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Original Research Article

A COMPARISON OF MLA IN THE HILLY REGIONS OF UTTARAKHAND

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Abstract

Background: The human foot is a very strong and complex anatomical system that offers a flexible surface that is useful for ground plane adaptation, shock absorption, weight transfer, and movement. Based on the anatomy of MLA, three sorts of feet have been proposed: normal, pes planus, and pes cavus. **Materials and Methods:** This study included 600 people. 100 men and 100 women from Garhwal, Jaunsar, and Kumaon of Uttarakhand. It includes NDT for both weight-bearing and non-weight-bearing individuals for both the right and the left feet. Before measuring the NH of both weight-bearing and non-weight-bearing, the feet are assessed using anthropometric measurements and ocular inspection, foot history is asked and the consent form is signed after giving the research instructions. **Result:** It lends credence to the hypothesis that Garhwali females were the ones with flat feet most often observed acc. to NDT. On the other hand, the most frequently found flat feet in males were Kumaoni feet. Jaunsari's were found with high arched/ Pes cavus feet. The BMI of the Jaunsari was less than the Garhwali's and Kumaoni's. The Kumaoni were the most found with a max BMI in comparison to other hilly individuals i.e. - Garhwali and Jaunsari. • The majority of Jaunsari were discovered to be neutral and very few to have flat feet. For the Garhwali female group, the p-value was 0.015, indicating significance; for the Garhwali male group, it was 0.06, the Jaunsari female group 0.29, and for the Jaunsari male group 0.0014, indicating highly significant results. The p-value for the male and female Kumaoni groups is 0.15 and 0.16, respectively. A p-value of 0.05 is regarded as significant. **Conclusion:** There is a lack of previous research, not many studies have been carried out in this field. Most of the individuals showed low-arched feet in the Garhwali and Kumaoni regions of Uttarakhand i.e., abnormal foot typology, preventive measures should be encouraged, such as adequate foot care, compensatory exercises, proper shoe selection, physiotherapy, etc. For young Indian individuals between the ages of 20 and 50, the current study has produced an extensive database on the morphology of the Medial Longitudinal Arch (MLA) using the NDT. Prior research on this subject has not compared the right and left feet of people living in Uttarakhand's hilly regions. The database that this study reports will be very important to podiatrists, orthopaedic surgeons, and foot prosthetics and orthotics companies.

INTRODUCTION

Evolution's most significant advance was the creation of the bipedal walk and upright posture. All creatures, including mammals and reptiles, are quadrupeds, meaning that all four limbs are needed for locomotion and weight transmission. Their bodies lie parallel to the ground. The development of an erect posture caused the forelimbs to become independent structures and the hindlimbs to bear the brunt of weight transmission. Primates have benefited greatly from these modifications, and eventually, Homo sapiens and sapiens (humans) have grown very adaptable and have begun to experience the advantages of bipedal stride. He has been chasing after prey, scaling trees to get fruit, and cultivating land to provide food. As human evolution continued, he developed into a sociable animal, giving rise to the ideas of the family and society. This led to competitiveness in social life on several levels. As civilization became more sophisticated, community activities emerged.[1]

The human foot is an extremely robust and intricate anatomical system, with 26 bones in total, 33 joints,

42 muscles, and over 50 tendons, ligaments, and other soft tissues in surrounding areas. The forefoot, midfoot, and hindfoot are the three primary areas of the foot that support the weight of the body and enable bipedal locomotion. [2-3] The bones of the foot are not arranged in a horizontal plane but rather in arches. They allow the feet to bear the weight of the body when standing and act as shock absorbers during movement, i.e., during walking, running, jumping, etc. There are two types of foot arches: longitudinal and transverse arches. The longitudinal arch consists of a medial and a lateral part. Its medial part, i.e., the medial longitudinal arch (MLA) is made up of the calcaneus, the talus, the navicular, the three cuneiform bones (medial, intermediate, and lateral), and the first three metatarsal bones. It is higher than the lateral arch and is called the foot arch normally. The lateral part, i.e., the lateral longitudinal arch (LLA) is composed of the calcaneus, the cuboid, and the fourth and fifth metatarsals. [4-5]

The geometry of the foot, the bones, the strength of the ligaments, and muscular fatigue all influence how the MLA is arranged. Numerous factors can influence foot posture and typology, including biological characteristics (race, age, sex), foot abnormalities such as flatfoot and clubfoot, neurological elements as diabetic neuropathy, genetic problems and diseases such as rheumatoid arthritis, inherited factors - trauma (damage to the ankle and foot). Other factors include pregnancy (increased ligamentous laxity), footwear selection (poor footwear choices may lead to foot deformities), and physical activity/ sports participation (high-impact exercises and intensive training programs may have negative effects on foot posture). Also, gender can be considered a risk factor; statistically speaking men are more prone to having flat feet, while women are more prone to having high arches. [6-7]

Three types of feet—normal, pes planus, and pes cavus—have been hypothesized based on the anatomy of MLA. Pes planus, Pes cavus, Talipes Equinus, Talipes Equino varus, Talipes Equino valgus, Metatarsus adductus, Calcaneo valgus, Plano valgus, and other frequent congenital or developmental foot abnormalities are among them. Pes planus, or flat foot, is a common ailment that affects adults.[3]

MATERIALS AND METHODS

The study is cross-sectional and is conducted in the Department of Anatomy, Shri Guru Ram Rai Institute of Medical and Health Science, Patel Nagar, Dehradun, Uttarakhand.

Inclusion Criteria
The healthy Individuals between 20-50 years of age, 100 males and 100 females from each hilly Garhwal, Jaunsar and Kumaon regions of Uttarakhand. And the migrated individuals staying in these particular regions ancestrally and for more than 20 years.

Exclusion Criteria
Following surgery, instances of accidents, individuals suffering from burns, fractures, paralysis, CTEV, patients under the age of twenty, individuals older than fifty, patients with disabilities, instances of obesity, individuals with a history of external foot radiation, persons who have migrated and lived in these specific areas for less than 20 years, as well as those with foot illnesses.

Study Tool
Custom-made Index card, Digital Vernier Calliper, Colour marker, Pencil, height measuring inch tape, Digital weight machine.

A cross-sectional study of 600 individuals from the hilly Garhwal, Jaunsar and Kumaon regions of Uttarakhand and of three different age groups between 20-30, 30-40, and 40-50 are provided by accurate guidance and instructions before the examination and the sample collection in a proper manner according to the institutional ethical committee clearance. The Consent form is read & signed by each individual before the sample collection. All the data is entered in spreadsheets and analyzed by standard protocol. SPSS version 1 is used for analyzing the data. The normality of the data is tested using the Shapiro-Wilk test. The median and Interquartile range (IQR) is calculated for the demographic parameters. The ND among males, females, and different age groups is compared using Mann Whitney U test. The criteria are to determine flat foot ND of ≥ 10 mm. Using these criteria, the prevalence is calculated separately for males, females, different age groups, and also for the entire study population. A p-value of less than 0.05 is considered statistically significant.

Sample Analysis
The following parameters will be assayed from every participating individual:
1. Arch Height (AH) of weight-bearing right root
2. Arch Height (AH) of weight-bearing left root
3. Arch Height (AH) of the right foot without weight
4. Arch Height (AH) of left foot without weight
5. Navicular Drop of right foot (RND) in a single report.
6. Navicular Drop of left foot (LND) in a single report.
7. Height, Weight, and BMI are also calculated for different age groups among the study population.

Most frequently, visual observation, navicular/ arch height, angular foot measurements (radiography), and footprint measurements (podography/ plantography) are employed to categorize foot typology and posture. The feet can be checked while moving (dynamic examination) or while they are stationary (static examination). The navicular/ midfoot height is one of the anthropometric parameters of the feet used in this investigation. The first evaluation of the kind and posture of the foot is done through visual observation or inspection. There are three types of feet: normal, flat, and high-arched. The alignment of the foot and ankle can be categorized as neutral, pronated and supinated. This

classification helps to provide a general understanding of the foot typology and posture and highlights areas that require further examination.

For the foot assessment of the participating individuals in the present study, first of all the navicular tuberosity is located and its distance from the ground is marked on the custom-made index card to calculate the NH in a non-weight-bearing individual in a sitting position then the same is measured and marked on custom made index card for a weight-bearing individual in standing position, now the height of the medial longitudinal arch is measured by the digital vernier calliper to calculate the navicular drop (ND) for both. The difference between the navicular heights of both measurements is called ND. If the ND drop is greater than 10 mm, the foot is overpronated and would be deemed pathological, a value lower than 5mm is considered supinated and values in between 5mm-10mm are neutral.[3-8]
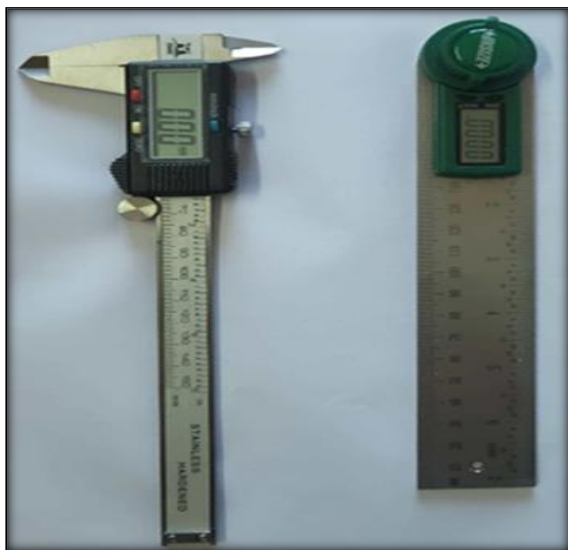

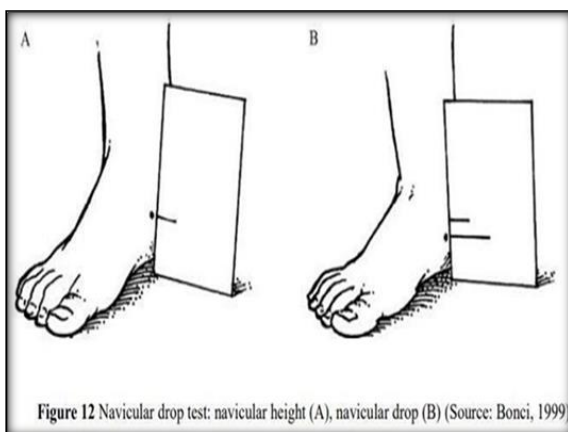**Image 1: A. Digital vernier calliper, B. digital goniometer**

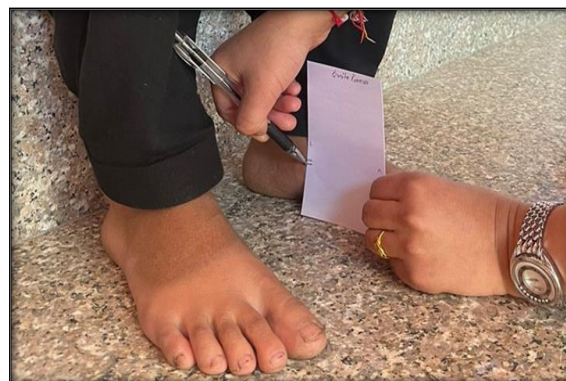**Image 2: Navicular drop test A. Navicular height B. Navicular drop**

Image 3: Custom made index card, Navicular height and Navicular drop

RESULTS

In the present study among the total studied female population of the hilly regions of Garhwali, Jaunsari and Kamaoni's, [Figure 1] shows the percentage of pes planus RF was found highest in Garhwali females (46%), 32% RF pes planus were Kumaoni females, 18% RF pes planus were found Jaunsari females. On the other hand percentage of pes cavus RF was found highest in Jaunsari females (45%), 15% of RF pes cavus were Kumaon's and 10% pes cavus were found Garhwali females. The percentage of NF was found as 53% KF > 44% GF > 37% JF.

Among the total studied female population [Figure 2] shows that the percentage of pes planus LF was found highest in Garhwali females (35%), 29% LF pes planus were Kumaoni females, 10% LF pes planus were found Jaunsari females. On the other hand percentage of pes cavus LF was found highest in Jaunsari females (43%), 22% of LF pes cavus were Kumaon's and 16% pes cavus were found Garhwali females. The percentage of NF was found as 49% KF =49% GF > 47% JF.

In the present study among the total studied male population [Figure 3] shows the percentage of pes planus RF was found highest in Kumaoni males (39%), 38% RF pes planus were Garhwali males, 8% RF pes planus were found Jaunsari males. On the other hand percentage of pes cavus RF was found highest in Jaunsari males (43%), 16% of RF pes cavus were Garhwali males and 14% pes cavus were found Kumaoni males. The percentage of NF was found as 49% JM > 47% KM > 46% GM.

Among the total studied male population [Figure 4] shows that the percentage of pes planus LF was found highest in Kumaoni males (47%), 31% LF pes planus were Garhwali males, 18% LF pes planus were found Jaunsari males. On the other hand percentage of pes cavus LF was found highest in Jaunsari males (32%), 16% of LF pes cavus were Garhwali females and 13% pes cavus were found Kumaoni males. The percentage of NF was found as 53% GM > 50% JM > 40% KM.

[Figure 5] shows the mean±SD cm value of RFNH as 52.95±7.37, LFNH as 50.98±8.77, RFNHW as 43.41±8.05, LFNHW as 41.95±8.38, RND as

9.30±3.51, LND as 9.36±4.06. The median is 53.41 for RFNH, 52.08 for LFNH, 44.54 for RFNHW, 43.80 for LFNHW, 9.26 for RND, and 8.92 for LND. The IQR is 7.58 for RFNH, 9.54 for LFNH, 7.46 for RFNHW, 7.18 for LFNHW, 5.99 for RND, and 4.72 for LND. The p-value for RFNH and LFNH is 0.07 (not significant), for RFNHW and LFNHW it is 0.21(not significant), for RND and LND it is 0.84 (not significant). The Mann-Whitney U test is not significant for the whole Garhwali female group.

[Figure 6] shows the mean±SD cm value of RFNH as 54.54±9.72, LFNH as 52.18±11.29, RFNHW as 45.17±10.40, LFNHW as 43.76±11.33, RND as 9.29±4.34, LND as 8.65±3.55. The median is 56.09 for RFNH, 54.32 for LFNH, 46.37 for RFNHW, 46.47 for LFNHW, 9.04 for RND, and 8.25 for LND. The IQR is 12.94 for RFNH, 14.05 for LFNH, 13.02 for RFNHW, 14.50 for LFNHW, 6.46 for RND, and 4.83 for LND. The p-value for RFNH and LFNH is 0.23 (not significant, for RFNHW and LFNHW it is 0.59(not significant), for RND and LND it is 0.41 (not significant). The Mann-Whitney U test is not significant for the whole Garhwali male group.

[Figure 7] shows the mean±SD cm value of RFNH as 49.52±5.93, LFNH as 47.92±5.33, RFNHW as 42.98±7.05, LFNHW as 41.95±7.04, RND as 6.54±3.84, LND as 5.94±3.71. The median is 50.24 for RFNH, 49.53 for LFNH, 43.65 for RFNHW, 43.32 for LFNHW, 5.49 for RND, and 5.68 for LND. The IQR is 7.13 for RFNH, 7.69 for LFNH, 10.37 for RFNHW, 9.12 for LFNHW, 5.81 for RND, and 4.38 for LND. The p-value for RFNH and LFNH is 0.22 (not significant, for RFNHW and LFNHW it is 0.49(not significant), for RND and LND it is 0.30 (not significant). The Mann-Whitney U test is not significant for the whole Jaunsari female group.

[Figure 8] shows the mean±SD cm value of RFNH as 54.46±3.92, LFNH as 54.84±3.96, RFNHW as 48.66±3.60, LFNHW as 47.92±4.66, RND as 5.80±2.63, LND as 6.92±3.05. The median is 53.84 for RFNH, 54.78 for LFNH, 48.77 for RFNHW, 47.63 for LFNHW, 5.52 for RND, and 6.74 for LND. The IQR is 6.19 for RFNH, 7.12 for LFNH, 4.06 for RFNHW, 8.48 for LFNHW, 3.38 for RND, and 5.02 for LND. The p-value for RFNH and LFNH is 0.59 (not significant, for RFNHW and LFNHW it is 0.51(not significant), for RND and LND it is 0.009 which is highly significant. The Mann-Whitney U test is significant for RND and LND but not significant for RFNH and LFNH as well as not significant for RFNHW and LFNHW for Jaunsari male group.

[Figure 9] shows the mean±SD cm value of RFNH as 46.95±6.69, LFNH as 48.00±6.57, RFNHW as 41.15±8.42, LFNHW as 39.62±5.46, RND as 8.64±3.40, LND as 8.06±3.65. The median is 49.40 for RFNH, 48.75 for LFNH, 40.90 for RFNHW, 39.68 for LFNHW, 8.78 for RND, and 7.30 for LND. The IQR is 9.91 for RFNH, 8.60 for LFNH, 9.5 for RFNHW, 7.41 for LFNHW, 5.29 for RND, and 5.69 for LND. The p-value for RFNH and LFNH is 0.25 (not significant, for RFNHW and LFNHW it is

0.22(not significant), for RND and LND it is 0.15 (not significant). The Mann-Whitney U test is not significant for the whole Kumaoni female group.
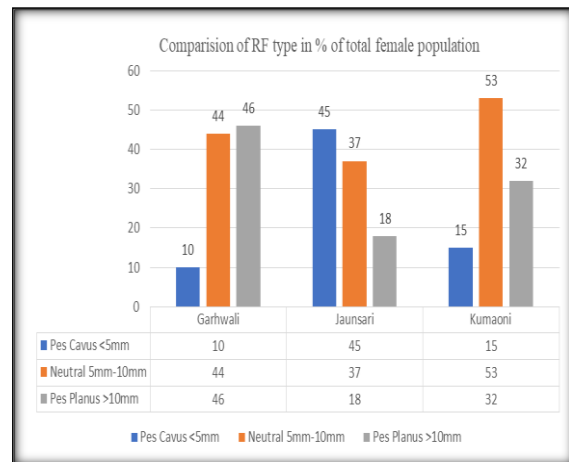

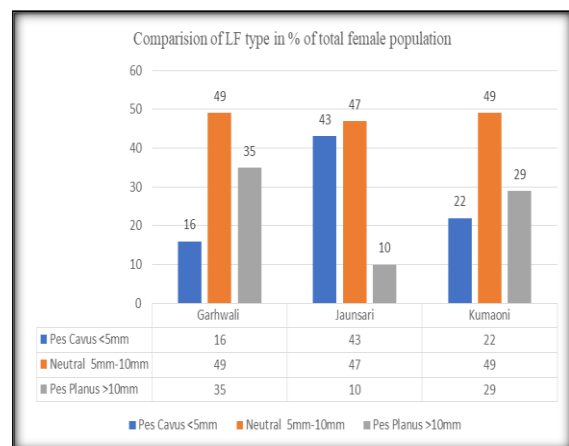**Figure 1: Comparison of RF type in % of total female population**

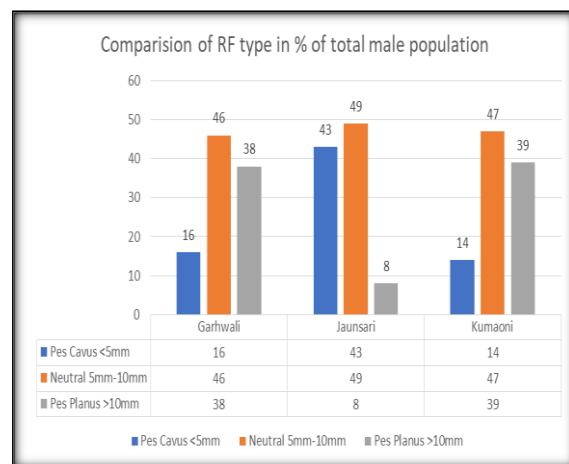**Figure 2: Comparison of LF type in % of total female population**

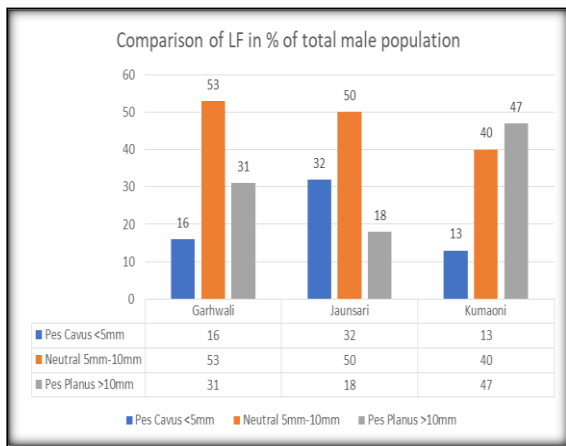

Figure 3: Comparison of RF type in % of total male population

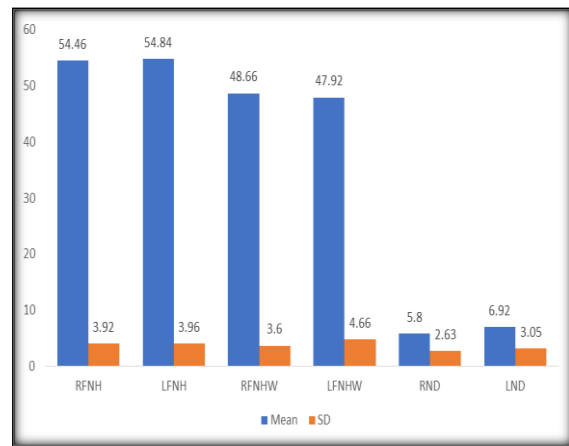**Figure 4: Comparison of LF type in % of the total male population**
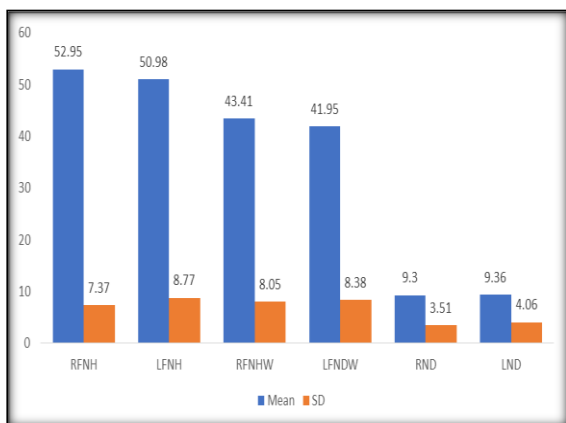

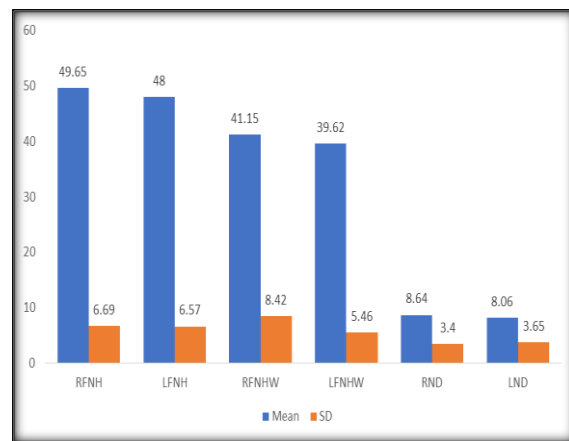**Figure 8: Jaunsari male group**

Figure 5: Garhwali female group

Figure 9: Kumauni female group
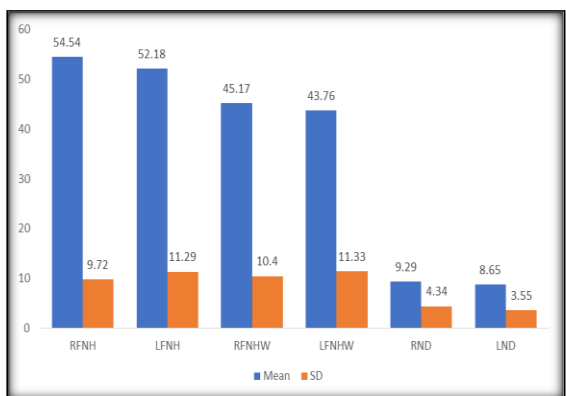
Figure 6: Garhwali male group
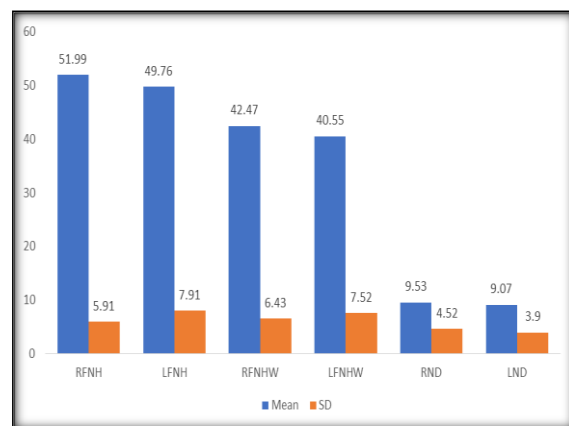
Figure 10: Kumauni male group
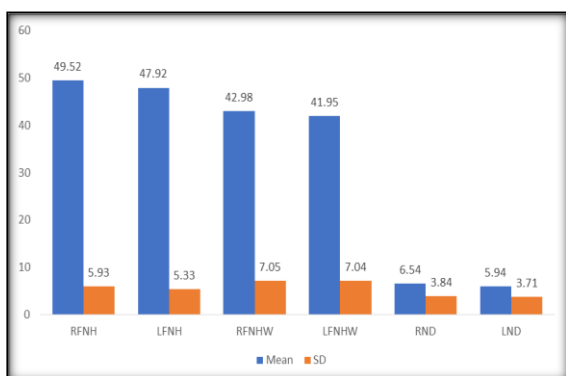
Figure 7: Jaunsari female group

[Figure 10] shows the mean±SD cm value of RFNH as 51.99±5.91, LFNH as 49.76±7.91, RFNHW as 42.47±6.43, LFNHW as 40.55±7.52, RND as 9.53±4.52, LND as 9.07±3.90. The median is 51.26 for RFNH, 52.21 for LFNH, 41.58 for RFNHW, 40.67 for LFNHW, 8.58 for RND, and 8.92 for LND. The IQR is 9.47 for RFNH, 15.17 for LFNH, 9.23 for RFNHW, 10.8 for LFNHW, 7.31 for RND, and 6 for LND. The p-value for RFNH and LFNH is 0.35 (not significant, for RFNHW and LFNHW it is 0.16 (not significant), for RND and LND it is 0.65 (not significant). The Mann-Whitney U test is not significant for the whole Kumaoni male group.

Table 1: Comparison of RF type in % of total female population

Group	Total number	Pes Cavus <5mm	Neutral 5mm-10mm	Pes Planus >10mm
Garhwali	100	10	44	46
Jaunsari	100	45	37	18
Kumaoni	100	15	53	32

Table 2: Comparison of LF type in % of total female population

Group	Total number	Pes Cavus <5mm	Neutral 5mm-10mm	Pes Planus >10mm
Garhwali	100	16	49	35
Jaunsari	100	43	47	10
Kumaoni	100	22	49	29

Table 3: Comparison of RF type in % of total male population

Group	Total number	Pes Cavus <5mm	Neutral 5mm-10mm	Pes Planus >10mm
Garhwali	100	16	46	38
Jaunsari	100	43	49	8
Kumaoni	100	14	47	39

Table 4: Comparison of LF type in % of total male population

Group	Total number	Pes Cavus <5mm	Neutral 5mm-10mm	Pes Planus >10mm
Garhwali	100	16	53	31
Jaunsari	100	32	50	18
Kumaoni	100	13	40	47

Table 5: Garhwali female group

	GF					
	Mean	SD	Median	U-test	p-Value	IQR
RFNH	52.95	7.37	53.41	4402	0.07	7.58
LFNH	50.98	8.77	52.08			9.54
RFNHW	43.41	8.05	44.54	4486	0.21	7.46
LFNHW	41.95	8.38	43.80			7.18
RND	9.30	3.51	9.26	4916.5	0.84	5.99
LND	9.36	4.06	8.92			4.72

Table 6: Garhwali male group

	GM					
	Mean	SD	Median	U-test	p-value	Interquartile Range
RFNH	54.54	9.72	56.09		0.23	12.94
LFNH	52.18	11.29	54.32	4515.5		14.05
RFNHW	45.17	10.40	46.37	4783	0.59	13.02
LFNHW	43.76	11.33	46.47			14.50
RND	9.29	4.34	9.04	4662	0.41	6.46
LND	8.65	3.55	8.25			4.83

Table 7: Jaunsari female group

	JF					
	Mean	SD	Median	U-test	p-value	Interquartile Range
RFNH	49.52	5.93	50.24	4327.5	0.22	7.13
LFNH	47.92	5.33	49.53			7.69
RFNHW	42.98	7.05	43.65	4847	0.49	10.37
LFNHW	41.95	7.04	43.32			9.12
RND	6.54	3.84	5.49	4578.5	0.30	5.81
LND	5.94	3.71	5.68			4.38

Table 8: Jaunsari male group

	JM					
	Mean	SD	Median	U-test	p-value	Interquartile Range
RFNH	54.46	3.92	53.84	4781	0.59	6.19
LFNH	54.84	3.96	54.78			7.12
RFNHW	48.66	3.60	48.77	4732	0.51	4.06
LFNHW	47.92	4.66	47.63			8.48
RND	5.80	2.63	5.52	3945	0.009	3.38
LND	6.92	3.05	6.74			5.02

Table 9: Kumauni female group

	KF					
	Mean	SD	Median	U-test	p-value	Interquartile Range
RFNH	49.65	6.69	49.40	4531.5	0.25	9.91
LFNH	48.00	6.57	48.75			8.60
RFNHW	41.15	8.42	40.90	4502	0.22	9.5
LFNHW	39.62	5.46	39.68			7.41
RND	8.64	3.40	8.78	4419.5	0.15	5.29
LND	8.06	3.65	7.30			5.69

Table 10: Kumauni male group

	KM					
	Mean	SD	Median	U-test	p-value	Interquartile Range
RFNH	51.99	5.91	51.26	4619	0.35	9.47
LFNH	49.76	7.91	52.21			15.17
RFNHW	42.47	6.43	41.58	4427	0.16	9.23
LFNHW	40.55	7.52	40.67			10.8
RND	9.53	4.52	8.58	4820	0.65	7.31
LND	9.07	3.90	8.92			6

DISCUSSION

In the present study among the total studied female population of the hilly regions of Garhwali, Jaunsari and Kamaoni's, [Figure 1] shows the percentage of pes planus RF was found highest in Garhwali females (46%), 32% RF pes planus were Kumaoni females, 18% RF pes planus were found Jaunsari females. On the other hand percentage of pes cavus RF was found highest in Jaunsari females (45%), 15% of RF pes cavus were Kumaoni's and 10% pes cavus were found in Garhwali females. The percentage of NF was found as 53% KF > 44% GF > 37% JF.

Among the total studied female population [Figure 2] shows that the percentage of pes planus LF was found highest in Garhwali females (35%), 29% LF pes planus were Kumaoni females, 10% LF pes planus were found in Jaunsari females. On the other hand percentage of pes cavus LF was found highest in Jaunsari females (43%), 22% of LF pes cavus were Kumaoni's and 16% pes cavus were found Garhwali females. The percentage of NF was found as 49% KF =49% GF > 47% JF.

In the present study among the total studied male population [Figure 3] shows the percentage of pes planus RF was found highest in Kumaoni males (39%), 38% RF pes planus were Garhwali males, 8% RF pes planus were found Jaunsari males. On the other hand percentage of pes cavus RF was found highest in Jaunsari males (43%), 16% of RF pes cavus were Garhwali males and 14% pes cavus were found in Kumaoni males. The percentage of NF was found as 49% JM > 47% KM > 46% GM.

Among the total studied male population [Figure 4] shows that the percentage of pes planus LF was found highest in Kumaoni males (47%), 31% LF pes planus were Garhwali males, 18% LF pes planus were found Jaunsari males. On the other hand percentage of pes cavus LF was found highest in Jaunsari males (32%), 16% of LF pes cavus were Garhwali females and 13% pes cavus were found Kumaoni males. The

percentage of NF was found as 53% GM > 50% JM > 40% KM.

In the present study in comparison of the RF and LF in the Garhwali female group, [Figure 5] shows the mean±SD cm value of RFNH as 52.95±7.37, LFNH as 50.98±8.77, RFNHW as 43.41±8.05, LFNHW as 41.95±8.38, RND as 9.30±3.51, LND as 9.36±4.06. The median is 53.41 for RFNH, 52.08 for LFNH, 44.54 for RFNHW, 43.80 for LFNHW, 9.26 for RND, and 8.92 for LND. The IQR is 7.58 for RFNH, 9.54 for LFNH, 7.46 for RFNHW, 7.18 for LFNHW, 5.99 for RND, and 4.72 for LND. The p-value for RFNH and LFNH is 0.07 which is not significant, for RFNHW and LFNHW it is 0.21(not significant), for RND and LND it is 0.84 (not significant). The Mann-Whitney U test is not significant for the whole Garhwali female group.

In the present study in comparison of the RF and LF in the Garhwali male group, [Figure 6] shows the mean±SD cm value of RFNH as 54.54±9.72, LFNH as 52.18±11.29, RFNHW as 45.17±10.40, LFNHW as 43.76±11.33, RND as 9.29±4.34, LND as 8.65±3.55. The median is 56.09 for RFNH, 54.32 for LFNH, 46.37 for RFNHW, 46.47 for LFNHW, 9.04 for RND, and 8.25 for LND. The IQR is 12.94 for RFNH, 14.05 for LFNH, 13.02 for RFNHW, 14.50 for LFNHW, 6.46 for RND, and 4.83 for LND. The p-value for RFNH and LFNH is 0.23 (not significant, for RFNHW and LFNHW it is 0.59(not significant), for RND and LND it is 0.41 (not significant). The Mann-Whitney U test is not significant for the whole Garhwali male group.

In the present study in comparison of the RF and LF in the Jaunsari female group, [Figure 7] shows the mean±SD cm value of RFNH as 49.52±5.93, LFNH as 47.92±5.33, RFNHW as 42.98±7.05, LFNHW as 41.95±7.04, RND as 6.54±3.84, LND as 5.94±3.71. The median is 50.24 for RFNH, 49.53 for LFNH, 43.65 for RFNHW, 43.32 for LFNHW, 5.49 for RND, and 5.68 for LND. The IQR is 7.13 for RFNH, 7.69 for LFNH, 10.37 for RFNHW, 9.12 for LFNHW, 5.81 for RND, and 4.38 for LND. The p-

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value for RFNH and LFNH is 0.22 (not significant, for RFNHW and LFNHW it is 0.49(not significant), for RND and LND it is 0.30 (not significant). The Mann-Whitney U test is not significant for the whole Jaunsari female group.

In the present study in comparison of the RF and LF in the Jaunsari male group, [Figure 8] shows the mean±SD cm value of RFNH as 54.46±3.92, LFNH as 54.84±3.96, RFNHW as 48.66±3.60, LFNHW as 47.92±4.66, RND as 5.80±2.63, LND as 6.92±3.05. The median is 53.84 for RFNH, 54.78 for LFNH, 48.77 for RFNHW, 47.63 for LFNHW, 5.52 for RND, and 6.74 for LND. The IQR is 6.19 for RFNH, 7.12 for LFNH, 4.06 for RFNHW, 8.48 for LFNHW, 3.38 for RND, and 5.02 for LND. The p-value for RFNH and LFNH is 0.59 (not significant, for RFNHW and LFNHW it is 0.51(not significant), for RND and LND it is 0.009 which is highly significant. The Mann-Whitney U test is significant for RND and LND but not significant for RFNH and LFNH as well as not significant for RFNHW and LFNHW for Jaunsari male group.

In the present study in comparison of the RF and LF in the Kumaoni female group, [Figure 9] shows the mean±SD cm value of RFNH as 46.95±6.69, LFNH as 48.00±6.57, RFNHW as 41.15±8.42, LFNHW as 39.62±5.46, RND as 8.64±3.40, LND as 8.06±3.65. The median is 49.40 for RFNH, 48.75 for LFNH, 40.90 for RFNHW, 39.68 for LFNHW, 8.78 for RND, and 7.30 for LND. The IQR is 9.91 for RFNH, 8.60 for LFNH, 9.5 for RFNHW, 7.41 for LFNHW, 5.29 for RND, and 5.69 for LND. The p-value for RFNH and LFNH is 0.25 (not significant, for RFNHW and LFNHW it is 0.22(not significant), for RND and LND it is 0.15 (not significant). The Mann-Whitney U test is not significant for the whole Kumaoni female group.

In the present study in comparison of the RF and LF in the Kumaoni male group, [Figure 10] shows the mean±SD cm value of RFNH as 51.99±5.91, LFNH as 49.76±7.91, RFNHW as 42.47±6.43, LFNHW as 40.55±7.52, RND as 9.53±4.52, LND as 9.07±3.90. The median is 51.26 for RFNH, 52.21 for LFNH, 41.58 for RFNHW, 40.67 for LFNHW, 8.58 for RND, and 8.92 for LND. The IQR is 9.47 for RFNH, 15.17 for LFNH, 9.23 for RFNHW, 10.8 for LFNHW, 7.31 for RND, and 6 for LND. The p-value for RFNH and LFNH is 0.35 (not significant, for RFNHW and LFNHW it is 0.16 (not significant), for RND and LND it is 0.65 (not significant). The Mann-Whitney U test is not significant for the whole Kumaoni male group.

Reddy et al. report that out of the 300 participants in the study, 11.6% had bilateral flat feet (males 3.3% and females 8.3%). According to certain writers, the prevalence of bilateral flat foot was 11.25% by Bhoir et al., 5.2% by Arthi et al., and 13.6% by Ashok et al. The reason for discrepancies in the prevalence of flat feet among adults can be traced back to the varying sample sizes employed by various writers. [3,8,9,12]

Nielsen et al. studied 280 participants and stated that dynamic navicular drop is influenced by foot length and gender, and no significant effect was found on age (p=0.27) or BMI (p=0.88).[14]

Ashok et al. (2017) reported that the mean±SD of right ND (mm) was 0.67±0.42 and left ND (mm) was 0.69±0.42. They also found that there was a significant link between right ND and height and weight, but not with BMI. There was no significant relationship seen between left ND and BMI, weight, or height.[3]

Reddy et al. (2021) report that the mean±SD of the right ND (mm) was 0.74±0.25 and the left ND (mm) was 0.69±0.24. The study also found a highly significant association between the right and left ND and weight (p=0.00) and BMI (p=0.00). A significant correlation was also found between right ND and height (p=0.026). Both the left and right ND's correlations with age and height were not statistically significant. Their findings showed no association between age or gender and flat feet. However, flat foot was more common among female students and those in the 19–20 age range. Possible causes include variations in the sample sizes for males and females as well as between age groups. Students with normal weight had 4.6% of flat feet bilaterally and 1.4% unilaterally. Students with overweight were having 5.4% of flat feet bilaterally and 1.2% unilaterally. Students with class I obesity had 1.6% flat foot bilaterally and 0.4% unilaterally. The correlation of the ND, AI, and FPI with BMI, and weight was highly significant. It shows that the flat foot is associated with BMI and weight. Only the correlation of right ND and AI with foot length and height was significant so, a flat foot may or may not be associated with foot length and height.[8]

According to Egwu et al., the adult population in Anambra has a prevalence of flat feet of 8.9% bilaterally and 5% unilaterally.[15]

In a study including fifty teenagers between the ages of 14 and 20, Pranathi et al. found that the prevalence was 6% unilaterally and 8% bilaterally.[16]

The recreational runners, mean±SD arch height index was 0.340 ± 0.030, as reported by Butler et al. Although the arch height index was identical for both sexes, men's feet were larger than women's. The gadget used in the arch height index measurement method is dependable for use amongst testers and streamlines the measuring process for logging the arch height index. When determining possible structural characteristics that may predispose an individual to lower-extremity injuries, the arch height index may be useful.[17]

Females are more likely than males to have flat feet, according to Eluwa et al. In the southern Nigerian state of Akwa Ibom, the incidence of flat feet was found: - 13.4% of people had flat feet overall, with 5.8% of men and 7.6% of women having the condition.[18]

According to Umar et al., male participants in their study had a higher propensity than their female counterparts to acquire flat foot based on all the evaluated anthropometric foot factors. Out of 200

Yoruba school children, they found that 13% of men and 12% of females had flat feet.[19]

Chang et al. report that among 1,222 Taiwanese school-age children, the incidence percentages of flat feet were 67% for males and 49% for females.[10] According to research by Reihaneh et al., girls are somewhat more often than boys to have flat feet (75.2% of girls and 72.6% of boys had flat feet, although there was no statistically significant difference).[20]

Before this study, some individuals were unaware that they had a flat foot and did not report any pain or functional abnormality. Very few with higher BMI reported having experienced pain or numbness in the past. The study's limitations include the fact that it was limited to the hilly populations of Uttarakhand's Garhwal, Jaunsar, and Kumaon regions. The study did not involve any other population. The sample sizes for men and women were equal, but the ages of the participants were not. Just people between the ages of 20 and 50 participated in the survey. The discrepancies between the ND for the RF and the LF for the entire research population were marked on the custom-made index cards.

CONCLUSION

Based on the results and the methodology used, we have concluded that in the present study done on 600 individuals (Garhwali, Jaunsari and Kumaoni) between the age group of 20-50 years, the finding indicated that the majority of people in the hilly regions of Uttarakhand, the Garhwali's and Kumaoni's had low-arched feet, the Jausari's had high arched/ pes cavus feet. Pes planus RF was found highest in Garhwali females (46%), 32% RF pes planus were Kumaoni females, 18% RF pes planus were found in Jaunsari females. Pes cavus RF was found highest in Jaunsari females (45%), 15% of RF pes cavus were Kumaoni's and 10% pes cavus were found in Garhwali females. The percentage of NF was found as 53% KF > 44% GF > 37% JF. Pes planus LF was found highest in Garhwali females (35%), 29% LF pes planus were Kumaoni females, 10% LF pes planus were found Jaunsari females. Pes cavus LF was found highest in Jaunsari females (43%), 22% of LF pes cavus were Kumaoni's and 16% pes cavus were found in Garhwali females. The percentage of NF was found as 49% KF =49% GF > 47% JF. Among the total studied male population, Pes planus RF was found highest in Kumaoni males (39%), 38% RF pes planus were Garhwali males, and 8% RF pes planus were found in Jaunsari males. Pes cavus RF was found highest in Jaunsari males (43%), 16% of RF pes cavus were Garhwali males and 14% pes cavus were found in Kumaoni males. The percentage of NF was found as 49% JM > 47% KM > 46% GM. Pes planus LF was found highest in Kumaoni males (47%), 31% LF pes planus were Garhwali males, 18% LF pes planus were found Jaunsari males. Pes cavus LF was found highest in

Jaunsari males (32%), 16% of LF pes cavus were Garhwali females and 13% pes cavus were found Kumaoni males. The percentage of NF was found as 53% GM > 50% JM > 40% KM.

There is a dearth of prior research in this area; not many studies have been conducted. As a result, preventive measures including appropriate shoe selection, physiotherapy, compensatory exercises, and good foot care should be encouraged more. Our study generates a comprehensive database on the morphology of the MLA utilizing the ND test for young Indian individuals aged 20 to 50. People who live in Uttarakhand's hilly regions have not had their RF and LF compared in previous studies on this topic. Podiatrists, orthopedic surgeons, and companies that manufacture foot prosthesis and orthotics will find great value in the database that this study reports.

REFERENCES

1. Niemitz C. The evolution of the upright posture and gait--a review and a new synthesis. Naturwissenschaften. 2010 Mar;97(3):241-63. doi: 10.1007/s00114-009-0637-3. Epub 2010 Feb 3. PMID: 20127307; PMCID: PMC2819487.
2. Prihonska J, Kalichova M. Analysis of foot typology in basketball players. Dissertation, Bruno. 2018.
3. Aenumulapalli A, Kulkarni MM, Gandotra AR. Prevalence of flexible flat foot in adults: A crosssectional study. Journal of clinical and diagnostic research: JCDR. 2017 Jun;11(6):AC17-20.
4. GOONETILLEKE, R.S. The science of footwear. Boca Raton: CRC Press, 2013. ISBN 978-1-4398-3569-2
5. MUSCOLINO, J.E. Kinesiology: the skeletal system and muscle function. 3rd ed., St. Louis: Elsevier, 2017. ISBN 978-0-323-39620-2
6. MANN, R.A. Acquired flatfoot in adults. Clinical Orthopaedics and Related Research. 1983, Vol. 181, p. 46-51. ISSN 0009-921X
7. ABEGAZ, B. A., AWOKE, D.G. Factors affecting foot arch development in Northern Ethiopia. Anatomy. 2017, Vol. 11, no. 1, p. 26-29 DOI: 10.2399/ana.16.056
8. Reddy GPK, Kishve P. Prevalence of flat foot among medical students and its impact on quality of life and functionality. Int J Res Med Sci 2021;9:1082-9
9. Bhoir MT. prevalence of flat foot among 18 to 25 years old physiotherapy students: cross sectional study. Indian J Basic Appl Med Res. 2014;3(4):272-78.
10. Chang YW, Hung YW, Wu HW. Measurements of foot arch in standing, level walking, vertical jump and sprint start. Int J Sport Exerc Sci. 2010;2(2):31-8.
11. Brody DM. Techniques in the evaluation and treatment of injured runner. Orthopaed Clin North Am. 1982;13(3):541-58.
12. Ganapathy A, Sadeesh T, Rao S. Morphometric analysis of foot in young adult individuals. World J Pharm Pharm Sci. 2015;4(8):980-93.
13. Queen RM, Mall NA, Hardaker WM, Nunley JA 2nd. Describing the medial longitudinal arch using footprint indices and a clinical grading system. Foot Ankle Int. 2007;28(4):456-62
14. Nielsen RG, Rathleff MS, Simonsen OH, Langberg H. Determination of normal values for navicular drop during walking: a new model correcting for foot length and gender. J Foot Ankle Res. 2009;2:12.
15. Ukoha UU, Egwu OA, Okafor IJ, Ogugua PC, Igwenagu VU. Pes planus: incidence among an adult population in Anambra State, Southeast Nigeria. Int J Biomed Adv Res. 2012;3(3):166-8.
16. Pranati T, YuvrajBabu K, Ganesh K. Assessment of plantar arch index and prevalence of flat feet among South Indian Adolescent Population. J Pharm Sci Res. 2017; 9(4):490-492.

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International Journal of Academic Medicine and Pharmacy (www.academicmed.org)
ISSN (O): 2687-5365; ISSN (P): 2753-6556

17. Butler RJ, Hillstrom H, Song J, Richards CJ, Davis IS. Arch height index measurement system: establishment of reliability and normative values. J Am Podiatr Med Assoc. 2008;98(2):102. Erratum in: J Am Podiatr Med Assoc. 2008;98(4):277.

18. Eluwa MA, Omini RB, Kpela TB, Ekanem, Akpantah. The incidence of pes planus amongst Akwa Ibom state students in the University of Calabar. Internet J Forens Sci. 2009;3(2).

19. Umar MBT, Adeyemi P. Incidence of flat foot and anthropometric comparison between flat and normal foot of the Yoruba Ehtnic Group of Nigeria. Res J Appl Sci. 2010;5:412-6.

20. Askary Kachoosangy R, Aliabadi F, Ghorbani M. Prevalence of flat foot: comparison between male and female primary school students. Iranian Rehabil J. 2013;11(3):22-4

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International Journal of Academic Medicine and Pharmacy (www.academicmed.org)
ISSN (O): 2687-5365; ISSN (P): 2753-6556