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Evaluation Of Hindfoot Alignment In Weight-Bearing Position Using Lazer Beam In Salesperson

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Abstract **-** Context: The prolonged standing position is an important factor in the onset of foot musculoskeletal disorders among salesperson. The subtalar joint is in neutral when it is neither pronated nor supinated. The incorrect foot position causing excessive and prolonged pronation or supination during standing phase with biomechanical abnormalities would be believed to increase the risk of overuse injuries. A goniometer-based measurement method was created, but the results were unreliable. As a result, this method of measuring calcaneal angle is more efficient and dependable Aim: The main aim of this study is to evaluate hindfoot alignment especially calcaneal angle deviation from center in weight-bearing position using laser beam in salesperson Methods and material: An cross sectional study was conducted among 100 salesperson of age group 20-30 year. Their hindfoot alignment of both the foot using Lazer beam were measured. Any calcaneal deviations like inversion or eversion or central alignment were noted. Results: Among the 100 participants collected, there was prevalence of musculoskeletal injuries and pain in 86% of participants. The most common prevalence of pain was in low back (62%), knees (30%), shoulders (27%) and wrist (18%). 2 Conclusion: It is evident that delivery boys are exposed to a lot of musculoskeletal discomforts and have complaints of pain in low back, shoulders, knees, and wrist. The factors such as carrying weight, long working hours, and static faulty posture are the risk factors for these groups of people.

keywords **-** Hindfoot alignment, Weight-bearing position, Laser beam, calcaneal deviations, salesperson

INTRODUCTION

The hindfoot, which is a component of the subtalar joint, conducts a variety of complicated motions to protect against shock and produce propulsive force during a gait. [(1)] The calcaneus, the biggest of the human tarsal bones, creates the longitudinal arch of the foot. [(7)] Many studies have found that hindfoot malalignment is a risk factor for ankle injury, stress fracture, and tendonitis. [(1)] Prolonged hours of standing cause stress on the medial longitudinal arch from pounding on the surface. [(6)] Prolonged standing and walking are required tasks for salespeople. Prolonged standing is a significant component in the development of foot musculoskeletal disorder. [(2)]

You might be familiar with the pain and discomfort in your feet that you feel when your job requires you to stand for the most of your working day. Your entire body may experience changes in posture, back pain, and foot problems. [(4)]

It has been demonstrated that standing for extended periods of time at work is linked to a range of health issues, including low back pain and leg pain, cardiovascular issues, exhaustion, and discomfort. This occurs as a result of reduction in blood supply to the muscles, which causes fatigue [(3)] According to study, at least 50% of workers are at risk of musculoskeletal disorders as a result of spending considerable amounts of time standing at work. [(5)]

Several occupations include spending a significant amount of time on your feet. After a long day of pounding, everything from heel to toe can hurt. [(5)] Ankle and foot occupational difficulties have gotten less attention than other body regions, such as the hand, neck, and lumbar spine. [(7)]

Standing is one of the most favoured working postures in a variety of fields since it allows humans a great deal of physical freedom and mobility. [13] This encourages workers to be more efficient and productive. [14] Yet, standing erect for an extended amount of time, also known as Prolonged Standing, can cause physiological discomfort, exhaustion, and even health problems such as Musculoskeletal Diseases (MSDs). [13] In the long run, they may sustain occupational injuries. [14]

In weight bearing, the main purpose of the subtalar joint is to absorb the forced lower extremity transverse plane rotation that occurs during walking and other weight bearing activities. [8] In a neutral position, the subtalar joint is neither pronated nor supinated, and the longitudinal midlines of the leg and calcaneus are aligned. [9] When the subtalar joint pronates, the tibia rotates internally, shifting the knee medially to the foot, and the hip and knee joints flex due to the structure of the tibia and talus. [9]

As the main point of contact between the body and the ground in humans, the foot and ankle are among the most intricate musculoskeletal systems in the body. The improper foot position, which causes excessive and prolonged pronation or supination during the standing phase, is thought to increase the risk of overuse injuries. [9]

Several measurement methods along the body surface assist in measuring hindfoot alignment. Nevertheless, no efficient and accurate measurement method has been created. A goniometer-based measurement method was created, but the results were unreliable. [1] As a result, this method of measuring calcaneal angle is more efficient and dependable. Thus, this is a more efficient and reliable way of measuring calcaneal angle.

NEED OF STUDY

The job of salesperson requires prolonged standing for a maximum number of hours in a day. Because of long standing hours, it causes stress on the medial longitudinal arch from pounding on the surface. Prolonged standing can cause fatigue, leg cramps and backache. In the longer term, this may damage the ankle, knee and hip joints and make muscles ache. Therefore, in order to understand the deviation in the hindfoot especially in the calcaneal angle, present study is undertaken.

REVIEW OF LITERATURE

1. A study **"Novel method for evaluation of hindfoot alignment in weight-bearing position using laser beam" by Tadasuke Ohnish** in2018 reported that It is clinically important to accurately evaluate the alignment of hindfoot alignment from the body surface in weight-bearing position. Measurement with a goniometer requires experience, and the reliability in this measurement is also in question. The correlation between the measurement result along the body surface with or without laser and radiography was investigated. It was concluded that the correlation between radiography and HAML for measuring hindfoot alignment was good. This finding implies that HAML can be used as a screening test. [1] [J Phys Ther Sci. **2018 Mar; 30:474–478]**
2. A study **"Are custom-made foot orthoses of any interest on the treatment of foot pain for prolonged standing workers?**" by **Tristan Tarrade** reported that prolonged standing position is an important factor in the onset of foot musculoskeletal disorders among workers. Conclusion made was the custom-made shape allows for a better-balanced distribution of foot peak pressure thanks to its support and stimulation of the foot arches particularly through a shift of pressure from the heel to the midfoot. [2] **[Applied ErgonomicsVolume 80, October 2019, Pages 130-135]**
3. A study "**Why Do My Feet Hurt After Standing During the Work Day?"** by **Mark E Spier** reported about various reasons of foot pain and concluded by giving few exercises as well as change In work pattern for eliminating the pain. [4]
4. A study "**Evidence of Health Risks Associated with Prolonged Standing at Work and Intervention Effectiveness"** by **Thomas R. Waters**, that Prolonged standing at work has been shown to be associated with a number of potentially serious health outcomes, such as lower back and leg pain, cardiovascular problems, fatigue, discomfort, and pregnancy related health outcomes. Recent studies have been conducted examining the relationship between these health outcomes and the amount of time spent standing while on the job. He

concluded that Interventions designed to reduce risk of adverse health outcomes due to prolonged standing can be effective. [3] **[Rehabil Nurs. 2015 May-Jun; 40:148–165.]**

5. A study **"A narrative review of musculoskeletal problems of the lower extremity and back associated with the interface between occupational tasks, feet, footwear and flooring**" by **Jennifer Anderson 1, Anita E Williams 1, Christopher J Nester 1** reported at least 50% of workers are exposed to the risk of musculoskeletal disorders (MSD) due spending prolonged hours standing at work. It was concluded that altering flooring provided mixed results, while footwear appeared to have the potential to affect MSD, although the dearth of literature limited the conclusions that could be drawn. [5] **[PMID: 28032439**]
6. A study **"Prevalence and incidence of flat foot due to prolonged standing among traffic police in Navsari**" by Dr. **Amit S Patel, Jolly H Pandya, Raj D Viramgama, Magduma M Aakhalu and Bhumika A Vishwakarma** reported that, as traffic police officers have long standing hours on duty, medial longitudinal arch may become flat due to stress from pounding on surface. It was concluded that that effect of prolonged standing is responsible for causing of flat foot in traffic police of Navsari district with normal BMI and overweight BMI almost equally. [6]

AIM

AIM: To evaluate hindfoot alignment especially calcaneal angle deviation from centre in weight-bearing position using laser beam in salesperson.

OBJECTIVES: To assess hindfoot alignment especially calcaneal angle deviation from centre in weight-bearing position using laser beam in salesperson.

HYPOTHESIS

NULL HYPOTHESIS: After assessment, using laser beam, it will suggest that there will be no deviation in hindfoot alignment.

ALTERNATE HYPOTHESIS: After assessment, using laser beam, it will suggest that there is deviation in hindfoot alignment.

METHODOLOGY

STUDY DESIGN: Cross- sectional study

SAMPLING METHOD: Convenience sampling

SAMPLE SIZE: 100

STUDY SETUP: Local store/mart Mumbai (Suburban) & Navi Mumbai

INCLUSION CRITERIA: 1. salesperson: male, female

2. Working hours: at least 8 hr/day

3. age: 20- 30yr

4. Experience: atleast 1yr

EXCLUSION CRITERIA: 1. Previous history of hip, knee, ankle or foot trauma/injury/surgery.

2. Confirmed diagnosis of RA, ankylosis spondylitis, polio

3. Any congenital deformity of the lower limb**.**

MATERIALS:

1. Consent form
2. Data collection sheet
3. Vertical laser beam
4. Pen

OUTCOME MEASURE: Laser Beam brand: Universal Buyer. New level laser plastic horizon vertical measure tape aligner bubbles ruler multifunction leveller tool.

PROCEDURE

- Ethical clearance was obtained from the Institutional Ethics Committee of TMV'S Lokmanya Tilak College of Physiotherapy, Kharghar.
- The purpose and the procedure of the study was clearly explained to the participants and the informed consents were taken.
- Demographic data of the participants were obtained and later evaluation is done.
- Participants were selected as per the criteria
- We drew some landmarks on the body surface to measure hindfoot alignment.
- First the patient was taken in a prone position to mark the landmarks.
- We marked three points on the bisection line of the calcaneus and one point at the Achilles tendon. The outline of the calcaneus was palpated to mark them.
- After marking the landmarks, participants were made to stand.
- Participant stood with feet apart (10cm).

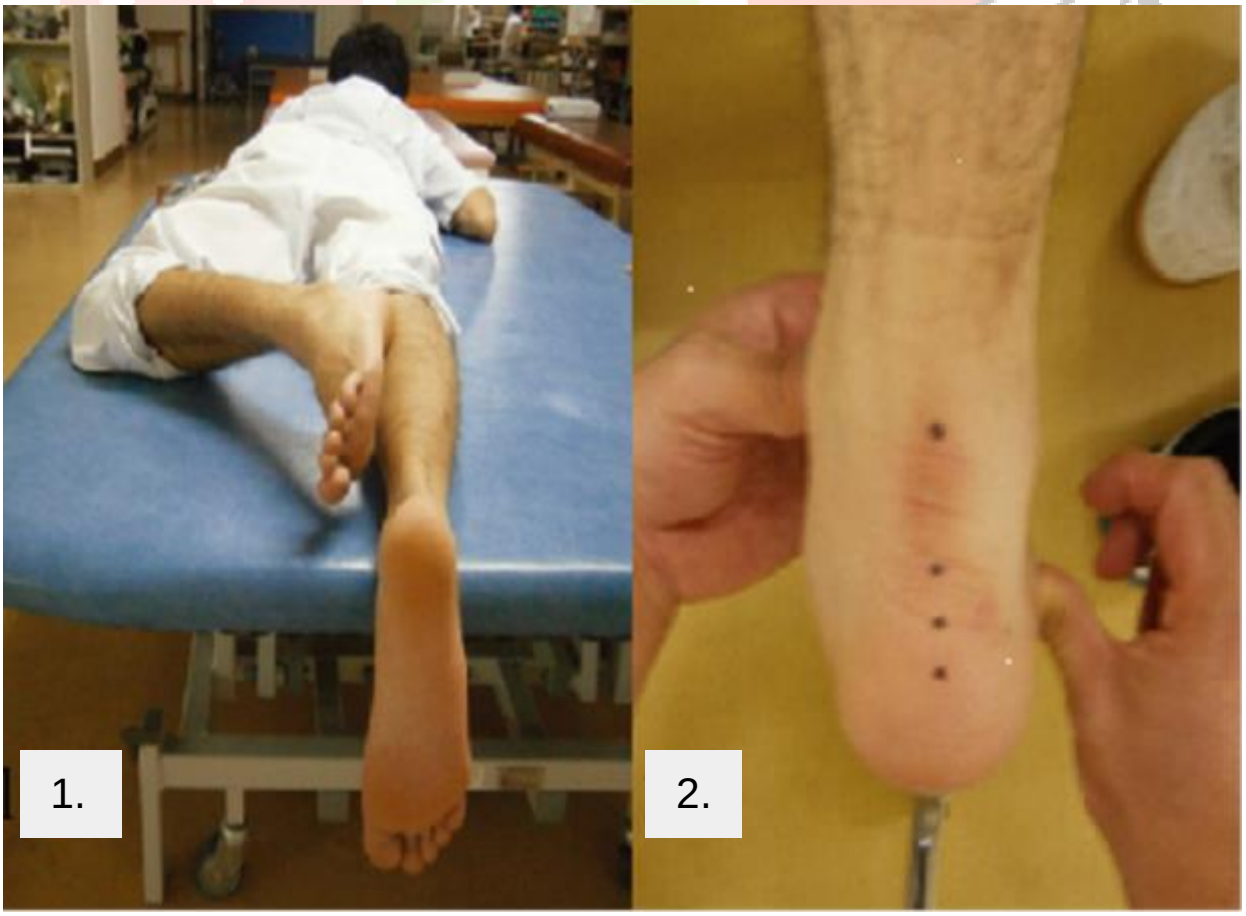

Figure 1: Position for marking landmarks. The subject was positioned in prone.
Figure 2: Three points on the calcaneus and one point at the achilles tendon.
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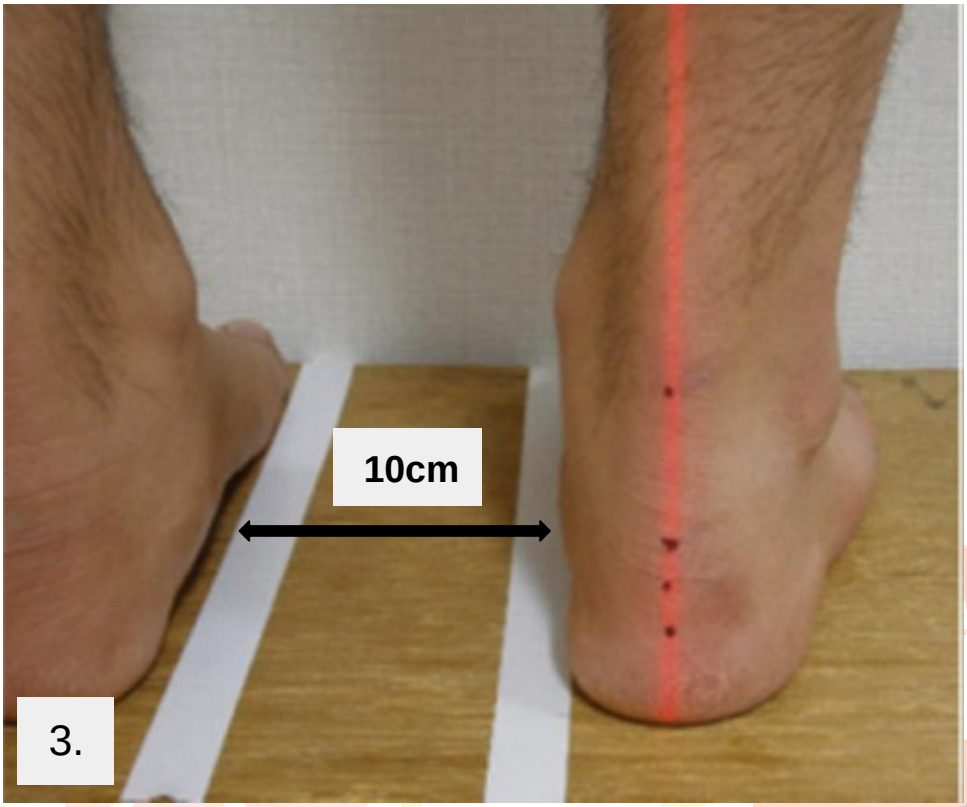


Figure3: The laser beam was directed vertically from the floor to pass through the middle of the achilles tendon.

- The laser beam source was 1m away from the heel on the posterior aspect of the subject.
- We then evaluated the calcaneal varus–valgus alignment by projecting a vertical laser beam
- Both right and left feet were assessed in all participants.
- Any deviations like calcaneal valgus(eversion) or varus(inversion) or central alignment were noted.

STATISTICAL ANALYSIS AND RESULTS

STATISTICAL ANALYSIS: - Data analysis was done using MS EXCEL for calculating percentage values of left and right foot.

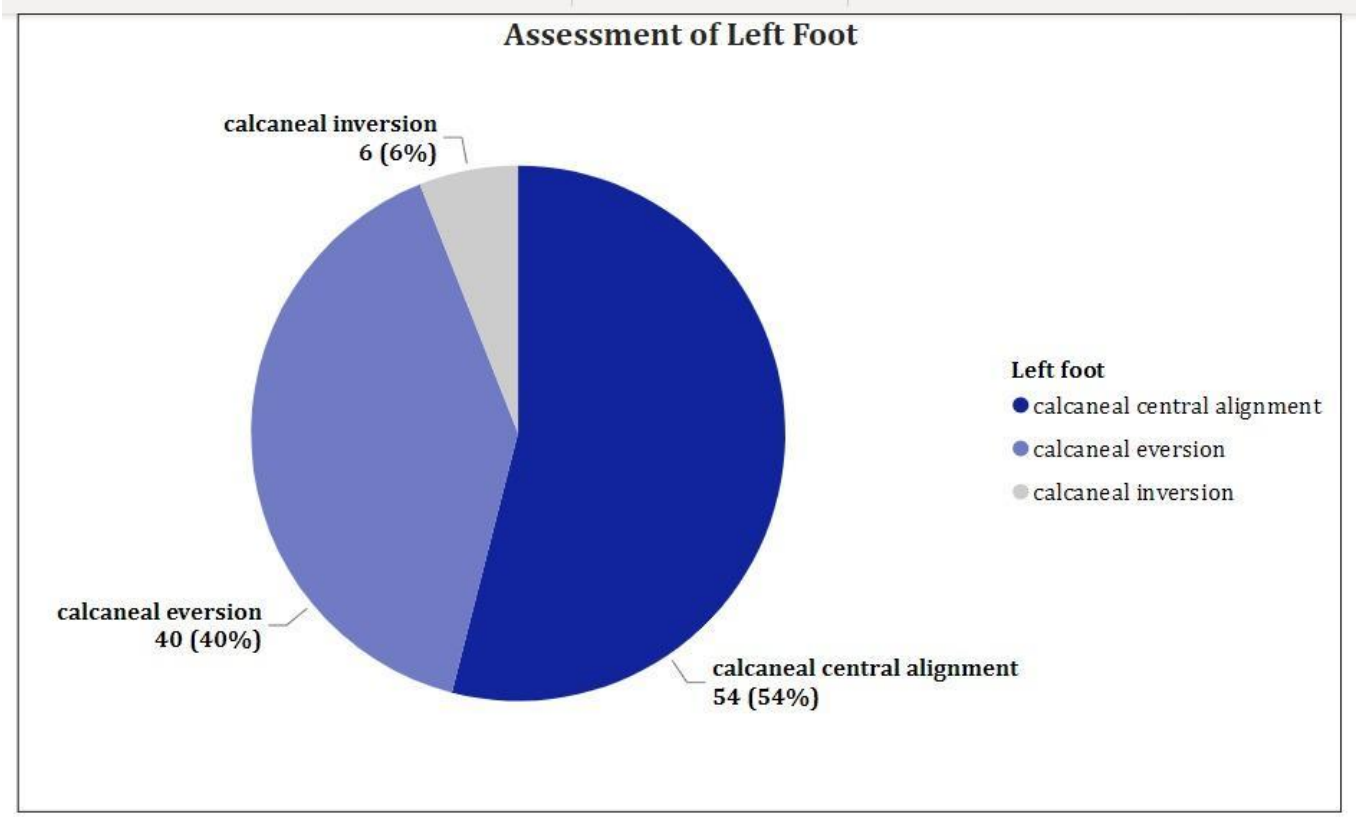
RESULTS: -

Gender	Count of gender
Male	86
Female	14
Total	100

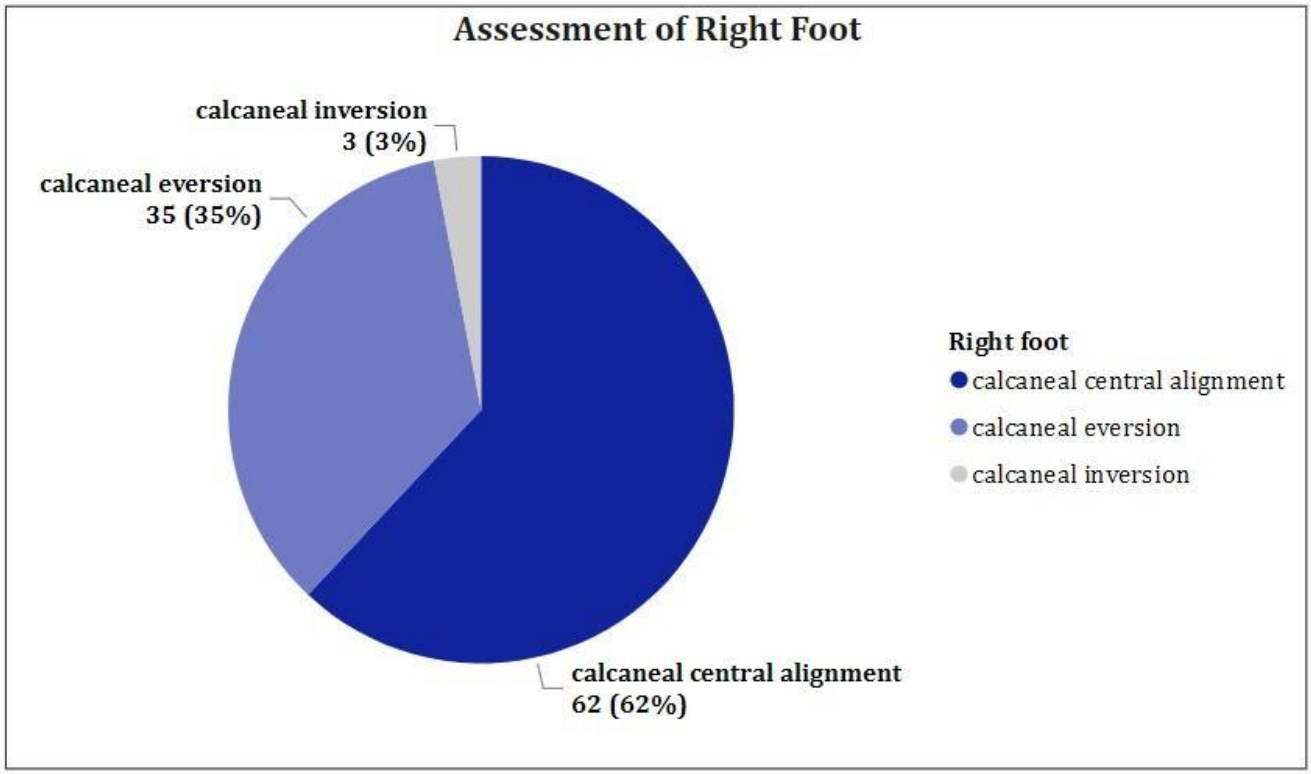
Table 1: Number of participants.

The above table represents those one hundred salespersons participated in the research. This includes 86% males and 14% female salesperson.

Graph 1: Assessment of left foot.



The above pie diagram represents the assessment of the left foot. It shows that 54% of the assessed left foot showed calcaneal central alignment. While 40% of the assessed left foot of the salesperson showed calcaneal eversion and only 6% showed calcaneal inversion.



Graph 2: Assessment of the right foot.

The above pie diagram represents the assessment of the right foot. It shows that 62% of the assessed right foot showed calcaneal central alignment. While 35% of the assessed right foot of the salesperson showed calcaneal eversion and only 3% showed calcaneal inversion.

After data analysis, we found that the left foot showed more deviation i.e., 46% than the right foot which showed 38% of deviation.

DISCUSSION

This study was done to evaluate hindfoot alignment in weight bearing position using laser beam in salesperson.

Standing is one of the most favoured working postures since it allows individuals a great deal of physical freedom and movement. Prolonged standing, on the other hand, causes physiological discomfort, muscle fatigue, and pain, and may contribute to the development of serious health hazards such as Musculoskeletal Disorders (MSDs), with a particular focus on regions such as the back, leg, and foot. [(10)]

Many bone landmarks were chosen for this purpose. Three points are marked along the calcaneus bisection line, and one point is marked at the Achilles tendon. To identify them, the calcaneus outlines was palpated. The laser beam source will be 1m away from the subject's heel on the posterior side. For the purpose of assessing any calcaneal deviations, a vertical laser beam will be projected. [(1)]

A total of 150 salesperson from different local stores were approached for the data collection. Out of which 30 did not give consent for the same. Other 20 participants were excluded since they did not fulfil the inclusion criteria. Total of 100 salesperson were completing all the points of inclusion criteria, so they were included in the study.

From the data we collected, we saw that in our study the majority were male population. According to the results, the majority of the population showed calcaneal central alignment in right as well as left foot. Although few proportions of the participants showed calcaneal eversion in one or the other foot or both. Few participants showed calcaneal inversion.

Changes in the tilt of the subtalar joint axis alter the range of motion of component movements and have an impact on both foot and leg posture in weight bearing. [(8)] Due to the superimposed body weight, while a person is weight-bearing, the calcaneus is on the ground and typically free to move around a longitudinal axis,

i.e. in an inversion or eversion motion .Weight-bearing subtalar joint motion has a direct influence on the segments and joints above it .The calcaneus, which bears our weight, will still contribute to the eversion part of subtalar motion when we are standing .When a weight-bearing subtalar joint is pronated, it creates a medial rotation force on the leg, which can affect the knee and hip joints .In the same way that subtalar pronation and supination can impose rotatory pressures on the leg during weight bearing, rotation of the leg can also have an effect on the subtalar joint .In the standing posture, there is more flexion, adduction, and tibial internal rotation, according to research.[12] As the talus is medially rotated (adducted) by the moving tibiofibular mortise, this internal(medial) rotary torque produced on the weight-bearing leg will inevitably cause subtalar pronation. [11] Thus, we can see participants showing calcaneal eversion in one or the other foot or both.

Similarly, the weight-bearing calcaneus will continue to provide the subtalar motion inversion component. The linked component of talar abduction moves the mortise (the tibia and fibula) laterally when the subtalar joint supinates in a weight-bearing position, resulting in lateral rotation of the leg. Similar to how the subtalar joint can be affected by pronation and supination, rotation of the leg can also have an impact on the subtalar joint. The mortise and the talus's main body are carried laterally when a lateral rotatory force is applied to the weight-bearing leg, causing the subtalar joint to supinate. [11]

Few other possible causes for calcaneal eversion seen includes overpronation i.e., when the foot rolls inward too much during prolonged standing, causing the ankle to excessively evert. Weakness or tightness of the foot and ankle muscles causing muscle imbalance or weakness can affect the alignment and stability of the foot and ankle bones, leading to excessive eversion. Structural abnormalities of the foot such as flat feet or high arches, can affect the alignment of the foot bones and contribute to excessive eversion. Footwear that does not provide adequate support or stability for the foot can contribute to excessive pronation. Trauma or injury to the foot and ankle damages the bones, ligaments, or tendons in the foot and ankle can affect the alignment of the foot bones and lead to excessive eversion. As we age, the tissues and structures in our feet and ankles can become less flexible and resilient, leading to changes in foot mechanics. Few of the causes were considered, and participants were accordingly excluded. [15]

Possible causes for calcaneal inversion seen are supination where the foot rolls outward during walking, running or prolonged standing causing the arch to elevate and the heel to invert. Some people are born with congenital deformities like foot deformities that lead to calcaneal inversion. The muscles that support the ankle and foot can become weak due to inactivity or neuromuscular disorder, leading to abnormal foot mechanics and calcaneal inversion. Damage to the ligaments and tendons that attach to the calcaneus can cause it to deviate from its normal position. Osteoarthritis and rheumatoid arthritis can cause inflammation and damage to the joints of the foot, leading to inversion. Trauma like fracture to the foot and ankle can cause damage to the bones and soft tissues that affect the alignment of the calcaneus. Few of the causes were considered, and participants were accordingly excluded. [16]

Mismatches between the foot and the footwear degrade foot function and can cause the foot to endure excessive pressure from shoes that are too tight or uncomfortable friction from shoes that are too loose .The structural deformation caused by weight bearing on the foot skeleton can be linked to the variations with increased load .The calcaneus acts as a support strut, flattening both the medial longitudinal arch and the transverse arch when the body weight travels from the talus to the other bones .Foot orthotics are frequently utilized for an array of reasons, which includes lowering pressure on the foot and preventing over-eversion and over-inversion.[17]

CONCLUSION

The study concluded that after assessment, using laser beam, it suggested that there is minor deviation in hindfoot alignment. Although the majority of the salesperson showed central alignment. However, few of the participants showed calcaneal eversion i.e., 40% in left foot (graph1) and 35% in right foot (graph2). The participants also showed calcaneal inversion i.e., 6% in left foot (graph1) and 3% in right foot (graph2).

LIMITATIONS

While the position of the subtalar joint may help us understand the structure and function of the foot, its influence must also be taken into account in relation to other interrelated factors, such as structural deviations (such as femoral or tibial rotation), extrinsic factors like footwear, running surfaces, and activity level (amount

and change), and physiological factors like obesity or disease. Weight, height, age, and job tenure must all be considered because they are connected to the discomfort rating that comes with prolonged standing. [10] Leg dominance should also be taken into consideration.

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ANNEXURE-1

CONSENT FORM

Title: - "_____"

PARTICIPANTS: - I confirm that_____(investigator) has explained to me the purpose of the research, the study procedure and possible risk and benefits that I may experience. I have read and understood this consent to participate as a subject in this research project.

Name: - Date: -

Signature: -

INVESTIGATOR: -

I have explained to _____ the purpose of the research, the procedure required and the possible risk and benefits to the best of my ability. I have made every effort to make participants understand and clear all questions put forward.

Date: -

ANNEXURE-2

INFORMATION SHEET

A study "EVALUATION OF HINDFOOT ALIGNMENT IN WEIGHT-BEARING POSITION USING LASER BEAM IN SALESPERSON" is being conducted in order to understand the deviation in the hindfoot especially in calcaneal angle, present.

You will be a part of this study if you meet all the points of the inclusion criteria. Then with your consent I will mark the necessary landmark for assessment. Following which you will be asked to stand with feet apart and with the help of a laser beam I will assess the alignment.

Your information will be kept confidential. During publication if needed some general information might be revealed but your identity will not be disclosed.

If you have any questions to be asked or you wish to opt out of the study, please feel free to do that.

ANNEXURE-3

DATA COLLECTION SHEET

Name: - Age: -

Gender: - Contact no.: -

Address: - Occupation: -

Assessment: -

	Right	Left
Calcaneal inversion		
Calcaneal eversion		
Calcaneal central alignment		