers exhibit deviations in horizontal head, shoulder, and pelvic alignments, as well as lateral trunk alignment. The quadriceps angles, however, remain within the normal range for the majority. Forward head and shoulder angles are predominantly above the reference values, while genu recurvatum is relatively rare. These findings highlight specific postural characteristics of Bhangra dancers, which could be crucial for understanding their biomechanics and developing targeted training or corrective strategies.

Table 44 displaying number and percentage of the Bhangra dancers having normal or deviation in the posture

Variable	Ref. Value	Number of participants meeting the criteria	Number of participants not meeting criteria	Percentage of participants meeting criteria
Horizontal Alignment of the Head	0°	11.00	59.00	15.71
Horizontal Alignment of the Acromion	0°	1.00	69.00	1.43
Horizontal Alignment of the ASIS's	0°	6.00	64.00	8.57

Lateral Trunk Alignment	0°	4.00	66.00	5.71
Q Angle-Left	15°	53.00	17.00	75.71
Q Angle-Right	15°	57.00	13.00	81.43
Rear-foot Angle - Left	(-) 5° to (+) 5°	33.00	37.00	47.14
Rear-foot Angle - Right	(-) 5° to (+) 5°	33.00	37.00	47.14
Right Forward Head Angle	> 50°	37.00	33.00	52.86
Right Shoulder Angle	> 52°	44.00	26.00	62.86
Right Genu Recurvatum	< (-) 10°	8.00	62.00	11.43
Left Forward Head Angle	> 50°	47.00	23.00	67.14
Left Shoulder angle	> 52°	56.00	14.00	80.00
Left Genu Recurvatum	< (-) 10°	3.00	67.00	4.29

4.29.2 Non-Dancer

The table 45 provides an in-depth analysis of alignment measures for a group of non-dancers, highlighting their deviations from specific reference values. These measures include the horizontal alignment of the head, acromion's, and ASIS, lateral trunk alignment, quadriceps angles, forward head angles, shoulder angles, and genu recurvatum. The significance of these deviations is assessed using t-tests. For the horizontal alignment of the head (HAH), the mean value is -0.33 with SD 2.94 and a SEM of 0.35. The mean difference of -0.33 results in a t value of -0.95 and p value of 0.35, indicating no significant deviation from the reference value of 0°. Similarly, the horizontal alignment of the acromion (HAA) shows a mean value of -0.15 with SD 2.05 and a SEM of 0.25. The mean difference of -0.15 yields a t value of -0.62 and p value of 0.54, suggesting no significant deviation from the reference value. However, for the horizontal alignment of the ASIS (HAAS), the mean value is -1.02 with SD 2.58 and a SEM of 0.31. The mean difference of -1.02 results in a t value of -3.32 and p value of 0.00, indicating a significant deviation from the reference value of 0°. The lateral trunk alignment (LTA), the mean value is 0.95 with SD 2.85 and a SEM of 0.34. The mean difference of 0.95 leads to a t value of 2.79 and p value of 0.01, showing a significant deviation from the reference value of 0°. For the left quadriceps angle (LQA), the mean value is 15.88 with SD 7.23 and a SEM of 0.86. The mean difference of 0.88 results in a t value of 1.01 and p value of 0.31, indicating no significant deviation from the reference value of 15°. Similarly, the right quadriceps angle (RQA) has a mean value of 15.14 with SD 9.19 and a SEM of 1.10. The mean difference of 0.14 yields a t value of 0.13 and p value of 0.90, showing no significant deviation from the reference value. For the right forward head angle (RFHA), the mean value is 55.01 with SD 6.01 and a SEM of 0.72. The mean difference of 5.01 leads to a t value of 6.97 and p value of 0.00, indicating a significant deviation from the reference value of 50°. The left forward head angle (LFHA) has a mean value of 56.51 with SD 6.60 and a SEM of 0.79. The mean difference of 6.51 results in a t value of 8.26 and p value of 0.00, showing a significant deviation from the reference value of 50°. The right shoulder angle (RSA) presents a mean value of 52.26 with SD 15.34 and a SEM of 1.83. The mean difference of 0.26 yields a t value of 0.14 and p value of 0.89, indicating no significant deviation from the reference value of 52°. Conversely, the left shoulder angle (LSA) has a mean value of 48.70 with SD 12.16 and a SEM of 1.45. The mean difference of -3.30 leads to a t value of -2.27 and p value of 0.03, showing a significant deviation from the reference value of 52°. Lastly, for right genu recurvatum (RGR), the mean value is -5.14 with SD 6.35 and a SEM of 0.76. The mean difference of 4.86 results in a t value of 6.41 and p value of 0.00, indicating a significant deviation from the reference value of -10°. Similarly, left genu recurvatum (LGR) has a mean value of -6.35 with SD 6.38 and a SEM of 0.76. The mean difference of 3.65 leads to a t value of 4.78 and p value of 0.00, showing a significant deviation from the reference value of -10°. In conclusion, the non-dancers exhibit significant deviations from reference values in several alignment measures. Notably, there are significant deviations in the horizontal alignment of the ASIS, lateral trunk alignment, forward head angles, and genu recurvatum.

Table 45 displaying inferential statistics of posture variables of Non-dancer group (Compared with normative values)

Variables	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t	Sig. (2-tailed)
			Test Value = 0			
HAH	-0.33	2.94	0.35	-0.33	-0.95	0.35
HAA	-0.15	2.05	0.25	-0.15	-0.62	0.54
HAAS	-1.02	2.58	0.31	-1.02	-3.32	**0.00**
LTA	0.95	2.85	0.34	0.95	2.79	**0.01**
		Test Value = 15				
LQA	15.88	7.23	0.86	0.88	1.01	0.31
RQA	15.14	9.19	1.10	0.14	0.13	0.90
			Test Value = 50			
RFHA	55.01	6.01	0.72	5.01	6.97	**0.00**
LFHA	56.51	6.60	0.79	6.51	8.26	**0.00**
		Test Value = 52				
RSA	52.26	15.34	1.83	0.26	0.14	0.89
LSA	48.70	12.16	1.45	-3.30	-2.27	**0.03**
		Test Value = -10				
RGR	-5.14	6.35	0.76	4.86	6.41	**0.00**
LGR	-6.35	6.38	0.76	3.65	4.78	**0.00**

Note: HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right Genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum

The table 46 provides a detailed overview of alignment measures for a group of non-dancers, comparing the number and percentage of participants meeting specific reference values. These measures are essential for understanding the common postural characteristics within this group. For the horizontal alignment of the head (HAH), only 3 out of 70 participants meet the reference value of 0°, which accounts for 4.29% of the group. This suggests that the vast majority of the participants (95.71%) had deviations in the horizontal alignment of their head. The horizontal alignment of the acromion's (HAA) shows an even more striking result, with none of the participants meeting the reference value of 0°, indicating a complete deviation in shoulder alignment among the group. Similarly, the horizontal alignment of the ASIS (HAAS) reveals that only 3 participants (4.29%) meet the reference value, highlighting significant variability in pelvic alignment. For lateral trunk alignment (LTA), only 1 participant (1.43%) meets the reference value of 0°, indicating that nearly all dancers exhibit deviations in trunk alignment.

The quadriceps angle measures show that a moderate portion of the participants had quadriceps angles close to the reference values. For the left quadriceps angle (LQA), 33 out of 70 participants (47.14%) meet the reference value of 15°. Similarly, for the right quadriceps angle (RQA), 34 participants (48.57%) meet the same reference. This indicates that approximately half of the dancers had quadriceps angles within the normal range, while the other half exhibits deviations.

The rear-foot angle measures display a more balanced distribution. For the left rear-foot angle (LRA), 39 participants (55.71%) meet the reference range of (-) 5° to (+) 5°, suggesting that slightly more than half of the dancers had rear-foot angles within the normal range. The right rear-foot angle (RRA) shows that 35 participants (50.00%) meet the reference range, indicating an equal distribution between those with normal and deviated rear-foot angles.

When examining the forward head and shoulder angles, a substantial portion of the dancers exhibit higher values than the reference. The right forward head angle (RFHA) has a reference value of > 50°, with 55 participants (78.57%) meeting this criterion. This suggests a significant prevalence of increased forward head posture. The left forward head angle (LFHA) similarly shows that 58 participants (82.86%) exceed the reference value of 50°, indicating a high occurrence of forward head posture. In contrast, the right shoulder angle (RSA) shows that 29 participants (41.43%) exceed the reference value of 52°, suggesting that less than half of the participants had shoulder angles above the reference value. The left shoulder angle (LSA) reveals that only 23 participants (32.86%) exceed the reference value of 52°, indicating that the majority of dancers do not exhibit significantly high shoulder angles.

The Genu recurvatum measures show that this condition is relatively rare among the dancers. For the right genu recurvatum (RGR), 68 participants (97.14%) meet the reference value of < (-) 10°, indicating that almost all dancers do not exhibit hyperextension of the knee beyond -10°. Similarly, the left genu recurvatum (LGR) shows that 68 participants (97.14%) meet the reference value, reinforcing the rarity of this condition in the group.

In conclusion, the non-dancers exhibit significant deviations from reference values in several alignment measures, particularly in the horizontal alignment of the head, acromion's, and ASIS, as well as forward head postures. However, quadriceps angles are within the normal range for about half of the participants, and genu recurvatum is relatively rare. These findings provide valuable insights into the postural characteristics of non-dancers, which can be crucial for developing targeted interventions and understanding their biomechanics.

Table 46 displaying number and percentage of the Non-dancers having normal or deviation in the posture

Variable	Reference Value	Number of participants meeting the criteria	Number of participants not meeting criteria	Percentage of participants meeting criteria
HAH	0°	3.00	67.00	4.29
HAA	0°	0.00	70.00	0.00
HAAS	0°	3.00	67.00	4.29
LTA	0°	1.00	69.00	1.43
LQA	15°	33.00	37.00	47.14
RQA	15°	34.00	36.00	48.57
RFA	(-) 5° to (+) 5°	39.00	31.00	55.71
LFA	(-) 5° to (+) 5°	35.00	35.00	50.00
RFHA	> 50°	55.00	15.00	78.57
RSA	> 52°	29.00	41.00	41.43
RGR	< (-) 10°	68.00	2.00	97.14
LFHA	> 50°	58.00	12.00	82.86
LSA	> 52°	23.00	47.00	32.86
LGR	< (-) 10°	68.00	2.00	97.14

Note: HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right Genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum, LFA: left rearfoot angle, RFA: Left rearfoot angle

4.30 Inferential statistics of posture variables between the group (Bhangra dancer group and Non- Dancer group)

The table 47 provides a detailed overview about the inferential statistics of postural variables between the wo groups. The mean difference in HAH between Bhangra dancers and non-dancers is 0.44 with a standard error difference of 0.50. The F-value is 0.16 with significance level (Sig.) of 0.69, indicating that the variance between the two groups is not significantly different. The t value is 0.89 with a two-tailed significance of 0.38, suggesting no significant difference in the HAH between the two groups.

The mean difference for HAA is 0.83 with a standard error difference of 0.34. The F-value is 0.02 with significance level of 0.89. The t value is 2.42 with a two-tailed significance of 0.02, indicating a significant difference in the HAA between Bhangra dancers and non-dancers.

For HAAS, the mean difference is 0.81 with a standard error difference of 0.40. The F-value is 3.89 with significance level of 0.05, suggesting a borderline significant difference in the variance. The t value is 2.02 with a two-tailed significance of 0.05, indicating a significant difference in the HAAS between the two groups.

The mean difference in LTA is -0.18 with a standard error difference of 0.46. The F-value is 4.60 with significance level of 0.03, suggesting significant variance. The t value is -0.39 with a two-tailed significance of 0.69, indicating no significant difference in the LTA between the groups.

The mean difference for LQA is -4.88 with a standard error difference of 1.22. The F-value is 0.14 with significance level of 0.71. The t value is -3.99 with a two-tailed significance of 0.00, indicating a highly significant difference in the LQA between Bhangra dancers and non-dancers.

The mean difference in RQA is -8.07 with a standard error difference of 1.45. The F-value is 2.90 with significance level of 0.09. The t value is -5.56 with a two-tailed significance of 0.00, indicating a highly significant difference in the RQA between the two groups.

The mean difference for LRA is 3.23 with a standard error difference of 1.93. The F-value is 0.32 with significance level of 0.57. The t value is 1.67 with a two-tailed significance of 0.10, suggesting no significant difference in the LRA between the groups.

The mean difference in RRA is 2.69 with a standard error difference of 1.77. The F-value is 0.06 with significance level of 0.81. The t value is 1.52 with a two-tailed significance of 0.13, indicating no significant difference in the RRA between Bhangra dancers and non-dancers.

The mean difference for RFHA is -2.88 with a standard error difference of 1.13. The F-value is 3.20 with significance level of 0.08. The t value is -2.55 with a two-tailed significance of 0.01, indicating a significant difference in the RFHA between the groups.

The mean difference in RSA is 4.56 with a standard error difference of 2.59. The F-value is 0.16 with significance level of 0.69. The t value is 1.76 with a two-tailed significance of 0.08, suggesting no significant difference in the RSA between the groups.

The mean difference for RGR is 4.89 with a standard error difference of 1.07. The F-value is 0.02 with significance level of 0.90. The t value is 4.58 with a two-tailed significance of 0.00, indicating a highly significant difference in the RGR between Bhangra dancers and non-dancers.

The mean difference in LFHA is -3.27 with a standard error difference of 1.13. The F-value is 0.42 with significance level of 0.52. The t value is -2.89 with a two-tailed significance of 0.00, indicating a significant difference in the LFHA between the groups.

The mean difference for LSA is 13.74 with a standard error difference of 2.32. The F-value is 4.21 with significance level of 0.04, suggesting significant variance. The t value is 5.93 with a two-tailed significance of 0.00, indicating a highly significant difference in the LSA between Bhangra dancers and non-dancers.

The mean difference in LGR is 6.37 with a standard error difference of 1.00. The F-value is 0.09 with significance level of 0.76. The t value is 6.35 with a two-tailed significance of 0.00, indicating a highly significant difference in the LGR between the groups.

The statistical analysis shows that several postural and alignment measurements significantly differ between Bhangra dancers and non-dancers. Notable differences include HAA, HAAS, LQA, RQA, RFHA, RGR, LFHA, LSA, and LGR, which all show statistically significant differences, indicating that the specific demands of Bhangra dancing may influence these postural and alignment characteristics.

Table 47 displaying inferential statistics of posture variables between the group (Bhangra dancer group and Non- Dancer group)

Variables	Mean Difference	Std. Error Difference	F	Sig.	t	Sig. (2-tailed)
HAH	0.44	0.50	0.16	0.69	0.89	0.38
HAA	0.83	0.34	0.02	0.89	2.42	**0.02**
HAAS	0.81	0.40	3.89	0.05	2.02	**0.05**
LTA	-0.18	0.46	4.60	0.03	-0.39	0.69
LQA	-4.88	1.22	0.14	0.71	-3.99	**0.00**
RQA	-8.07	1.45	2.90	0.09	-5.56	**0.00**
LRA	3.23	1.93	0.32	0.57	1.67	0.10
RRA	2.69	1.77	0.06	0.81	1.52	0.13
RFHA	-2.88	1.13	3.20	0.08	-2.55	**0.01**
RSA	4.56	2.59	0.16	0.69	1.76	0.08
RGR	4.89	1.07	0.02	0.90	4.58	**0.00**

LFHA	-3.27	1.13	0.42	0.52	-2.89	**0.00**
LSA	13.74	2.32	4.21	0.04	5.93	**0.00**
LGR	6.37	1.00	0.09	0.76	6.35	**0.00**

Note: HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right Genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum

4.31 Descriptive statistics of Plantar pressure (Static Variables) of the Participants (Bhangra Dancers and Non-dancers) (N=140)

The table presents the descriptive statistics of various plantar pressure parameters for both Bhangra dancers and non-dancers (N=140). These parameters include measurements related to the forefoot and hindfoot areas, thrust, and distribution, as well as total foot area, maximum pressure, average pressure, thrust, and weight-bearing for both left & right feet.

Forefoot Measures, these descriptive statistics provide an overview of the variability and central tendencies of plantar pressure measures in both Bhangra and non-dancers, highlighting the differences in pressure distribution and alignment between the two groups.

4.31.1 Forefoot Area (LFFA and RFFA)

The range of the left forefoot area (LFFA) is 47, with values spanning from 0 to 47. The mean LFFA is 19.36, with SD 11.04, indicating considerable variation among participants. The variance is 121.95. For the right forefoot area (RFFA), the range is 51, with values from 0 to 51. The mean RFFA is 14.07, with SD 10.63, indicating moderate variation. The variance is 112.90.

4.31.2 Forefoot Thrust (LFFT and RFFT)

The left forefoot thrust (LFFT) ranges from 0 to 51, with a mean of 14.31 and a SD of 9.60, indicating moderate variation. The variance is 92.23. The right forefoot thrust (RFFT) has a range of 33, with values between 0 and 33. The mean RFFT is 8.67, and the SD is 7.34, showing considerable variation. The variance is 53.92.

4.31.3 Forefoot Distribution (LFFD and RFFD)

The left forefoot distribution (LFFD) ranges from 0 to 67, with a mean of 25.16 and a SD of 16.45, indicating substantial variation. The variance is 270.51. For the right forefoot distribution (RFFD), the range is 100, with values from 0 to 100. The mean RFFD is 20.41, with a high SD of 17.82, indicating significant variability. The variance is 317.45.

4.31.4 Hindfoot Area (LHFA and RHFA)

The left hindfoot area (LHFA) ranges from 9 to 48, with a mean of 28.70 and a SD of 7.18, indicating less variation compared to forefoot measures. The variance is 51.59. The right hindfoot area (RHFA) ranges broadly from 0 to 299, with a mean of 29.48 and a substantial SD of 24.59, reflecting high variability. The variance is 604.58.

4.31.5 Hindfoot Thrust (LHFT and RHFT)

The left hindfoot thrust (LHFT) ranges from 17 to 69, with a mean of 42.29 and a SD of 11.21, indicating moderate variability. The variance is 125.56. The right hindfoot thrust (RHFT) ranges from 0 to 64, with a mean of 34.66 and a SD of 10.26, indicating moderate variability. The variance is 105.22.

4.31.6 Hindfoot Distribution (LHFD and RHFD)

The left hindfoot distribution (LHFD) ranges from 33 to 100, with a mean of 74.76 and a SD of 16.46, showing significant variability. The variance is 271.00. For the right hindfoot distribution (RHFD), the range is 100, with values from 0 to 100. The mean RHFD is 79.58, with a high SD of 17.80, reflecting significant variability. The variance is 316.95.

4.31.7 Total Foot Area (TLFA and TRFA)

The total left foot area (TLFA) ranges from 18 to 333, with a mean of 50.37 and a high SD of 28.68, indicating considerable variability. The variance is 822.80. The total right foot area (TRFA) ranges from 7 to 88, with a mean of 41.55 and a SD of 15.96, showing considerable variability. The variance is 254.67.

4.31.8 Total Foot Maximum Pressure (TLFMP and TRFMP)

The total left foot maximum pressure (TLFMP) ranges widely from 1071 to 3444, with a mean of 2107.86 and a high SD of 482.70, indicating significant variability. The variance is 232997.24. The total right foot maximum pressure (TRFMP) ranges from 819 to 3434, with a mean of 1771.28 and a SD of 461.62, indicating considerable variability. The variance is 213088.89.

4.31.9 Total Foot Average Pressure (TLFAP and TRFAP)

The total left foot average pressure (TLFAP) ranges from 497 to 1756, with a mean of 860.84 and a SD of 222.69, indicating moderate variability. The variance is 49591.27. The total right foot average pressure (TRFAP) ranges from 388 to 1636, with a mean of 775.38 and a SD of 210.43, showing considerable variability. The variance is 44280.63.

4.31.10 Total Foot Thrust (TLFTH and TRFTH)

The total left foot thrust (TLFTH) ranges from 33 to 93, with a mean of 56.64 and a SD of 8.67, indicating moderate variability. The variance is 75.14. The total right foot thrust (TRFTH) ranges from 7 to 67, with a mean of 43.36 and a SD of 8.67, indicating moderate variability. The variance is 75.14.

4.31.11 Total Foot Weight Bearing (TLFWB and TRFWB)

The total left foot weight-bearing (TLFWB) ranges from 21 to 81, with a mean of 37.99 and a SD of 8.27, indicating moderate variability. The variance is 68.40. The total right foot weight-bearing (TRFWB) ranges from 4 to 81, with a mean of 29.41 and a SD of 9.24, indicating considerable variability. The variance is 85.32.

Table 48 displaying descriptive statistics of Plantar pressure (Static Variables) of the Participants (Bhangra Dancers and Non-dancers) (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
LFFA	47.00	0.00	47.00	19.36	11.04	121.95
LFFT	51.00	0.00	51.00	14.31	9.60	92.23
LFFD	67.00	0.00	67.00	25.16	16.45	270.51
LHFA	39.00	9.00	48.00	28.70	7.18	51.59
LHFT	52.00	17.00	69.00	42.29	11.21	125.56
LHFD	67.00	33.00	100.00	74.76	16.46	271.00
RFFA	51.00	0.00	51.00	14.07	10.63	112.90
RFFT	33.00	0.00	33.00	8.67	7.34	53.92
RFFD	100.00	0.00	100.00	20.41	17.82	317.45
RHFA	299.00	0.00	299.00	29.48	24.59	604.58
RHFT	64.00	0.00	64.00	34.66	10.26	105.22
RHFD	100.00	0.00	100.00	79.58	17.80	316.95
TLFA	315.00	18.00	333.00	50.37	28.68	822.80
TLFMP	2373.00	1071.00	3444.00	2107.86	482.70	232997.24
TLFAP	1259.00	497.00	1756.00	860.84	222.69	49591.27
TLFTH	60.00	33.00	93.00	56.64	8.67	75.14
TLFWB	60.00	21.00	81.00	37.99	8.27	68.40
TRFA	81.00	7.00	88.00	41.55	15.96	254.67
TRFMP	2615.00	819.00	3434.00	1771.28	461.62	213088.89
TRFAP	1248.00	388.00	1636.00	775.38	210.43	44280.63

TRFTH	60.00	7.00	67.00	43.36	8.67	75.14
TRFWB	77.00	4.00	81.00	29.41	9.24	85.32

LFFA: Left Forefoot Area, LFFT: Left Forefoot Thrust, LFFD: Left Forefoot Distribution, RFFA: Right Forefoot Area, RFFT: Right Forefoot Thrust, RFFD: Right Forefoot Distribution, LHFA: Left Hindfoot Area, LHFT: Left Hindfoot Thrust, LHFD: Left Hindfoot Distribution, RHFA: Right Hindfoot Area, RHFT: Right Hindfoot Thrust, RHFD: Right Hindfoot Distribution, TLFA: Total Left Foot Area, TLFAP: Total Left Foot Average Pressure, TLFMP: Total Left Foot Maximum Pressure, TLFTH: Total Left Foot Thrust, TLFW: Total Left Foot weight bearing, TRFA: Total Right Foot Area, TRFAP: Total Right Foot Average Pressure, TRFMP: Total Right Foot Maximum Pressure, TRFTH: Total Right Foot Thrust, TRFW: Total Right Foot Weight Bearing

4.32 Descriptive statistics of Plantar Pressure of the two Group participants (Bhangra Dance Group and Non Dance Group)

The table 49 provides analysis of plantar pressure in Bhangra dancers compared to non-dancers reveals several differences across various parameters. The left forefoot area (LFFA) for Bhangra dancers has a mean of 22.40 with SD 11.60, indicating a larger mean area compared to non-dancers, who had a mean of 16.33 with SD 9.61. This suggests that Bhangra dancers typically exhibit a greater left forefoot area.

For the left forefoot thrust (LFFT), Bhangra dancers show a mean of 13.77 with SD 8.14, while non-dancers had a slightly higher mean of 14.84 with SD 10.91. This indicates that, although the mean thrust is similar, non-dancers exhibit greater variability in their left forefoot thrust.

In terms of the left forefoot distribution (LFFD), the mean for Bhangra dancers is 24.99 with SD 15.33, which is very close to the mean of non-dancers at 25.33 with SD 17.60. This similarity suggests that both groups distribute pressure similarly across the left forefoot.

For the left hindfoot area (LHFA), Bhangra dancers had a mean of 31.11 with SD 6.40, which is higher than the mean of 26.29 with SD 7.15 observed in non-dancers. This implies that Bhangra dancers typically have a larger left hindfoot area.

When examining the left hindfoot thrust (LHFT), the mean for Bhangra dancers is 42.47 with SD 11.13, almost identical to the mean of 42.11 with SD 11.36 for non-dancers. This indicates very similar thrust values between the two groups.

The left hindfoot distribution (LHFD) also shows close values, with Bhangra dancers having a mean of 75.01 and a SD of 15.33, compared to non-dancers with a mean of 74.51 and a SD of 17.63. Again, this suggests similar pressure distribution in the left hindfoot.

In the right forefoot area (RFFA), Bhangra dancers had a mean of 15.56 and a SD of 11.48, while non-dancers had a mean of 12.59 with SD 9.54, indicating slightly larger forefoot areas in Bhangra dancers.

The right forefoot thrust (RFFT) shows Bhangra dancers with a mean of 8.19 and a SD of 7.28, and non-dancers with a mean of 9.16 and a SD of 7.43, indicating similar thrust values.

For the right forefoot distribution (RFFD), Bhangra dancers had a mean of 17.87 with SD 14.97, whereas non-dancers had a mean of 22.94 with SD 20.06, suggesting greater variability and generally higher values in non-dancers.

In the right hindfoot area (RHFA), Bhangra dancers exhibit a mean of 35.11 with SD 33.15, compared to non-dancers who had a lower mean of 23.84 and a smaller SD of 7.37. This indicates a significantly larger hindfoot area among Bhangra dancers.

The right hindfoot thrust (RHFT) shows a mean of 35.51 with SD 7.91 for Bhangra dancers, while non-dancers had a mean of 33.80 with SD 12.16, suggesting similar but slightly higher thrust values in Bhangra dancers.

For the right hindfoot distribution (RHFD), Bhangra dancers had a mean of 82.13 with SD 14.97, and non-dancers had a mean of 77.03 with SD 20.03, indicating slightly higher distribution values among Bhangra dancers.

The total left foot area (TLFA) is larger in Bhangra dancers, with a mean of 53.84 and a SD of 15.32, compared to non-dancers who had a mean of 46.90 and a much larger SD of 37.39.

The total left foot maximum pressure (TLFMP) is higher in non-dancers, with a mean of 2146.83 and a SD of 456.75, compared to Bhangra dancers who had a mean of 2068.90 and a SD of 507.61. However, Bhangra dancers had a lower mean total left foot average pressure (TLFAP) of 794.90 compared to 926.77 in non-dancers.

The total left foot thrust (TLFTH) is very similar between the groups, with Bhangra dancers having a mean of 56.27 and a SD of 7.33, and non-dancers having a mean of 57.00 and a SD of 9.87. Total left foot weight bearing (TLFWB) is also similar, with means of 38.43 and 37.56 for Bhangra and non-dancers, respectively.

For the right foot, Bhangra dancers had a total right foot area (TRFA) mean of 46.70 with SD 16.29, whereas non-dancers had a mean of 36.40 with SD 13.92. The total right foot maximum pressure (TRFMP) shows means of 1749.60 and 1792.96 for Bhangra and non-dancers, respectively.

The total right foot average pressure (TRFAP) is lower in Bhangra dancers with a mean of 715.47 compared to 835.29 in non-dancers. Lastly, the total right foot thrust (TRFTH) and total right foot weight bearing (TRFWB) show similar values across both groups, indicating overall similar pressure and thrust characteristics in the right foot.

Table 49 displaying descriptive statistics of Plantar Pressure of the two Group participants (Bhangra Dance Group and Non Bhangra Dance Group)

Variables	Group	Mean	Std. Deviation	Std. Error Mean
LFFA	Bhangra Dancer	22.40	11.60	1.39
	Non-Dancer	16.33	9.61	1.15
LFFT	Bhangra Dancer	13.77	8.14	0.97
	Non-Dancer	14.84	10.91	1.30
LFFD	Bhangra Dancer	24.99	15.33	1.83
	Non-Dancer	25.33	17.60	2.10
LHFA	Bhangra Dancer	31.11	6.40	0.76
	Non-Dancer	26.29	7.15	0.86
LHFT	Bhangra Dancer	42.47	11.13	1.33
	Non-Dancer	42.11	11.36	1.36
LHFD	Bhangra Dancer	75.01	15.33	1.83
	Non-Dancer	74.51	17.63	2.11
RFFA	Bhangra Dancer	15.56	11.48	1.37
	Non-Dancer	12.59	9.54	1.14
RFFT	Bhangra Dancer	8.19	7.28	0.87
	Non-Dancer	9.16	7.43	0.89
RFFD	Bhangra Dancer	17.87	14.97	1.79
	Non-Dancer	22.94	20.06	2.40
RHFA	Bhangra Dancer	35.11	33.15	3.96
	Non-Dancer	23.84	7.37	0.88
RHFT	Bhangra Dancer	35.51	7.91	0.95
	Non-Dancer	33.80	12.16	1.45
RHFD	Bhangra Dancer	82.13	14.97	1.79
	Non-Dancer	77.03	20.03	2.39
TLFA	Bhangra Dancer	53.84	15.32	1.83
	Non-Dancer	46.90	37.39	4.47
TLFMP	Bhangra Dancer	2068.90	507.61	60.67
	Non-Dancer	2146.83	456.75	54.59
TLFAP	Bhangra Dancer	794.90	179.85	21.50
	Non-Dancer	926.77	242.35	28.97

TLFTH	Bhangra Dancer	56.27	7.33	0.88
	Non-Dancer	57.00	9.87	1.18
TLFWB	Bhangra Dancer	38.43	6.09	0.73
	Non-Dancer	37.56	10.02	1.20
TRFA	Bhangra Dancer	46.70	16.29	1.95
	Non-Dancer	36.40	13.92	1.66
TRFMP	Bhangra Dancer	1749.60	378.36	45.22
	Non-Dancer	1792.96	534.00	63.82
TRFAP	Bhangra Dancer	715.47	136.75	16.34
	Non-Dancer	835.29	251.44	30.05
TRFTH	Bhangra Dancer	43.73	7.33	0.88
	Non-Dancer	43.00	9.87	1.18
TRFWB	Bhangra Dancer	30.39	8.27	0.99
	Non-Dancer	28.43	10.07	1.20

Note: LFFA: Left Forefoot Area, LFFT: Left Forefoot Thrust, LFFD: Left Forefoot Distribution, RFFA: Right Forefoot Area, RFFT: Right Forefoot Thrust, RFFD: Right Forefoot Distribution, LHFA: Left Hindfoot Area, LHFT: Left Hindfoot Thrust, LHFD: Left Hindfoot Distribution, RHFA: Right Hindfoot Area, RHFT: Right Hindfoot Thrust, RHFD: Right Hindfoot Distribution, TLFA: Total Left Foot Area, TLFAP: Total Left Foot Average Pressure, TLFMP: Total Left Foot Maximum Pressure, TLFTH: Total Left Foot Thrust, TLFW: Total Left Foot weight bearing, TRFA: Total Right Foot Area, TRFAP: Total Right Foot Average Pressure, TRFMP: Total Right Foot Maximum Pressure, TRFTH: Total Right Foot Thrust, TRFW: Total Right Foot Weight Bearing

4.33 Inferential statistics of Plantar Pressure (static) within the Group participants

4.33.1 Bhangra Dance Group

The mean LFFA is 22.40 with SD 11.60 and a SEM of 1.39. The mean difference is 6.84 with SD 8.75 and a SEM of 1.05. The t value is 6.55, and the result is statistically significant with p value of 0.00.

The mean LFFD is 13.77 with SD 8.14 and a SEM of 0.97. The mean difference is 5.59 with SD 7.20 and a SEM of 0.86. The t value is 6.49, and the result is statistically significant with p value of 0.00. The mean LHFA is 8.19 with SD 7.28 and a SEM of 0.87. The mean LHFT is 24.99 with SD 15.33 and a SEM of 1.83. The mean difference is 7.11 with SD 12.61 and a SEM of 1.51. The t value is 4.72, and the result is statistically significant with p value of 0.00. The mean RFFA is 31.11 with SD 6.40 and a SEM of 0.76. The mean difference is -4.00 with SD 32.29 and a SEM of 3.86. The t value is -1.04, and the result is not statistically significant with p value of 0.30. The mean RFFD is 42.47 with SD 11.13 and a SEM of 1.33.

The mean difference is 6.96 with SD 13.61 and a SEM of 1.63. The t value is 4.28, and the result is statistically significant with p value of 0.00. The mean RHFT is 35.51 with SD 7.91 and a SEM of 0.95. The mean RHFD is 75.01 with SD 15.33 and a SEM of 1.83. The mean difference is -7.11 with SD 12.61 and a SEM of 1.51. The t value is -4.72, and the result is statistically significant with p value of 0.00. The mean TLFA is 53.84 with SD 15.32 and a SEM of 1.83. The mean difference is 7.14 with SD 10.60 and a SEM of 1.27. The t value is 5.64, and the result is statistically significant with p value of 0.00. The mean TLFAP is 2068.90 with SD 507.61 and a SEM of 60.67. The mean difference is 319.30 with SD 581.59 and a SEM of 69.51. The t value is 4.59, and the result is statistically significant with p value of 0.00. The mean TLFTH is 1749.60 with SD 378.36 and a SEM of 45.22. The mean TLFWB is 794.90 with SD 179.85 and a SEM of 21.50. The mean difference is 79.43 with SD 164.28 and a SEM of 19.63. The t value is 4.05, and the result is statistically significant with p value of 0.00. The mean TRFA is 715.47 with SD 136.75 and a SEM of 16.34. The mean TRFMP is 56.27 with SD 7.33 and a SEM of 0.88. The mean difference is 12.54 with SD 14.67 and a SEM of 1.75. The t value is 7.16, and the result is statistically significant with p value of 0.00. The mean TRFAP is 43.73 with SD 7.33 and a SEM of 0.88. The mean TRFTH is 38.43 with SD 6.09 and a SEM of 0.73. The mean difference is 8.04 with SD 9.15 and a SEM of 1.09. The t value is 7.35, and the result is statistically significant with p value of 0.00. The mean TRFWB is 30.39 with SD 8.27 and a SEM of 0.99. The results demonstrated in table 50 had several plantar pressure parameters are significantly different within the Bhangra Dance Group, indicating distinctive pressure distributions and foot dynamics in this group.

Table 50 displaying inferential statistics of Plantar Pressure (static) of Bhangra dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	Mean Differences	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)
LFFA	22.40	11.60	1.39	6.84	8.75	1.05	6.55	**0.00**
LFFT	15.56	11.48	1.37					
LFFD	13.77	8.14	0.97	5.59	7.20	0.86	6.49	**0.00**
LHFA	8.19	7.28	0.87					
LHFT	24.99	15.33	1.83	7.11	12.61	1.51	4.72	**0.00**
LHFD	17.87	14.97	1.79					
RFFA	31.11	6.40	0.76	-4.00	32.29	3.86	-1.04	0.30
RFFT	35.11	33.15	3.96					
RFFD	42.47	11.13	1.33	6.96	13.61	1.63	4.28	**0.00**
RHFA	35.51	7.91	0.95					
RHFT	75.01	15.33	1.83	-7.11	12.61	1.51	-4.72	**0.00**
RHFD	82.13	14.97	1.79					
TLFA	53.84	15.32	1.83	7.14	10.60	1.27	5.64	**0.00**
TLFMP	46.70	16.29	1.95					
TLFAP	2068.90	507.61	60.67	319.30	581.59	69.51	4.59	**0.00**
TLFTH	1749.60	378.36	45.22					
TLFWB	794.90	179.85	21.50	79.43	164.28	19.63	4.05	**0.00**

TRFA	715.47	136.75	16.34					
TRFMP	56.27	7.33	0.88	12.54	14.67	1.75	7.16	**0.00**
TRFAP	43.73	7.33	0.88					
TRFTH	38.43	6.09	0.73	8.04	9.15	1.09	7.35	**0.00**
TRFWB	30.39	8.27	0.99					

Note: LFFA: Left Forefoot Area, LFFT: Left Forefoot Thrust, LFFD: Left Forefoot Distribution, RFFA: Right Forefoot Area, RFFT: Right Forefoot Thrust, RFFD: Right Forefoot Distribution, LHFA: Left Hindfoot Area, LHFT: Left Hindfoot Thrust, LHFD: Left Hindfoot Distribution, RHFA: Right Hindfoot Area, RHFT: Right Hindfoot Thrust, RHFD: Right Hindfoot Distribution, TLFA: Total Left Foot Area, TLFAP: Total Left Foot Average Pressure, TLFMP: Total Left Foot Maximum Pressure, TLFTH: Total Left Foot Thrust, TLFW: Total Left Foot weight bearing, TRFA: Total Right Foot Area, TRFAP: Total Right Foot Average Pressure, TRFMP: Total Right Foot Maximum Pressure, TRFTH: Total Right Foot Thrust, TRFW: Total Right Foot Weight Bearing

4.33.2 Non-Dancer Group

The mean LFFA is 16.33 with SD 9.61 and a SEM of 1.15. The mean difference is 3.74 with SD 6.36 and a SEM of 0.76. The t value is 4.92, and the result is statistically significant with p value of 0.00. The mean LFFD is 14.84 with SD 10.91 and a SEM of 1.30. The mean difference is 5.69 with SD 9.49 and a SEM of 1.13. The t value is 5.01, and the result is statistically significant with p value of 0.00. The mean LHFA is 9.16 with SD 7.43 and a SEM of 0.89. The mean LHFT is 25.33 with SD 17.60 and a SEM of 2.10. The mean difference is 2.40 with SD 17.80 and a SEM of 2.13. The t value is 1.12, and the result is not statistically significant with p value of 0.27. The mean RFFA is 26.29 with SD 7.15 and a SEM of 0.86. The mean difference is 2.44 with SD 5.91 and a SEM of 0.71. The t value is 3.46, and the result is statistically significant with p value of 0.00. The mean RFFD is 42.11 with SD 11.36 and a SEM of 1.36. The mean difference is 8.31 with SD 17.21 and a SEM of 2.06. The t value is 4.04, and the result is statistically significant with p value of 0.00. The mean RHFT is 33.80 with SD 12.16 and a SEM of 1.45. The mean RHFD is 74.51 with SD 17.63 and a SEM of 2.11. The mean difference is -2.51 with SD 17.67 and a SEM of 2.11. The t value is -1.19, and the result is not statistically significant with p value of 0.24. The mean TLFA is 46.90 with SD 37.39 and a SEM of 4.47. The mean difference is 10.50 with SD 37.66 and a SEM of 4.50. The t value is 2.33, and the result is statistically significant with p value of 0.02. The mean TLFAP is 2146.83 with SD 456.75 and a SEM of 54.59. The mean difference is 353.87 with SD 600.41 and a SEM of 71.76. The t value is 4.93, and the result is statistically significant with p value of 0.00. The mean TLFWB is 926.77 with SD 242.35 and a SEM of 28.97. The mean difference is 91.89 with SD 233.81 and a SEM of 27.95. The t value is 3.27, and the result is statistically significant with p value of 0.00. The mean TRFMP is 57.00 with SD 9.87 and a SEM of 1.18. The mean difference is 14.00 with SD 19.73 and a SEM of 2.36. The t value is 5.94, and the result is statistically significant with p value of 0.00. The mean TRFTH is 37.56 with SD 10.02 and a SEM of 1.20. The mean difference is 9.13 with SD 12.92 and a SEM of 1.54. The t value is 5.91, and the result is statistically significant with p value of 0.00. The results displayed in table 51 shows that several plantar pressure parameters exhibit significant differences within the Non-Bhangra Dance Group, highlighting variations in plantar pressure distribution and foot mechanics in this group.

Table 51 displaying inferential statistics of Plantar Pressure (static) of Non-dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	Mean Differences	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)
LFFA	16.33	9.61	1.15	3.74	6.36	.76	4.92	**0.00**
LFFT	12.59	9.54	1.14					
LFFD	14.84	10.91	1.30	5.69	9.49	1.13	5.01	**0.00**
LHFA	9.16	7.43	0.89					
LHFT	25.33	17.60	2.10	2.40	17.80	2.13	1.12	0.27
LHFD	22.94	20.06	2.40					
RFFA	26.29	7.15	0.86	2.44	5.91	0.71	3.46	**0.00**
RFFT	23.84	7.37	0.88					
RFFD	42.11	11.36	1.36	8.31	17.21	2.06	4.04	**0.00**
RHFA	33.80	12.16	1.45					
RHFT	74.51	17.63	2.11	-2.51	17.67	2.11	-1.19	0.24
RHFD	77.03	20.03	2.39					
TLFA	46.90	37.39	4.47	10.50	37.66	4.50	2.33	**0.02**
TLFMP	36.40	13.92	1.66					
TLFAP	2146.83	456.75	54.59	353.87	600.41	71.76	4.93	**0.00**
TLFTH	1792.96	534.00	63.82					
TLFWB	926.77	242.35	28.97	91.89	233.81	27.95	3.27	**0.00**

TRFA	835.29	251.44	30.05					
TRFMP	57.00	9.87	1.18	14.00	19.73	2.36	5.94	**0.00**
TRFAP	43.00	9.87	1.18					
TRFTH	37.56	10.02	1.20	9.13	12.92	1.54	5.91	**0.00**
TRFWB	28.43	10.07	1.20					

Note: LFFA: Left Forefoot Area, LFFT: Left Forefoot Thrust, LFFD: Left Forefoot Distribution, RFFA: Right Forefoot Area, RFFT: Right Forefoot Thrust, RFFD: Right Forefoot Distribution, LHFA: Left Hindfoot Area, LHFT: Left Hindfoot Thrust, LHFD: Left Hindfoot Distribution, RHFA: Right Hindfoot Area, RHFT: Right Hindfoot Thrust, RHFD: Right Hindfoot Distribution, TLFA: Total Left Foot Area, TLFAP: Total Left Foot Average Pressure, TLFMP: Total Left Foot Maximum Pressure, TLFTH: Total Left Foot Thrust, TLFW: Total Left Foot weight bearing, TRFA: Total Right Foot Area, TRFAP: Total Right Foot Average Pressure, TRFMP: Total Right Foot Maximum Pressure, TRFTH: Total Right Foot Thrust, TRFW: Total Right Foot Weight Bearing

4.34 Inferential Statistics of Plantar Pressure (static) between the two groups

In comparing the plantar pressure parameters between the Bhangra Dance Group and the Non-Bhangra Dance Group, we can see various significant and non-significant differences. The table 52 provide a details of the results.

4.34.1 Left Forefoot Area (LFFA)

The F-value for LFFA is 2.55 with p value of 0.11, indicating no significant difference in the variances between the two groups. The t-test shows significant difference in the means with a t value of 3.37 and p value of 0.00. The mean difference between the two groups is 6.07 with a standard error difference of 1.80, suggesting that the Bhangra Dance Group has a significantly higher mean LFFA compared to the Non-Bhangra Dance Group.

4.34.2 Left Forefoot Thrust (LFFT)

The F-value for LFFT is 6.97 with p value of 0.01, indicating a significant difference in the variances. However, the t-test does not show significant difference in the means ($t = -0.66$, $p = 0.51$) with a mean difference of -1.07 and a standard error difference of 1.63.

4.34.3 Left Forefoot Distribution (LFFD)

The F-value for LFFD is 1.42 with p value of 0.23, indicating no significant difference in the variances. The t-test also shows no significant difference in the means ($t = -0.12$, $p = 0.90$) with a mean difference of -0.34 and a standard error difference of 2.79.

4.34.4 Left Hindfoot Area (LHFA)

The F-value for LHFA is 0.77 with p value of 0.38, indicating no significant difference in the variances. The t-test shows significant difference in the means ($t = 4.21$, $p = 0.00$) with a mean difference of 4.83 and a standard error difference of 1.15, suggesting that the Bhangra Dance Group has a significantly higher mean LHFA compared to the Non-Bhangra Dance Group.

3.34.5 Left Hindfoot Thrust (LHFT)

The F-value for LHFT is 0.01 with p value of 0.94, indicating no significant difference in the variances. The t-test does not show significant difference in the means ($t = 0.19$, $p = 0.85$) with a mean difference of 0.36 and a standard error difference of 1.90.

3.34.6 Left Hindfoot Distribution (LHFD)

The F-value for LHFD is 1.70 with p value of 0.19, indicating no significant difference in the variances. The t-test also shows no significant difference in the means ($t = 0.18$, $p = 0.86$) with a mean difference of 0.50 and a standard error difference of 2.79.

3.34.7 Right Forefoot Area (RFFA)

The F-value for RFFA is 5.23 with p value of 0.02, indicating a significant difference in the variances. The t-test shows no significant difference in the means ($t = 1.66$, $p = 0.10$) with a mean difference of 2.97 and a standard error difference of 1.78.

3.34.8 Right Forefoot Thrust (RFFT)

The F-value for RFFT is 0.10 with p value of 0.75, indicating no significant difference in the variances. The t-test does not show significant difference in the means ($t = -0.78$, $p = 0.44$) with a mean difference of -0.97 and a standard error difference of 1.24.

3.34.9 Right Forefoot Distribution (RFFD)

The F-value for RFFD is 4.04 with p value of 0.05, indicating a significant difference in the variances. The t-test shows no significant difference in the means ($t = -1.70$, $p = 0.09$) with a mean difference of -5.07 and a standard error difference of 2.99.

3.34.10 Right Hindfoot Area (RHFA)

The F-value for RHFA is 2.57 with p value of 0.11, indicating no significant difference in the variances. The t-test shows significant difference in the means ($t = 2.78$, $p = 0.01$) with a mean difference of 11.27 and a standard error difference of 4.06, suggesting that the Bhangra Dance Group has a significantly higher mean RHFA compared to the Non-Bhangra Dance Group.

3.34.11 Right Hindfoot Thrust (RHFT)

The F-value for RHFT is 11.18 with p value of 0.00, indicating a significant difference in the variances. However, the t-test does not show significant difference in the means ($t = 0.99$, $p = 0.32$) with a mean difference of 1.71 and a standard error difference of 1.73.

3.34.12 Right Hindfoot Distribution (RHFD)

The F-value for RHFD is 4.00 with p value of 0.05, indicating a significant difference in the variances. The t-test shows no significant difference in the means ($t = 1.71$, $p = 0.09$) with a mean difference of 5.10 and a standard error difference of 2.99.

3.34.13 Total Left Foot Area (TLFA)

The F-value for TLFA is 0.52 with p value of 0.47, indicating no significant difference in the variances. The t-test shows no significant difference in the means ($t = 1.44$, $p = 0.15$) with a mean difference of 6.94 and a standard error difference of 4.83.

3.34.14 Total Left Foot Maximum Pressure (TLFMP)

The F-value for TLFMP is 0.66 with p value of 0.42, indicating no significant difference in the variances. The t-test shows no significant difference in the means ($t = -0.95$, $p = 0.34$) with a mean difference of -77.93 and a standard error difference of 81.62.

3.34.15 Total Left Foot Average Pressure (TLFAP)

The F-value for TLFAP is 1.62 with p value of 0.20, indicating no significant difference in the variances. The t-test shows significant difference in the means (t = -3.66, p = 0.00) with a mean difference of -131.87 and a standard error difference of 36.07, suggesting that the Non-Bhangra Dance Group has a significantly higher mean TLFAP compared to the Bhangra Dance Group.

3.34.16 Total Left Foot Weight Bearing (TLFWB)

The F-value for TLFWB is 10.17 with p value of 0.00, indicating a significant difference in the variances. However, the t-test does not show significant difference in the means (t = 0.62, p = 0.53) with a mean difference of 0.87 and a standard error difference of 1.40.

3.34.17 Total Right Foot Area (TRFA)

The F-value for TRFA is 4.00 with p value of 0.05, indicating a significant difference in the variances. The t-test shows significant difference in the means (t = 4.02, p = 0.00) with a mean difference of 10.30 and a standard error difference of 2.56, suggesting that the Bhangra Dance Group has a significantly higher mean TRFA compared to the Non-Bhangra Dance Group.

3.34.18 Total Right Foot Maximum Pressure (TRFMP)

The F-value for TRFMP is 4.52 with p value of 0.04, indicating a significant difference in the variances. The t-test shows no significant difference in the means (t = -0.55, p = 0.58) with a mean difference of -43.36 and a standard error difference of 78.22.

3.34.19 Total Right Foot Average Pressure (TRFAP)

The F-value for TRFAP is 12.27 with p value of 0.00, indicating a significant difference in the variances. The t-test shows significant difference in the means (t = -3.50, p = 0.00) with a mean difference of -119.81 and a standard error difference of 34.21, suggesting that the Non-Bhangra Dance Group has a significantly higher mean TRFAP compared to the Bhangra Dance Group.

3.34.20 Total Right Foot Thrust (TRFTH)

The F-value for TRFTH is 4.33 with p value of 0.04, indicating a significant difference in the variances. However, the t-test does not show significant difference in means (t = 0.50, p = 0.62) with a mean difference of 0.73 and a standard error difference of 1.47.

3.34.21 Total Right Foot Weight Bearing (TRFWB)

The F-value for TRFWB is 0.25 with p value of 0.62, indicating no significant difference in the variances. The t-test shows no significant difference in the means (t = 1.26, p = 0.21) with a mean difference of 1.96 and a standard error difference of 1.56.

In conclusion, the inferential statistics reveal that there are significant differences between the Bhangra Dance Group and the Non-Bhangra Dance Group in several plantar pressure parameters. These findings highlight the unique plantar pressure characteristics of Bhangra dancers compared to non-dancers

Table 52 displaying inferential Statistics of Plantar Pressure (static) between the two groups

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
LFFA	2.55	0.11	3.37	**0.00**	6.07	1.80
LFFT	6.97	0.01	-0.66	0.51	-1.07	1.63
LFFD	1.42	0.23	-0.12	0.90	-0.34	2.79
LHFA	0.77	0.38	4.21	**0.00**	4.83	1.15
LHFT	0.01	0.94	0.19	0.85	0.36	1.90
LHFD	1.70	0.19	0.18	0.86	0.50	2.79
RFFA	5.23	0.02	1.66	0.10	2.97	1.78
RFFT	0.10	0.75	-0.78	0.44	-0.97	1.24
RFFD	4.04	0.05	-1.70	0.09	-5.07	2.99
RHFA	2.57	0.11	2.78	**0.01**	11.27	4.06
RHFT	11.18	0.00	0.99	0.32	1.71	1.73
RHFD	4.00	0.05	1.71	0.09	5.10	2.99
TLFA	0.52	0.47	1.44	0.15	6.94	4.83
TLFMP	0.66	0.42	-0.95	0.34	-77.93	81.62
TLFAP	1.62	0.20	-3.66	**0.00**	-131.87	36.07
TLFTH	4.33	0.04	-0.50	0.62	-0.73	1.47
TLFWB	10.17	0.00	0.62	0.53	0.87	1.40
TRFA	4.00	0.05	4.02	**0.00**	10.30	2.56
TRFMP	4.52	0.04	-0.55	0.58	-43.36	78.22
TRFAP	12.27	0.00	-3.50	**0.00**	-119.81	34.21
TRFTH	4.33	0.04	0.50	0.62	0.73	1.47
TRFWB	0.25	0.62	1.26	0.21	1.96	1.56

Note: LFFA: Left Forefoot Area, LFFT: Left Forefoot Thrust, LFFD: Left Forefoot Distribution, RFFA: Right Forefoot Area, RFFT: Right Forefoot Thrust, RFFD: Right Forefoot Distribution, LHFA: Left Hindfoot Area, LHFT: Left Hindfoot Thrust, LHFD: Left Hindfoot Distribution, RHFA: Right Hindfoot Area, RHFT: Right Hindfoot Thrust, RHFD: Right Hindfoot Distribution, TLFA: Total Left Foot Area, TLFAP: Total Left Foot Average Pressure, TLFMP: Total Left Foot Maximum Pressure, TLFTH: Total Left Foot Thrust, TLFW: Total Left Foot weight bearing, TRFA: Total Right Foot Area, TRFAP: Total Right Foot Average Pressure, TRFMP: Total Right Foot Maximum Pressure, TRFTH: Total Right Foot Thrust, TRFW: Total Right Foot Weight Bearing

4.35 Descriptive statistics of Plantar Pressure (Postural) of the Participants (Bhangra Dancers and Non Dancers) (N=140)

The descriptive statistics for the variables in this study given in the table 53 provides a comprehensive overview of their distributions, central tendencies, and dispersions. The length variable, which ranges from 151.60 to 1534.90, has a mean of 495.24 and a SD of 262.17, indicating a high degree of variability. This is further evidenced by the substantial variance of 68,734.97. The area variable exhibits an even more pronounced range, stretching from 2.80 to 18,814.20, with a mean of 527.13 and a SD of 1,855.42, resulting in a massive variance of 3,442,580.30. This suggests that the area measurements are highly dispersed.

The length/area ratio ranges from 0.08 to 111.29, with a mean of 7.32, a SD of 13.69, and a variance of 187.36, indicating some extreme values affecting the spread. The average quarter speed, with values between 4.80 and 49.00, has a mean of 15.66 and a SD of 8.40, leading to a variance of 70.55, showing moderate variability in speed. Similarly, X speed, which ranges from 4.10 to 45.70, has a mean of 13.83, a SD of 7.81, and a variance of 61.03. Y speed ranges from 1.40 to 27.50, with a mean of 6.92, a SD of 3.95, and a variance of 15.57, indicating lower variability compared to X speed.

The X deviation, ranging from 0.40 to 23.20, has a mean of 3.74, a SD of 3.35, and a variance of 11.22, while the Y deviation ranges from 0.30 to 19.10, with a mean of 3.78, a SD of 3.29, and a variance of 10.81. These deviations show moderate spread around their means. The variable DevX0, which ranges from -70.30 to 53.90, has a mean of -14.77, a SD of 18.21, and a variance of 331.55, indicating high variability. DevY0, with a range from -80.70 to 609.00, has a mean of -30.96, a SD of 59.58, and a variance of 3,549.36, reflecting significant dispersion.

Lastly, DevMx and DevMy demonstrate substantial variability, with ranges of -364.00 to 28.80 and -77.30 to 73.30, means of -15.82 and -34.19, SDs of 33.33 and 21.83, and variances of 1,111.00 and 476.44, respectively. These figures indicate notable fluctuations in these measurements. Collectively, these descriptive statistics highlight the diversity and variability within the dataset, providing essential context for further statistical analysis and interpretation.

Table 53 displaying descriptive statistics of Plantar Pressure (Postural) of the Participants (Bhangra Dancers and Non Bhangra Dancers) (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Length	1383.30	151.60	1534.90	495.24	262.17	68734.97
Area	18811.40	2.80	18814.20	527.13	1855.42	3442580.30
Length/Area	111.21	0.08	111.29	7.32	13.69	187.36
Average Q Speed	44.20	4.80	49.00	15.66	8.40	70.55
X Speed	41.60	4.10	45.70	13.83	7.81	61.03
Y Speed	26.10	1.40	27.50	6.92	3.95	15.57
X Deviation	22.80	0.40	23.20	3.74	3.35	11.22
Y Deviation	18.80	0.30	19.10	3.78	3.29	10.81
DevX0	124.20	-70.30	53.90	-14.77	18.21	331.55
DevY0	689.70	-80.70	609.00	-30.96	59.58	3549.36
Dev Mx	392.80	-364.00	28.80	-15.82	33.33	1111.00
Dev My	150.60	-77.30	73.30	-34.19	21.83	476.44

4.36 Descriptive statistics of Plantar pressure (Postural) of the two groups (Bhangra Dancer Group and Non Dancer Group)

The comparative analysis of variables between Bhangra dancers and Non-dancers given in table 54 reveals distinct patterns in their measurements. For length, Bhangra dancers had a mean of 476.89 with SD 234.81 and a SEM of 28.07, whereas Non-dancers exhibit a higher mean of

513.59, a greater SD of 287.48, and a SEM of 34.36. In terms of area, Bhangra dancers show a considerably higher mean of 586.92 with a substantial SD of 2283.72 and a SEM of 272.96, compared to Non-dancers who had a mean of 467.33, a lower SD of 1308.59, and a SEM of 156.41. The length/area ratio for Bhangra dancers stands at 7.88 with SD 15.99 and a SEM of 1.91, while Non-dancers had a ratio of 6.77, a SD of 11.00, and a SEM of 1.31.

Analyzing the speed variables, Bhangra dancers had an average quarter speed of 14.90 with SD 7.53 and a SEM of 0.90, whereas Non-dancers had a higher average of 16.41, a SD of 9.18, and a SEM of 1.10. X speed for Bhangra dancers is 13.43 with SD 7.36 and a SEM of 0.88, compared to Non-dancers' mean of 14.23, SD of 8.28, and SEM of 0.99. Y speed reveals that Bhangra dancers had a mean of 6.10, a SD of 2.73, and a SEM of 0.33, while Non-dancers had a higher mean of 7.75, a SD of 4.75, and a SEM of 0.57.

In terms of deviation, Bhangra dancers had an X deviation mean of 3.66 with SD 3.31 and a SEM of 0.40, whereas Non-dancers had a slightly higher mean of 3.83, a SD of 3.41, and a SEM of 0.41. The Y deviation for Bhangra dancers is 3.90 with SD 3.53 and a SEM of 0.42, compared to Non-dancers' mean of 3.66, SD of 3.05, and SEM of 0.36.

Examining the deviation from the X-axis (DevX0), Bhangra dancers had a mean of -12.47, a SD of 17.09, and a SEM of 2.04, while Non-dancers show a greater deviation with a mean of -17.07, a SD of 19.11, and a SEM of 2.28. For the Y-axis deviation (DevY0), Bhangra dancers exhibit a mean of -36.96 with SD 24.98 and a SEM of 2.99, compared to Non-dancers' mean of -24.95, a notably higher SD of 80.33, and a SEM of 9.60.

Lastly, the maximum deviation from the X-axis (DevMx) reveals that Bhangra dancers had a mean of -11.66, a SD of 15.09, and a SEM of 1.80, whereas Non-dancers exhibit a mean of -19.99, a higher SD of 44.44, and a SEM of 5.31. The maximum deviation from the Y-axis (DevMy) shows Bhangra dancers with a mean of -37.42, a SD of 17.52, and a SEM of 2.09, compared to Non-dancers' mean of -30.96, a SD of 25.13, and a SEM of 3.00. These differences in means, SDs, and standard errors indicate varying levels of consistency and dispersion within the two groups across the different variables.

Table 54 displaying descriptive statistics of Plantar pressure (Postural) of the two groups (Bhangra Dance Group and Non Bhangra Dance Group)

Variables	Group	Mean	Std. Deviation	Std. Error Mean
Length	Bhangra Dancer	476.89	234.81	28.07
	Non-Dancer	513.59	287.48	34.36
Area	Bhangra Dancer	586.92	2283.72	272.96
	Non-Dancer	467.33	1308.59	156.41
Length/Area	Bhangra Dancer	7.88	15.99	1.91
	Non-Dancer	6.77	11.00	1.31
Average Q Speed	Bhangra Dancer	14.90	7.53	0.90
	Non-Dancer	16.41	9.18	1.10
X Speed	Bhangra Dancer	13.43	7.36	0.88
	Non-Dancer	14.23	8.28	0.99
Y Speed	Bhangra Dancer	6.10	2.73	0.33
	Non-Dancer	7.75	4.75	0.57
X Deviation	Bhangra Dancer	3.66	3.31	0.40
	Non-Dancer	3.83	3.41	0.41
Y Deviation	Bhangra Dancer	3.90	3.53	0.42
	Non-Dancer	3.66	3.05	0.36
DevX0	Bhangra Dancer	-12.47	17.09	2.04
	Non-Dancer	-17.07	19.11	2.28
DevY0	Bhangra Dancer	-36.96	24.98	2.99
	Non-Dancer	-24.95	80.33	9.60
Dev Mx	Bhangra Dancer	-11.66	15.09	1.80
	Non-Dancer	-19.99	44.44	5.31
Dev My	Bhangra Dancer	-37.42	17.52	2.09
	Non-Dancer	-30.96	25.13	3.00

4.37 Inferential statistics of Plantar Pressure (Postural) between the Groups (Bhangra Dance group and Non Dance Group)

The inferential statistical analysis between Bhangra dancers and Non-dancers given in table 55 reveals various significant and non-significant differences across several variables. For the length, the mean difference is -36.70 with a standard error difference of 44.37, resulting in a t value of -0.83 and a non-significant p value of 0.41. For the area, the mean difference is 119.59 with a standard error difference of 314.59, yielding a t value of 0.38 and a non-significant p value of 0.70. In terms of the length/area ratio, the mean difference is 1.11 with a standard error difference of 2.32, resulting in a t value of 0.48 and a non-significant p value of 0.63.

For average quarter speed, the mean difference is -1.51 with a standard error difference of 1.42, yielding a t value of -1.06 and a non-significant p value of 0.29. X speed shows a mean difference of -0.80 with a standard error difference of 1.32, resulting in a t value of -0.60 and a non-significant p value of 0.55. Y speed, however, shows a significant mean difference of -1.65 with a standard error difference of 0.65, yielding a t value of -2.52 and a significant p value of 0.01.

For X deviation, the mean difference is -0.17 with a standard error difference of 0.57, resulting in a t value of -0.30 and a non-significant p value of 0.77. Y deviation shows a mean difference of 0.24 with a standard error difference of 0.56, yielding a t value of 0.43 and a non-significant p value of 0.67. The deviation from the X-axis (DevX0) reveals a mean difference of 4.59 with a standard error difference of 3.06, resulting in a t value of 1.50 and a non-significant p value of 0.14. The deviation from the Y-axis (DevY0) shows a mean difference of -12.02 with a standard error difference of 10.05, yielding a t value of -1.20 and a non-significant p value of 0.23.

For the maximum deviation from the X-axis (DevMx), the mean difference is 8.33 with a standard error difference of 5.61, resulting in a t value of 1.49 and a non-significant p value of 0.14. The maximum deviation from the Y-axis (DevMy) shows a mean difference of -6.46 with a standard error difference of 3.66, yielding a t value of -1.76 and a marginally non-significant p value of 0.08. These results suggest that while there are some significant differences, particularly in the Y speed, many of the other variables do not show statistically significant differences between the two groups.

Table 55 displaying inferential statistics of Plantar Pressure (Postural) between the two groups

Variables	Mean Difference	Std. Error Difference	F	Sig.	t	Sig. (2-tailed)
Length	-36.70	44.37	2.03	0.16	-0.83	0.41
Area	119.59	314.59	0.46	0.50	0.38	0.70
Length/Area	1.11	2.32	0.82	0.37	0.48	0.63
Average Q Speed	-1.51	1.42	2.41	0.12	-1.06	0.29
X Speed	-0.80	1.32	1.14	0.29	-0.60	0.55
Y Speed	-1.65	0.65	11.33	0.00	-2.52	**0.01**
X Deviation	-0.17	0.57	0.17	0.68	-0.30	0.77
Y Deviation	0.24	0.56	0.72	0.40	0.43	0.67
DevX0	4.59	3.06	0.01	0.93	1.50	0.14
DevY0	-12.02	10.05	1.57	0.21	-1.20	0.23
Dev Mx	8.33	5.61	1.25	0.27	1.49	0.14
Dev My	-6.46	3.66	7.94	0.01	-1.76	0.08

4.38 Descriptive statistics of the Plantar Pressure (dynamic) of the participants (Bhangra Dancer and Non Dancer) N=140

The descriptive statistics of dynamic plantar pressure for the participants, both Bhangra dancers and Non-dancers, show a comprehensive analysis of their gait and foot pressure characteristics. For AreaStep1, the range is 79.00 with a minimum of 12.00 and a maximum of 91.00. The mean is 48.19, with SD 14.42 and a variance of 208.06. AreaStep2 shows a range of 70.00, with a minimum of 19.00 and a maximum of 89.00. The mean for AreaStep2 is 51.33, with SD 12.63 and a variance of 159.62. Similarly, AreaStep3 has a range of 85.00, with values from 3.00 to 88.00, a mean of 46.41, a SD of 12.63, and a variance of 159.52.

The Average Ground Pressure (AGP) for Step1 ranges from 1474.00 to 4403.00, with a mean of 2516.09, a SD of 463.05, and a variance of 214412.56. For Step2, AGP ranges from 257.00 to 4605.00, with a mean of 2413.21, a SD of 469.66, and a variance of 220578.78. AGP for Step3 ranges from 206.00 to 4855.00, with a mean of 2482.85, a SD of 521.08, and a variance of 271519.51.

Maximal Pressure (MP) in Step1 has an extensive range from 37.00 to 53335.00, with a mean of 5352.23, a SD of 4243.90, and a variance of 18010674.35. Step2 MP ranges from 2391.00 to 49990.00, with a mean of 5117.97, a SD of 3972.32, and a variance of 15779336.60. For Step3, MP ranges from 2574.00 to 10701.00, with a mean of 5241.23, a SD of 1253.31, and a variance of 1570785.36.

In terms of step duration, Left Step Duration (LSTD) ranges from 170.00 to 880.00, with a mean of 574.96, a SD of 94.38, and a variance of 8907.73. Right Step Duration (RSTD) has a range from 200.00 to 950.00, with a mean of 572.00, a SD of 104.10, and a variance of 10837.70. Left Step Length (LSL) ranges from 359.00 to 672.00, with a mean of 572.44, a SD of 45.73, and a variance of 2090.98. Right Step Length (RSL) ranges from 383.00 to 695.00, with a mean of 567.34, a SD of 60.29, and a variance of 3634.99.

For toe-out measurements, Left Toe-Out (LTO) ranges from 2.29 to 29.74, with a mean of 6.73, a SD of 4.01, and a variance of 16.08. Right Toe-Out (RTO) ranges from 1.13 to 26.60, with a mean of 6.28, a SD of 3.76, and a variance of 14.12.

Stride duration and length show the following statistics: Left Stride Duration (LSRD) ranges from 980.00 to 2370.00, with a mean of 1745.88, a SD of 245.30, and a variance of 60171.66. Right Stride Duration (RSRD) ranges from 1054.00 to 2660.00, with a mean of 1727.55, a SD of 238.27, and a variance of 56772.09. Left Stride Length (LSTL) ranges from 648.00 to 1720.00, with a mean of 1134.98, a SD of 111.29, and a variance of 12384.70. Right Stride Length (RSTL) ranges from 625.00 to 1720.00, with a mean of 1138.62, a SD of 128.52, and a variance of 16518.04.

Finally, the Gait Cycle Duration (GCD) shows that Left GCD ranges from 550.00 to 1620.00, with a mean of 1148.30, a SD of 168.37, and a variance of 28348.38. Right GCD ranges from 750.00 to 1790.00, with a mean of 1173.36, a SD of 167.79, and a variance of 28153.07. These statistics provide a detailed understanding of the dynamic plantar pressure characteristics and gait parameters for both groups of dancers.

Table 56 displaying descriptive statistics of the Plantar Pressure (dynamic) of the participants (Bhangra Dancer and Non Bhangra Dancer) N=140

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
AreaStep1	79.00	12.00	91.00	48.19	14.42	208.06
AreaStep2	70.00	19.00	89.00	51.33	12.63	159.62
AreaStep3	85.00	3.00	88.00	46.41	12.63	159.52
AGPStep1	2929.00	1474.00	4403.00	2516.09	463.05	214412.56
AGPStep2	4348.00	257.00	4605.00	2413.21	469.66	220578.78
AGPStep3	4649.00	206.00	4855.00	2482.85	521.08	271519.51
MPStep1	53298.00	37.00	53335.00	5352.23	4243.90	18010674.35

MPStep2	47599.00	2391.00	49990.00	5117.97	3972.32	15779336.60
MPStep3	8127.00	2574.00	10701.00	5241.23	1253.31	1570785.36
LSTD	710.00	170.00	880.00	574.96	94.38	8907.73
RSTD	750.00	200.00	950.00	572.00	104.10	10837.70
LSL	313.00	359.00	672.00	572.44	45.73	2090.98
RSL	312.00	383.00	695.00	567.34	60.29	3634.99
LTO	27.45	2.29	29.74	6.73	4.01	16.08
RTO	25.47	1.13	26.60	6.28	3.76	14.12
LSRD	1390.00	980.00	2370.00	1745.88	245.30	60171.66
RSRD	1606.00	1054.00	2660.00	1727.55	238.27	56772.09
LSTL	1072.00	648.00	1720.00	1134.98	111.29	12384.70
RSTL	1095.00	625.00	1720.00	1138.62	128.52	16518.04
LGCD	1070.00	550.00	1620.00	1148.30	168.37	28348.38
RGCD	1040.00	750.00	1790.00	1173.36	167.79	28153.07

Note: AGP: Average Pressure, MP: Maximal Pressure, LSTD: Left Step duration, RSTD: Right Step duration, LSL: Left step length, RSL: Right step length, LTO: Left Toe-out, RTO: Right Toe-out, LSRD: Left stride duration, RSRD: Right stride duration, LSTL: Left stride length, RSTL: Right stride length, LGCD: Left Gait cycle duration, RGCD: Right Gait cycle duration

4.39 Descriptive statistics of Plantar Pressure (dynamic) of the two groups (Bhangra dancer group and Non Dancer group)

The descriptive statistics for the dynamic plantar pressure of the Bhangra dancers and Non-dancers are provided in Table 54, highlighting the differences between the two groups. For AreaStep1, Bhangra dancers had a mean of 50.26 (SD = 12.84) with a SEM of 1.53, while Non-dancers had a mean of 46.13 (SD = 15.67) with a SEM of 1.87. In AreaStep2, Bhangra dancers had a mean of 54.26 (SD = 12.46) and a SEM of 1.49, whereas Non-dancers had a mean of 48.40 (SD = 12.20) and a SEM of 1.46. For AreaStep3, the mean for Bhangra dancers is 49.20 (SD = 11.65) with a SEM of 1.39, compared to Non-dancers with a mean of 43.63 (SD = 13.03) and a SEM of 1.56.

When looking at Average Ground Pressure (AGP), for Step1, Bhangra dancers had a mean of 2474.70 (SD = 350.40) with a SEM of 41.88, while Non-dancers had a higher mean of 2557.49 (SD = 552.88) with a SEM of 66.08. AGP Step2 shows Bhangra dancers with a mean of 2349.91 (SD = 407.00) and a SEM of 48.65, while Non-dancers had a mean of 2476.50 (SD = 520.17) and a SEM of 62.17. For AGP Step3, Bhangra dancers had a mean of 2480.47 (SD = 319.10) and a SEM of 38.14, compared to Non-dancers with a mean of 2485.23 (SD = 667.19) and a

SEM of 79.74.

Maximal Pressure (MP) for Step1 shows a mean of 4827.44 (SD = 1078.34) and a SEM of 128.89 for Bhangra dancers, whereas Non-dancers had a significantly higher mean of 5877.01 (SD = 5878.84) and a SEM of 702.66. MP Step2 reveals Bhangra dancers with a mean of 4730.49 (SD = 860.80) and a SEM of 102.89, compared to Non-dancers with a mean of 5505.46 (SD = 5544.52) and a SEM of 662.70. For MP Step3, the mean for Bhangra dancers is 5194.00 (SD = 967.82) with a SEM of 115.68, while Non-dancers had a mean of 5288.46 (SD = 1491.02) and a SEM of 178.21.

Examining step durations, Left Step Duration (LSTD) for Bhangra dancers has a mean of 564.14 (SD = 97.93) with a SEM of 11.70, compared to Non-dancers with a mean of 585.79 (SD = 90.10) and a SEM of 10.77. Right Step Duration (RSTD) shows Bhangra dancers with a mean of 565.71 (SD = 108.56) and a SEM of 12.97, while Non-dancers had a mean of 578.29 (SD = 99.84) and a SEM of 11.93.

Left Step Length (LSL) reveals a mean of 571.17 (SD = 47.30) and a SEM of 5.65 for Bhangra dancers, in contrast to Non-dancers with a mean of 573.71 (SD = 44.40) and a SEM of 5.31. Right Step Length (RSL) shows Bhangra dancers with a mean of 553.96 (SD = 51.70) and a SEM of 6.18, while Non-dancers had a mean of 580.73 (SD = 65.47) and a SEM of 7.83.

Regarding toe-out measurements, Left Toe-Out (LTO) for Bhangra dancers has a mean of 5.94 (SD = 2.64) with a SEM of 0.32, compared to Non-dancers with a mean of 7.52 (SD = 4.91) and a SEM of 0.59. Right Toe-Out (RTO) shows Bhangra dancers with a mean of 5.77 (SD = 2.76) and a SEM of 0.33, whereas Non-dancers had a mean of 6.80 (SD = 4.50) and a SEM of 0.54.

Stride durations and lengths also show interesting patterns. Left Stride Duration (LSRD) for Bhangra dancers has a mean of 1734.19 (SD = 263.81) and a SEM of 31.53, while Non-dancers had a mean of 1757.57 (SD = 226.59) and a SEM of 27.08. Right Stride Duration (RSRD) reveals Bhangra dancers with a mean of 1721.67 (SD = 238.71) and a SEM of 28.53, compared to Non-dancers with a mean of 1733.43 (SD = 239.40) and a SEM of 28.61.

Left Stride Length (LSTL) shows Bhangra dancers with a mean of 1122.83 (SD = 123.82) and a SEM of 14.80, while Non-dancers had a mean of 1147.13 (SD = 96.53) and a SEM of 11.54. Right Stride Length (RSTL) reveals Bhangra dancers with a mean of 1135.01 (SD = 145.54) and a SEM of 17.40, compared to Non-dancers with a mean of 1142.23 (SD = 109.85) and a SEM of 13.13.

Lastly, Gait Cycle Duration (GCD) statistics indicate that Left GCD for Bhangra dancers has a mean of 1129.29 (SD = 166.20) and a SEM of 19.86, while Non-dancers had a mean of 1167.31

(SD = 169.57) and a SEM of 20.27. Right GCD shows Bhangra dancers with a mean of 1153.29 (SD = 160.21) and a SEM of 19.15, whereas Non-dancers had a mean of 1193.44 (SD = 173.87) and a SEM of 20.78.

Table 57 displaying descriptive statistics of Plantar Pressure (dynamic) of the two groups

Variables	Group	Mean	Std. Deviation	Std. Error Mean
AreaStep1	Bhangra Dancer	50.26	12.84	1.53
	Non-Dancer	46.13	15.67	1.87
AreaStep2	Bhangra Dancer	54.26	12.46	1.49
	Non-Dancer	48.40	12.20	1.46
AreaStep3	Bhangra Dancer	49.20	11.65	1.39
	Non-Dancer	43.63	13.03	1.56
AGPStep1	Bhangra Dancer	2474.70	350.40	41.88
	Non-Dancer	2557.49	552.88	66.08
AGPStep2	Bhangra Dancer	2349.91	407.00	48.65
	Non-Dancer	2476.50	520.17	62.17
AGPStep3	Bhangra Dancer	2480.47	319.10	38.14
	Non-Dancer	2485.23	667.19	79.74
MPStep1	Bhangra Dancer	4827.44	1078.34	128.89
	Non-Dancer	5877.01	5878.84	702.66
MPStep2	Bhangra Dancer	4730.49	860.80	102.89
	Non-Dancer	5505.46	5544.52	662.70
MPStep3	Bhangra Dancer	5194.00	967.82	115.68
	Non-Dancer	5288.46	1491.02	178.21
LSTD	Bhangra Dancer	564.14	97.93	11.70
	Non-Dancer	585.79	90.10	10.77
RSTD	Bhangra Dancer	565.71	108.56	12.97
	Non-Dancer	578.29	99.84	11.93
LSL	Bhangra Dancer	571.17	47.30	5.65
	Non-Dancer	573.71	44.40	5.31
RSL	Bhangra Dancer	553.96	51.70	6.18
	Non-Dancer	580.73	65.47	7.83

LTO	Bhangra Dancer	5.94	2.64	0.32
	Non-Dancer	7.52	4.91	0.59
RTO	Bhangra Dancer	5.77	2.76	0.33
	Non-Dancer	6.80	4.50	0.54
LSRD	Bhangra Dancer	1734.19	263.81	31.53
	Non-Dancer	1757.57	226.59	27.08
RSRD	Bhangra Dancer	1721.67	238.71	28.53
	Non-Dancer	1733.43	239.40	28.61
LSTL	Bhangra Dancer	1122.83	123.82	14.80
	Non-Dancer	1147.13	96.53	11.54
RSTL	Bhangra Dancer	1135.01	145.54	17.40
	Non-Dancer	1142.23	109.85	13.13
LGCD	Bhangra Dancer	1129.29	166.20	19.86
	Non-Dancer	1167.31	169.57	20.27
RGCD	Bhangra Dancer	1153.29	160.21	19.15
	Non-Dancer	1193.44	173.87	20.78

Note: AGP: Average Pressure, MP: Maximal Pressure, LSTD: Left Step duration, RSTD: Right Step duration, LSL: Left step length, RSL: Right step length, LTO: Left Toe-out, RTO: Right Toe-out, LSRD: Left stride duration, RSRD: Right stride duration, LSTL: Left stride length, RSTL: Right stride length, LGCD: Left Gait cycle duration, RGCD: Right Gait cycle duration

4.40 Inferential statistics of Plantar Pressure (dynamic) within the groups (Bhangra dancer group and Non Dancer group)

4.40.1 Bhangra Dancer

In the table 58, we examine the inferential statistics of various plantar pressure parameters for the Bhangra dance group. The parameters analyzed include left & right step duration (LSTD and RSTD), left & right step length (LSL and RSL), left & right toe-out angle (LTO and RTO), left & right stride duration (LSRD and RSRD), left & right stride length (LSTL and RSTL), and left & right gait cycle duration (LGCD and RGCD). These parameters provide insight into the dynamic aspects of plantar pressure during dance movements.

For the left step duration (LSTD), the mean value for Bhangra dancers was 564.14 milliseconds with SD 97.93 milliseconds and a SEM of 11.70. When compared to the non-Bhangra dance group, the t value was -0.112, and the significance level (Sig. 2-tailed) was 0.911, indicating no significant difference between two groups. The right step duration (RSTD) showed similar results with a mean of 565.71 milliseconds and a SD of 108.56 milliseconds, but no t-test was performed for this parameter.

The left step length (LSL) had a mean of 571.17 millimeters with SD 47.30 millimeters and a SEM of 5.65. The t value was 2.305 with significance level of 0.024, suggesting a significant difference between Bhangra dancers and the non-dancers. For the right step length (RSL), the mean was 553.96 millimeters with SD 51.70 millimeters, but no t-test was conducted for this parameter.

Regarding the left toe-out angle (LTO), the mean was 5.94 degrees with SD 2.64 degrees and a SEM of 0.32. The t value was 0.421, and the significance level was 0.675, indicating no significant difference between groups. Similarly, the right toe-out angle (RTO) had a mean of 5.77 degrees and a SD of 2.76 degrees, with no t-test conducted.

For the left stride duration (LSRD), the mean was 1734.19 milliseconds with SD 263.81 milliseconds and a SEM of 31.53. The t value was 0.461, and the significance level was 0.646, indicating no significant difference. The right stride duration (RSRD) had a mean of 1721.67 milliseconds and a SD of 238.71 milliseconds, with no t-test performed.

The left stride length (LSTL) showed a mean of 1122.83 millimeters with SD 123.82 millimeters and a SEM of 14.80. The t value was -0.886, and the significance level was 0.379, indicating no significant difference. The right stride length (RSTL) had a mean of 1135.01 millimeters and a SD of 145.54 millimeters, with no t-test conducted.

Finally, the left gait cycle duration (LGCD) had a mean of 1129.29 milliseconds with SD 166.20 milliseconds and a SEM of 19.86. The t value was -1.249, and the significance level was 0.216, indicating no significant difference between groups. The right gait cycle duration (RGCD) had a mean of 1153.29 milliseconds and a SD of 160.21 milliseconds, with no t-test conducted.

Overall, the inferential statistics suggest that most parameters do not show significant differences between the Bhangra dance group and the non-Bhangra dance group, except for the left step length, which was significantly different. These results provide valuable insights into the dynamic plantar pressure characteristics of Bhangra dancers, which can inform training and performance optimization strategies.

Table 58 displaying inferential statistics of Plantar Pressure (dynamic) within the Bhangra dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)
LSTD	564.14	97.93	11.70	-1.57	117.72	14.07	-0.11	0.91
RSTD	565.71	108.56	12.97					
LSL	571.17	47.30	5.65	17.21	62.50	7.47	2.31	0**.02**
RSL	553.96	51.70	6.18					
LTO	5.94	2.64	0.32	0.17	3.30	0.39	0.42	0.67
RTO	5.77	2.76	0.33					
LSRD	1734.19	263.81	31.53	12.51	227.14	27.15	0.46	0.65
RSRD	1721.67	238.71	28.53					
LSTL	1122.83	123.82	14.80	-12.19	115.03	13.75	-0.89	0.38
RSTL	1135.01	145.54	17.40					
LGCD	1129.29	166.20	19.86	-24.00	160.73	19.21	-1.25	0.22
RGCD	1153.29	160.21	19.15					

Note: AGP: Average Pressure, MP: Maximal Pressure, LSTD: Left Step duration, RSTD: Right Step duration, LSL: Left step length, RSL: Right step length, LTO: Left Toe-out, RTO: Right Toe-out, LSRD: Left stride duration, RSRD: Right stride duration, LSTL: Left stride length, RSTL: Right stride length, LGCD: Left Gait cycle duration, RGCD: Right Gait cycle duration

4.40.2 Non Dancers

In this section, we delve into the inferential statistics of various plantar pressure parameters for the non-Bhangra dance group. This analysis includes parameters such as left & right step duration (LSTD and RSTD), left & right step length (LSL and RSL), left & right toe-out angle (LTO and RTO), left & right stride duration (LSRD and RSRD), left & right stride length (LSTL and RSTL), and left & right gait cycle duration (LGCD and RGCD). These metrics are critical for understanding the dynamic plantar pressure characteristics during walking or running in non-dancers.

For the left step duration (LSTD), non-dancers had a mean value of 585.79 milliseconds, with SD 90.10 milliseconds and a SEM of 10.77. The t value for this parameter was 0.49, with significance level (Sig. 2-tailed) of 0.63, indicating no significant difference between non-Bhangra dance group and the Bhangra dance group. The right step duration (RSTD) had a mean of 578.29 milliseconds and a SD of 99.84 milliseconds, but no t-test was performed for this parameter.

For the left step length (LSL), the mean was 573.71 millimeters with SD 44.40 millimeters and a SEM of 5.31. The mean difference between the groups was -7.01 millimeters, with a t value of -0.71 and a significance level of 0.48, indicating no significant difference. The right step length (RSL) had a mean of 580.73 millimeters and a SD of 65.47 millimeters, with no t-test conducted.

The left toe-out angle (LTO) for non-dancers was 7.52 degrees, with SD 4.91 degrees and a SEM of 0.59. The t value was 0.95, with significance level of 0.34, indicating no significant difference between groups. The right toe-out angle (RTO) had a mean of 6.80 degrees and a SD of 4.50 degrees, with no t-test conducted.

The left stride duration (LSRD) had a mean of 1757.57 milliseconds, with SD 226.59 milliseconds and a SEM of 27.08. The t value was 0.91, with significance level of 0.37, indicating no significant difference. The right stride duration (RSRD) had a mean of 1733.43 milliseconds and a SD of 239.40 milliseconds, with no t-test conducted.

For the left stride length (LSTL), the mean was 1147.13 millimeters, with SD 96.53 millimeters and a SEM of 11.54. The t value was 0.45, with significance level of 0.65, indicating no significant difference. The right stride length (RSTL) had a mean of 1142.23 millimeters and a SD of 109.85 millimeters, with no t-test conducted.

The left gait cycle duration (LGCD) had a mean of 1167.31 milliseconds, with SD 169.57 milliseconds and a SEM of 20.27. The t value was -1.08, with significance level of 0.28, indicating no significant difference between groups. The right gait cycle duration (RGCD) had a mean of 1193.44 milliseconds and a SD of 173.87 milliseconds, with no t-test conducted.

In summary, the inferential statistics reveal that there are no significant differences in the majority of plantar pressure parameters between the non-Bhangra dance group and the Bhangra dance group. These findings suggest that the dynamic characteristics of plantar pressure are largely similar between the two groups, providing a comparative baseline for further analysis and interpretation.

Table 59 displaying inferential statistics of Plantar Pressure (dynamic) within the Bhangra dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	Mean Difference	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)
LSTD	585.79	90.10	10.77	7.50	128.87	15.40	0.49	0.63
RSTD	578.29	99.84	11.93					
LSL	573.71	44.40	5.31	-7.01	82.70	9.88	-0.71	0.48
RSL	580.73	65.47	7.83					
LTO	7.52	4.91	0.59	0.72	6.29	0.75	0.95	0.34
RTO	6.80	4.50	0.54					
LSRD	1757.57	226.59	27.08	24.14	221.29	26.45	0.91	0.37
RSRD	1733.43	239.40	28.61					
LSTL	1147.13	96.53	11.54	4.90	90.87	10.86	0.45	0.65
RSTL	1142.23	109.85	13.13					
LGCD	1167.31	169.57	20.27	-26.13	202.32	24.18	-1.08	0.28
RGCD	1193.44	173.87	20.78					

Note: AGP: Average Pressure, MP: Maximal Pressure, LSTD: Left Step duration, RSTD: Right Step duration, LSL: Left step length, RSL: Right step length, LTO: Left Toe-out, RTO: Right Toe-out, LSRD: Left stride duration, RSRD: Right stride duration, LSTL: Left stride length, RSTL: Right stride length, LGCD: Left Gait cycle duration, RGCD: Right Gait cycle duration

4.41 Inferential statistics of Plantar Pressure (dynamic) between the two groups (Bhangra dance group and Non Dance group)

This section examines the dynamic plantar pressure parameters between the Bhangra dance group and the non-Bhangra dance group using inferential statistics. Various aspects, including different step areas and pressures, step duration, step length, toe-out angles, stride duration, stride length, and gait cycle duration, were analyzed to determine if there are significant differences between the two groups.

For Area Step1, the mean difference between the groups was 4.13 with a standard error difference of 2.42. The F-value of 1.71 and a significance level of 0.19, along with a t value of 1.70 and a significance level of 0.09, indicate no significant difference between groups for this parameter. In contrast, Area Step2 and Area Step3 showed significant differences. Area Step2 had a mean difference of 5.86 and a standard error difference of 2.08, with a t value of 2.81 and a significance level of 0.01. Similarly, Area Step3 had a mean difference of 5.57 and a standard error difference of 2.09, with a t value of 2.67 and a significance level of 0.01. These results suggest that the Bhangra dance group and the non-Bhangra dance group differ significantly in their plantar pressure distribution for these specific step areas.

Average pressure (AGP) measures during different steps did not show significant differences. For AGPStep1, the mean difference was -82.79 with a standard error difference of 78.24, and the t value was -1.06 with significance level of 0.29. AGPStep2 and AGPStep3 also showed no significant differences, with t-values of -1.60 and -0.05, respectively, and corresponding significance levels of 0.11 and 0.96. The maximal pressure (MP) during steps also did not differ significantly between the groups, as indicated by the results for MPStep1, MPStep2, and MPStep3.

Step duration parameters, both left (LSTD) and right (RSTD), did not show significant differences between the two groups. The mean difference for LSTD was -21.64 with a standard error difference of 15.90, and the t value was -1.36 with significance level of 0.18. Similarly, RSTD had a mean difference of -12.57 and a t value of -0.71, with significance level of 0.48. These results indicate that the duration of steps is comparable between Bhangra and non-dancers.

In terms of step length, the left step length (LSL) did not show a significant difference, with a mean difference of -2.54 and a t value of -0.33 (significance level 0.74). However, the right step length (RSL) revealed a significant difference, with a mean difference of -26.77, a t value of -2.68, and a significance level of 0.01. This finding suggests that Bhangra dancers may had a shorter right step length compared to non-dancers.

The left toe-out angle (LTO) showed a significant difference between groups, with a mean difference of -1.58, a t value of -2.37, and a significance level of 0.02. This suggests that the left toe-out angle is less pronounced in Bhangra dancers compared to non-dancers. However, the right toe-out angle (RTO) did not show a significant difference, with a t value of -1.63 and a significance level of 0.11.

Stride duration and length parameters did not reveal significant differences between the groups. For left stride duration (LSRD), the mean difference was -23.39 with a t value of -0.56 and a significance level of 0.57, while the right stride duration (RSRD) had a mean difference of -11.76 and a t value of -0.29 with significance level of 0.77. Left stride length (LSTL) and right stride length (RSTL) also showed no significant differences, with t-values of -1.29 and -0.33, respectively, and corresponding significance levels of 0.20 and 0.74.

Gait cycle duration, both left (LGCD) and right (RGCD), did not show significant differences between the groups. For LGCD, the mean difference was -38.03 with a t value of -1.34 and a significance level of 0.18. Similarly, RGCD had a mean difference of -40.16 with a t value of -1.42 and a significance level of 0.16. These findings suggest that the overall duration of the gait cycle is comparable between Bhangra dancers and non-dancers.

Overall, the comparison between Bhangra and non-dancers reveals significant differences in specific plantar pressure parameters, particularly in the areas of AreaStep2, AreaStep3, right step length (RSL), and left toe-out angle (LTO). These differences highlight unique biomechanical adaptations in Bhangra dancers, which can be crucial for understanding the impact of this dance form on plantar pressure dynamics. However, many parameters, including step duration, stride duration, and gait cycle duration, did not show significant differences, indicating that certain aspects of dynamic plantar pressure are similar between the two groups.

Table 60 displaying inferential statistics of Plantar Pressure (dynamic) between the two groups

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
AreaStep1	1.71	0.19	1.70	0.09	4.13	2.42
AreaStep2	0.05	0.83	2.81	**0.01**	5.86	2.08
AreaStep3	0.74	0.39	2.67	**0.01**	5.57	2.09
AGPStep1	8.12	0.01	-1.06	0.29	-82.79	78.24
AGPStep2	3.86	0.05	-1.60	0.11	-126.59	78.94
AGPStep3	8.91	0.00	-0.05	0.96	-4.76	88.40
MPStep1	2.17	0.14	-1.47	0.14	-1049.57	714.38
MPStep2	3.16	0.08	-1.16	0.25	-774.97	670.64
MPStep3	9.00	0.00	-0.44	0.66	-94.46	212.46
LSTD	0.14	0.71	-1.36	0.18	-21.64	15.90
RSTD	0.88	0.35	-0.71	0.48	-12.57	17.63
LSL	0.00	0.97	-0.33	0.74	-2.54	7.75
RSL	3.92	0.05	-2.68	**0.01**	-26.77	9.97
LTO	9.75	0.00	-2.37	**0.02**	-1.58	0.67
RTO	7.14	0.01	-1.63	**0.11**	-1.03	0.63
LSRD	0.53	0.47	-0.56	0.57	-23.39	41.57
RSRD	0.29	0.59	-0.29	0.77	-11.76	40.41
LSTL	0.06	0.81	-1.29	0.20	-24.30	18.77
RSTL	0.30	0.58	-0.33	0.74	-7.21	21.79
LGCD	0.03	0.86	-1.34	0.18	-38.03	28.38
RGCD	0.30	0.58	-1.42	0.16	-40.16	28.26

Note: AGP: Average Pressure, MP: Maximal Pressure, LSTD: Left Step duration, RSTD: Right Step duration, LSL: Left step length, RSL: Right step length, LTO: Left Toe-out, RTO: Right Toe-out, LSRD: Left stride duration, RSRD: Right stride duration, LSTL: Left stride length, RSTL: Right stride length, LGCD: Left Gait cycle duration, RGCD: Right Gait cycle duration

4.42 Descriptive statistics of physical characteristics of the participants (Bhangra dancers and Non Dancer) (N=140)

The table 61 presents a detailed statistical summary of various fitness and performance variables for a sample population of 140 participants, consisting of 70 Bhangra dancers and 70 non-dancers. The table includes a range of measures, each described by its range, minimum, maximum, mean, SD, and variance, providing a comprehensive overview of the data's distribution and variability.

4.42.1 Fitness Index

The fitness index, which measures overall fitness, exhibits a range of 46.54 units with values spanning from a minimum of 10.06 to a maximum of 56.60. The mean fitness index is 39.25 with SD 12.78, indicating considerable variability among the participants. The variance of 163.33 reflects the diversity in fitness levels within the sample.

4.42.2 Jump Height

Jump height, an indicator of lower body explosive strength, ranges from 16.00 cm to 89.00 cm, with an average of 50.04 cm. The SD is 17.53, and the variance is 307.30, demonstrating significant differences in jump performance across the participants.

4.42.3 Peak Power

Peak power, calculated from jump height and body weight, varies widely from 1666.80 to 6696.80 watts. The mean peak power is 4025.57 watts with a high SD of 1214.35, indicating large fluctuations in power output among individuals. The substantial variance of 1,474,652.71 underscores the diverse power capabilities within the group.

4.42.4 Push-Up Performance and Efficacy

Push-up performance, measured by the number of push-ups completed, ranges from 19.50 to 114.23, with a mean of 38.97 and a SD of 16.31, reflecting a broad spectrum of upper body endurance. The variance is 266.11. Push-up efficacy, a ratio of performance to time, ranges from 0.53 to 3.08 with an average of 1.74 and a SD of 0.53, suggesting moderate variability in efficiency among participants.

4.42.5 Crunches Performance and Efficacy

Crunches performance spans from 12.38 to 175.20, with a mean of 37.46 and a SD of 15.54, indicating a wide range of core strength and endurance. The variance is 241.34. Crunches efficacy ranges from 0.34 to 4.85, with an average score of 1.81 and a SD of 0.67, pointing to significant differences in efficiency.

4.42.6 Balance Measures

The table includes several balance-related measures: left leg absolute reach (LLAR), right leg absolute reach (RLAR), left leg relative reach (LLRR), right leg relative reach (RLRR), left leg composite reach (LLCR), and right leg composite reach (RLCR). These measures assess balance and stability through reach distances. The LLAR and RLAR had means of 80.20 cm and 80.48 cm, respectively, with similar SDs around 12.16 and 12.61. The LLRR and RLRR, expressed as percentages of limb length, had means of 85.58% and 85.66%, respectively, with SDs of 15.07 and 14.53, reflecting consistent performance across limbs. The composite reach measures (LLCR and RLCR) show identical statistics to the relative reach, reinforcing the reliability of these balance metrics.

4.42.7 V Sit and Reach Score

The V sit and reach test, a measure of flexibility, ranges from 0.00 to 15.00 with a mean score of 7.18 and a SD of 2.98, indicating varied flexibility levels among participants. The variance is 8.87.

Table 61 displaying descriptive statistics of physical characteristics of the participants (Bhangra dancers and Non Bhangra Dancer) (N=140)

Variables	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Fitness index	46.54	10.06	56.60	39.24	12.78	163.33
Jump height	73.00	16.00	89.00	50.03	17.52	307.29
Peak power	5030.00	1666.80	6696.80	4025.59	1214.35	1474652.7
PUP	94.73	19.50	114.23	38.96	16.31	266.11
PUE	2.55	.53	3.08	1.74	0.52	0.281
CRP	162.82	12.38	175.20	37.45	15.53	241.33
CRE	4.51	.34	4.85	1.80	0.67	0.44
LLAR	90.33	50.67	141.00	80.20	12.15	147.83
RLAR	90.34	49.33	139.67	80.48	12.61	159.01
LLRR	106.13	49.67	155.80	85.57	15.07	227.14
RLRR	92.49	48.37	140.86	85.66	14.53	211.16

LLCR	106.13	49.67	155.80	85.57	15.07	227.14
RLCR	92.49	48.37	140.86	85.66	14.53	211.16
VSR	15.00	0.00	15.00	7.17	2.97	8.86

Note: PUP: push-up performance, PUE: push-up efficacy, CRP: crunches performance, CRE: crunches efficacy, LLAR: left leg absolute reach (cm), RLAR: Right leg absolute reach (cm), LLRR: left leg relative reach (%), RLRR: Right leg relative reach (%), LLCR: Left leg composite reach (%), RLCR: Right leg composite reach (%), VSR: V sit and reach

4.43 Descriptive statistics of physical characteristics of Bhangra group and Non dancer group

4.43.1 Bhangra Dancer group

The statistical summary for the Bhangra dancer group, given in table 62, highlights various fitness and performance metrics. The fitness index for this group shows a mean of 49.17 with SD 2.07 and a variance of 4.27, indicating a high level of overall fitness with minimal variability among the dancers. Jump height, an indicator of lower body explosive strength, has a mean of 64.57 cm, a SD of 10.50, and a variance of 110.16, suggesting some variability in performance. The mean peak power is 5039.37 watts, with SD 712.15 and a variance of 507,164.00, reflecting the diverse power output capabilities of the dancers.

Push-up performance averages at 29.67 push-ups, with SD 3.63 and a variance of 13.21, showing moderate variability in upper body endurance. Push-up efficacy, the ratio of performance to time, has a mean of 2.05, a SD of 0.27, and a variance of 0.07, indicating consistent efficiency. Crunches performance averages 42.32, with SD 3.09 and a variance of 9.57, demonstrating relatively consistent core strength and endurance. Crunches efficacy is also consistent, with a mean of 1.43, a SD of 0.11, and a variance of 0.01.

Balance measures, including left leg absolute reach (LLAR) and right leg absolute reach (RLAR), show means of 75.80 cm and 76.72 cm, respectively, both with SD 2.43 and a variance of 5.90. Relative reach distances for the left leg (LLRR) and right leg (RLRR) had means of 79.10% and 80.09%, respectively, with SDs of 5.07 and 5.18 and variances of 25.69 and 26.87, indicating some variability in balance performance. Composite reach distances mirror the relative reach distances, reinforcing the reliability of these measures. Finally, the V sit and reach score, measuring flexibility, averages 7.86, with SD 2.86 and a variance of 8.15, showing varied flexibility levels among the dancers.

Table 62 displaying descriptive statistics of physical characteristics of Bhangra group

Variables	Mean	Std. Deviation	Variance
Fitness index	49.17	2.07	4.27
Jump height	64.57	10.50	110.16
Peak power	5039.37	712.15	507164.00
Push-up performance	29.67	3.63	13.21
Push-up efficacy	2.05	0.27	0.07
Crunches performance	42.32	3.09	9.57
Crunches efficacy	1.43	0.11	0.01
LLAR	75.80	2.43	5.90
RLAR	76.72	2.43	5.90
LLRR	79.10	5.07	25.69
RLRR	80.09	5.18	26.87
LLCR	79.10	5.07	25.69
RLCR	80.09	5.18	26.87
V Sit and Reach score	7.86	2.86	8.15

Note: LLAR: left leg absolute reach (cm), RLAR: Right leg absolute reach (cm), LLRR: left leg relative reach (%), RLRR: Right leg relative reach (%), LLCR: Left leg composite reach (%), RLCR: Right leg composite reach (%)

4.43.2 Non-dancer group

The statistical summary for the non-dancer group, given in table 63 highlights several fitness and performance metrics. The fitness index for this group has a mean of 29.32, with SD 11.18 and a variance of 124.89, indicating lower overall fitness levels and greater variability compared to the Bhangra dancers. Jump height, reflecting lower body explosive strength, averages 35.51 cm with SD 8.97 and a variance of 80.39, suggesting less consistency in performance.

Peak power has a mean of 3011.78 watts, a SD of 614.95, and a variance of 378,163.33, showing a wide range of power output among the participants. Push-up performance averages 48.26 push-ups, with SD 18.64 and a variance of 347.48, indicating significant variability in upper body endurance. Push-up efficacy, the ratio of performance to time, has a mean of 1.43, a SD of 0.54, and a variance of 0.29, demonstrating moderate efficiency variation.

Crunches performance has a mean of 32.59, a SD of 20.70, and a variance of 428.61, showing high variability in core strength and endurance. Crunches efficacy has a mean of 2.19, a SD of 0.77, and a variance of 0.60, indicating variability in efficiency.

Balance measures, including left leg absolute reach (LLAR) and right leg absolute reach (RLAR), had means of 84.60 cm and 84.25 cm, with SDs of 15.89 and 16.90 and variances of 252.63 and 285.68, respectively, showing considerable variability. Relative reach distances for the left leg (LLRR) and right leg (RLRR) had means of 92.05% and 91.24%, with SDs of 18.63 and 18.32 and variances of 346.92 and 335.46, indicating significant variability in balance performance. Composite reach distances mirror the relative reach distances, reflecting consistency in these balance measures. The V sit and reach score, measuring flexibility, averages 6.50, with SD 2.96 and a variance of 8.78, showing moderate flexibility levels among the participants.

Table 63 displaying descriptive statistics of physical characteristics of Bhangra group

Variables	Mean	Std. Deviation	Variance
Fitness index	29.32	11.18	124.89
Jump height	35.51	8.97	80.39
Peak power	3011.78	614.95	378163.33
Push-up performance	48.26	18.64	347.48
Push-up efficacy	1.43	0.54	0.29
Crunches performance	32.59	20.70	428.61
Crunches efficacy	2.19	0.77	0.60
LLAR	84.60	15.89	252.63
RLAR	84.25	16.90	285.68
LLRR	92.05	18.63	346.92
RLRR	91.24	18.32	335.46
LLCR	92.05	18.63	346.92
RLCR	91.24	18.32	335.46
V Sit and Reach score	6.50	2.96	8.78

Note: LLAR: left leg absolute reach (cm), RLAR: Right leg absolute reach (cm), LLRR: left leg relative reach (%), RLRR: Right leg relative reach (%), LLCR: Left leg composite reach (%), RLCR: Right leg composite reach (%)

4.44 Inferential statistics of physical characteristics within the groups (Bhangra Dancer group and Non-dancer group)

4.44.1 Bhangra Dancer Group

The inferential statistics for the Bhangra dancer group in table 64 highlight significant differences in balance measures between the left & right limbs. The mean left leg absolute reach

(LLAR) is 75.80 cm with SD 2.43, while the right leg absolute reach (RLAR) is slightly higher at 76.72 cm with the same SD. The mean difference between LLAR and RLAR is -0.92, with a t value of -240.03 and a significance level of 0.00, indicating a highly significant difference.

For relative reach distances, the left leg relative reach (LLRR) has a mean of 79.10% with SD 5.07, compared to the right leg relative reach (RLRR) which has a mean of 80.09% and a SD of 5.18. The mean difference between LLRR and RLRR is -0.99, with a t value of -21.68 and a significance level of 0.00, also showing a significant difference.

The left leg composite reach (LLCR) and right leg composite reach (RLCR) mirror the relative reach distances, with the same means, SDs, mean differences, t-values, and significance levels. These results suggest that the Bhangra dancers had a statistically significant difference in the balance performance between their left & right legs.

Table 64 displaying inferential statistics of physical characteristics within the Bhangra dancer group

Variables	Mean	Std. Deviation	Mean difference	t	sig. (2-tailed)
LLAR	75.80	2.43			
RLAR	76.72	2.43	-0.92	-240.03	**0.00**
LLRR	79.10	5.07			
RLRR	80.09	5.18	-0.99	-21.68	**0.00**
LLCR	79.10	5.07			
RLCR	80.09	5.18	-0.99	-21.68	**0.00**

Note: LLAR: left leg absolute reach (cm), RLAR: Right leg absolute reach (cm), LLRR: left leg relative reach (%), RLRR: Right leg relative reach (%), LLCR: Left leg composite reach (%), RLCR: Right leg composite reach (%)

4.44.2 Non-dancer Group

For the non-dancer group (table 65), the balance measures show less significant differences between the left & right limbs. The mean left leg absolute reach (LLAR) is 84.60 cm with SD 15.89, and the right leg absolute reach (RLAR) is 84.25 cm with SD 16.90. The mean difference between LLAR and RLAR is 0.35, with a t value of 0.38 and a significance level of 0.71, indicating no significant difference.

The left leg relative reach (LLRR) has a mean of 92.05% with SD 18.63, while the right leg relative reach (RLRR) has a mean of 91.24% with SD 18.32. The mean difference between LLRR and RLRR is 0.81, with a t value of 0.76 and a significance level of 0.45, also showing no significant difference.

The left leg composite reach (LLCR) and right leg composite reach (RLCR) had the same means, SDs, mean differences, t-values, and significance levels as the relative reach distances, further indicating no significant differences in balance performance between the left & right legs for non-dancers.

Table 65 displaying inferential statistics of physical characteristics within the Non-dancer group

Variables	Mean	Std. Deviation	Std. Error Mean	Mean difference	t	Sig. (2-tailed)
LLAR	84.60	15.89	1.90			
RLAR	84.25	16.90	2.02	0.35	0.38	0.71
LLRR	92.05	18.63	2.23			
RLRR	91.24	18.32	2.19	0.81	0.76	0.45
LLCR	92.05	18.63	2.23			
RLCR	91.24	18.32	2.19	0.81	0.76	0.45

Note: LLAR: left leg absolute reach (cm), RLAR: Right leg absolute reach (cm), LLRR: left leg relative reach (%), RLRR: Right leg relative reach (%), LLCR: Left leg composite reach (%), RLCR: Right leg composite reach (%)

4.45 Inferential statistics of physical characteristics between the groups (Bhangra Dancer group and Non-dancer group)

The comparison of physical characteristics between the Bhangra dancer group and the non-dancer group in table 66 reveals significant differences across various fitness and performance measures. Bhangra dancers exhibited superior physical fitness, with a mean fitness index of 49.17 compared to 29.32 in non-dancers, a statistically significant difference ($t=14.61$, $p<0.001$). Similarly, Bhangra dancers demonstrated greater jump height (mean difference of 29.06 cm, $t=17.62$, $p<0.001$) and higher peak power (mean difference of 2027.59 watts, $t=18.03$, $p<0.001$).

In terms of upper body endurance, non-dancers performed better in push-up performance with a significant mean difference of -18.60 ($t=-8.19$, $p<0.001$), while Bhangra dancers had higher push-up efficacy (mean difference of 0.63, $t=8.68$, $p<0.001$). For crunches, Bhangra dancers showed superior performance (mean difference of 9.73, $t=3.89$, $p<0.001$), although their crunches efficacy was significantly lower (mean difference of -0.76, $t=-8.16$, $p<0.001$).

Balance measures, including left leg absolute reach (LLAR), right leg absolute reach (RLAR), left leg relative reach (LLRR), right leg relative reach (RLRR), left leg composite reach (LLCR), and right leg composite reach (RLCR), were all significantly better among Bhangra dancers. The mean differences in balance measures ranged from -7.53 to -12.94, all with p values less than 0.001, indicating superior balance and stability in Bhangra dancers.

Flexibility, assessed through the V Sit and Reach test, was also higher in Bhangra dancers with a mean difference of 1.36 ($t=2.76$, $p<0.05$), reflecting slightly better flexibility.

Overall, the findings indicate that Bhangra dancers possess significantly better physical characteristics in terms of fitness index, jump height, peak power, and balance measures compared to non-dancers. These findings underscore the physical demands and benefits associated with Bhangra dance training, highlighting its potential to enhance various aspects of physical fitness and performance.

Table 66 displaying inferential statistics of physical characteristics between the groups

Variables	F	Sig.	t	Sig. (2-tailed)	Mean Difference
Fitness index	93.15	0.00	14.61	**0.00**	19.85
Jump height	5.08	0.03	17.62	**0.00**	29.06
Peak power	3.00	0.09	18.03	**0.00**	2027.59
Push-up performance	67.94	0.00	-8.19	**0.00**	-18.60
Push-up efficacy	19.72	0.00	8.68	**0.00**	0.63
Crunches performance	17.47	0.00	3.89	**0.00**	9.73
Crunches efficacy	67.59	0.00	-8.16	**0.00**	-0.76
LLAR	55.81	0.00	-4.58	**0.00**	-8.80
RLAR	76.53	0.00	-3.69	**0.00**	-7.53
LLRR	36.66	0.00	-5.61	**0.00**	-12.94
RLRR	49.46	0.00	-4.90	**0.00**	-11.15
LLCR	36.66	0.00	-5.61	**0.00**	-12.94
RLCR	49.46	0.00	-4.90	**0.00**	-11.15
V Sit and Reach score	0.82	0.37	2.76	**0.01**	1.36

Note: LLAR: left leg absolute reach (cm), RLAR: Right leg absolute reach (cm), LLRR: left leg relative reach (%), RLRR: Right leg relative reach (%), LLCR: Left leg composite reach (%), RLCR: Right leg composite reach (%)

4.46 Correlation Between Foot variables, Limb variables, Foot Angles, Foot Indices, Plantar Pressure, Postural, and Performance Variables of the Bhangra dancers

Understanding the correlations among foot variables, limb variables, foot angles, foot indices, plantar pressure, postural, and performance variables is critical in assessing the biomechanical and physiological characteristics specific to Bhangra dancers. These correlations provide insights into how foot anatomy, limb dynamics, foot alignment, and indices such as the Foot Posture Index (FPI) and plantar pressure distribution influence both postural alignment and physical performance metrics crucial for Bhangra dance. By examining these relationships, it becomes possible to tailor training interventions and injury prevention strategies that optimize movement efficiency, reduce injury risks, and enhance overall performance outcomes in this specialized dance form.

4.46.1 Correlation between foot variables and demographic variables of Bhangra dancers

The correlation analysis of various foot characteristics, including foot size, truncated foot size, dorsum height, navicular height, and navicular drop, alongside demographic variables such as age, weight, height, and BMI, reveals several significant relationships (table 67). The correlations between weight and height ($r = 0.379$, $p < 0.01$) and weight and BMI ($r = 0.728$, $p < 0.01$) are both significant, indicating that as individuals' height and weight increase, their BMI also tends to increase proportionally. This relationship is expected, as BMI is derived from height and weight. However, height is negatively correlated with BMI ($r = -0.356$, $p < 0.01$), suggesting that taller individuals in this sample may had a lower BMI, which could be due to a greater muscle mass or different body composition compared to shorter individuals.

Foot size measurements, including both left & right foot size, are highly correlated with each other ($r = 0.997$, $p < 0.01$), reflecting symmetry in foot length. Similarly, truncated foot sizes for both feet show a near-perfect correlation ($r = 0.998$, $p < 0.01$), which further emphasizes the bilateral symmetry of foot dimensions. Moreover, the truncated foot sizes are strongly correlated with full foot sizes ($r \approx 0.834$, $p < 0.01$), indicating that truncation does not significantly alter the proportional relationship between foot sizes.

Dorsum height correlations reveal significant relationships with weight ($r = 0.286$ for the left foot, $r = 0.294$ for the right foot, both $p < 0.05$), suggesting that individuals with higher weight may had greater dorsum heights. The dorsum heights between the left & right feet are also strongly correlated ($r = 0.748$, $p < 0.01$), reflecting consistency in foot structure between both feet. Navicular height shows significant correlations with dorsum height ($r = 0.750$ for the left foot, $r = 0.656$ for the right foot, both $p < 0.01$), suggesting a relationship between these two anatomical features.

Navicular drop, which indicates foot arch flexibility, is negatively correlated with dorsum height ($r = -0.362$ for the left foot, $r = -0.320$ for the right foot, both $p < 0.01$). This implies that greater dorsum height, which is indicative of a higher arch, is associated with lesser navicular drop, indicating less flexibility or movement in the arch. Additionally, a weak positive correlation exists between navicular drop in the left & right feet ($r = 0.323$, $p < 0.01$), suggesting some degree of symmetry in arch flexibility between feet.

The correlations highlight several significant relationships, particularly between bilateral foot measurements and between foot characteristics and demographic variables such as weight and

BMI. These findings provide insight into the symmetrical nature of foot dimensions and the interplay between foot structure and overall body composition.

Table 67 displaying correlation between foot variables and demographic variables of Bhangra dancers

Variables	Age	Weight	Height	BMI	FSL	FSR	TFL	TFR	DFL	DFR	NHL	NHR	NDL	NDR
Age	1													
Weight	.167	1												
Height	-.049	.379**	1											
BMI	.210	.728**	-.356**	1										
FSL	-.036	-.008	.164	-.140	1									
FSR	-.036	-.020	.157	-.146	.997**	1								
TFL	-.074	-.073	.109	-.162	.834**	.834**	1							
TFR	-.077	-.078	.114	-.169	.836**	.836**	.998**	1						
DFL	.081	.286*	-.019	.294*	.116	.118	.019	.006	1					
DFR	.024	.194	.020	.168	.021	.020	-.055	-.066	.748**	1				
NHL	-.012	.210	.022	.184	.174	.175	.134	.122	.750**	.508**	1			
NFR	-.066	.174	.069	.111	.155	.161	.166	.159	.460**	.656**	.531**	1		
NDL	-.021	-.050	.157	-.174	-.105	-.110	-.097	-.083	-.362**	-.320**	-.242*	-.178	1	
NDR	-.100	-.076	.130	-.177	-.093	-.095	-.074	-.071	-.103	-.097	.121	-.016	.323**	1

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right,

4.46.2 Correlation between foot variables and limb variables of Bhangra dancers

The correlation analysis between various measurements, including true and apparent lengths, thigh girth, calf girth, and foot characteristics, (table 68) reveals several significant relationships that offer valuable insights into the interdependencies among these variables.

The true lengths of the left & right sides show an extremely high correlation ($r = 0.997$, $p < 0.01$), indicating near-perfect bilateral symmetry. Similarly, the apparent lengths of the left & right sides are almost perfectly correlated ($r = 0.999$, $p < 0.01$), demonstrating consistent measurements across both sides. The apparent lengths also show high correlations with the true lengths on the corresponding sides ($r = 0.889$ for the left, $r = 0.887$ for the right, both $p < 0.01$), suggesting that apparent lengths are reliable indicators of true lengths.

Thigh girth measurements on the left & right sides are highly correlated ($r = 0.973$, $p < 0.01$), as are the calf girth measurements ($r = 0.994$, $p < 0.01$), indicating strong bilateral symmetry. However, the correlations between thigh and calf girth measurements are moderate (ranging from $r = 0.389$ to $r = 0.407$, all $p < 0.01$), suggesting that while there is some relationship, thigh and calf girths are relatively independent measurements.

Foot size measurements on both sides are highly correlated with each other ($r = 0.329$, $p < 0.01$), but their correlations with other measurements are generally weak. For instance, foot size shows weak correlations with true limb length ($r = 0.328$ for left, $r = 0.329$ for right, both $p < 0.01$) and apparent limb length ($r = 0.307$ to 0.311, all $p < 0.01$). The correlations between foot size and thigh or calf girth measurements are non-significant, indicating that foot size may not be directly influenced by limb lengths or girths.

Truncated foot size measurements also show weak correlations with other measurements. For example, the correlation with true limb length is 0.191 for both left & right sides, and with apparent length, it is slightly lower (ranging from 0.154 to 0.162). The correlations with thigh and calf girths are non-significant, suggesting that truncated foot sizes are not strongly related to these measurements.

Dorsum height measurements on the left & right sides show moderate to strong correlations with apparent lengths ($r = 0.364$ for left, $r = 0.373$ for right, both $p < 0.01$) and significant correlations with calf girths ($r = 0.508$ for left, $r = 0.425$ for right, both $p < 0.01$). This suggests that dorsum height is somewhat related to both foot length and calf girth.

Navicular height, a measure often associated with arch height, shows some moderate correlations with dorsum height ($r = 0.309$ for left, $r = 0.342$ for right, both $p < 0.01$), indicating a relationship between these two measurements. However, the correlations between navicular height and true or apparent lengths, as well as thigh and calf girths, are generally weak or non-significant.

Navicular drop, which measures the flexibility of the arch, shows significant negative correlations with apparent limb length (r = -0.230 for left, r = -0.234 for right, both $p < 0.01$) and calf girth (r = -0.310 for left, r = -0.300 for right, $p < 0.01$ and $p < 0.05$ respectively). This indicates that greater navicular drop, indicative of a more flexible or lower arch, is associated with lower apparent lengths and smaller calf girths.

The analysis highlights significant bilateral symmetry in true and apparent limb lengths, thigh and calf girths, and foot characteristics. The relationships between limb lengths, girths, and foot measurements provide insights into the proportionality and functional anatomy of the lower limbs. These findings can inform further studies on the biomechanics and clinical assessments of limb and foot characteristics.

Table 68 displaying correlation between foot variables and limb variables of Bhangra dancers

Variables	TLLL	TLLR	ALLL	ALLR	TGL	TGR	CGL	CGR
TLLL	1							
TLLR	.997**	1						
ALLL	.889**	.887**	1					
ALLR	.884**	.883**	.999**	1				
TGL	.126	.116	.229	.231	1			
TGR	.115	.104	.211	.212	.973**	1		
CGL	.155	.148	.487**	.505**	.393**	.407**	1	
CGR	.129	.122	.457**	.474**	.389**	.420**	.994**	1
FSL	.328**	.329**	.307**	.311**	-.034	-.044	.185	.186
FSR	.329**	.330**	.306*	.309**	-.038	-.049	.180	.178
TFL	.191	.189	.160	.162	-.040	-.039	.058	.064
TFR	.191	.189	.154	.155	-.043	-.041	.048	.054
DFL	.139	.128	.364**	.370**	.157	.161	.508**	.496**
DFR	.189	.183	.373**	.375**	.171	.172	.425**	.411**
NHL	.019	.015	.126	.138	-.085	-.065	.309**	.307**
NFR	-.015	.006	.153	.159	.073	.053	.342**	.334**
NDL	-.044	-.034	-.230	-.234	.035	.055	-.310**	-.300*
NDR	-.028	-.016	-.074	-.060	-.123	-.040	-.021	-.006

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: TLLL: True limb length left, TLLR: True limb length right, ALLL: Apparent limb length left, ALLR: Apparent limb length right, TGL: Thigh Girth left, TGR: Thigh Girth right, CGL: Calf Girth left, CGR: Calf Girth right, Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right.

4.46.3 Correlation between foot variables and angles of Bhangra dancers

The correlation analysis between various foot angles (Left Clarks angle (LCA), Right Clarks angle (RCA), Left Medial Longitudinal angle (LMLA), Right Medial Longitudinal angle (RMLA), Left Torsion angle (LTA), Right Torsion angle (RTA), Left Rear-foot angle (LRFA), Right Rear-foot angle (RRFA)) and other foot and lower limb measurements reveals several important relationships (table 69).

Foot sizes, both left & right, show weak and generally non-significant correlations with the foot angles. For instance, the correlation between left foot size and LCA is -0.158, and with RCA is -0.079, neither of which is significant. Similar weak correlations are observed for the right foot size with these angles. This indicates that foot size may not have a substantial impact on the measured angles of the foot.

Truncated foot sizes display slightly stronger correlations with foot angles, though still not statistically significant for most angles. For example, the left truncated foot size correlates -0.218 with LCA and -0.077 with RCA, indicating a weak negative relationship.

Dorsum height on the left foot shows a significant positive correlation with RTA ($r = 0.255$, $p < 0.05$), suggesting that individuals with higher dorsum height may had a larger right torsion angle. Dorsum height on the right foot, however, does not show significant correlations with any foot angles.

Navicular height, which measures the height of the navicular bone and thus the arch of the foot, shows generally weak and non-significant correlations with the foot angles, indicating that navicular height may not strongly influence these specific foot angles.

Navicular drop, which reflects the flexibility of the foot arch, shows some notable correlations. The left navicular drop is significantly negatively correlated with the left torsion angle ($r = -0.314$, $p < 0.01$) and right torsion angle ($r = -0.261$, $p < 0.05$). This suggests that greater navicular drop, indicating a more flexible arch, is associated with smaller torsion angles, implying a relationship between arch flexibility and torsion of the foot.

When examining the inter-relationships between the foot angles themselves, several significant correlations emerge. The left & right Clarks angles (LCA and RCA) are strongly correlated ($r = 0.698$, $p < 0.01$), suggesting symmetry between the two feet. The left medial longitudinal angle (LMLA) and right medial longitudinal angle (RMLA) are also significantly correlated ($r = 0.601$, $p < 0.01$), further emphasizing bilateral symmetry in these angles.

The left torsion angle (LTA) and right torsion angle (RTA) show a significant correlation ($r = 0.459$, $p < 0.01$), indicating a bilateral relationship in foot torsion. Additionally, the left torsion angle is significantly negatively correlated with RMLA ($r = -0.292$, $p < 0.05$), suggesting that changes in the medial longitudinal angle might affect torsion.

Finally, the left & right rear-foot angles (LRFA and RRFA) exhibit a strong correlation ($r = 0.594$, $p < 0.01$), indicating a high degree of symmetry in rear-foot angles between the two feet.

The correlation analysis highlights significant relationships primarily within the foot angles themselves, underscoring the bilateral symmetry of these measurements. While foot sizes and truncated foot sizes show weak correlations with foot angles, dorsum height, and navicular drop reveal some noteworthy associations with specific angles. These findings enhance our understanding of the interplay between foot structure and foot angles, providing a foundation for further biomechanical and clinical research.

Table 69 displaying correlation between foot variables and angles of Bhangra dancers

Variables	LCA	RCA	LMLA	RMLA	LTA	RTA	LRFA	RRFA
FSL	-.158	-.079	-.012	.060	-.119	-.057	-.097	-.144
FSR	-.161	-.078	-.010	.060	-.108	-.057	-.088	-.147
TFL	-.218	-.077	-.088	.006	-.041	-.018	-.117	-.095
TFR	-.216	-.073	-.085	.011	-.043	-.011	-.126	-.101
DFL	-.087	-.161	.025	-.085	.110	.255*	.052	.184
DFR	.040	-.103	.024	-.034	.113	.152	-.013	.183
NHL	-.114	-.024	-.071	-.064	-.012	.087	-.030	.005
NFR	.015	.109	.111	.049	.048	.157	-.203	-.050
NDL	.109	.191	.062	.099	-.314**	-.261*	-.093	-.225
NDR	-.085	.006	.003	.211	-.147	-.090	-.292*	-.248*
LCA	1	.698**	.023	-.090	-.108	-.137	.030	.106
RCA		1	.102	.028	-.195	-.136	-.083	-.103
LMLA			1	.601**	-.082	.102	.131	.177
RMLA				1	-.292*	-.069	.021	.019
LTA					1	.459**	.142	.295*
RTA						1	-.046	.156
LRFA							1	.594**
RRFA								1

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right, LCA: Left Clarks angle, RCA: Right Clarks angle, LMLA: Left Medial Longitudinal angle, RMLA: Right Medial Longitudinal angle, LTA: Left Torsion angle, RTA: Left Torsion angle, LRFA: Left Rear-foot angle, RRFA: Right Rear-foot angle

4.46.4 Correlation between foot variables and indices of Bhangra dancers

The correlation analysis between foot measurements and indices related to foot posture and arch height reveals several significant relationships. Foot size, both left & right, shows weak to moderate correlations with various indices (table 70). Specifically, the correlation between foot size and the Left Arch Index (LAI) is -0.234 for the left and -0.231 for the right, while the correlation with the Right Arch Index (RAI) is -0.360 for both sides, indicating that larger foot sizes are associated with lower arch indices. This relationship is statistically significant at the 0.01 level for the RAI.

Truncated foot size also shows significant negative correlations with the arch indices. The correlation with LAI is -0.389 for the left and -0.400 for the right, and with RAI, it is -0.498 for the left and -0.508 for the right, all significant at the 0.01 level. These results suggest that a larger truncated foot size is associated with a lower arch height.

Dorsum height, an indicator of the height of the foot's arch, shows very strong correlations with the arch indices. The correlations with LAI are 0.907 for the left and 0.724 for the right, and with RAI, they are 0.650 for the left and 0.886 for the right, all significant at the 0.01 level. This strong relationship indicates that a higher dorsum height corresponds to a higher arch index.

Navicular height, another measure related to arch height, shows moderate correlations with the arch indices. For LAI, the correlations are 0.642 for the left and 0.352 for the right, and for RAI, they are 0.401 for the left and 0.477 for the right, all significant at the 0.01 level. These results suggest that higher navicular heights are associated with higher arch indices.

Navicular drop, a measure of arch flexibility, shows significant negative correlations with both LAI and RAI. For LAI, the correlations are -0.289 for the left and -0.059 for the right, and for RAI, they are -0.236 for the left and -0.057 for the right. The negative correlations indicate that a greater navicular drop, which suggests more flexible or lower arches, is associated with lower arch indices.

The correlations between the Staheli Indices (LSI and RSI) and the Chippaux Smirak Indices (LCSI and RCSI) are high, with LSI and RSI showing a correlation of 0.646 and LCSI and RCSI showing a correlation of 0.665, all significant at the 0.01 level. This suggests that these indices are related measures of foot posture and arch height.

The Foot Posture Index Scores (LFPIS and RFPIS) show moderate correlations with RSI (0.306) and LSI (0.063), indicating that higher foot posture scores are associated with higher Staheli Indices. The correlation between LFPIS and RFPIS is 0.477, indicating that foot posture scores on the left & right sides are moderately related.

In summary, the correlation analysis highlights significant relationships between foot size, truncated foot size, dorsum height, navicular height, and navicular drop with various foot posture and arch height indices. These findings provide insights into how different measurements of foot dimensions and posture are interrelated and can inform further research on foot biomechanics and clinical assessments.

Table 70 displaying correlation between foot variables and indices of Bhangra dancers

Variables	LSI	RSI	LCSI	RCSI	LAI	RAI	LFPIS	RFPIS
FSL	.029	.163	.045	.099	-.234	-.360**	.105	.045
FSR	.036	.166	.055	.106	-.231	-.360**	.100	.058
TFL	.034	.126	.019	.075	-.389**	-.498**	.197	.064
TFR	.031	.123	.014	.073	-.400**	-.508**	.193	.065
DFL	.162	.138	.199	.166	.907**	.650**	.159	.179
DFR	.099	.061	.111	.069	.724**	.886**	.221	.170
NHL	-.016	.015	.011	.002	.642**	.401**	.015	.077
NFR	-.066	-.088	-.052	-.099	.352**	.477**	.004	.076
NDL	-.188	-.184	-.285*	-.205	-.289*	-.236*	-.062	-.151
NDR	.055	.084	.015	-.022	-.059	-.057	-.107	-.031
LSI	1	.646**	.920**	.699**	.106	.037	.063	.008
RSI		1	.561**	.929**	.055	-.024	.306**	.236*
LCSI			1	.665**	.146	.053	-.034	.039
RCSI				1	.100	.005	.225	.210
LAI					1	.821**	.074	.148
RAI						1	.114	.135
LFPIS							1	.477**
RFPIS								1

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right, LSI: Left Staheli Index, RSI: Right Staheli Index, LCSI: Left Chippaux Smirak Index, RCSI: Right Chippaux Smirak Index, LAI: Left Arch Index, RAI: Right Arch Index, LFPIS: Left Foot Posture Index Score, RFPIS: Right foot Posture Index Score

4.46.5 Correlation between foot variables and plantar pressure (static) variables of Bhangra dancers

The table 71 provides a detailed exploration of correlations between various foot dimensions and static plantar pressure variables, offering insights into foot biomechanics and pressure distribution during static standing conditions.

Foot size measurements, both left & right, show moderate positive correlations with total left foot area (TLFA) and average pressure (TLFAP). Specifically, foot size left (cm) correlates positively with TLFA (0.151) and negatively with TLFAP (-0.096), indicating that larger foot sizes are associated with greater foot area and lower average pressure. Similarly, foot size right (cm) exhibits similar trends with TLFA (0.161) and TLFAP (-0.102).

Truncated foot sizes demonstrate varied associations with static pressure variables. Truncated foot size left (cm) shows positive correlations with total left foot maximum pressure (TLFMP) and thrust (TLFTH), suggesting that smaller, truncated measurements may influence maximum pressure and thrust dynamics during static standing. Truncated foot size right (cm) also displays similar trends with TLFMP and TLFTH.

Dorsum height measurements reveal more significant associations with static pressure variables. Left dorsum height (cm) correlates notably with total right foot area (TRFA) and total left foot weight-bearing (TLFW), indicating that higher left dorsum heights may influence foot weight-bearing capacity and overall foot area. Meanwhile, right dorsum height (cm) shows positive correlations with TLFA (0.147), TRFA (0.083), and TRFW (0.145), suggesting that greater dorsum heights on the right foot are associated with larger foot areas and enhanced weight-bearing capabilities.

In contrast, navicular height measurements show weaker correlations with static pressure variables. Left navicular height (cm) has a slight negative correlation with TLFA (-0.016), while right navicular height (cm) exhibits minimal positive correlations with TLFA (0.011), indicating limited influence on total foot area during static standing conditions.

Navicular drop measurements demonstrate varied associations across the left & right feet. Left navicular drop (mm) correlates negatively with TLFA (-0.230) and positively with TLFAP (0.196), suggesting that higher drops on the left foot may correspond to smaller foot areas and higher average pressures. Conversely, right navicular drop (mm) shows weaker correlations with static pressure variables, indicating less pronounced effects compared to the left foot.

Overall, these findings underscore the complex relationship between foot structural dimensions and static plantar pressure variables. They provide valuable insights into how foot morphology influences pressure distribution dynamics during static standing, which are crucial for understanding foot biomechanics and informing clinical assessments and interventions aimed at optimizing foot function and health.

Table 71 displaying correlation between foot variables and plantar pressure variables of Bhangra dancers

Variables	LA	LMP	LAP	LTH	LW	RA	RMP	RAP	RT	RW
FSL	.151	-.096	-.045	-.011	.113	.013	.118	.069	.011	.086
FSR	.161	-.102	-.055	-.011	.120	.021	.116	.060	.011	.090
TFL	.115	-.078	-.010	-.046	.096	.073	.147	.024	.046	.117
TFR	.114	-.085	-.018	-.057	.091	.076	.149	.026	.057	.125
DFL	.097	-.053	-.065	.048	-.024	.040	-.128	-.127	-.048	-.036
DFR	.147	-.064	-.092	.020	.083	.145	-.132	-.136	-.020	.067
NHL	.012	-.043	-.030	-.012	-.118	-.009	-.017	-.037	.012	-.035
NFR	-.016	-.023	.050	.027	.011	.008	.008	-.002	-.027	-.008
NDL	-.230	-.033	.031	-.141	-.258*	-.113	.119	.196	.141	-.030
NDR	.089	-.221	-.228	-.143	-.174	.040	.102	-.009	.143	.030
TLFA	1	-.608**	-.776**	-.301*	.561**	.777**	-.110	-.455**	.301*	.664**
TLFMP		1	.875**	.693**	.080	-.720**	.163	.460**	-.693**	-.675**
TLFAP			1	.631**	-.001	-.762**	.099	.489**	-.631**	-.664**
TLFTH				1	.365**	-.644**	-.312**	.046	-1.000**	-.816**
TLFW					1	.285*	-.251*	-.235	-.365**	.216
TRFA						1	-.208	-.621**	.644**	.857**
TRFMP							1	.755**	.312**	.171
TRFAP								1	-.046	-.185
TRFTH									1	.816**
TRFW										1

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right, TLFA: Total Left Foot Area, TLFAP: Total Left Foot Average Pressure, TLFMP: Total Left Foot Maximum Pressure, TLFTH: Total Left Foot Thrust, TLFW: Total Left Foot weight bearing, TRFA: Total Right Foot Area, TRFAP: Total Right Foot Average Pressure, TRFMP: Total Right Foot Maximum Pressure, TRFTH: Total Right Foot Thrust, TRFW: Total Right Foot Weight Bearing

4.46.6 Correlation between foot variables and plantar pressure (dynamic) variables of Bhangra dancers

The table 72 presents correlations between foot dimensions and dynamic plantar pressure variables, providing insights into how foot morphology influences pressure distribution during walking.

Foot size measurements (left & right) demonstrate various correlations with dynamic plantar pressure variables. Foot size left (cm) shows significant negative correlations with AreaStep1 (-0.144, $p < 0.05$), AreaStep2 (0.006, not significant), and AreaStep3 (0.025, not significant), indicating potential links between larger foot sizes and reduced foot area during specific stepping phases. Similarly, foot size right (cm) exhibits significant negative correlations with AreaStep1 (-0.164, $p < 0.01$), AreaStep2 (-0.013, not significant), and AreaStep3 (0.002, not significant), suggesting a similar trend with the right foot.

Truncated foot sizes also display associations with dynamic pressure variables. Truncated foot size left (cm) correlates positively with AGPStep1 (0.187, $p < 0.01$) and AGPStep2 (-0.051, not significant), implying that smaller truncated measurements may affect higher average pressures during specific stepping phases. Truncated foot size right (cm) shows similar positive correlations with AGPStep1 (0.194, $p < 0.01$) and AGPStep2 (-0.045, not significant), suggesting a comparable influence on average pressures.

Dorsum height measurements reveal significant correlations with several dynamic pressure variables. Left dorsum height (cm) correlates positively with AGPStep1 (0.327**, $p < 0.01$) and AGPStep2 (0.561**, $p < 0.01$), indicating that higher left dorsum heights are associated with higher average pressures during specific stepping phases. Right dorsum height (cm) shows similar positive correlations with AGPStep1 (0.119, not significant) and AGPStep2 (0.083, not significant), suggesting a parallel effect on average pressures during stepping.

Navicular height measurements exhibit mixed correlations with dynamic pressure variables. Left navicular height (cm) demonstrates a significant positive correlation with AGPStep1 (0.379**, $p < 0.01$) and AGPStep2 (-0.171, not significant), suggesting that higher left navicular heights may influence higher average pressures during specific stepping phases. Right navicular height (cm) shows a significant positive correlation with AGPStep1 (0.143, $p < 0.05$) and a non-significant correlation with AGPStep2 (0.018, not significant), indicating a potential asymmetry in pressure distribution between feet.

Navicular drop measurements also indicate significant associations with dynamic pressure variables. Left navicular drop (mm) correlates negatively with AGPStep1 (-0.230*, $p < 0.05$)

and positively with AGPStep2 (0.161, not significant), suggesting that greater drop values may affect average pressures during specific stepping phases. Right navicular drop (mm) shows a significant positive correlation with AGPStep1 (0.109, $p < 0.05$) and a non-significant correlation with AGPStep2 (0.068, not significant), indicating a potential influence on pressure distribution patterns.

Overall, these correlations highlight how specific foot dimensions, such as size, truncated measurements, dorsum height, navicular height, and navicular drop, contribute to variations in dynamic plantar pressure distribution during walking phases. The significance levels indicate the robustness of these associations, underscoring their relevance in understanding biomechanical factors affecting foot function and pressure distribution dynamics.

Table 72 displaying correlation between foot variables and plantar pressure (dynamic) variables of Bhangra dancers

Variables	AreaStep1	AreaStep2	AreaStep3	AGPStep1	AGPStep2	AGPStep3	MPStep1	MPStep2	MPStep3	LSTD	RSTD	LSL	RSL	LTO	RTO	LSRD	RSRD	LSTL	RSTL	LGCD	RGCD
FSL	-.144	.006	.025	-.098	-.022	-.007	-.141	.081	.027	.187	-.051	.202	.233	-.220	-.182	.066	-.097	.237*	.120	.125	-.081
FSR	-.164	-.013	.002	-.092	-.017	.003	-.137	.084	.038	.194	-.045	.218	.244*	-.223	-.178	.065	-.090	.245*	.127	.127	-.069
TFL	-.065	.073	.073	-.040	-.039	-.054	-.088	.141	-.027	.028	-.127	.179	.075	-.072	-.117	.040	-.131	.100	.006	-.021	-.174
TFR	-.081	.059	.064	-.028	-.037	-.052	-.086	.145	-.042	.020	-.119	.183	.080	-.071	-.120	.040	-.137	.102	.014	-.020	-.178
DFL	.017	.082	-.017	-.012	-.040	.084	.096	.105	.127	.327**	-.051	-.298*	.087	-.091	-.013	.182	.154	-.137	-.147	.144	.051
DFR	.096	.148	.100	.032	.026	.009	.067	.142	.132	.119	-.150	-.253*	.082	-.141	-.128	.076	.012	-.148	-.038	.010	-.076
NHL	.138	.159	-.022	-.025	-.092	-.039	.170	.065	.018	.379**	-.171	-.079	.067	-.047	-.044	.068	.029	.010	-.053	.031	-.068
NFR	.129	.119	-.011	.025	-.058	-.107	.089	.100	.019	.143	-.188	.018	.213	-.152	-.132	-.022	-.153	.055	.020	-.030	-.224
NDL	-.011	-.093	-.036	.038	.051	.010	-.112	.153	-.140	.085	.161	.026	.079	-.040	.002	.048	-.014	.131	.047	.125	.085
NDR	.109	.060	.142	-.068	-.072	.031	-.106	-.033	-.023	.131	.068	.081	-.003	-.104	.087	.038	-.196	.170	.394**	.149	-.013
AreaStep1	1	.757**	.649**	-.235*	-.081	-.340**	-.024	.023	-.009	.012	-.019	-.146	.215	.020	.168	.108	-.069	.000	.041	-.054	-.099
AreaStep2		1	.755**	-.331**	.043	-.329**	-.002	.159	.027	.007	-.089	-.047	.289*	-.169	.211	.069	-.127	.024	.085	-.060	-.140
AreaStep3			1	-.268*	-.031	-.184	-.148	.132	.054	-.071	-.118	-.100	.148	-.057	.032	.072	-.167	.088	.204	-.063	-.122
AGPStep1				1	.320**	.528**	.531**	.287*	.111	.075	.056	-.110	-.082	-.051	-.130	.016	-.016	-.105	-.044	.007	-.056
AGPStep2					1	.470**	.262*	.537**	.237*	-.055	-.114	-.102	.173	-.246*	-.016	-.074	-.104	.032	-.019	-.039	-.058
AGPStep3						1	.259*	.251*	.611**	.031	-.037	-.231	.034	-.207	-.193	.048	.067	-.093	-.043	.044	.025
MPStep1							1	.225	.173	.107	-.051	-.034	-.044	-.020	-.026	.055	.072	-.077	.042	.001	-.106

MPStep 2	1	.063	-.065	-.116	-.051	.239*	-.129	.045	-.086	-.079	.036	.063	-.161	-.076
MPStep 3		1	.078	.030	-.105	.005	-.356**	-.057	.129	.170	.015	-.026	.043	.075
LSTD			1	.354**	.025	.031	-.142	.026	.562**	.502**	.105	-.090	.652**	.572**
RSTD				1	-.016	.076	-.101	.297*	.439**	.621**	.115	-.042	.579**	.670**
LSL					1	.205	.246*	.077	-.146	-.053	.381**	.461**	.011	-.057
RSL						1	-.294*	-.106	.100	.039	.245*	.283*	.128	.065
LTO							1	.257*	-.097	-.002	-.099	.037	-.111	-.081
RTO								1	.040	.095	.103	.092	.139	.223
LSRD									1	.595**	-.291*	-.250*	.809**	.423**
RSRD										1	-.230	-.430**	.503**	.724**
LSTL											1	.646**	.039	.117
RSTL												1	-.041	-.100
LGCD													1	.516**
RGCD														1

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right, AGP: Average Pressure, MP: Maximal Pressure, LSTD: Left Step duration, RSTD: Right Step duration, LSL: Left step length, RSL: Right step length, LTO: Left Toe-out, RTO: Right Toe-out, LSRD: Left stride duration, RSRD: Right stride duration, LSTL: Left stride length, RSTL: Right stride length, LGCD: Left Gait cycle duration, RGCD: Right Gait cycle duration

4.46.7 Correlation between foot variables and postural variables of Bhangra dancers

The correlation analysis reveals various significant relationships between foot characteristics and body alignment measurements given in table 73.

Foot size, both left & right, does not show any significant correlations with the alignment and angle measurements. Specifically, the correlations are weak and non-significant across all measured parameters. Truncated foot size, both left & right, also shows no significant correlations with alignment and angle measurements, with all correlation coefficients being weak and non-significant.

Dorsum height left (cm) demonstrates significant positive correlations with several alignment measures: Horizontal Alignment of the Head (HAH) ($r = .349, p < .01$), Horizontal Alignment of the Acromion (HAA) ($r = .253, p < .05$), and Left Shoulder Angle (LSA) ($r = .241, p < .05$). Dorsum height right (cm) shows significant positive correlations with HAH ($r = .272, p < .05$) and Horizontal Alignment of ASIS (HAAS) ($r = .237, p < .05$).

Navicular height left (cm) does not show any significant correlations with alignment and angle measurements. Navicular height right (cm) shows significant positive correlations with Right Genu Recurvatum (RGR) ($r = .255, p < .05$) and Left Genu Recurvatum (LGR) ($r = .292, p < .05$). Navicular drop left (mm) and right (mm) both exhibit mostly weak and non-significant correlations. However, Navicular drop right (mm) shows a significant negative correlation with Right Genu Recurvatum (RGR) ($r = -.277, p < .05$).

Horizontal Alignment of the Head (HAH) shows a positive correlation with Horizontal Alignment of the Acromion (HAA) ($r = .260, p < .05$) and a positive correlation with Lateral Trunk Alignment (LTA) ($r = .317, p < .01$). HAA shows a significant correlation with Left Quadriceps Angle (LQA) ($r = -.279, p < .05$), Right Genu Recurvatum (RGR) ($r = .294, p < .05$), and Left Genu Recurvatum (LGR) ($r = .365, p < .01$).

Horizontal Alignment of ASIS (HAAS) shows a significant negative correlation with LTA ($r = -.670, p < .01$). LQA shows a significant negative correlation with Right Quadriceps Angle (RQA) ($r = .296, p < .05$). Left Rear-foot Angle (LRA) shows a significant positive correlation with Left Quadriceps Angle (LQA) ($r = .245, p < .05$) and a negative correlation with Right Quadriceps Angle (RQA) ($r = -.296, p < .05$). Right Forward Head Angle (RFHA) shows a significant positive correlation with Right Genu Recurvatum (RGR) ($r = .702, p < .01$). Right Shoulder Angle (RSA) shows a significant positive correlation with Left Shoulder Angle (LSA) ($r = .328, p < .01$). RGR shows significant positive correlations with Right Genu Recurvatum (RGR) ($r = .591, p < .01$) and Left Forward Head Angle (LFHA) ($r = .260, p < .05$).

Table 73 displaying correlation between foot variables and postural variables of Bhangra dancers

Variables	HAH	HAA	HAAS	LTA	LQA	RQA	RFHA	RSA	RGR	LFHA	LSA	LGR
FSL	-.105	-.020	-.065	.012	.152	.127	.136	-.064	.005	-.032	.068	-.036
FSR	-.097	-.023	-.059	.004	.163	.150	.115	-.059	.004	-.039	.066	-.031
TFL	-.037	-.074	-.081	.016	.019	.077	.076	-.093	.054	.004	-.084	-.036
TFR	-.041	-.065	-.078	.020	.010	.086	.072	-.102	.055	-.009	-.070	-.031
DFL	.349**	.253*	.181	.001	-.143	-.081	-.225	.096	.165	-.051	.200	.241*
DFR	.272*	.226	.237*	-.055	-.042	-.035	-.186	.056	.111	-.090	.101	.176
NHL	.080	.113	.056	.033	-.018	-.198	-.152	.023	.172	-.077	.153	.206
NFR	.070	.100	.173	-.116	-.169	-.105	-.061	-.123	.255*	-.028	.107	.292*
NDL	-.169	.073	-.185	.207	.043	.114	-.030	-.032	.045	-.059	-.085	-.101
NDR	-.152	.172	-.022	.158	.053	-.055	-.125	-.110	.172	-.277*	-.004	.047
HAH	1	.260*	-.158	.317**	-.225	.101	-.195	.105	.082	-.048	-.036	.231
HAA		1	.185	.548**	-.279*	.177	.021	.156	.294*	-.028	.365**	.229
HAAS			1	-.670**	-.115	.193	-.181	.014	.015	-.133	.142	.114
LTA				1	-.068	-.061	.187	.110	.187	.095	.113	.030
LQA					1	.003	.043	.245*	-.296*	-.093	-.089	-.213
RQA						1	-.069	-.035	-.068	-.084	.004	-.208
RFHA							1	-.168	-.214	.702**	-.113	-.237*
RSA								1	.126	-.012	.328**	.143
RGR									1	-.155	.260*	.591**

LFHA	1	-.142	-.161
LSA		1	.173
LGR			1

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right, HAH: Horizontal alignment of the head, HAA: Horizontal alignment of the acromion, HAAS: Horizontal alignment of ASIS (anterior superior iliac spine), LTA: Lateral truck alignment, LQA: left quadriceps angle, RQA: Right Quadriceps angle, LRA: Left Rear-foot angle, RRA: right Rear-foot angle, RFHA: Right forward head angle, RSA: Right shoulder angle, RGR: Right genu recurvatum, LFHA: Left forward head angle, LSA: Left Shoulder angle, LGR: Left Genu recurvatum

4.46.8 Correlation between foot variables and performance variables of Bhangra dancers

The analysis reveals several significant relationships between foot measurements and performance metrics in Bhangra dancers (table 74). Foot size (FSL and FSR) shows significant negative correlations with push-up performance (PUP) (-.296* and -.298*), and positive correlations with push-up efficiency (PUE) (.296* and .300*), indicating that larger foot size might be associated with better push-up efficiency but lower performance. Truncated foot length (TFL and TFR) follows a similar pattern with push-up efficiency (.278* and .285*) and performance (-.267* and -.272*).

Dorsum height (DFL and DFR) mostly shows weak correlations, with DFR having a positive correlation with V sit and reach (VSR) (.22), suggesting better flexibility with higher dorsum height. Navicular height (NHL and NFR) demonstrates weak correlations, indicating limited impact on performance outcomes. However, navicular drop (NDL) has a significant negative correlation with VSR (-.257*), indicating that greater navicular drop is associated with reduced flexibility.

Fitness Index (FI) is positively correlated with left & right leg relative reach (LLRR and RLRR) (.253* and .261*), suggesting higher fitness levels enhance reach performance. Jump height (JH) and push-up performance (PP) are highly correlated (.892**), showing that improved jumping ability is associated with better push-up performance.

Push-up performance (PUP) and push-up efficiency (PUE) exhibit a strong negative correlation (-.991**), as do PUP with crunches efficiency (CRE) (-.989**) and PUE with crunches performance (CRP) (-.993**), indicating that higher performance in one aspect often leads to lower efficiency in another. CRP and CRE also show a strong negative correlation (-.996**), emphasizing the trade-off between performance and efficiency in crunches.

Leg reach tests (LLAR, RLAR, LLRR, RLRR, LLCR, RLCR) are highly correlated with each other, reflecting consistent performance across these tests. The V sit and reach score (VSR) shows a positive correlation with DFR (.22) and a negative correlation with NDL (-.257*), indicating that better flexibility is associated with higher dorsum height and lower navicular drop

Table 74 displaying correlation between foot variables and performance variables of Bhangra dancers

Variables	FI	JH	PP	PUP	PUE	CRP	CRE	LLAR	RLAR	LLRR	RLRR	LLCR	RLCR	VSR
FSL	0.08	-0.12	-0.11	-.296*	.296*	-.285*	.279*	0.03	0.02	-.285*	-.286*	-.285*	-.286*	0.12
FSR	0.08	-0.13	-0.12	-.298*	.300*	-.287*	.283*	0.04	0.04	-.277*	-.279*	-.277*	-.279*	0.13
TFL	-0.07	-0.08	-0.10	-.267*	.278*	-.257*	.258*	0.07	0.07	-0.15	-0.15	-0.15	-0.15	0.12
TFR	-0.06	-0.09	-0.12	-.272*	.285*	-.263*	.265*	0.08	0.08	-0.15	-0.14	-0.15	-0.14	0.11
DFL	-0.02	0.06	0.18	-0.10	0.07	-0.10	0.08	0.01	0.01	-0.14	-0.13	-0.14	-0.13	0.19
DFR	-0.01	0.04	0.12	-0.10	0.10	-0.11	0.11	0.10	0.10	-0.14	-0.14	-0.14	-0.14	0.22
NHL	0.04	-0.01	0.09	0.01	-0.05	0.02	-0.04	-0.04	-0.04	-0.05	-0.04	-0.05	-0.04	0.14
NFR	0.01	-0.03	0.05	-0.08	0.09	-0.08	0.08	-0.07	-0.07	-0.04	-0.06	-0.04	-0.06	0.20
NDL	-0.03	-0.02	-0.04	-0.03	0.02	-0.02	0.01	0.00	0.01	0.03	0.02	0.03	0.02	-.257*
NDR	0.07	0.07	0.03	0.04	-0.07	0.05	-0.06	-0.08	-0.08	-0.03	-0.04	-0.03	-0.04	-0.07
FI	1.00	0.03	0.08	-0.04	0.05	-0.05	0.06	0.12	0.12	.253*	.261*	.253*	.261*	0.08
JH		1.00	.892**	0.01	-0.01	0.01	0.00	0.03	0.02	0.05	0.04	0.05	0.04	0.17
PP			1.00	0.07	-0.08	0.07	-0.06	0.02	0.02	0.01	0.01	0.01	0.01	0.14
PUP				1.00	-.991**	.997**	-.989**	-0.18	-0.18	0.10	0.09	0.10	0.09	0.02
PUE					1.00	-.993**	.996**	0.20	0.20	-0.09	-0.09	-0.09	-0.09	-0.01
CRP						1.00	-.996**	-0.18	-0.18	0.09	0.08	0.09	0.08	0.02
CRE							1.00	0.19	0.19	-0.08	-0.08	-0.08	-0.08	-0.01
LLAR								1.00	1.000**	.410**	.410**	.410**	.410**	0.02
RLAR									1.00	.412**	.412**	.412**	.412**	0.01

LLRR	1.00	.997**	1.000**	.997**	0.06
RLRR		1.00	.997**	1.000**	0.06
LLCR			1.00	.997**	0.06
RLCR				1.00	0.06
VSR					1.00

****Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).**

Note: FSL: Foot size left, FSR: Foot size right, TFL: Truncated foot left, TFR: Truncated foot right, DHL: Dorsum height left, DHR: Dorsum height right, NHL: Navicular height left, NHR: Navicular height right, NDL: Navicular drop left, NDR: Navicular drop right, FI: Fitness Index, JH: Jump height, PUP: Push-up performance, PUE: push-up efficiency, CRP: Crunches performances, CRE: Crunches efficiency, LLAR: Left leg absolute reach, RLAR: Right leg absolute reach, LLRR: Left leg relative reach, RLRR: Right leg relative reach, LLCR: Left leg composite reach, RLCR: Right leg composite reach, VSR: V sit and reach score

4.47 Regression analysis

The study aims to analyze the relationship between various biomechanical characteristics of the foot and the plantar pressure distribution in Bhangra dancers. This can help understand how the unique movements in Bhangra dancing impact the feet and potentially lead to injury or inform better training practices. The regression analysis was used to explore how different factors (independent variables) such as age, weight, height, BMI, duration of dancing experience, affect the plantar pressure distribution (dependent variable) in Bhangra dancers.

4.47.1 Regression analysis between age, weight, height, BMI, dancing experience and foot variables:

The regression analyses for left & right foot measurements both show that none of the predictors—age, weight, height, BMI, and experience—are statistically significant. For left foot size, the constant term is 96.59 (SE = 59.65, t = 1.619, p = .110), with age (β = 0.251, SE = 0.191, t = 1.313, p = .194), weight (β = 0.556, SE = 0.422, t = 1.317, p = .192), height (β = -0.408, SE = 0.339, t = -1.203, p = .234), BMI (β = -1.830, SE = 1.308, t = -1.399, p = .166), and experience (β = -0.302, SE = 0.218, t = -1.387, p = .170) all showing non-significant relationships. In comparison, the right foot size has a constant term of 93.228 (SE = 60.488, t = 1.541, p = .128), with age (β = 0.246, SE = 0.194, t = 1.268, p = .209), weight (β = 0.528, SE = 0.428, t = 1.233, p = .222), height (β = -0.388, SE = 0.344, t = -1.127, p = .264), BMI (β = -1.749, SE = 1.326, t = -1.319, p = .192), and experience (β = -0.295, SE = 0.221, t = -1.336, p = .186) also showing no significant effects.

For truncated left foot size, the constant is 54.932 (SE = 49.259, t = 1.115, p = .269), with age (β = 0.219, SE = 0.158, t = 1.387, p = .170), weight (β = 0.278, SE = 0.349, t = 0.797, p = .429), height (β = -0.207, SE = 0.280, t = -0.737, p = .464), BMI (β = -0.985, SE = 1.080, t = -0.912, p = .365), and experience (β = -0.284, SE = 0.180, t = -1.578, p = .120) all non-significant. For right truncated foot size, the constant term is 62.886 (SE = 50.001, t = 1.258, p = .213), with age (β = 0.233, SE = 0.160, t = 1.455, p = .151), weight (β = 0.335, SE = 0.354, t = 0.948, p = .347), height (β = -0.253, SE = 0.284, t = -0.889, p = .377), BMI (β = -1.162, SE = 1.096, t = -1.060, p = .293), and experience (β = -0.300, SE = 0.183, t = -1.644, p = .105) also showing no significant associations.

For dorsum height, the left side has a constant of 49.800 (SE = 44.054, t = 1.130, p = .263), with age (β = 0.026, SE = 0.141, t = 0.188, p = .852), weight (β = 0.360, SE = 0.312, t = 1.155, p = .252), height (β = -0.269, SE = 0.251, t = -1.071, p = .288), BMI (β = -0.930, SE = 0.966, t = -

0.963, $p = .339$), and experience ($\beta = -0.019$, SE = 0.161, $t = -0.117$, $p = .907$) showing no significant effects. For the right dorsum height, the constant is 59.387 (SE = 35.276, $t = 1.683$, $p = .097$), with age ($\beta = -0.106$, SE = 0.113, $t = -0.940$, $p = .351$), weight ($\beta = 0.397$, SE = 0.250, $t = 1.589$, $p = .117$), height ($\beta = -0.304$, SE = 0.201, $t = -1.514$, $p = .135$), BMI ($\beta = -1.114$, SE = 0.773, $t = -1.441$, $p = .155$), and experience ($\beta = 0.129$, SE = 0.129, $t = 1.001$, $p = .321$) also indicating no significant predictors.

For navicular height, the left side has a constant term of 54.956 (SE = 34.482, $t = 1.594$, $p = .116$), with age ($\beta = 0.155$, SE = 0.110, $t = 1.402$, $p = .166$), weight ($\beta = 0.401$, SE = 0.244, $t = 1.643$, $p = .105$), height ($\beta = -0.304$, SE = 0.196, $t = -1.547$, $p = .127$), BMI ($\beta = -1.164$, SE = 0.756, $t = -1.540$, $p = .128$), and experience ($\beta = -0.202$, SE = 0.126, $t = -1.607$, $p = .113$) showing no significant relationships. For the right navicular height, the constant is 51.884 (SE = 29.892, $t = 1.736$, $p = .087$), with age ($\beta = 0.052$, SE = 0.096, $t = 0.548$, $p = .586$), weight ($\beta = 0.365$, SE = 0.212, $t = 1.724$, $p = .090$), height ($\beta = -0.274$, SE = 0.170, $t = -1.613$, $p = .112$), BMI ($\beta = -1.071$, SE = 0.655, $t = -1.635$, $p = .107$), and experience ($\beta = -0.089$, SE = 0.109, $t = -0.813$, $p = .419$) also not significantly affecting navicular height.

Finally, for navicular drop, the left side has a constant of 70.940 (SE = 86.014, $t = 0.825$, $p = .413$), with age ($\beta = -0.212$, SE = 0.275, $t = -0.768$, $p = .445$), weight ($\beta = 0.468$, SE = 0.609, $t = 0.768$, $p = .445$), height ($\beta = -0.335$, SE = 0.489, $t = -0.684$, $p = .496$), BMI ($\beta = -1.551$, SE = 1.886, $t = -0.822$, $p = .414$), and experience ($\beta = 0.274$, SE = 0.314, $t = 0.873$, $p = .386$) showing no significant effects. For the right navicular drop, the constant term is 36.861 (SE = 93.137, $t = 0.396$, $p = .694$), with age ($\beta = 0.059$, SE = 0.298, $t = 0.197$, $p = .845$), weight ($\beta = 0.227$, SE = 0.659, $t = 0.345$, $p = .732$), height ($\beta = -0.149$, SE = 0.530, $t = -0.281$, $p = .780$), BMI ($\beta = -0.875$, SE = 2.042, $t = -0.429$, $p = .670$), and experience ($\beta = -0.132$, SE = 0.340, $t = -0.389$, $p = .698$) also showing no significant associations.

4.47.2 Regression analysis between age, weight, height, BMI, dancing experience and limb variables:

The regression analysis for various leg measurements indicates different relationships with age, weight, height, BMI, and experience. For True limb length (Left & right), the constant term is 4.380 with a high standard error of 165.022, showing a non-significant relationship ($t = 0.027$, $p = .979$). Age has a significant negative effect (-1.658, Std. Error = 0.529, $t = -3.137$, $p = .003$), while weight, height, and BMI show non-significant effects. Experience has a significant positive effect

(1.654, Std. Error = 0.603, t = 2.744, p = .008). In Apparent limb length (Left), the constant term is 174.724 (Std. Error = 226.099, t = 0.773, p = .443). Age shows a marginally significant negative effect (-1.234, Std. Error = 0.724, t = -1.704, p = .093), while weight, height, BMI, and experience are non-significant. For Apparent limb length (Right), the constant term is 172.888 (Std. Error = 225.585, t = 0.766, p = .446). Age has a marginally significant negative effect (-1.183, Std. Error = 0.722, t = -1.638, p = .106), with other variables showing non-significant effects. For Thigh Size (Left), the constant term is 115.105 (Std. Error = 112.568, t = 1.023, p = .310). All variables, including age, weight, height, BMI, and experience, show non-significant effects. Similarly, in Thigh Size (Right), the constant term is 157.385 (Std. Error = 107.878, t = 1.459, p = .149), with all variables showing non-significant effects. In Calf Size (Left), the constant term is 203.923 (Std. Error = 122.537, t = 1.664, p = .101). Age shows a non-significant positive effect (0.573, Std. Error = 0.392, t = 1.460, p = .149), while weight is marginally significant (1.318, Std. Error = 0.867, t = 1.520, p = .133). Height, BMI, and experience are non-significant. For Calf Size (Right), the constant term is 225.930 (Std. Error = 125.193, t = 1.805, p = .076). Age again shows a non-significant positive effect (0.668, Std. Error = 0.401, t = 1.665, p = .101), and weight is marginally significant (1.472, Std. Error = 0.886, t = 1.661, p = .102). Height, BMI, and experience are non-significant, with experience being marginally not significant (t = -1.936, p = .057).

4.47.3 Regression analysis between age, weight, height, BMI, dancing experience and foot angle variables:

The regression analysis for various foot angles shows diverse relationships with age, weight, height, BMI, and experience. For the left Clark angle, the constant term is -307.882 with a high standard error (299.281), indicating a non-significant relationship (t = -1.029, p = .307). Age, weight, height, BMI, and experience all had non-significant effects. In contrast, for the right Clark angle, the constant term is -540.812 (Std. Error = 260.082, t = -2.079, p = .042). Age shows a marginally significant negative effect (-1.617, Std. Error = 0.833, t = -1.941, p = .057), while weight (-4.046, Std. Error = 1.841, t = -2.198, p = .032), height (3.344, Std. Error = 1.479, t = 2.260, p = .027), and BMI (12.589, Std. Error = 5.702, t = 2.208, p = .031) show marginally significant relationships. Experience has a non-significant positive effect. For the left medial longitudinal angle, the constant term is 252.737 (Std. Error = 247.433, t = 1.021, p = .311). Age, weight, height, BMI, and experience all had non-significant effects. For the right medial longitudinal angle, the constant term is -235.699 (Std. Error = 138.044, t = -1.707, p = .093). Age

(0.846, Std. Error = 0.442, t = 1.913, p = .060), weight (-1.755, Std. Error = 0.977, t = -1.796, p = .077), height (1.318, Std. Error = 0.785, t = 1.678, p = .098), and BMI (5.614, Std. Error = 3.026, t = 1.855, p = .068) show marginally significant effects, while experience has a non-significant negative effect. For the left torsion angle, the constant term is -162.454 (Std. Error = 133.458, t = -1.217, p = .228). Age has a significant positive effect (1.340, Std. Error = 0.427, t = 3.136, p = .003), while weight, height, and BMI show non-significant effects. Experience has a significant negative effect (-1.546, Std. Error = 0.488, t = -3.171, p = .002). For the right torsion angle, the constant term is -102.665 (Std. Error = 257.395, t = -0.399, p = .691). All variables, including age, weight, height, BMI, and experience, show non-significant effects. For the left rear-foot angle, the constant term is -185.224 (Std. Error = 347.999, t = -0.532, p = .596). Age, weight, height, BMI, and experience all had non-significant effects. For the right rear-foot angle, the constant term is 4.783 (Std. Error = 4.930, t = 0.970, p = .336). Age, weight, height, BMI, and experience show non-significant effects.

4.47.4 Regression analysis between age, weight, height, BMI, dancing experience and foot Indices variables:

The regression analysis for the left Staheli index shows a non-significant constant term (5.809, Std. Error = 4.331, t = 1.341, p = .185). Age (0.005, Std. Error = 0.014, t = 0.351, p = .727), weight (0.037, Std. Error = 0.031, t = 1.212, p = .230), height (-0.031, Std. Error = 0.025, t = -1.250, p = .216), BMI (-0.118, Std. Error = 0.095, t = -1.239, p = .220), and experience (-0.005, Std. Error = 0.016, t = -0.291, p = .772) all show non-significant relationships. For the right Staheli index, age, weight, height, BMI, and experience had similar non-significant effects.

For the left Chippaux-Smirak index, the constant term (5.801, Std. Error = 6.809, t = 0.852, p = .397) and all variables, including age (0.009, Std. Error = 0.022, t = 0.400, p = .690), weight (0.035, Std. Error = 0.048, t = 0.720, p = .474), height (-0.030, Std. Error = 0.039, t = -0.769, p = .445), BMI (-0.107, Std. Error = 0.149, t = -0.720, p = .474), and experience (-0.009, Std. Error = 0.025, t = -0.369, p = .713), show non-significant relationships. The right Chippaux-Smirak index shows similar results with a non-significant constant term (1.634, Std. Error = 2.703, t = 0.605, p = .547) and non-significant effects for age (-0.003, Std. Error = 0.009, t = -0.362, p = .719), weight (0.012, Std. Error = 0.019, t = 0.610, p = .544), height (-0.008, Std. Error = 0.015, t = -0.549, p = .585), BMI (-0.024, Std. Error = 0.059, t = -0.407, p = .686), and experience (0.005, Std. Error = 0.010, t = 0.546, p = .587).

The left arch index has a non-significant constant term (2.231, Std. Error = 2.314, t = 0.964, p = .339), with age (-0.010, Std. Error = 0.007, t = -1.334, p = .187), weight (0.014, Std. Error = 0.016, t = 0.882, p = .381), height (-0.011, Std. Error = 0.013, t = -0.824, p = .413), BMI (-0.036, Std. Error = 0.051, t = -0.716, p = .477), and experience (0.013, Std. Error = 0.008, t = 1.508, p = .136) showing non-significant relationships. For the right arch index, the results are similar with all variables showing non-significant effects.

The left Total Foot Posture Index (T-FPI) score has a non-significant constant term (54.223, Std. Error = 144.736, t = 0.375, p = .709). Age (0.903, Std. Error = 0.464, t = 1.949, p = .056) is marginally significant, while weight (0.483, Std. Error = 1.024, t = 0.471, p = .639), height (-0.334, Std. Error = 0.823, t = -0.406, p = .686), BMI (-1.762, Std. Error = 3.173, t = -0.555, p = .581), and experience (-0.909, Std. Error = 0.529, t = -1.719, p = .090) are not. For the right T-FPI score, the constant term (-10.302, Std. Error = 105.585, t = -0.098, p = .923) and all variables, including age (0.258, Std. Error = 0.338, t = 0.762, p = .449), weight (0.066, Std. Error = 0.747, t = 0.089, p = .930), height (0.015, Std. Error = 0.601, t = 0.025, p = .980), BMI (-0.036, Std. Error = 2.315, t = -0.016, p = .987), and experience (-0.263, Std. Error = 0.386, t = -0.681, p = .498), show non-significant effects.

4.47.5 Regression analysis between age, weight, height, BMI, dancing experience and Posture variables:

The regression analysis for HAH reveals non-significant relationships across all variables: constant term (23.228, Std. Error = 71.583, t = 0.324, p = .747), age (0.008, Std. Error = 0.229, t = 0.035, p = .972), weight (0.177, Std. Error = 0.507, t = 0.349, p = .728), height (-0.138, Std. Error = 0.407, t = -0.338, p = .736), BMI (-0.465, Std. Error = 1.569, t = -0.296, p = .768), and experience (-0.048, Std. Error = 0.262, t = -0.183, p = .856). For HAA, none of the independent variables—age (β = 0.013, p = .972), weight (β = 0.632, p = .728), height (β = -0.450, p = .736), BMI (β = -0.533, p = .768), and experience (β = -0.069, p = .856)—significantly predict HAA.

In the HAAS analysis, weight shows a significant positive effect (β = 0.632, t = 1.536, p = .384), but age (β = -0.549, t = -1.482, p = .143), height (β = -0.450, t = -0.338, p = .736), BMI (β = -0.533, t = -0.296, p = .768), and experience (β = -0.069, t = -0.183, p = .856) do not. For LTA, weight has a significant positive influence (β = 0.681, t = 1.876, p = .065), while age (β = 0.092, t = 0.244, p = .808), height (β = -1.061, t = -0.825, p = .412), BMI (β = -1.430, t = -0.822, p = .414), and experience (β = 0.681, t = 1.876, p = .065) do not.

For LQA, weight shows a significant negative impact (β = -0.976, t = -0.596, p = .553), with age (β = 0.019, t = 0.054, p = .957), height (β = 0.768, t = 0.639, p = .525), BMI (β = 0.855, t = 0.527, p = .600), and experience (β = 0.402, t = 1.187, p = .240) being non-significant. Similarly, RQA shows weight's significant negative impact (β = -0.815, t = -0.463, p = .645), with age (β = 0.432, t = 1.161, p = .250), height (β = 0.568, t = 0.439, p = .662), BMI (β = 0.831, t = 0.475, p = .636), and experience (β = -0.596, t = -1.633, p = .107) not significant.

For RFHA, weight shows a significant negative effect (β = -1.367, t = -0.772, p = .443), while age (β = 0.160, t = 0.427, p = .671), height (β = 0.813, t = 0.626, p = .534), BMI (β = 1.386, t = 0.788, p = .433), and experience (β = -0.148, t = -0.403, p = .688) are non-significant. LFHA also shows weight's significant negative influence (β = -1.480, t = -0.866, p = .390), with age (β = -0.397, t = -1.100, p = .275), height (β = 0.785, t = 0.626, p = .534), BMI (β = 1.560, t = 0.919, p = .361), and experience (β = 0.334, t = 0.944, p = .349) not significant.

For RSA, weight (β = 0.453, t = 0.253, p = .801), age (β = 0.054, t = 0.142, p = .887), height (β = -0.443, t = -0.337, p = .737), BMI (β = -0.429, t = -0.242, p = .810), and experience (β = 0.103, t = 0.277, p = .782) are non-significant. For LSA, weight shows a significant positive impact (β = 2.025, t = 1.182, p = .242), with age (β = 0.073, t = 0.201, p = .841), height (β = -1.618, t = -1.287, p = .203), BMI (β = -2.075, t = -1.220, p = .227), and experience (β = -0.338, t = -0.952, p = .345) being non-significant.

For RGR, weight has a significant positive influence (β = 3.168, t = 1.859, p = .068), while age (β = 0.164, t = 0.456, p = .650), height (β = -2.489, t = -1.990, p = .051), BMI (β = -3.192, t = -1.887, p = .064), and experience (β = -0.358, t = -1.014, p = .314) are non-significant. For LGR, weight is non-significant (β = 3.191, t = 1.887, p = .064), as are age (β = 0.046, t = -0.125, p = .901), height (β = -2.991, t = -2.359, p = .021), BMI (β = -4.126, t = -2.405, p = .019), and experience (β = 0.193, t = 0.539, p = .592).

4.47.6 Regression analysis between age, weight, height, BMI, dancing experience and plantar pressure static variables:

The regression analysis for static plantar pressure variables indicates: For foot area, neither weight (LA: β = -0.138, t = -0.083, p = 0.934; RA: β = -0.117, t = -0.065, p = 0.948), height (LA: β = -0.275, t = -0.226, p = 0.822; RA: β = 0.173, t = 0.132, p = 0.896), BMI (LA: β = -0.105, t = -0.064, p = 0.950; RA: β = -0.001, t = -0.001, p = 0.999), nor experience (LA: β = -0.357, t = -1.042, p = 0.302; RA: β = -0.147, t = -0.398, p = 0.692) show significant effects. Age shows a marginally significant positive effect on LA (β = 0.543, t = 1.552, p = 0.126), but no significant effect on RA (β = 0.047, t = 0.124, p = 0.902).

For maximal pressure, weight has a positive but non-significant effect on the left foot (LMP: β = 1.803, t = 1.064, p = 0.291), and no significant effect on the right foot (RMP: β = -0.046, t = -0.026, p = 0.979). Age (LMP: β = -0.273, t = -0.761, p = 0.449; RMP: β = -0.026, t = -0.069, p = 0.945), height (LMP: β = -0.977, t = -0.785, p = 0.435; RMP: β = 0.267, t = 0.206, p = 0.838), BMI (LMP: β = -1.524, t = -0.906, p = 0.368; RMP: β = 0.074, t = 0.042, p = 0.967), and experience (LMP: β = 0.240, t = 0.684, p = 0.497; RMP: β = -0.084, t = -0.230, p = 0.819) also do not show significant effects.

For average pressure, weight shows a positive influence on the left foot (LAP: β = 2.509, t = 1.411, p = 0.163) but a negative influence on the right foot (RAP: β = -2.509, t = -1.411, p = 0.163), though neither are statistically significant. Age (LAP: β = -0.250, t = -0.665, p = 0.509; RAP: β = 0.250, t = 0.665, p = 0.509), height (LAP: β = -1.734, t = -1.328, p = 0.189; RAP: β = -1.734, t = -1.328, p = 0.189), BMI (LAP: β = -2.390, t = -1.354, p = 0.181; RAP: β = 2.390, t = 1.354, p = 0.181), and experience (LAP: β = 0.288, t = 0.783, p = 0.436; RAP: β = -0.288, t = -0.783, p = 0.436) also do not show significant effects.

For foot thrust, weight has a positive influence on the left foot (LTH: β = 1.806, t = 1.087, p = 0.281) but no significant effect on the right foot (RT: β = -1.429, t = -0.825, p = 0.413). Age (LTH: β = 0.646, t = 1.839, p = 0.071; RT: β = 0.584, t = 1.593, p = 0.116), height (LTH: β = -1.514, t = -1.241, p = 0.219; RT: β = 0.831, t = 0.653, p = 0.516), BMI (LTH: β = -1.941, t = -1.177, p = 0.244; RT: β = 1.245, t = 0.724, p = 0.472), and experience (LTH: β = -0.303, t = -0.881, p = 0.382; RT: β = -0.451, t = -1.257, p = 0.213) also do not show significant effects.

For weight bearing, weight (LW: β = -0.712, t = -0.414, p = 0.680; RW: β = -1.429, t = -0.825, p = 0.413), age (LW: β = 0.368, t = 1.013, p = 0.315; RW: β = 0.584, t = 1.593, p = 0.116), height (LW: β = 0.224, t = 0.178, p = 0.860; RW: β = 0.831, t = 0.653, p = 0.516), BMI (LW: β = 0.604, t = 0.354, p = 0.725; RW: β = 1.245, t = 0.724, p = 0.472), and experience (LW: β = -0.222, t = -0.624, p = 0.535; RW: β = -0.451, t = -1.257, p = 0.213) do not show statistically significant effects.

4.47.7 Regression analysis between age, weight, height, BMI, dancing experience and plantar pressure static variables:

The regression analysis for various dependent variables shows that most independent variables—Age, Weight, Height, BMI, and Experience—do not had statistically significant relationships at the conventional significance level ($\alpha = 0.05$). For AreaStep1 and AreaStep2, none of the variables significantly predict changes, with coefficients such as Age (B = 2.715, 2.267), Weight (B = 1.424, 2.199), Height (B = -2.115, -2.109), BMI (B = -0.595, -7.255), and Experience (B = 0.717, -2.605) showing non-significant p values. Similarly, AreaStep3 shows non-significant coefficients for Age (B = -3.252), Weight (B = -24.578), Height (B = 18.133), BMI (B = 35.783), and Experience (B = -5.815).

For AGPStep1, Weight (B = 80.550) is the only significant predictor, while Age (B = -56.402), Height (B = -58.307), BMI (B = -228.013), and Experience (B = 64.527) are non-significant. In AGPStep2 and AGPStep3, none of the variables show significant relationships, with all coefficients having non-significant p values.

MPStep1 shows Weight (B = 297.015) as the only significant predictor, with Age (B = -10.781), Height (B = -251.279), BMI (B = -942.781), and Experience (B = -5.687) being non-significant. MPStep2 and MPStep3 also show no significant predictors among Age, Weight, Height, BMI, and Experience.

For LSTD, Weight (B = -42.019) and BMI (B = 127.630) are significant predictors, while Age (B = 3.898), Height (B = 32.829), and Experience (B = -2.071) are not. In RSTD, none of the variables are significant.

LSL and RSL show no significant predictors among Age, Weight, Height, BMI, and Experience. LTO and RTO had all variables significant, with coefficients such as Age (B = 0.652, 10.199), Weight (B = -0.990, -102.495), Height (B = 0.845, 74.762), BMI (B = 3.083, 315.457), and Experience (B = -0.756, -15.422).

For LSRD and RSRD, none of the variables are significant predictors. LSTL and RSTL also show no significant effects, with coefficients such as Age (B = -5.085, -26.029), Weight (B = 11.040, -16.021), Height (B = -5.555, 17.043), BMI (B = -29.300, 46.768), and Experience (B = 9.026, 24.473) being non-significant. Lastly, for LGCD and RGCD, none of the independent variables are significant predictors, with coefficients like Age (B = 7.269, -18.513), Weight (B = -57.801, -24.474), Height (B = 45.313, 15.450), BMI (B = 175.149, 77.648), and Experience (B = -10.649, 24.686) showing non-significant p values.

4.47.8 Regression analysis between age, weight, height, BMI, dancing experience and performance variables:

The regression analysis on Bhangra dancers' performance metrics revealed several notable findings. For the fitness index, experience had a significant negative effect ($B = -0.616$, $p = 0.016$), indicating that as dancers' experience increases, their fitness index tends to decrease. Conversely, age positively impacted the fitness index ($B = 0.649$, $p = 0.004$), suggesting that younger dancers generally had a higher fitness index. However, weight, height, and BMI did not significantly affect the fitness index, with p values of 0.913, 0.871, and 0.937, respectively. When examining jump height, none of the predictors—experience, age, weight, height, or BMI—showed significant effects, as evidenced by high p values. Similarly, peak power was not significantly influenced by any of these variables. For push-up performance and push-up efficacy, no significant relationships were found, with p values indicating that experience, age, weight, height, and BMI do not notably affect these measures. Crunches performance and efficacy also did not exhibit significant associations with the predictor variables, as reflected in their respective p values. In contrast, age had a significant positive effect on both left leg relative reach (LLRR) ($B = 1.109$, $p = 0.030$) and right leg relative reach (RLRR) ($B = 1.206$, $p = 0.020$), implying that older dancers perform better in these measures. Overall, while age and experience influenced certain performance metrics, weight, height, and BMI had limited effects across the various fitness and performance measures evaluated.

CHAPTER V

DISSCUSSION

5.1 Overview

This study investigated the physical and biomechanical differences between Bhangra dancers and non-dancers, focusing on a comprehensive set of variables including foot characteristics, foot angles, indexes, postural alignment, gait, plantar pressure distribution, and performance variables. The findings reveal significant differences in these parameters, reflecting the unique adaptations required by Bhangra dancing. These results provide insights into how the physical demands of Bhangra influence various biomechanical aspects and offer implications for optimizing training, injury prevention, and performance enhancement.

5.1.1 Foot Characteristics

Our study found that Bhangra dancers exhibited higher dorsum and navicular heights compared to non-dancers. The dorsum height for dancers averaged 7.16 cm on the left and 7.01 cm on the right which was significantly greater than the 5.99 cm and 6.00 cm as observed in non-dancers. The navicular heights for dancers averaged 5.29 cm on the left and 5.46 cm on the right, compared to non-dancers' having 4.92 cm and 4.96 cm. These increases suggest structural adaptations in response to the high-impact nature of Bhangra dancing. The higher dorsum and navicular heights may enhance shock absorption and stability, key for handling the repetitive stresses and dynamic movements inherent in Bhangra. A similar result has been demonstrated in the study where the researchers performed 3D kinematic analysis to know about the contribution of leg and foot in turn out phase of ballet. The authors of this study revealed that the dancers exhibit increase or minimal changes in navicular height during functional turn-out and during landing the dancers showed instable arch. The study also added that maintaining a high arch in the turnout stance was emphasized by dance instructors (116).

The Feiss line analysis supports these findings. An elevated dorsum height relative to the navicular height indicates improved arch formation and alignment. This adaptation is likely a response to the demands of Bhangra, which includes frequent high-impact steps and rapid direction changes. Enhanced arch height and dorsum structure may contribute to better stability and reduced injury risk, facilitating the performance of complex dance movements.

5.1.2 Foot Angles

Foot angles were assessed through various measures including rear-foot angle, Clark's angle, torsion angle, and medial longitudinal angle. Bhangra dancers exhibited a range of foot angle adaptations compared to non-dancers. The rear-foot angle, which indicates the alignment of the heel relative to the tibia, was found to be more variable among dancers, reflecting their adaptation to dynamic foot positioning. Clark's angle, which measures the arch height relative to the forefoot and hindfoot, was also higher in dancers, indicating a more pronounced arch formation, likely contributing to improved shock absorption. Similar results were recorded by a study having a significant difference in the the Clarke angle between ballet dancers and students. Dancers had higher mean Clarke angles, indicating that their feet likely had a higher arch due to a shorter plantar fascia. The study also determines that the higher Clarke angle among the dancer suggests that ballet dancers may generate greater forces from their posterior calf muscles (117). A study suggested that the feet with the higher Clark angle (Clarke angle > 55°) had shorter lever arm for forces transmitted by Achilles tendon. This results in greater muscular force which is needed during landing and acting as shock absorber (118).

In our study medial longitudinal angle was assessed and there was significant difference between Bhangra dancer and non-dance. In our study dancer group had decreased MLA, potentially for providing more support and stability during dance performance, which was supported by the study conducted among kathak dancers. The results of this study had a similar findings stating in the Medial Longitudinal Arch angle was decreased in 95% of the left feet and 92.5% of the right feet. The authors of this study justified it by a reason by saying that for enhancing stability during weight bearing, the arch collapse and foot pronates more to increase foot contact area (119). Another research added that the repetitive tapping and overuse of the intrinsic muscles can lead to further flattening of the arch and increased pronation and additionally, practicing on hard floors can contribute to arch flattening due to the increased demand on the foot's invertors to control motion (120).

The tibial torsion angle refers to the rotational alignment of the tibia bone in the lower leg. It is the angle formed between the axis of the femur and the axis of the tibia. This angle helps determine how the tibia is oriented relative to the knee and ankle joints. and in our study torsion angle was found to be greater in dancers, suggesting that their feet had adapted to handle rotational stresses common in Bhangra movements, supported by a research confirmed variability in tibial torsion angle. In this study tibial torsion in dancers was measured using MRI to understand its role in total ballet. It found significant difference in the tibial torsion among dancers and between legs. the tibial torsion ranged from 16° to 60° on the right leg and 16° to 52° on the left leg (121).

5.1.3 Indexes

In our study several foot indexes were evaluated, including the Staheli index, Chippaux index, arch index, and foot posture index. The Staheli index, which provides a measure of the foot's arch height and arch length ratio, was higher in Bhangra dancers, supporting the observed increases in dorsum and navicular heights. The Chippaux index, which assesses the proportion of the foot's length occupied by the arch, also indicated a more pronounced arch in dancers. Our study has been supported by a similar study conducted among folk dancers, the result of this study indicated Significant differences in the Chippaux-Smirak index (CSI), Staheli index (SI), of the right foot, and CSI and SI of the left foot between healthy and unhealthy dancers (122).

The arch index, reflecting the ratio of the area of the foot's arch to the total foot area, was higher in Bhangra dancers, aligning with the structural adaptations observed. A similar study reflected the same results after analyzing arch index among the female dancers and the results revealed significance difference between dancer group and reference group (123).

Foot posture index reflected the overall alignment of the foot, in our study the foot posture index, showed a greater degree of variability among dancers, suggesting that the repetitive, high-impact movements of Bhangra contribute to diverse postural adaptations. A study with a cross-sectional observational study design observed ankle dorsiflexion, foot pronation (navicular drop test), and foot posture (Foot Posture Index) and the results showed significant differences between the two groups for left foot Posture Index (124).

5.1.4 Plantar Pressure Distribution

Plantar pressure distribution assessments revealed that Bhangra dancers exhibit larger foot areas and altered pressure distributions compared to non-dancers. For example, the left forefoot area was significantly larger for dancers, averaging 49.95 cm^2 compared to 44.23 cm^2 for non-dancers. Additionally, dancers showed higher thrust values in the hindfoot area, with an average of 10.77 N compared to 9.84 N in non-dancers.

These findings suggest that the biomechanics of Bhangra dancing lead to greater engagement of the foot surface and altered pressure patterns. The increased forefoot area and higher thrust values reflect adaptations to handle the high-impact and dynamic nature of the dance. These changes likely contribute to improved performance and reduced injury risk by optimizing pressure distribution and shock absorption. Our findings are supported by several studies, among them one concluded that increase n pressure was observed at both hallux region and left hind foot among the dancers so chances of getting hallux valgus are more among dancers so preventive measures should be taken from the beginning (125). Plantar pressure was assessed in Latin dancers and the results revealed increased forefoot area and pressure and the suggested reason was that it could be the effect of high heel dancing (126).

In our study forefoot, hindfoot, and midfoot distances were also analyzed to understand the impact of Bhangra on foot structure. Bhangra dancers had larger forefoot and hindfoot distances, indicating a wider foot stance, which may be beneficial for stability and balance during dance movements. The midfoot distance was also larger, reflecting the structural changes associated with high-impact dance activities. The increased forefoot and hindfoot distances can be attributed to the frequent use of these areas in Bhangra, which involves rapid foot placement and substantial weight-bearing. This adaptation may enhance the dancer's ability to perform complex footwork while maintaining balance and stability.

5.1.5 Postural Alignment

Postural alignment assessments revealed significant differences in posture between Bhangra dancers and non-dancers. These variations can be linked to the dynamic and repetitive movements of Bhangra. The continuous adjustment of foot positioning required by Bhangra leads to adaptations in foot posture, with increased pronation and supination reflecting the need for stability and flexibility during dance. The more centered head alignment observed in dancers may be a compensatory mechanism related to the symmetrical nature of Bhangra movements, which emphasizes balance and coordination. A similar study with the goal to assess postural adjustment among ballet dancers and it was revealed significant difference between dancers and control group. The dancers had greater hip external rotation, more experienced dancers there was changes in lumbar lordosis angle as well and in the dancers with more than 9 years of experience smaller navicular angle was also found. So this reflects that there are changes in the body alignment of dancers and it is going to increase with every passing year (127). Our dancer group also had the changes in several parts of the body.

5.1.6 Gait Analysis

Gait analysis showed that Bhangra dancers had shorter step lengths and step durations compared to non-dancers. The right step length for dancers averaged 553.96 mm, while non-dancers averaged 580.73 mm. Step durations were also shorter for dancers, with left & right step durations averaging 564.14 ms and 565.71 ms, respectively, compared to non-dancers' 585.79 ms and 578.29 ms. These differences in gait parameters are likely due to the rapid, high-energy movements characteristic of Bhangra. The shorter step lengths and durations reflect the need for quick, powerful movements, which are essential for the performance of dynamic dance sequences. Despite these variations, the overall stride and gait cycle durations remained comparable, suggesting that while specific gait parameters are adapted for Bhangra, the fundamental rhythm of walking is preserved. A study conducted with the aim to analyses the difference between gait patterns of dancers and non-dancers and suggested that Dancers exhibit greater medial shear force and altered balance dynamics, including decreased CoP velocity during pre-swing, delayed peak CoP velocity in mid-stance, and a straighter CoP trajectory at push off. These changes in walking patterns from intense dancing activities may increase the risk of ankle sprains.

5.1.7 Performance Variables

Fitness assessments revealed that Bhangra dancers demonstrate superior cardiovascular endurance compared to the non-dancers despite having a higher mean resting heart rate. Additionally, dancers performed better in vertical jump tests, indicating greater lower body power, and showed superior balance and flexibility in the Y balance test and V sit and reach test.

These performance variables highlight the high physical demands of Bhangra, which enhance cardiovascular endurance, lower body strength, and overall physical fitness. The rigorous nature of Bhangra training, characterized by intense and sustained effort, contributes to these superior performance outcomes. Enhanced cardiovascular endurance and lower body power are critical for maintaining high-performance levels and minimizing injury risk during complex dance routines.

The study provides a comprehensive understanding of the biomechanical and physical adaptations in Bhangra dancers compared to non-dancers. Significant differences in foot characteristics, angles, indexes, footprint parameters, postural alignment, gait, plantar pressure, and performance variables underscore the unique demands of Bhangra dancing. These adaptations are crucial for optimizing performance and reducing injury risk. By elucidating these specific biomechanical and physical changes, the study offers valuable understanding for enhancing training programs and improving the health and performance of Bhangra dancers. A study supporting our concept by their study findings. The study suggest there is significant correlation between the aesthetic competence and fitness variables (128). There are several studies supporting the concept that dancers had more fitness as compared to non-dancers (129,130).

5.2 Research Implications of the study

Bhangra is not only a physically demanding dance form but also a culturally significant one. Research should explore how cultural practices and traditions influence the training, performance, and injury patterns of Bhangra dancers.

The study's findings on the biomechanical adaptations in Bhangra dancers provide an understanding for sports scientists, physiotherapists, and dance trainers. The significant differences in foot characteristics and plantar pressure distribution highlight the need of tailored training programs for the specific needs of Bhangra dancers. Future research could explore how these adaptations influence overall performance and injury rates over time, thereby developing more effective training and rehabilitation protocols.

The unique plantar pressure distributions and structural foot adaptations in Bhangra dancers suggest the need for customized footwear and orthotic devices. The Researchers and footwear designers can collaborate to create products that offer enhanced support, stability, and shock absorption tailored to the specific requirements of Bhangra dancers. Further studies could evaluate the effectiveness of these customized solutions in preventing injuries and improving performance.

The altered gait and postural characteristics observed in Bhangra dancers indicate that dance-specific training can influence natural movement patterns. Researchers should investigate the long-term effects of such training on gait and posture, assessing whether these adaptations contribute to or diminish injury risk.

5.3 Clinical relevance of the study

The clinical significance of this study lies in its potential to transform the management and preventive strategies for Bhangra dancers, a group with unique biomechanical and physiological demands. By identifying specific foot characteristics and plantar pressure distributions, the study provides valuable insights into the risk factors for common injuries such as stress fractures, tendinitis, and plantar fasciitis. This understanding allows for the development of targeted intervention programs, including strength and conditioning exercises, stretching routines, and proprioceptive training, which can significantly reduce injury incidence and enhance performance.

Moreover, the study's findings can guide the design and prescription of custom orthotic devices and specialized footwear that provide adequate support and cushioning, thus addressing abnormal foot postures and redistributing plantar pressures. These customized solutions not only alleviate discomfort but also prevent injuries, contributing to the dancers' overall foot health and stability.

In rehabilitation, the detailed biomechanical and physiological profiles outlined by the study enable clinicians to tailor rehabilitation programs to the specific needs of Bhangra dancers. This personalized approach ensures more effective recovery and quicker return to optimal performance levels. Additionally, the study highlights the importance of regular screenings and early detection of potential issues, facilitating timely interventions that prevent the progression of injuries.

Educating Bhangra dancers about proper foot care, the risks of overtraining, and the benefits of preventive measures can empower them to maintain their health proactively. Furthermore, training dance instructors to recognize early signs of biomechanical issues and implement preventive strategies can further enhance dancer safety and performance. Overall, the clinical implications of this study offer a comprehensive framework for improving the health, performance, and longevity of Bhangra dancers.

5.4 Limitation of the study

- The study design of this study is cross-sectional, the data collected represents a single point in time, making it difficult to establish causality or examine changes over time.
- The study involved a relatively small sample size of 140 participants (70 Bhangra dancers and 70 non-dancers), which may limit the generalizability of the findings to the broader population of Bhangra dancers and dancers of other forms.
- The study focused exclusively on Indian Male Bhangra dancers, potentially limiting the applicability of results to female dancers and those from different cultural backgrounds.
- The strict exclusion criteria might have resulted in a more homogeneous sample, potentially missing variations in foot characteristics within the Bhangra dancer population.
- The exclusion of individuals with recent musculoskeletal injuries or certain health conditions may have limited the understanding of how these factors interact with dance practices.
- The study did not account for potential biomechanical differences resulting from variations in dance techniques, intensity, and duration of practice among participants.
- The Environmental factors such as dance surfaces, footwear, and training conditions were not controlled, which could influence foot mechanics and pressure distribution.
- The study relied on specific tools such as the Wintrack system for plantar pressure assessment and manual measurements for foot characteristics, which may be subject to measurement error or variability.
- The study may be subject to observer bias, especially in the manual measurement of foot characteristics and postural assessments.

5.6 Future scope of the study

- The longitudinal studies need to be conducted to track changes in foot characteristics and plantar pressures over time in dancers and non-dancers.
- The participants from different dance styles, genders, ethnicities, and age groups to enhance generalizability of findings should be involved.
- The Investigation on the impact of specific training programs, footwear interventions, or injury prevention strategies on foot health and performance should be done.
- Explore how cultural practices, environmental conditions, and daily footwear influence foot characteristics and plantar pressure.
- Compare foot biomechanics and plantar pressures across different dance forms and physical activities to identify unique or shared characteristics.
- Incorporate broader health assessments, including overall fitness, musculoskeletal health, and psychological well-being, to provide a more comprehensive understanding of dancer health.
- Develop predictive models for injury risk based on foot characteristics and plantar pressures, and evaluate targeted prevention

CHAPTER VI

CONCLUSION

This study provides valuable insights into the differences in foot characteristics, plantar pressure, and related physical attributes between Bhangra dancers and non-dancers. The cross-sectional analysis of 70 Bhangra dancers and 70 non-dancers revealed significant variations in several key areas. Notably, Bhangra dancers demonstrated higher dorsum and navicular heights, indicative of distinct foot biomechanics associated with their dance form. They also showed differences in foot angles and pressure distributions, with a greater prevalence of pronated and supinated postures compared to non-dancers.

The Key findings indicate that Bhangra dancers exhibit higher dorsum height (left: 7.16 cm, right: 7.01 cm) and navicular height (left: 5.29 cm, right: 5.46 cm) than non-dancers (dorsum height left: 5.99 cm, right: 6.00 cm; navicular height left: 4.92 cm, right: 4.96 cm). Dancers also show lower Clark's Angles (left: 26.30°, right: 28.16°) and Medial Longitudinal Arch Angles (left: 146.38°, right: 147.30°) compared to non-dancers (Clark's Angles left: 31.81°, right: 32.73°; Medial Longitudinal Arch Angles left: 153.10°, right: 153.07°). Additionally, dancers demonstrate increased pronation (39.3%) and highly pronated foot postures (7.1%) compared to non-dancers (19.3% pronation, 0% highly pronated).

Plantar pressure analysis reveals that dancers have larger foot contact areas, with a left forefoot area of 49.95 cm^2 and hindfoot area of 56.45 cm^2, compared to non-dancers (left forefoot: 44.23 cm^2, hindfoot: 51.12 cm^2). In dynamic measures, dancers show a higher step area (586.92 mm^2) than non-dancers (467.33 mm^2) but a lower Y-speed (6.10 vs. 7.75). Postural assessments highlight significant differences, such as a decreased Left Quadriceps Angle (-4.88, $t = -3.99$, $p < 0.001$) and increased Right Gene Recurvatum (4.89, $t = 4.58$, $p < 0.001$).

Correlation and regression analyses further revealed the influence of foot structure on plantar pressure and postural alignment, stating a significant relationship between dorsum height and total left foot area ($r = 0.147$) and navicular height and left arch index ($r = 0.724$). Regression analysis suggest that the general predictors (age, weight, height, BMI) do not significantly impact most foot variables, specific angles such as the Right Clark Angle show marginal associations ($\beta = -0.14$, $p = 0.07$).

Despite the strengths of this study, including a well-defined sample and comprehensive assessment methods, limitations such as the cross-sectional design, sample homogeneity, and reliance on specific technologies must be acknowledged. Future research should address these limitations through longitudinal studies, diverse participant groups, and advanced measurement techniques.

In conclusion, Bhangra dancers exhibit distinct biomechanical adaptations that affect foot posture, plantar pressure, and gait, potentially increasing their risk of injuries. These findings highlight the necessity of targeted training and injury prevention strategies to optimize performance while minimizing musculoskeletal stress in Bhangra dancers. Future research should explore longitudinal effects and intervention programs to enhance dancer safety and performance.

SUMMARY

- The study aimed to analyze differences in foot characteristics, plantar pressure, and physical attributes between Bhangra dancers and non-dancers using a cross-sectional observational design.
- The sample consisted of 70 Bhangra dancers and 70 non-dancers, selected based on specific inclusion criteria related to health, fitness, and dance experience, with exclusions for various health conditions.
- Data collection involved demographic assessments (age, height, weight, BMI, hand/leg dominance, resting heart rate), detailed foot measurements (foot size, arch height, navicular height/drop), static and dynamic plantar pressure assessments, fitness tests, postural evaluations, and footprint analysis.
- Results showed that Bhangra dancers had significantly higher dorsum and navicular heights, larger foot areas, and different foot angles compared to non-dancers.
- Plantar pressure analysis revealed that dancers had larger foot areas and lower average pressure values compared to non-dancers.
- Foot Posture and gait analysis indicated a higher prevalence of pronated and supinated foot postures among dancers, with differences in step length, toe-out angle, and step durations compared to non-dancers.
- Statistical analyses confirmed significant differences in various physical and biomechanical attributes between the two groups, though some foot angles and posture variables showed no significant differences.
- The study's limitations include its cross-sectional design, which restricts causal inferences, and a homogenous sample that may limit generalizability.
- Future research should include longitudinal studies, diverse participant groups, advanced measurement technologies, and exploration of intervention strategies for injury prevention and performance optimization.
- Clinically, the study's findings suggest the need for tailored training and injury prevention strategies for Bhangra dancers, offering insights into specific foot biomechanics and pressure patterns associated with Bhangra dancing.

REFERENCES

1. Koutedakis Y, Jamurtas A. The dancer as a performing athlete: Physiological considerations.Sport Med. 2004;34(10):651–61.
2. Bennett D. Careers in Dance: Beyond Performance to the Real World of Work. J Danc Educ. 2009;9(1):27–34.
3. Hopper LS, Blevins P, Erskine S, Hendry D, Hill R, Longbottom R. Sustaining dancer wellbeing through independent professional dance careers. Theatr Danc Perform Train. 2020;11(4):470–86.
4. Frederiksen, L. E., & Chang, S.-M. L. (2024). Dance cultures around the world. Human Kinetics.
5. Motta-Valencia K. Dance-Related Injury. Phys Med Rehabil Clin N Am. 2006;17(3):697–723.
6. Rinonapoli G, Graziani M, Ceccarini P, Razzano C, Manfreda F, Caraffa A. Epidemiology of injuries connected with dance: a critical review on epidemiology. Med Glas. 2020;17(2):256–64.
7. Kenny SJ, Palacios-Derflingher L, Shi Q, Whittaker JL, Emery CA. Association Between Previous Injury and Risk Factors for Future Injury in Preprofessional Ballet and Contemporary Dancers. Clin J Sport Med. 2019;29(3):209–17.
8. van Seters C, van Rijn RM, van Middelkoop M, Stubbe JH. Risk Factors for Lower-Extremity Injuries Among Contemporary Dance Students. Clin J Sport Med. 2020;30(1):60–6.
9. Lee L, Reid D, Cadwell J, Palmer P. Injury Incidence, Dance Exposure and the Use Of the Movement Competency Screen (Mcs) to Identify Variables Associated with Injury In Full-Time Pre-Professional Dancers. Int J Sports Phys Ther. 2017;12(3):352.
10. Ryan AJ, Stephens RE. (1987). Dance medicine : a comprehensive guide. Pluribus Press ; Physician and Sportsmedicine:361.
11. Sun Y, Liu H. Prevalence and risk factors of musculoskeletal injuries in modern and contemporary dancers: a systematic review and meta-analysis. Front Public Heal. 2024 ;12:1325536.
12. Bronner, S., Ojofeitimi, S., & Spriggs, J. (2003). Occupational Musculoskeletal Disorders

in Dancers. Physical Therapy Reviews, 8(2), 57–68.

13. Van Seters C, Van Rijn RM, van Middelkoop M, Stubbe JH. Risk Factors for Lower-Extremity Injuries Among Contemporary Dance Students. Clin J Sport Med. 2020;30(1):60–6.
14. Paul JK, Kapoor S. Indian Anthropological Association Dance related Injuries among Bharatanatyam Dancers. 2018;28(2):21–33.
15. Anbarasi V, Rajan D V, Adalarasu K. Analysis of Lower Extremity Muscle Flexibility among Indian Classical Bharathnatyam Dancers. Int J Med Heal Sci. 2012;6(6):167–72.
16. Ambrosio Noris. (2022). Learning about dance: Dance as an art form and entertainmen. Kendall hunt.
17. Lee C. Ballet in western culture : a history of its origins and Evolution. 2002;368.
18. Lansdale J, Layson J. Dance history : an introduction. Routledge; 1994;289.
19. History of Dance - From Ancient Rituals to Modern Dances.
20. Chakravorty P. From Interculturalism to Historicism: Reflections on Classical Indian Dance. Danc Res J. 2000;32(2):108–19.
21. Schreffler G. Situating bhangra dance: a critical introduction. South Asian Hist Cult. 2013;4(3):384–412.
22. Riegger CL. Anatomy of the Ankle and Foot. Phys Ther. 1988 Dec 1;68(12):1802–14.
23. Schreffler, G. (2021). Dhol: Drummers, Identities, and Modern Punjab. University of Illinois Press.
24. File:Bhangra-dance.jpg - Wikimedia Commons. https://commons. wikimedia.org/wiki/ File:Bhangra-dance.jpg.
25. Koutedakis Y, Owolabi EO, Apostolos M. Dance Biomechanics: A Tool for Controlling Health, Fitness, and Training. J Danc Med Sci. 2008;12(3):83–90.
26. Krasnow, D., Wilmerding, V., Stecyk, S., Wyon, M., & Koutedakis, Y. (2011). Biomechanical Research in Dance: A Literature Review. Medical Problems of Performing Artists, 26(1), 3–23.
27. Wilson, M., & Kwon, Y. H. (2008). The role of biomechanics in understanding dance movement: a review. Journal of dance medicine & science : official publication of the International Association for Dance Medicine & Science, 12(3), 109–116.
28. Lin CF, Su FC, Wu HW. Ankle biomechanics of ballet dancers in relevé en pointé dance.

Res Sport Med. 2005;13(1):23–35.

29. Ahonen J. (2008). Biomechanics of the foot in dance: a literature review. Journal of dance medicine & science : official publication of the International Association for Dance Medicine & Science, 12(3), 99–108.

30. Bejjani FJ, Voloshin A, Frankel VH, Dominguez R. Musculoskeletal Demands on Flamenco Dancers: A Clinical and Biomechanical Study. Foot Ankle Int. 1988;8(5):254–63.

31. Vastola R, Coppola S, Sibilio M. Motion Analysis Technologies for Biomechanical Gait and Postural Analysis in Ballet. J Sport Sci. 2016;4:241–6.

32. Shah, S., Weiss, D. S., & Burchette, R. J. (2012). Injuries in professional modern dancers: incidence, risk factors, and management. Journal of dance medicine & science : official publication of the International Association for Dance Medicine & Science, 16(1), 17–25.

33. Steinberg N, Siev-Ner I, Peleg S, Dar G, Masharawi Y, Zeev A, et al. Extrinsic and intrinsic risk factors associated with injuries in young dancers aged 8-16 years. J Sports Sci. 2012;30(5):485–95.

34. Póvoa, A. R., Costa, C. M., Simões, S., Azevedo, A. M., & Oliveira, R. (2023). Irish Dancing Injuries and Associated Risk Factors: A Systematic Review. International journal of environmental research and public health, 20(12), 6190.

35. Toro J, Guerrero M, Sentis J, Castro J, Puértolas C. Eating disorders in Ballet dancing students: Problems and risk factors. Eur Eat Disord Rev. 2009;17(1):40–9.

36. Stracciolini A, Micheli LJ, Sugimoto D, Biernacki JL, Fraser J. Risk factors for lower-extremity injuries in female ballet dancers: a systematic review. journals.lww.com. 2018.

37. Koutedakis Y, Owolabi EO, Apostolos M. Dance biomechanics: a tool for controlling health, fitness, and training. J Dance Med Sci. 2008;12(3):83–90.

38. Bonnel F, Bonnin M, Canovas F, Chamoun M, Bouysset M. Anatomy of the foot and ankle. Bone Jt Disord Foot Ankle. 1998;1–14.

39. Hazari A, Maiya AG, Nagda T V. Kinematics and Kinetics of Ankle and Foot Complex. Concept Biomech Kinesiol. 2021;165–80.

40. Angin S, Demirbüken İ. Ankle and foot complex. Comp Kinesiol Hum Body Norm Pathol Cond. 2020;411–39.

41. Donatelli R, Donatelli G, Baycroft C. (2024). Foot and Ankle : Anatomy, Mechanics, and Rehabilitation. Foundations of Orthopedic Physical Therapy;308–36.

42. Blom A, Warwick D, Whitehouse M (Michael R., Preceded by (work) : Solomon L. The ankle and foot. 2017;609–48.
43. McKeon PO, Wikstrom EA, Prentice WE, Zinder SM. Rehabilitation of Ankle and Foot Injuries. Rehabil Tech Sport Med Athl Train. 2024;731–84.
44. Mkandawire, C., Ledoux, W. R., Sangeorzan, B. J., & Ching, R. P. (2005). Foot and ankle ligament morphometry. Journal of rehabilitation research and development, 42(6), 809–820.
45. Döring S, Provyn S, Marcelis S, Shahabpour M, Boulet C, de Mey J, et al. Ankle and midfoot ligaments: Ultrasound with anatomical correlation: A review. Eur J Radiol. 2018;107:216–26.
46. Flanigan RM, DiGiovanni BF. Peripheral Nerve Entrapments of the Lower Leg, Ankle, and Foot. Foot Ankle Clin. 2011;16(2):255–74.
47. Martinoli C, Court-Payen M, Michaud J, Padua L, Altafini L, Marchetti A, et al. Imaging of neuropathies about the ankle and foot. Semin Musculoskelet Radiol. 2010;14(3):344–56.
48. Brockett CL, Chapman GJ. Biomechanics of the ankle. Orthop Trauma. 2016;30(3):232–8.
49. Gwani AS, Asari MA, Ismail ZIM. How the three arches of the foot intercorrelate. Folia Morphol (Warsz). 2017;76(4):682–8.
50. Mauri-Stecca, M. V., Jonely, H., & Others. (2022). Musculoskeletal management of the ankle and foot. IAOM-US.
51. Dahle LK, Mueller M, Delitto A, Diamond JE. Visual Assessment of Foot Type and Relationship of Foot Type to Lower Extremity Injury. 1991;14(2):70–4.
52. Tsai LC, Yu B, Mercer VS, Gross MT. Comparison of Different Structural Foot Types for Measures of Standing Postural Control. 2006;36(12):942–53.
53. Liu HC, Cheng Y, Ho JJ. Associations of ergonomic and psychosocial work hazards with musculoskeletal disorders of specific body parts: A study of general employees in Taiwan. Int J Ind Ergon. 2020;76:102935.
54. Joseph L, Vasanthan L, Standen M, Kuisma R, Paungmali A, Pirunsan U, et al. Causal Relationship Between the Risk Factors and Work-Related Musculoskeletal Disorders Among Professional Drivers: A Systematic Review. Hum Factors. 2023;65(1):62–85.
55. Yang F, Di N, Guo W wei, Ding W bin, Jia N, Zhang H, et al. The prevalence and risk factors of work related musculoskeletal disorders among electronics manufacturing

workers: a cross-sectional analytical study in China. BMC Public Health. 2023;23(1):1–11.

56. McBride C, Bronner S. Injury characteristics in professional modern dancers: A 15-year analysis of work-related injury rates and patterns. J Sports Sci. 2022;40(7):821–37.

57. Anand Prakash, A., K, M., & Akilesh, V. (2024). Umbrella review of musculoskeletal injury burden in dancers: implication for practice and research. The Physician and sportsmedicine, 52(1), 12–25.

58. Póvoa AR, Costa CM, Simões S, Azevedo AM, Oliveira R. Irish Dancing Injuries and Associated Risk Factors: A Systematic Review. Int J Environ Res Public Health. 2023;20(12):6190.

59. Cahalan R, Bargary N, O'Sullivan K. Pain and Injury in Elite Adolescent Irish Dancers. https://doi.org/1012678/1089-313X22291. 2018;22(2):91–9.

60. Hung RKH, Yung PSH, Ling SKK, Samartzis D, Chan C, Hiller C, et al. Prevalence of dance-related injuries and associated risk factors among children and young Chinese dance practitioners. Med (United States). 2023;102(47):E36052.

61. Dang, Y., Koutedakis, Y., Chen, R., & Wyon, M. (2024). Injury incidence and severity in Chinese pre-professional dancers: A prospective weekly monitoring survey. Journal of science and medicine in sport, 27(2), 86–91.

62. Mullerpatan RP, Bharnuke JK. Differences in Foot Characteristics Between Bharatanatyam Dancers and Age-Matched Non-Dancers. Med Probl Perform Art. 2022;37(1):53–7.

63. Costa MSS, Ferreira AS, Orsini M, Silva EB, Felicio LR. Characteristics and prevalence of musculoskeletal injury in professional and non-professional ballet dancers. Brazilian J Phys Ther. 2016;20(2):166–75.

64. Chathurani G, Dassanayake YB, Fernando SN, Gunarathna LS, Gunarathne LK, Chandrasekara NC, et al. Prevalence of musculoskeletal injuries among university undergraduates following Sri Lankan traditional dancing. PLoS One. 2023;18(8):e0288155.

65. Prabhakaran Nair S, Kotian S, Mullerpatan R, Hiller C. Survey of musculoskeletal disorders among Indian dancers in Mumbai and Mangalore. Journal Danc Med Sci. 2018;22(2):67–74.

66. Kumar LP, Shenoy SJ. Survey of musculoskeletal injuries among female bharatanatyam dancers in the Udupi District of India. Med Probl Perform Art. 2021;36(3):199–206.

67. Rajesh NS, Anurag M, Jaywant N, Danish S, Deepti P. Prevalance of ankle instability

among kathak dancers in Jalgaon District- A cross sectional observational study. VIMS J Phys Ther. 2023;5(2):20–5.

68. Steinberg N, Siev-Ner I, Peleg S, Dar G, Masharawi Y, Zeev A, et al. Extrinsic and intrinsic risk factors associated with injuries in young dancers aged 8–16 years. J Sports Sci. 2012;30(5):485–95.

69. Sneha Balakrishnan P, Thomas A. Low back pain in dancers- a systematic review. J Res Adm. 2023;5(2):2556–63.

70. Cheers, N., Matheson, M., Skinner, I., & Wells, C. (2024). Perspectives and Experiences of Dance-Related Injuries: A Qualitative Survey of Adolescent Pre-Professional Ballet Dancers in Australia. Journal of dance medicine & science : official publication of the International Association for Dance Medicine & Science, 28(2), 90–108.

71. Sun, Y., & Liu, H. (2024). Prevalence and risk factors of musculoskeletal injuries in modern and contemporary dancers: a systematic review and meta-analysis. Frontiers in public health, 12, 1325536.

72. MacSweeney, N. D. H., Shaw, J. W., Simkin, G. P., Pedlar, C. R., Price, P. D. B., Mahaffey, R., & Cohen, D. D. (2024). Jumping Asymmetries and Risk of Injuries in Preprofessional Ballet. The American journal of sports medicine, 52(2), 492–502.

73. Russell JA, McEwan IM, Koutedakis Y, Wyon MA. Clinical Anatomy and Biomechanics of the Ankle in Dance. 2008;12(3):75–82.

74. Masal Intern S, Abdul Kalam A, Borkar Associate Professor P, Masal S, Borkar P. Epidemiology of musculoskeletal injuries in Indian classical dancers: A systematic review. 310 ~ Int J Phys Educ Sport Heal. 2021 ;8(3).

75. Zhao Y, Liu Z, Zhang X, Yang L, Chen W. Analysis of characteristics in china classic dancers' gait pattern. Wuyong CHEN Leather Footwear J. 2018;18(2).

76. Mcnitt-Gray JL, Koff SR, Hall BL. The Influence of Dance Training and Foot Position on Landing Mechanics. Source Med Probl Perform Artist. 1992;7(3):87–91.

77. Hendry D, Campbell A, Ng L, Harwood A, Wild C. The Difference in Lower Limb Landing Kinematics between Adolescent Dancers and Non-Dancers. 2019;23(2):72–9.

78. Alfuth M, Luetkecosmann J, Knicker A. Comparison of Plantar Sensitivity, Dynamic Balance, and Lower Extremity Joint Range of Motion between Experienced Female Ballet Dancers and Female Non-Dancing Athletes a Cross-Sectional Study. 2021;25(4):238–48.

79. Lung CW, Chern JS, Hsieh LF, Yang SW. The Differences in Gait Pattern Between Dancers and Non-Dancers. J Mech. 2008;24(4):451–7.
80. Janura M, Procházková M, Svoboda Z, Bizovská L, Jandová S, Konečný P. Standing balance of professional ballet dancers and non-dancers under different conditions. PLoS One. 2019;14(10):e0224145.
81. Krityakiarana W, Jongkamonwiwat N. Comparison of Balance Performance between Thai Classical Dancers and Non-Dancers. 2016;20(2):72–8.
82. Paris-Alemany A, Torres-Palomino A, Marino L, Calvo-Lobo C, Gadea-Mateos L, La Touche R. Comparison of lumbopelvic and dynamic stability between dancers and non-dancers. Phys Ther Sport. 2018;33:33–9.
83. Castro-Méndez A, Mateos-Martínez D, Castillo-López JM, Vargas-Macías A. Evaluation of the Correlation Between Flamenco Dance and Ankle and Foot Posture. J Am Podiatr Med Assoc. 2022;112(1).
84. Chandan S, Tamaria S, Gaur D, Chadha C, Sharma P. Cross-Sectional Study of Foot Posture Index, Navicular Drop and Arch Index in Kathak Dancers. Int J Res Rev. 2018;5(6):157.
85. Sabharwal R, Singh S. Foot postural deviations in female kathak dancers. Int J Physiother. 2017;4(1):38–43.
86. Assessment of Foot Deviations and Associated Foot Injuries and its Effect on Foot Functional Activity among Amateur Adolescent Female Kathak Dancers in Selected Dance Schools in Bengaluru. Indian J Physiother Occup Ther - An Int J. 2023;17(3).
87. Vijayakumar K, Senthil Kumar S. Morphometric Analysis of Ankle and Foot in Classical Bharathanatyam Dancers Using Foot Posture Index (FPI) And Plantar Scan Images (PSI). IOSR J Dent Med Sci e-ISSN. 2016;15(6):20–5.
88. Acharya GU, Mahapatra C, Pradhan DK. Correlation between foot posture index and foot angle in Odissi dancers: An observational study. Saudi J Sport Med. 2023;23(2):44–8.
89. Ladha N, Jain H. Effect of Pronated And Supinated Foot Postures on Static and Dynamic Balance in Dancers. Indian J Physiother Occup Ther. 15(1).
90. Lung CW, Chern JS, Hsieh LF, Yang SW. The Differences in Gait Pattern Between Dancers and Non-Dancers. J Mech. 2008;24(4):451–7.
91. Prochazkova M, Tepla L, Svoboda Z, Janura M, Cieslarová M. Analysis of foot load during ballet dancers' gait. Acta Bioeng Biomech. 2014;16(2):41–5.

92. Janura M, Teplá L, Straková P, Kuboňová E, Svoboda Z, Javůrek F. Comparison of gait kinematics between professional ballet dancers and non-dancers. Neuroendocrinol Lett. 2018;39(5):385–90.
93. Author C, Astone S, Mignone A, Albano D. Comparison of gait kinematics and kinetics between qualified dancers and non-dancers. J Phys Educ Sport ®. 2019;19:2289–91.
94. Mullerpatan R, Bharnuke J, Hiller C. Gait Kinematics of Bharatanatyam Dancers with and without Low Back Pain. Crit Rev Phys Rehabil Med. 2019;31(1):1–10.
95. Astone S, Mignone A, Coppola S. Comparison of EMG profile during gait between qualified dancers and non dancers. 2020.
96. Cimelli SN, Curran SA. Influence of Turnout on Foot Posture and Its Relationship to Overuse Musculoskeletal Injury in Professional Contemporary Dancers: A Preliminary Investigation. J Am Podiatr Med Assoc. 2012;102(1):25–33.
97. Neelly K, Wallmann HW, Backus CJ. Validity of measuring leg length with a tape measure compared to a computed tomography scan. Physiother Theory Pract. 2013 ;29(6):487–92.
98. McPoil TG, Cornwall MW, Vicenzino B, Teyhen DS, Molloy JM, Christie DS, et al. Effect of using truncated versus total foot length to calculate the arch height ratio. Foot. 2008;18(4):220–7.
99. Spörndly-Nees S, Dåsberg B, Nielsen RO, Boesen MI, Langberg H. The navicular position test – a reliable measure of the navicular bone position during rest and loading. Int J Sports Phys Ther. 2011;6(3):199.
100. Aquino MRC, Avelar BS, Silva PL, Ocarino JM, Resende RA. Reliability of Foot Posture Index individual and total scores for adults and older adults. Musculoskelet Sci Pract. 2018;36:92–5.
101. Hegazy F, Aboelnasr E, Abuzaid M, Kim IJ, Salem Y. Comparing validity and diagnostic accuracy of clarke’s angle and foot posture index-6 to determine flexible flatfoot in adolescents: A cross-sectional investigation. J Multidiscip Healthc. 2021 ;14:2705–17.
102. Zuil-Escobar JC, Martínez-Cepa CB, Martín-Urrialde JA, Gómez-Conesa A. Medial Longitudinal Arch: Accuracy, Reliability, and Correlation Between Navicular Drop Test and Footprint Parameters. J Manipulative Physiol Ther. 2018;41(8):672–9.
103. Paecharoen S, Arunakul M, Tantivangphaisal N. Diagnostic Accuracy of Harris Imprint Index, Chippaux-Smirak Index, Staheli Index Compared With Talar-First Metatarsal Angle

for Screening Arch of Foot. Ann Rehabil Med. 2023 ;47(3):222–7.

104. Kim S, Yoo J, Woo D, Jung B, Choi B. Inter- and Intra- Rater Reliability of Navicular Drop Tests Position. J Korean Acad Phys Ther Sci. 2019;26(1):9–14.

105. Jonson SR, Gross MT. Intraexaminer reliability, interexaminer reliability, and mean values for nine lower extremity skeletal measures in healthy naval midshipmen. J Orthop Sports Phys Ther. 1997 ;25(4):253–63.

106. Langley B, Cramp M, Morrison SC. Clinical measures of static foot posture do not agree. J Foot Ankle Res. 2016;9(1).

107. Ramachandra P, Maiya AG, Kumar P. Test-retest reliability of the Win-Track platform in analyzing the gait parameters and plantar pressures during barefoot walking in healthy adults. Foot Ankle Spec. 2012;5(5):306–12.

108. Puig-Diví A, Escalona-Marfil C, Padullés-Riu JM, Busquets A, Padullés-Chando X, Marcos-Ruiz D. Validity and reliability of the Kinovea program in obtaining angles and distances using coordinates in 4 perspectives. PLoS One. 2019 ;14(6).

109. Roggio F, Bianco A, Palma A, Ravalli S, Maugeri G, Rosa M Di, et al. Technological advancements in the analysis of human motion and posture management through digital devices. World J Orthop. 2021;12(7):467.

110. Soliman W, Elsaidy IM. Evaluating the Validity and Reliability of Harvard Step Test to Predict VO2max in Terms of the Step Height According to the Knee Joint Angle. J Appl Sport Sci. 2011;1(2):126–32.

111. Cuberek R, Machová I, Lipenská M. Reliability of v sit-and-reach test used for flexibility self-assessment in females. Acta Univ Palacki Olomuc, Gymn. 2013;43(1).

112. Crotti M, Bosio A, Invernizzi PL. Validity and reliability of submaximal fitness tests based on perceptual variables. J Sports Med Phys Fitness. 2018;58(5):555–62.

113. Aragon-Vargas LF. Evaluation of Four Vertical Jump Tests: Methodology, Reliability, Validity, and Accuracy. Meas Phys Educ Exerc Sci. 2000 ;4(4):215–28.

114. Greenberg ET, Barle M, Glassman E, Jacob L, Jaafar H, Johnson A, et al. Reliability and stability of the y balance test in healthy early adolescentfemale athletes. Orthop J Sport Med. 2019;7(3 Suppl):2325967119S0005.

115. Kang H. Sample size determination and power analysis using the G*Power software. J Educ Eval Health Prof. 2021;18.

116. Carter SL, Duncan R, Weidemann AL, Hopper LS. Lower leg and foot contributions to turnout in female pre-professional dancers: A 3D kinematic analysis. J Sports Sci. 2018;36(19):2217–25.
117. Gorwa J, Michnik R, Nowakowska-Lipiec K. In Pursuit of the Perfect Dancer's Ballet Foot. The Footprint, Stabilometric, Pedobarographic Parameters of Professional Ballet Dancers. Biology (Basel). 2021;10(5).
118. Deforth M, Krähenbühl N, Zwicky L, Knupp M, Hintermann B. Supramalleolar Osteotomy for Tibial Component Malposition in Total Ankle Replacement. Foot ankle Int. 2017;38(9):952–6.
119. Sabharwal R, Singh S. Foot postural deviations in female kathak dancers. Int J Physiother. 2017;4(1).
120. Bates P. Shin splints--a literature review. Br J Sports Med. 1985 ;19(3):132–7.
121. Grossman G, Waninger KN, Voloshin A, Reinus WR, Ross R, Stoltzfus J, et al. Reliability and Validity of Goniometric Turnout Measurements Compared with MRI and Retro-Reflective Markers.2008;12(4):142–52.
122. Sarialioğlu N, Yasemin GÜRSOY Ş. Investigation of the Effects of Morphological Structure of the Foot and Ankle Flexibility in Folk Dancers on Foot and Ankle Disorders. Int J Sport Cult Sci. 2023;11(2):114–21.
123. Gorwa J, Nowakowska-Lipiec K, Guzik-Kopyto A, Wodarski P, Michnik R. Classic and indicative methods in the analysis of the foot arch and foot loads in professional folklore dancers on the basis of stabilographic tests. Acta Bioeng Biomech Orig Pap. 23(4):2021.
124. Castro-Méndez A, Mateos-Martínez D, Castillo-López JM, Vargas-Macías A. Evaluation of the Correlation Between Flamenco Dance and Ankle and Foot Posture. J Am Podiatr Med Assoc. 2022;112(1).
125. Bhat AA, Basha SA. Foot Pressure Mapping in Bharatanatyam Dancers and Age and Gender Matched Non-Dancers. RGUHS J Physiother. 2024 ;4(1).
126. Gu Y, Ren X, Li J, Rong M. Plantar pressure distribution during high-heeled Latin dancing. Int J Exp Comput Biomech. 2010;1(3):296.
127. Iunes DH, Elias IF, Carvalho LC, Dionísio VC. Postural adjustments in young ballet dancers compared to age matched controls. Phys Ther Sport. 2016;17:51–7.
128. Angioi M, Metsios GS, Twitchett E, Koutedakis Y, Wyon M. Association between Selected

Physical Fitness Parameters and Aesthetic Competence in Contemporary Dancers. J Danc Med Sci. 2009;13(4):115–23.

129. Koutedakis, Y., Hukam, H., Metsios, G., Nevill, A., Giakas, G., Jamurtas, A., & Myszkewycz, L. (2007). The effects of three months of aerobic and strength training on selected performance- and fitness-related parameters in modern dance students. Journal of strength and conditioning research, 21(3), 808–812.

130. Brown AC, Wells TJ, Schade ML, Smith DL, Fehling PC. Effects of Plyometric Training versus Traditional Weight Training on Strength, Power, and Aesthetic Jumping Ability in Female Collegiate Dancers. Journal of Dance Medicine & Science. 2023;11(2):38-44.

APPENDIX

Appendix 1: Patient Information Sheet English

Analyzing the foot biomechanical characteristics and plantar pressure in bhangra dancers

Aim:

This study aims to understand the Biomechanics of the Foot by analyzing the Static measures of the foot, Gait Parameters, and Plantar Pressures in dancers.

Objectives: (**The primary objective)**

To analyze the static biomechanical characteristics of foot in Bhangra Dancers and Non-Dancers.

To analyze the dynamic biomechanical characteristics of foot in Bhangra Dancers and Non-Dancers.

To analyze the plantar pressure in Bhangra Dancers and Non-Dancers.

To compare the prevalence of alteration in foot and ankle complex static biomechanical measures among the Bhangra dancers and Non-dancer's healthy individuals.

To compare the Spatio-temporal gait parameters and plantar pressure among the Bhangra dancers and Non-dancer's healthy individuals.

The secondary objective

To establish the co-relationship between static biomechanical measures of foot and ankle complex, Spatio-temporal gait parameters, plantar pressure, and injury patterns (frequency, size, and activity).

Benefits

There is need to conduct the research to reduce the risk of lower limb injury

This will be the first study analyzing the foot biomechanical characteristics and plantar pressure in Bhangra dancers

Risk

The study poses no threat to the health of the patient.

Confidentiality of records

There will not be any identification by name. Only the investigator will know the results. Any personal information will not be shared with relatives without prior permission

Freedom of individual to participate and to withdraw from study

You may also choose to leave the study at any point of time and your data will not be used.

Contact Information: If you have questions at any time about this study, you may contact the researcher whose contact information is provided below.

Researcher Details:	**Supervisor Details:**
Name: Sakshi Sadhu Address: Room No: 105 Block 3, Department of Physiotherapy Ph. No.: 9596857767	Name: Dr. Ramesh Chandra Patra Address: Room No: 105 Block 3, Department of Physiotherapy

Appendix 2: English Informed Consent form

Declaration:
I hereby declare that: -

(i) I have read and understood the information sheet for the above study and have had the opportunity to ask questions. The investigator and team have explained the study in details and have clarified all my doubts.

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) Investigator of the study will not need my Permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access.

(iv) I understand that my identity will not be revealed in any case to third parties.

(v) I agree not to restrict the use of any data or results for scientific purpose that arise from this study

(vi) I agree to take part in the above study.

Name of Subject: ____
Signature (or Thumb impression) of the Subject________________________________
Date: _____/_____/______

Signatory's Name: ____
Impartial witness /Legally Acceptable Representative signature _____________________
Date: _____/_____/______

Signatory's
Name____
Signature of the Authority/Investigator: ______________________________________
Date: _____/_____/______

Appendix 3: रोगी सूचना पत्रक (Hindi)

अध्ययन/परियोजना का शीर्षक

भांगड़ा नर्तकियों में पैर की जैव रासायनिक विशेषताओं और पौधे के दबाव का विश्लेषण

लक्ष्य:

• इस अध्ययन का उद्देश्य नर्तकियों में पैर के स्थिर माप, चाल पैरामीटर और तल के दबाव का विश्लेषण करके पैर के बायोमैकेनिक्स को समझना है।

उद्देश्य:

प्राथमिक उद्देश्य

• भांगड़ा नर्तक और गैर-नर्तक में पैर की स्थैतिक जैव यांत्रिक विशेषताओं का विश्लेषण करना।

• भांगड़ा नर्तक और गैर-नर्तक में पैर की गतिशील जैव यांत्रिक विशेषताओं का विश्लेषण करना।

• भांगड़ा नर्तक और गैर-नर्तकियों में तल के दबाव का विश्लेषण करना।

• भांगड़ा नर्तकों और गैर-नर्तकियों स्वस्थ व्यक्तियों के बीच पैर और टखने के जटिल स्थैतिक बायोमेकेनिकल उपायों में परिवर्तन की व्यापकता की तुलना करना।

• भांगड़ा नर्तकों और गैर-नर्तकियों के स्वस्थ व्यक्तियों के बीच अनुपात-अस्थायी चाल मापदंडों और तल के दबाव की तुलना करना।

द्वितीयक उद्देश्य

• पैर और टखने के परिसर के स्थैतिक बायोमेकेनिकल उपायों के बीच सह-संबंध स्थापित करने के लिए, स्थानिक-अस्थायी चाल पैरामीटर, तल का दबाव, और चोट पैटर्न (आवृत्ति, आकार और गतिविधि) ।

फ़ायदे

• निचले अंगों की चोट के जोखिम को कम करने के लिए अनुसंधान करने की आवश्यकता है

• भांगड़ा नर्तकियों में पैर की बायोमेकेनिकल विशेषताओं और तल के दबाव का विश्लेषण करने वाला यह पहला अध्ययन होगा

जोखिम अध्ययन से रोगी के स्वास्थ्य को कोई खतरा नहीं है।

अभिलेखों की गोपनीयता

नाम से कोई पहचान नहीं होगी। केवल अन्वेषक ही परिणामों को जानेंगे। पूर्व अनुमति के बिना किसी भी व्यक्तिगत जानकारी को रिश्तेदारों के साथ साझा नहीं किया जाएगा

व्यक्ति को भाग लेने और अध्ययन से हटने की स्वतंत्रता

आप किसी भी समय अध्ययन छोड़ना चुन सकते हैं और आपके डेटा का उपयोग नहीं किया जाएगा।

संपर्क जानकारी

यदि इस अध्ययन के बारे में आपके कोई प्रश्न हैं, तो आप उस शोधकर्ता से संपर्क कर सकते हैं जिसकी संपर्क जानकारी नीचे दी गई है।

Appendix 4: सूचित सहमति (Hindi)

घोषणा

(i) मैं पुष्टि करता हूं कि मैंने उपरोक्त अध्ययन के लिए सूचना पत्रक को पढ़ और समझ लिया है और मुझे प्रश्न पूछने का अवसर मिला है। अन्वेषक और टीम ने विस्तार से अध्ययन की व्याख्या की है और मेरी सभी शंकाओं का समाधान किया है।

(ii) मैं समझता हूं कि अध्ययन में मेरी भागीदारी स्वैच्छिक है और मैं बिना कोई कारण बताए, मेरी चिकित्सा देखभाल या कानूनी अधिकारों को प्रभावित किए बिना किसी भी समय वापस लेने के लिए स्वतंत्र हूं।

(iii) अध्ययन के अन्वेषक को वर्तमान अध्ययन और इसके संबंध में किए जाने वाले किसी भी अन्य शोध के संबंध में मेरे स्वास्थ्य रिकॉर्ड को देखने के लिए मेरी अनुमति की आवश्यकता नहीं होगी, भले ही मैं परीक्षण से हट जाऊं। मैं इस पहुंच के लिए सहमत हूं। हालांकि, मैं समझता हूं कि तीसरे पक्ष को जारी या प्रकाशित किसी भी जानकारी में मेरी पहचान का खुलासा नहीं किया जाएगा।

(iv) मैं इस अध्ययन से उत्पन्न होने वाले किसी भी डेटा या परिणामों के उपयोग को प्रतिबंधित नहीं करने के लिए सहमत हूं, बशर्ते कि उपयोग केवल वैज्ञानिक उद्देश्य (ओं) के लिए है।

(v) मैं उपरोक्त अध्ययन में भाग लेने के लिए सहमत हूं।

विषय के हस्ताक्षर (या अंगूठे का निशान)
____

दिनांक: _____/_____/______

हस्ताक्षरकर्ता का नाम: ____

निष्पक्ष गवाह/कानूनी रूप से स्वीकार्य प्रतिनिधि हस्ताक्षर ____________________________________

दिनांक: _____/_____/______

हस्ताक्षरकर्ता का नाम: ____

प्राधिकरण/अन्वेषक के हस्ताक्षर: ____

दिनांक: _____/_____/______

प्राधिकरण का नाम:____

Appendix 5: ਪੰਜਾਬੀ ਸਹਿਮਤੀ ਫਾਰਮ (Punjabi)

ਅਧਿਐਨ/ਪ੍ਰੋਜੈਕਟ ਦਾ ਸਿਰਲੇਖ

ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਵਿੱਚ ਪੈਰਾਂ ਦੀਆਂ ਬਾਇਓਮੈਕੈਨੀਕਲ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ ਅਤੇ ਪਲਾਂਟਰ ਪ੍ਰੈਸ਼ਰ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਨਾ

ਉਦੇਸ਼:

• ਇਸ ਅਧਿਐਨ ਦਾ ਉਦੇਸ਼ ਪੈਰਾਂ ਦੇ ਸਥਿਰ ਮਾਪਾਂ, ਗੇਟ ਪੈਰਾਮੀਟਰਾਂ, ਅਤੇ ਡਾਂਸਰਾਂ ਵਿੱਚ ਪਲੈਨਟਰ ਪ੍ਰੈਸ਼ਰ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਕੇ ਪੈਰਾਂ ਦੇ ਬਾਇਓਮੈਕਨਿਕਸ ਨੂੰ ਸਮਝਣਾ ਹੈ।

ਉਦੇਸ਼:

ਪ੍ਰਾਇਮਰੀ ਉਦੇਸ਼

• ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਅਤੇ ਗੈਰ-ਡਾਂਸਰਾਂ ਵਿੱਚ ਪੈਰਾਂ ਦੀਆਂ ਸਥਿਰ ਬਾਇਓਮੈਕਨੀਕਲ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਨ ਲਈ।
• ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਅਤੇ ਗੈਰ-ਡਾਂਸਰਾਂ ਵਿੱਚ ਪੈਰਾਂ ਦੀਆਂ ਗਤੀਸ਼ੀਲ ਬਾਇਓਮੈਕਨੀਕਲ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਨ ਲਈ।
• ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਅਤੇ ਗੈਰ-ਡਾਂਸਰਾਂ ਵਿੱਚ ਪਲਾਂਟਰ ਪ੍ਰੈਸ਼ਰ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਨਾ।
• ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਅਤੇ ਗੈਰ-ਡਾਂਸਰ ਤੰਦਰੁਸਤ ਵਿਅਕਤੀਆਂ ਵਿੱਚ ਪੈਰਾਂ ਅਤੇ ਗਿੱਟੇ ਦੇ ਗੁੰਝਲਦਾਰ ਸਥਿਰ ਬਾਇਓਮੈਕਨੀਕਲ ਮਾਪਾਂ ਵਿੱਚ ਤਬਦੀਲੀ ਦੇ ਪ੍ਰਚਲਣ ਦੀ ਤੁਲਨਾ ਕਰਨ ਲਈ।
• ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਅਤੇ ਗੈਰ-ਡਾਂਸਰ ਤੰਦਰੁਸਤ ਵਿਅਕਤੀਆਂ ਵਿੱਚ ਸਪੈਟੀਓ-ਟੈਂਪੋਰਲ ਗੇਟ ਪੈਰਾਮੀਟਰਾਂ ਅਤੇ ਪਲੰਟਰ ਪ੍ਰੈਸ਼ਰ ਦੀ ਤੁਲਨਾ ਕਰਨਾ।

ਸੈਕੰਡਰੀ ਉਦੇਸ਼

• ਪੈਰਾਂ ਅਤੇ ਗਿੱਟੇ ਦੇ ਕੰਪਲੈਕਸ ਦੇ ਸਥਿਰ ਬਾਇਓਮੈਕਨੀਕਲ ਮਾਪਾਂ, ਸਪੈਟੀਓ-ਟੈਂਪੋਰਲ ਗੇਟ ਪੈਰਾਮੀਟਰ, ਪਲੈਨਟਰ ਪ੍ਰੈਸ਼ਰ, ਅਤੇ ਸੱਟ ਦੇ ਪੈਟਰਨ (ਵਾਰਵਾਰਤਾ, ਆਕਾਰ ਅਤੇ ਗਤੀਵਿਧੀ) ਵਿਚਕਾਰ ਸਹਿ-ਸਬੰਧ ਸਥਾਪਤ ਕਰਨ ਲਈ।

ਲਾਭ

• ਹੇਠਲੇ ਅੰਗ ਦੀ ਸੱਟ ਦੇ ਜੋਖਮ ਨੂੰ ਘਟਾਉਣ ਲਈ ਖੋਜ ਕਰਨ ਦੀ ਲੋੜ ਹੈ
• ਭੰਗੜਾ ਡਾਂਸਰਾਂ ਵਿੱਚ ਪੈਰਾਂ ਦੇ ਬਾਇਓਮੈਕਨੀਕਲ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ ਅਤੇ ਪਲੰਟਰ ਪ੍ਰੈਸ਼ਰ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕਰਨ ਵਾਲਾ ਇਹ ਪਹਿਲਾ ਅਧਿਐਨ ਹੋਵੇਗਾ।

ਜੋਖਮ ਅਧਿਐਨ ਨਾਲ ਮਰੀਜ਼ ਦੀ ਸਿਹਤ ਲਈ ਕੋਈ ਖਤਰਾ ਨਹੀਂ ਹੈ।

ਰਿਕਾਰਡਾਂ ਦੀ ਗੁਪਤਤਾ

ਨਾਂ ਨਾਲ ਕੋਈ ਪਛਾਣ ਨਹੀਂ ਹੋਵੇਗੀ। ਸਿਰਫ਼ ਜਾਂਚਕਰਤਾ ਹੀ ਨਤੀਜੇ ਜਾਣੇਗਾ। ਕਿਸੇ ਵੀ ਨਿੱਜੀ ਜਾਣਕਾਰੀ ਨੂੰ ਅਗਾਊਂ ਇਜਾਜ਼ਤ ਤੋਂ ਬਿਨਾਂ ਰਿਸ਼ਤੇਦਾਰਾਂ ਨਾਲ ਸਾਂਝਾ ਨਹੀਂ ਕੀਤਾ ਜਾਵੇਗਾ

ਭਾਗ ਲੈਣ ਅਤੇ ਅਧਿਐਨ ਤੋਂ ਪਿੱਛੇ ਹਟਣ ਦੀ ਵਿਅਕਤੀਗਤ ਦੀ ਆਜ਼ਾਦੀ

ਤੁਸੀਂ ਕਿਸੇ ਵੀ ਸਮੇਂ ਅਧਿਐਨ ਛੱਡਣ ਦੀ ਚੋਣ ਕਰ ਸਕਦੇ ਹੋ ਅਤੇ ਤੁਹਾਡੇ ਡੇਟਾ ਦੀ ਵਰਤੋਂ ਨਹੀਂ ਕੀਤੀ ਜਾਵੇਗੀ।

ਸੰਪਰਕ ਜਾਣਕਾਰੀ

ਜੇਕਰ ਤੁਹਾਡੇ ਕੋਲ ਇਸ ਅਧਿਐਨ ਬਾਰੇ ਕਿਸੇ ਵੀ ਸਮੇਂ ਕੋਈ ਸਵਾਲ ਹਨ, ਤਾਂ ਤੁਸੀਂ ਖੋਜਕਰਤਾ ਨਾਲ ਸੰਪਰਕ ਕਰ ਸਕਦੇ ਹੋ ਜਿਸਦੀ ਸੰਪਰਕ ਜਾਣਕਾਰੀ ਹੇਠਾਂ ਦਿੱਤੀ ਗਈ ਹੈ।

ਖੋਜਕਰਤਾ ਦੇ ਵੇਰਵੇ: ਨਾਮ: ਸਾਕਸ਼ੀ ਸਾਧੂ ਪਤਾ: ਕਮਰਾ ਨੰ: 105 ਬਲਾਕ 3, ਫਿਜ਼ੀਓਥੈਰੇਪੀ ਵਿਭਾਗ ਫੋਨ ਨੰ: 9596857767	ਸੁਪਰਵਾਈਜ਼ਰ ਵੇਰਵੇ: ਨਾਮ: ਡਾ: ਰਮੇਸ਼ ਚੰਦਰ ਪਾਤਰਾ ਪਤਾ: ਕਮਰਾ ਨੰ: 105 ਬਲਾਕ 3, ਫਿਜ਼ੀਓਥੈਰੇਪੀ ਵਿਭਾਗ

Appendix 6: ਸੂਚਿਤ ਸਹਿਮਤੀ (Punjabi)

ਘੋਸ਼ਣਾ

(i) ਮੈਂ ਪੁਸ਼ਟੀ ਕਰਦਾ/ਕਰਦੀ ਹਾਂ ਕਿ ਮੈਂ ਉਪਰੋਕਤ ਅਧਿਐਨ ਲਈ ਜਾਣਕਾਰੀ ਸ਼ੀਟ ਨੂੰ ਪੜ੍ਹ ਅਤੇ ਸਮਝ ਲਿਆ ਹੈ ਅਤੇ ਮੈਨੂੰ ਸਵਾਲ ਪੁੱਛਣ ਦਾ ਮੌਕਾ ਮਿਲਿਆ ਹੈ। ਜਾਂਚਕਰਤਾ ਅਤੇ ਟੀਮ ਨੇ ਅਧਿਐਨ ਨੂੰ ਵੇਰਵਿਆਂ ਵਿੱਚ ਸਮਝਾਇਆ ਹੈ ਅਤੇ ਮੇਰੇ ਸਾਰੇ ਸ਼ੰਕਿਆਂ ਨੂੰ ਸਪੱਸ਼ਟ ਕੀਤਾ ਹੈ।

(ii) ਮੈਂ ਸਮਝਦਾ/ਸਮਝਦੀ ਹਾਂ ਕਿ ਅਧਿਐਨ ਵਿੱਚ ਮੇਰੀ ਭਾਗੀਦਾਰੀ ਸਵੈਇੱਛਤ ਹੈ ਅਤੇ ਇਹ ਕਿ ਮੈਂ ਕਿਸੇ ਵੀ ਸਮੇਂ, ਬਿਨਾਂ ਕੋਈ ਕਾਰਨ ਦੱਸੇ, ਮੇਰੀ ਡਾਕਟਰੀ ਦੇਖਭਾਲ ਜਾਂ ਕਾਨੂੰਨੀ ਅਧਿਕਾਰਾਂ ਨੂੰ ਪ੍ਰਭਾਵਿਤ ਕੀਤੇ ਬਿਨਾਂ ਵਾਪਸ ਲੈਣ ਲਈ ਸੁਤੰਤਰ ਹਾਂ।

(iii) ਅਧਿਐਨ ਦੇ ਤਫ਼ਤੀਸ਼ਕਾਰ ਨੂੰ ਮੌਜੂਦਾ ਅਧਿਐਨ ਦੇ ਸਬੰਧ ਵਿੱਚ ਮੇਰੇ ਸਿਹਤ ਰਿਕਾਰਡਾਂ ਨੂੰ ਦੇਖਣ ਲਈ ਮੇਰੀ ਇਜਾਜ਼ਤ ਦੀ ਲੋੜ ਨਹੀਂ ਹੋਵੇਗੀ ਅਤੇ ਇਸ ਦੇ ਸਬੰਧ ਵਿੱਚ ਕੀਤੀ ਜਾਣ ਵਾਲੀ ਕੋਈ ਹੋਰ ਖੋਜ, ਭਾਵੇਂ ਮੈਂ ਮੁਕੱਦਮੇ ਤੋਂ ਹਟ ਜਾਂਦਾ ਹਾਂ। ਮੈਂ ਇਸ ਪਹੁੰਚ ਲਈ ਸਹਿਮਤ ਹਾਂ। ਹਾਲਾਂਕਿ, ਮੈਂ ਸਮਝਦਾ/ਸਮਝਦੀ ਹਾਂ ਕਿ ਤੀਜੀ ਧਿਰ ਨੂੰ ਜਾਰੀ ਜਾਂ ਪ੍ਰਕਾਸ਼ਿਤ ਕੀਤੀ ਗਈ ਕਿਸੇ ਵੀ ਜਾਣਕਾਰੀ ਵਿੱਚ ਮੇਰੀ ਪਛਾਣ ਪ੍ਰਗਟ ਨਹੀਂ ਕੀਤੀ ਜਾਵੇਗੀ।

(iv) ਮੈਂ ਇਸ ਅਧਿਐਨ ਤੋਂ ਪੈਦਾ ਹੋਣ ਵਾਲੇ ਕਿਸੇ ਵੀ ਡੇਟਾ ਜਾਂ ਨਤੀਜਿਆਂ ਦੀ ਵਰਤੋਂ 'ਤੇ ਪਾਬੰਦੀ ਨਾ ਲਗਾਉਣ ਲਈ ਸਹਿਮਤ ਹਾਂ, ਪ੍ਰਦਾਨ ਕੀਤਾ ਗਿਆ ਹੈ ਵਰਤੋਂ ਕੇਵਲ ਵਿਗਿਆਨਕ ਉਦੇਸ਼ਾਂ(ਆਂ) ਲਈ ਹੈ।

(v) ਮੈਂ ਉਪਰੋਕਤ ਅਧਿਐਨ ਵਿੱਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਸਹਿਮਤ ਹਾਂ।

ਵਿਸ਼ੇ ਦੇ ਦਸਤਖਤ (ਜਾਂ ਅੰਗੂਠੇ ਦਾ ਨਿਸ਼ਾਨ)

ਤਾਰੀਖ਼: _____/_____/______

ਹਸਤਾਖਰਕਰਤਾ ਦਾ ਨਾਮ: ____

ਨਿਰਪੱਖ ਗਵਾਹ/ਕਾਨੂੰਨੀ ਤੌਰ 'ਤੇ ਸਵੀਕਾਰਯੋਗ ਪ੍ਰਤੀਨਿਧੀ ਦਸਤਖਤ ________

ਤਾਰੀਖ਼: _____/_____/______

ਹਸਤਾਖਰਕਰਤਾ ਦਾ ਨਾਮ: ____

ਅਥਾਰਟੀ/ਜਾਂਚਕਰਤਾ ਦੇ ਦਸਤਖਤ: ____________________
ਤਾਰੀਖ਼: _____/_____/______

ਅਥਾਰਟੀ ਦਾ ਨਾਮ:

Appendix 7: General Assessment form for Participants

Serial number________________ Dancer/Non-Dancer____________

Group allocated_______________ Date________________________

Name:		Contact number:	
Address:			
Age/Gender:	Weight:	Height:	BMI:
Temperature:	Heart rate:	Respiratory rate:	Blood Pressure:
Job & occupation:		Educational level:	
Hand Dominance:		Leg Dominance (use to kick a ball):	
If dancer, year of experience:		If dancer, training hours per week:	
Any history of past trauma/injury: Yes/No		Any diagnosed medical condition: Yes/No	

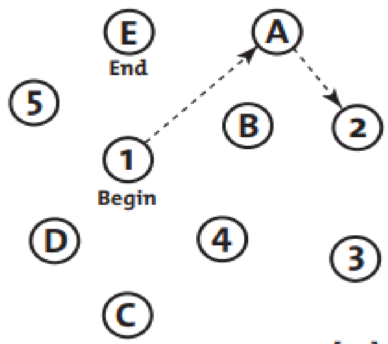
WHO (FIVE) WELL-BEING QUESTIONNAIRE

Please put a circle on each of the five statements which is closest to how you have been feeling over the last two weeks. Notice that higher numbers mean better wellbeing.

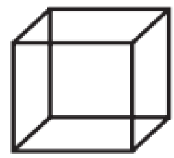
Over the last two weeks	All the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
I feel cheerful and in good spirits	5	4	3	2	1	0
I feel calm and relaxed	5	4	3	2	1	0
I feel active and vigorous	5	4	3	2	1	0
I wake up feeling fresh and rested	5	4	3	2	1	0
My daily life is filled with things that interest me	5	4	3	2	1	0

Present cognitive status: Montreal Cognitive Assessment (MOCA)

VISUOSPATIAL / EXECUTIVE



[ ]



Copy cube

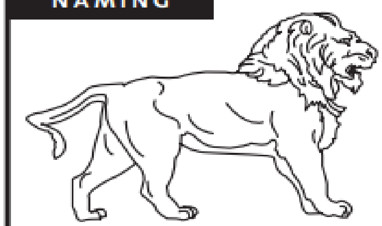
[ ]

Draw CLOCK (Ten past eleven)
(3 points)

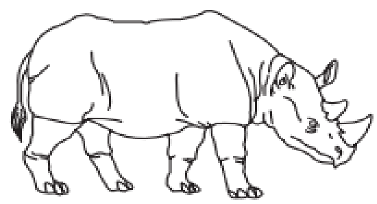
[ ] Contour [ ] Numbers [ ] Hands

POINTS: ___/5

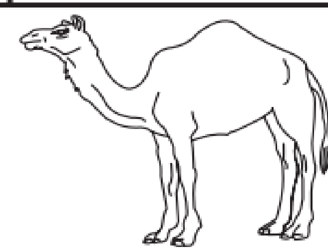
NAMING



[ ]



[ ]



[ ]

___/3

MEMORY

Read list of words, subject must repeat them. Do 2 trials. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION

Read list of digits (1 digit/ sec.). Subject has to repeat them in the forward order [ ] 2 1 8 5 4
Subject has to repeat them in the backward order [ ] 7 4 2

___/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors
[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

___/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65
4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**

___/3

LANGUAGE

Repeat : I only know that John is the one to help today. [ ]
The cat always hid under the couch when dogs were in the room. [ ]

___/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] ____ (N ≥ 11 words)

___/1

ABSTRACTION

Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler

___/2

DELAYED RECALL

Has to recall words WITH NO CUE	FACE [ ]	VELVET [ ]	CHURCH [ ]	DAISY [ ]	RED [ ]	Points for UNCUED recall only
Optional: Category cue						
Optional: Multiple choice cue						

___/5

ORIENTATION

[ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

___/6

Normal ≥ 26 / 30

TOTAL ___/30
Add 1 point if ≤ 12 yr edu

2021 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	**YES**	**NO**
1) Has your doctor ever said that you have a heart condition ☐ **OR** high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** ____________	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** ____________	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** ____________	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow Global Physical Activity Guidelines for your age (https://www.who.int/publications/i/item/9789240015128).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION

If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME ____________________ DATE ____________

SIGNATURE ____________________ WITNESS ____________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ____________________

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

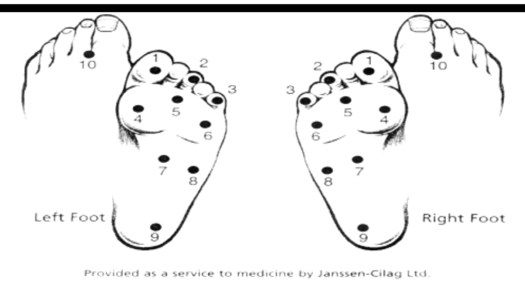
Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

01-11-2020

PART B (Specific Assessment form for Participants)

Variables	Left Foot Score	Right Foot Score	Difference
Foot Size			
Truncated foot length			
Arch height index			
Navicular height			
Navicular drop			
Medial Longitudinal arch angle			
Feiss line			
Tibial Torsion angle			
Rear-foot angle			
True Limb length			
Apparent Limb length			
Thigh Girth			
Calf Girth			
Sensory examination of the foot			
Clarke's angle			
Chippaux-Smirak index			
Staheli's Planter Arch Index			
Foot Posture Index			



- Loss of protective sensation = No feeling in less than 8 sites
- The monofilament should be wiped with a detergent cloth after use

	FACTOR	PLANE	SCORE 1 Date___ Comment___	
			Left (–2 to +2)	Right (–2 to +2)
Rearfoot	Talar head palpation	Transverse		
	Curves above and below lateral malleoli.	Frontal/ trans		
	Inversion/eversion of the calcaneus	Frontal		
Forefoot	Bulge in the region of the TNJ	Transverse		
	Congruence of the medial longtudinal arch	Sagittal		
	Abd/adduction of forefoot on rearfoot (too-many-toes).	Transverse		
	TOTAL			

Gait Variable (reading of 2 gait cycle starting with left and starting with right)

Static parameters for front and back of foot

	Left Front	**Left Back**	**Right Front**	**Right Back**
Area				
Distribution				
Trust				

Static parameters for whole foot

	Right	Left
Area		
Distribution		
Maximal Pressure		
Average Pressure		
Weight		

Dynamic results (Podometeric Results) Dominant leg

	Area	Average Pressure	Maximal Pressure
Step 1(rt)			
Step 2(lt)			
Step 3 (rt)			

Dynamic results (Spacio-Temporal Results)

	Left Side	Right Side
Step Duration (ms)		
Gait cycle (ms)		
Single Stance duration (ms)		
Double Stance duration (ms)		
Swing Duration (ms)		
Stride Duration (ms)		
Step length (mm)		
Gait cycle length (mm)		
Angle		

Postural sway

Length	X speed	Dev. X0
Area	Y speed	Dev. Y0
Length/Area	X deviation	Dev. Mx
Average Q Speed	Y deviation	Dev. My

Postural assessment

FRONT VIEW
POSTERIOR VIEW
LEFT LATERAL VIEW
RIGHT LATERAL VIEW

Dancer fitness testing

Parameters	**Score**
1. Resting heart rate	
2. Max heart rate	
3. Predictive VO2 MAX	
4. Harvard step test values	
5. Fitness Index test values	
6. Leg power values	
7. Crunches	
8. Push ups	
9. V sit and reach test	
10. Y Balance test (Dynamic Balance)	

Appendix 8: Dancer musculoskeletal injury assessment questionnaire (DMIAQ)

Section A (Demographic section)

Name	
Age	
Gender	
Address	
Hand Dominance	
Leg Dominance	
Years of practicing dance	
Days practicing dance per week	
Hours practicing dance per day	

Section B (Pain/Discomfort Section)

Do you have pain or discomfort currently in any part of the body?

Region	No (0)	Yes (1)			If yes	
		Mild (1)	Moderate (2)	Severe (3)	Left Side	Right Side
Neck						
Upper Back						
Lower Back						
Shoulder						
Elbow						
Wrist/Hand						
Hip						
Knee						
Ankle/Foot						

Note: (Total 27 scoring) Minimum- 0 and Maximum-27

Section C (Injury Section)

Do you have injury in any part of the body in last one year?

Region	No (0)	Yes (1)	Left Side	Right Side
Neck				
Upper Back				
Lower Back				
Shoulder				
Elbow				
Wrist/Hand				
Hip				
Knee				

Ankle/Foot				

Note: (Total 9 scoring) Minimum- 0 and Maximum-9

Section D (Reason Section)

What do you think could be the reason for pain/discomfort/injury?

COMPONENTS	NO (0)	YES (1)
Age factor		
Anatomical factors		
Biomechanical factors		
Fatigue		
Intense training		
Poor training		
Lack of conditioning		
Wrong techniques		
Practicing surface		
Environmental conditions		
Dietary habits		
Stress issues		
High competition		
Career fear		
Coaching methods		

Note: (Total 15 scoring) Minimum- 0 and Maximum-15

Section E (Preventive measure section)

Do you take any preventive measures to avoid injuries?

PREVENTIVE MEASURES	No (0)	Yes (1)
Proper conditioning (warmup & cool down)		
Proper diet		
Proper rest		
Proper consultation from doctors		
Proper techniques		
Proper training		
Supportive therapy		
Psychological counselling		
Avoid intense and odd training hours		
Ergonomic advices		

Appendix 9: Candidacy letter

LOVELY PROFESSIONAL UNIVERSITY

Centre for
Research Degree Programmes

LPU/CRDP/EC/20200115/0153

Dated: 18 Sep 2019

Sakshi Sadhu
VID: 41801018
Programme Name: Doctor of Philosophy (Physiotherapy)

Subject: Letter of Candidacy for Ph.D.

Dear Candidate,

We are very pleased to inform you that the Department Doctoral Board has approved your candidacy for the Ph.D. Programme on 18 Sep 2019 by accepting your research proposal entitled: "Analyzing the foot biomechanical characteristics and plantar pressure in Bhangra Dancers"

As a Ph.D. candidate you are required to abide by the conditions, rules and regulations laid down for Ph.D. Programme of the University, and amendments, if any, made from time to time.

We wish you the very best!!

In case you have any query related to your programme, please contact Centre of Research Degree Programmes.

Head

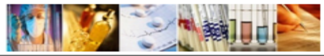
Centre for Research Degree Programmes

Note:-This is a computer generated certificate and no signature is required. Please use the reference number generated on this certificate for future conversations.

Jalandhar-Delhi G.T.Road, Phagwara, Punjab (India) - 144411
Ph: +91-1824-444594 E-mail: drp@lpu.co.in website: www.lpu.in

Appendix 10: Clinical trial Registry of India (CTRI registration)

CLINICAL TRIALS REGISTRY - INDIA
ICMR - National Institute of Medical Statistics



PDF of Trial
CTRI Website URL - http://ctri.nic.in

Clinical Trial Details (PDF Generation Date :- Mon, 09 Oct 2023 07:18:40 GMT)

CTRI Number	CTRI/2023/05/052343 [Registered on: 08/05/2023] - **Trial Registered Prospectively**
Last Modified On	04/05/2023
Post Graduate Thesis	Yes
Type of Trial	Observational
Type of Study	Cross Sectional Study
Study Design	Other
Public Title of Study	Static and dynamic foot biomechanical characteristics and plantar pressure in Bhangra Dancers
Scientific Title of Study	Analyzing the foot biomechanical characteristics and plantar pressure in Bhangra Dancers

Secondary IDs if Any

Secondary ID	Identifier
NIL	NIL

Details of Principal Investigator or overall Trial Coordinator (multi-center study)

Details of Principal Investigator	
Name	Sakshi Sadhu
Designation	PhD Scholar
Affiliation	Lovely Professional University
Address	Department of Physiotherapy, Lovely Professional University Phagwara Punjab-144411 Kapurthala PUNJAB 144411 India
Phone	7889573491
Fax	
Email	sakshi.22851@lpu.co.in

Details Contact Person (Scientific Query)

Details Contact Person (Scientific Query)	
Name	Dr Ramesh Chandra Patra
Designation	Assistant Professor
Affiliation	Lovely Professional University
Address	Department of Physiotherapy, Lovely Professional University Phagwara Punjab-144411 Kapurthala PUNJAB 144411 India
Phone	7009769587
Fax	
Email	ramesh.19500@lpu.co.in

Details Contact Person (Public Query)

Details Contact Person (Public Query)	
Name	Sakshi Sadhu
Designation	PhD Scholar
Affiliation	Lovely Professional University
Address	Department of Physiotherapy, Lovely Professional University Phagwara Punjab-144411 Kapurthala PUNJAB 144411 India
Phone	7889573491

Appendix 11: Ethical approval

Genebandhu Independent Ethics Committee
209-C II & III Floor, Masjid Moth, South Extension
Part-II New Delhi-110049 Tel: 011 4007 3808
E-mail: ethicscommittee.genebandhu@gmail.com

Ref- ECG005/2023
April 20, 2023

To,
Ms. Sakshi Sadhu
PhD Scholar
Lovely Professional University
Punjab

Protocol Number: ECG005/2023

Title: Analyzing the foot biomechanical characteristics and plantar pressure in Bhangra Dancers

Dear Sakshi,

The following documents were submitted to the ethics committee on April 7, 2023

- Research Objectives
- Participant Recruitment Procedures
- Inclusion and Exclusion Criteria
- Methodology
- Sample Size with justification
- Plan for statistical analysis of the study
- Informed Consent – English, Punjabi and Hindi
- General assessment form for participants
- Physical Activity Readiness questionnaire

The following members of the ethics committee were present at the meeting held on Zoom platform on April 16, 2023:

S.NO.	NAME	QUALIFICATIONS	DESIGNATION
1.	Dr. Praneet Kumar	MBBS, DHA, PGCH&FWM	Officiating Chairman Health Care Management Expert and Clinician
2.	Ms. Hema Pandey	Leadership Program on Nutrition Security and Sustainable Development	Healthcare Specialist and Member Secretary
3.	Dr. Vikash Ch. Mishra	PhD Biotechnology	Scientist and Lead Reviewer
4.	Dr. Archna Bambroo	MBBS, D.Ch.	Clinician
5.	Dr. Amrita Bahl	Doctoral Program in Health Education	Health and Education Expert
6	Dr. Girish Sharma	Scientist	Basic Scientist
7.	Mr. TS Chaudhary	Lawyer	Legal expert
8.	Ms. Shalini Puri	Social Worker	Social Representative

ethicsindia.org.in
CDSCO Registration No. ECR/339/Indt/DL/2021

Appendix 12: Conference certificate-1


ICRAHS
INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN HEALTH SCIENCES

LOVELY PROFESSIONAL UNIVERSITY
Transforming Education Transforming India

Certificate No. 266025

Certificate of Merit

This is to certify that **Prof./Dr./Mr./Ms. Sakshi Sadhu** has participated in **Oral presentation session** on topic **Evaluation of the different foot type among the young adults using Foot posture index to determine prevalence of pronated foot** awarded **First prize** in the **International Conference** on **"Recent Advances in Health Sciences" (ICRAHS-2023)** on the Theme of "Interdisciplinary Research: A key to transform Health care." from 14th April, 2023 to 15th April, 2023 organized by School of Pharmaceutical Sciences in association with Komar University of Sciences and Technology at Lovely Professional University, Punjab.

Date of Issue : 01-05-2023
Place : Phagwara (Punjab), India

Prepared by (Administrative Officer-Records)

Dr. M Vijay Kumar
General Chair

Prof. Dr. Kawis Aziz Faraj
Conference Co-Chair

Dr. Monica Gulati
Conference Chair

Appendix 13: Conference certificate-2


Serial No. 3ICP2022/783

LOVELY PROFESSIONAL UNIVERSITY

Transforming Education Transforming India

Certificate of Participation

This is to certify that Prof./Dr./Mr./Ms. Sakshi Sadhu has successfully participated as Delegate & Presented Poster/ Oral Presentation on PREVALENCE OF MUSCULOSKELETAL DISCOMFORT AMONG THE DANCERS IN INDIA in the 3rd International Conference of Pharmacy (ICP-2022) on the Theme of "Practice, Promotion & Publication of Innovation : A Way of Transforming Health" held on 09th & 10th November 2022 organized by School of Pharmaceutical Sciences in a collaboration with Indian Pharmaceutical Association (IPA) at Lovely Professional University, Punjab.

Mr. Suresh Khanna National Hon. Gen. Secretary, IPA	Dr. Bimlesh Kumar Organizing Secretary	Dr. T.V. Naryana National President IPA	Dr. Monica Gulati LOC Chairperson

Sri Herbasia Biotech

Tishk International University, Iraq

Appendix 14: Copyright certificate-1

Copyright Office https://copyright.gov.in/ReceiptDetails.aspx?reqid=82081

भारत सरकार / GOVERNMENT OF INDIA
कॉपीराइट कार्यालय / Copyright Office
बौद्धिक संपदा भवन,प्लॉट संख्या 32, सेक्टर 14, द्वारका, नई दिल्ली-110078 फोन: 011-28032496
Intellectual Property Bhawan, Plot No. 32, Sector 14, Dwarka, New Delhi-110078 Phone: 011-28032496
रसीद / Receipt

Copyright Office

PAGE No : 1

To,

Monica-Gulati
Registrar-Lovely professional University-

(M)-9888160523 : E-mail- runjhun.19532@lpu.co.in

RECEIPT NO : 78745
FILING DATE : 24/03/2023
BRANCH : Delhi
USER : Lovelyprofessionaluniversity

S.No	Form	Diary No.	Request No	Title	Amount (Rupees)
1	Form-XIV	7838/2023-CO/L	82081	Dancer musculoskeletal injury assessment questionnaire (DMIAQ)	500
Amount in Words		Rupees Five Hundreds			500

PAYMENT MODE	Transaction Id	CIN
Online	C-0000092340	2403230004512

(Administrative Officer)

*This is a computer genereated receipt, hence no signature required.

*Please provide your email id with every form or document submitted to the Copyright office so that you may also receive acknowledgements and other documents by email.

Appendix 15: Copyright certificate-2

INTELLECTUAL PROPERTY INDIA

Extracts from the Register of Copyrights

प्रतिलिप्यधिकार कार्यालय, भारत सरकार | Copyright Office, Government Of India

Dated:07/12/2023

1.	Registration Number	L-137234/2023
2.	Name, address and nationality of the applicant	LOVELY PROFESSIONAL UNIVERSITY , LOVELY PROFESSIONAL UNIVERSITY, JALANDHAR, DELHI-GT ROAD, PHAGWARA PUNJAB-144411 INDIAN
3.	Nature of the applicant's interest in the copyright of the work	OWNER
4.	Class and description of the work	LITERARY/ DRAMATIC WORK THE PURPOSE OF WORK IS TO DEVELOP THE EXERCISE PROTOCOL FOR FLATFOOT
5.	Title of the work	EXERCISE PROTOCOL FOR FLATFOOT
6.	Language of the work	ENGLISH
7.	Name, address and nationality of the author and if the author is deceased, date of his decease	SOUBHAGYABATI PRUSTY , LOVELY PROFESSIONAL UNIVERSITY, JALANDHAR, DELHI GT ROAD, PHAGWARA PUNJAB-144411 INDIAN SAKSHI SADHU , LOVELY PROFESSIONAL UNIVERSITY JALANDHAR, DELHI-GT ROAD, PHAGWARA PUNJAB-144411 INDIAN
8.	Whether the work is published or unpublished	UNPUBLISHED
9.	Year and country of first publication and name, address and nationality of the publisher	N.A.
10.	Years and countries of subsequent publications, if any, and names, addresses and nationalities of the publishers	N.A.
11.	Names, addresses and nationalities of the owners of various rights comprising the copyright in the work and the extent of rights held by each, together with particulars of assignments and licences, if any	LOVELY PROFESSIONAL UNIVERSITY , LOVELY PROFESSIONAL UNIVERSITY, JALANDHAR, DELHI-GT ROAD, PHAGWARA PUNJAB-144411 INDIAN
12.	Names, addresses and nationalities of other persons, if any, authorised to assign or licence of rights comprising the copyright	N.A.
13.	If the work is an 'Artistic work', the location of the original work, including name, address and nationality of the person in possession of the work. (In the case of an architectural work, the year of completion of the work should also be shown).	N.A.
14.	If the work is an 'Artistic work' which is used or capable of being used in relation to any goods or services, the application should include a certification from the Registrar of Trade Marks in terms of the provision to Sub-Section (i) of Section 45 of the Copyright Act, 1957.	N.A.
15.	If the work is an 'Artistic work', whether it is registered under the Designs Act 2000, if yes give details.	N.A.
16.	If the work is an 'Artistic work', capable of being registered as a design under the Designs Act 2000 whether it has been applied to an article though an industrial process and ,if yes ,the number of times it is reproduced.	N.A.
17.	Remarks, if any	THE WORK IS ORIGINAL AS DONE BY THE FACULTY AND STAFF OF LOVELY PROFESSIONAL UNIVERSITY

डायरी संख्या/Diary Number: 21331/2023-CO/L

आवेदन की तिथि/Date of Application: 11/08/2023

प्राप्ति की तिथि/Date of Receipt: 11/08/2023

Registrar of Copyrights

Appendix 16: Patent certificate

https://iprsearch.ipindia.gov.in/PatentSearch/PatentSearch/ViewApplicationStatus

Office of the Controller General of Patents, Designs & Trade Marks
Department of Industrial Policy & Promotion,
Ministry of Commerce & Industry,
Government of India

INTELLECTUAL PROPERTY INDIA

Application Details	
APPLICATION NUMBER	202311053635
APPLICATION TYPE	ORDINARY APPLICATION
DATE OF FILING	10/08/2023
APPLICANT NAME	Lovely Professional University,
TITLE OF INVENTION	AFOOT CORRECTION DEVICE WITH MOBILE APPLICATION CONTROL
FIELD OF INVENTION	BIO-MEDICAL ENGINEERING
E-MAIL (As Per Record)	dip@lpu.co.in
ADDITIONAL-EMAIL (As Per Record)	dip@lpu.co.in
E-MAIL (UPDATED Online)	
PRIORITY DATE	
REQUEST FOR EXAMINATION DATE	--
PUBLICATION DATE (U/S 11A)	01/09/2023

Application Status	
APPLICATION STATUS	Awaiting Request for Examination

View Documents

Filed → Published → RQ Filed → Under Examination → Disposed

In case of any discrepancy in status, kindly contact ipo-helpdesk@nic.in

Appendix 17: Research Publication 1

"A Letter of Appreciation and Suggestions: Improving Methodological Rigor and Questionnaire Design in Ballet Dance Injury Research"

https://doi.org/10.1177/1089313X24125527

Sakshi Sadhu and Dr. Ramesh Chandra Patra

Journal of Dance Medicine & Science (Scopus Indexed)

Abstract

Background: The research paper provides valuable insights into the perspectives of adolescent ballet dancers regarding dance-related injuries. The authors' work is commendable, but several methodological improvements could enhance the study's accuracy and reliability. As a researcher with similar interests, I offer suggestions to strengthen the data collection and analysis process. **Methods:** Original Approach: The study utilized an online survey for data collection, suitable for close-ended questions but less ideal for qualitative research. Suggested Improvements: Data Collection Method: One-on-one interviews, either structured or semi-structured, are recommended to obtain more accurate and in-depth responses.Sample Size: The original sample size of 15-30 participants is appropriate for direct interactions. However, for online surveys, a larger sample size of approximately 246 participants is recommended. This calculation is based on recent findings showing a prevalence rate of 79.8% in full-time and 63.2% in part-time ballet dancers in Australia, using a 95% confidence interval. Questionnaire Design: The original questionnaire was constructed from a literature review. To improve its quality, input from a focus group of experts should be incorporated. A shorter, clearer, and well-structured questionnaire is suggested to minimize bias. **Results:** By adopting these methodological enhancements, the study could achieve more reliable and comprehensive data. The inclusion of open-ended questions would provide deeper insights into the dancers' experiences and improve the impact and relevance of the research findings. **Conclusions:** The research paper offers valuable perspectives on dance-related injuries among adolescent ballet dancers. With the proposed methodological improvements, the study can yield more robust and insightful data, contributing significantly to the understanding of injury experiences in this population.

References

1. Cheers N, Matheson M, Skinner I, Wells C. Perspectives and experiences of dance-related injuries: a qualitative survey of adolescent pre-professional ballet dancers in Australia. *J Dance Med Sci*. 2024;28(2):90-108.

Crossref | PubMed | Google Scholar

2. Vassallo AJ, Pappas E, Stamatakis E, et al. Differences in the occurrence and characteristics of injuries between full-time and part-time dancers. *BMJ Open Sport Exerc Med*. 2018;4:e000324.

Crossref | Google Scholar

Appendix 18: Research Publication 2

Evaluation of Prevalence, Location and Pattern of Musculoskeletal Pain and Discomfort among Dancers

DOI 10.26773/smj.240713

Sakshi Sadhu, Dr. Ramesh Chandra Patra

Sport Mont (Scopus Indexed)

DOI 10.26773/smj.240713

SportMont

ORIGINAL SCIENTIFIC PAPER

Evaluation of Prevalence, Location and Pattern of Musculoskeletal Pain and Discomfort among Dancers

Sakshi Sadhu[1], Ramesh Chandra Patra[1], Madhusudhan Pal[2], Soubhagyabati Prusty[1], Agnel Prinson[1]

[1]Lovely Professional University, Department of Physiotherapy, School of allied health Sciences, Phagwara, Punjab, India, [2]Ministry of commerce & industry, Govt. of India, Footwear design & development institute, Noida, India

Abstract

Professional dancers are contemplated as athletes as it is involving repetitive and rhythmic movement. These strenuous activities are the negative stressors and reason for overuse injuries leading to discomfort and pain. This pain and discomfort results in some major issues in the future and it can affect their professional performance or career. This study aimed to exploring the prevalence, common region involved and relation of course of pain in different regions of the body in dancers. A total of 110 dancers, both male and female, participated in this cross-sectional study using the Nordic MSD questionnaire tool. The mean and standard deviation for age (years), height (cm), weight (kg), BMI (kg/cm^2), experience (years), and weekly practice hours were calculated as follows: for women, 21.87±4.47, 165.57±9.89, 60.98±17.85, 22.20±5.93, 8.05±5.47, and 8.98±6.93, and for men, 21.83±6.59, 173.73±7.34, 70.41±11.43, 23.23±3.24, 7.84±5.55, and 9.36±6.95. The result findings revealed, 30.8% participants had pain in the low back region that in last 7 days, followed by shoulder 27.3% and ankle 25.5%. In last 12 months 51% participants reported pain, discomfort and numbness in the lower back region followed by ankle/ foot and knee (31%). In response towards the restriction in the ADL, lower back pain cases (30%) were highest followed by knee (23.6%). The results also revealed that neck pain is strongly and positively associated with upper back pain(r=.601) and moderately related to shoulder pain (r=.467). The study concludes that the lower back region is more prevalent area for pain following the ankle and knee among dancers.

Keywords: *biomechanics, dancing, foot, ankle, injury, prevalence, epidemiology*

Introduction

Dancers are considered as athletes, using artistic statement with athletic skills performing a series of rhythmic body movements to the beats of music (Costa et al., 2016). Dance is an art involving motor activities with expression to interact with society (Aweto et al., 2014). In the past, dancing was considered to have cultural links, but nowadays it is also opted as a profession and forms the statement of social style rather than cultural links. Professional dancing requires hard training and more practice hours. The movement patterns in dancing involve transitions from one position to another that can be challenging and strenuous at the same time. This places a high physical and physiological demand on all the body's musculoskeletal systems (Motta-Valencia, 2006). This makes them more susceptible to musculoskeletal injuries, pain and discomfort, affecting their performance level and career (Russell, 2013). Myriads factors involve in different dancing activities, placing dancers at the risk of injuries resulting in pain and discomfort (Campoy et al., 2011). The factors are biomechanical faults, and mal-alignment caused over time due to different body movements, lack of flexibility and strength because of non-involvement in exercise regime before dancing (Huang et al., 2022).

Evidences underscore the pivotal role of biomechanical analysis in dance, emphasizing its significance in understand-

Correspondence:

Ramesh Chandra Patra
Lovely Professional University, Department of Physiotherapy, School of allied health Sciences, Phagwara, Punjab- 144411, India
E-mail ID: rameshpatra2208@gmail.com

Appendix 19: Research Publication 3

Predictors for Assessing the Elements that Challenge the Dancer's Limits: A Short Review
Vol.12 / Issue 67 / August / 2021
Sakshi Sadhu, Dr. Ramesh Chandra Patra
Indian Journal of Natural Sciences (Web of Science indexed)

Indian Journal of Natural Sciences *www.tnsroindia.org.in ©IJONS*
Vol.12 / Issue 67 / August / 2021 *International Bimonthly (Print)* *ISSN: 0976 – 0997*

REVIEW ARTICLE

Predictors for Assessing the Elements that Challenge the Dancer's Limits: A Short Review

Sakshi Sadhu[1*], Ramesh Chandra Patra[2] and Ammar Suhail[3]

[1]Research Scholar/Assistant Professor, Department of Physiotherapy, Lovely Professional University, Phagwara, Punjab, India.
[2]Assistant Professor, Department of Physiotherapy, Lovely Professional University, Phagwara, Punjab, India.
[3]Assistant Professor, Department of Physiotherapy, Lovely Professional University, Phagwara, Punjab, India.

Received: 16 June 2021 Revised: 21 June 2021 Accepted: 28 June 2021

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Lovely Professional University,
Phagwara, Punjab, India.
Email: Sakshi.22851@lpu.co.in

ABSTRACT

The main objective of this paper is to lay down the real meaning of a proverb, i.e. ***"Prevention is better than cure"***. Dance was and will be an integral part of the Indian society. It is associated with our cultural roots. The life of the dancers is full of struggle in terms of challenges they are facing in their career time. They suffer physically as well as mentally due to the stress, which results in the injuries. They cannot even express their state, as there is always a fear of replacement so they keep on suffering. There is limitation in the evidence in India related to the dance particularly the assessment component so the predictors is needed to find out the injury at the initial level so that we can prevent the injuries in dancers. This will help in prevent the career loss for them.

INTRODUCTION

Dance medicine has seen an exponential increase over last decade. It is defined as "the field of medicine which is specialized in evaluating and treatment of performing artist"(1). Traditionally it has moved into the field of sports medicine so it has become a specialized branch of sports medicine. The reason can be attributed due to the body movements used during dance that places a high physical and physiological demand on the all the systems of the body in terms of muscular and joint flexibility, stability, muscle strength, coordination, sensory motor integrity, etc.

Appendix 20: Research Publication 4

Efficacy of intrinsic foot strengthening program to improve the foot biomechanical characteristics and uneven plantar pressure distribution to reduce the risk of injury among Bhangra dancers: study protocol for Randomized controlled trial"

DMJ-24-0035.R1

Sakshi Sadhu, Dr. Ramesh Chandra Patra

Journal of Dance Medicine and Science

Abstract

Background:

Bhangra dance is vibrant and energy demanding art form involving dynamic footwork, jumps, kicks and rapid movements. Poor biomechanics and uneven plantar pressure is a crucial factor for injury among dancers thus, this study protocol aimed at evaluating the efficacy of comprehensive foot strengthening program in improving faulty foot biomechanics and plantar pressure distribution to reduce the risk of lower limb injuries among male Bhangra dancers.

Methods:

A single-blinded randomized controlled trial (RCT) will be performed. One hundred forty professional dancers will be recruited for this study based on G* power calculations. Seventy participants will be randomly allocated to the experimental group, undergoing a structured intrinsic foot strengthening program (IFSP; 12 weeks, 5 days/week, 30-60 minutes, mild-severe intensity). Seventy participants will be allocated to the waitlist control group, which will follow their exercise regime and dance training (randomization 1:1 ratio). Outcome measures to assess biomechanical characteristics of the foot and plantar pressure distribution will be foot posture index, navicular drop test, feiss line, arch height index, foot print parameters (Clark's Angle, Chippaux-Smirak Index, Staheli Index), and baropodometer at baseline (0 week), and at the end of the exercise program (after 12th week). Injury incidence and type will also be recorded using a self-designed questionnaire.

Discussion:

Bhangra dancers. The findings of this RCT will have implications for dance training protocols and injury prevention strategies.

Trial status:

Recruitment has not yet started.

Appendix 21: Master Sheet

Sadhu, Sakshi (2024), “My PHD Dataset”, Mendeley Data, V1, doi: 10.17632/mctc2wjtjy.1

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My PHD Dataset

Published: 22 July 2024 | Version 1 | Reserved DOI: 10.17632/mctc2wjtjy.1
Contributor: Sakshi Sadhu

Description

This is my PHD research project

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Files

Correlation.xlsx	42.5 KB
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Version 1 (Draft)
Published: Draft
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Cite this dataset

Sadhu, Sakshi (2024), “My PHD Dataset”, Mendeley Data, V1, doi: 10.17632/mctc2wjtjy.1

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Appendix 22: Plagiarism report

Thesis

ORIGINALITY REPORT

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