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COMPARATIVE ANALYSIS OF MALE AND FEMALE ADULT FOOT DEMOGRAPHIC DATA IN NIGERIA

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ABSTRACT: Anthropometric measurements form the bedrock for the design of products for consumers' use, therefore, accurate knowledge of the different dimensions and the methods of measurements are key to obtaining veritable data. The evolving nature of the population has made it imperative for a regular up - to - date foot demographic data to be developed and established. As there is paucity of such data, this study seeks to cover this gaping hole. This study adopted the traditional measurement method which entailed the use of anthropometric instruments by five (5) researchers to manually take body measurements of four hundred (400) adult subjects comprising 200 male and 200 female. The participants were within the age bracket of 18-55 years from University of Benin, Benin-City excluding the foreigners, pregnant women, children and individuals with musculoskeletal disorders (MSDS). Stratified random sampling technique was employed in selecting the subjects to be measured. Twenty-seven foot anthropometric data were taken excluding age and weight. The resulting data were descriptively analyzed using SPSS version 16 and paired sample t-test. Result of the descriptive statistics gave the mean age, weight and height of the pooled sample of the population as; 26.47 ± 7.65 years, 63.40 ± 14.07kg and 170.52 ± 8.82cm respectively. The result also revealed that stature is significantly higher in males than in females. The results of the t-test showed that foot length and foot breadth of males differ significantly from those of the females (16.785 and $P<0.001$), (20.468 and $P<0.001$). The implication of this is that the foot demographic data established would aid the design of prosthesis and footwear for better functionality.

Keywords: Demographic data, Foot Anthropometry, Prosthesis, Footwear, Descriptive statistics

1. INTRODUCTION

Data on modelling foot anthropometric dimensions for the design of prosthesis and footwear in Nigeria are rare. This situation has therefore established a yawning crevasse for the development of foot anthropometry that can serve as baseline for the design of prosthesis and footwear. Foot anthropometry has shown that foot dimensions vary widely with individuals and the import is that the design of foot wears including prosthesis must consider those variations in order to achieve the desired fitness. The need to also understand the biomechanics associated with the normal foot before any foot orthosis or surgical intervention can be applied is considered necessary. It is instructive to note that prosthesis in this context is referred to as an artificially made limb or part of the body that is used to replace a part of the body that is missing either due to amputation or lack of development while an orthosis is a device used to correct, accommodate, or enhance the use of a body part. However, this study is only concerned with prosthesis. Research interest in Foot anthropometry dates back to the 20th century. Seminal works on foot anthropometry include those by: [1] who examined the postural mechanism of

the human foot. Kondo [2] measured the foot of the students (5-18 years old) in Tokyo using stratified three-stage sampling and found out that foot growth ends in the order of height, breadth and length, that growth of foot stops sooner than stature. Foot measurement for shoe construction with reference to the relationship between foot length, foot breadth and ball girth was carried out by [3]. His study compared the ratios of ball girth/foot length and foot breadth/foot length between the Japanese male subjects and the French male. Wunderlich and Cavanagh [4] analyzed gender differences in foot shape in a large sample of young individuals. Univariate t-tests and multivariate discriminant analyses were employed in assessing the reliability of classification into gender classes, the significant difference between men and women for each foot and leg dimension. Their results showed that for a given stature, men have longer and broader feet than women. They differ at the first toe, lateral side of the foot, the arch and the ball of the foot. They also opined that during the manufacture of women's sport shoes, these differences should be taken into consideration. Also, [5] quantified the change in three dimensional foot shape under different weight- bearing conditions. An optical digitizing system was used to capture the 3-D plantar surface shape of the foot cast, measurements and comparisons were made. The result indicated that the contact area of the foot increased as the weight bearing increased. Likewise, rear foot width, foot length, foot breadth (width) increased while the arch angle, arch height and average height decreased. Ozden et al. [6] conducted a study on stature and sex estimate using foot and shoe dimensions. Xiong et al. [7] modeled foot dimensions so that the characteristic shape of feet, essentially the region of the mid foot can be understood. They noted that the lack of generalized models has been the cause of the difficulty in the application of foot anthropometry to design good fitting footwear. Fifty (50) Hong Kong Chinese adults comprising 24 females and 26 males took part in the study. The results from the application of mathematical models on the various measurements made, showed that foot height showed no direct relationship with foot length. This result is helpful in designing footwear that has an enhanced fit in the height dimension. Kanaani et al. [8] obtained 8 important foot dimensions and established that there is significant correlation between 85% of foot dimensions. The foot images were taken by a digital camera. A fit size to shoe design was developed by [9]. They selected 303 subjects randomly, in Malaysia for the research and it was revealed that there was a significant difference between the length of the right and left foot. Also, the width of the right and left foot also showed significant difference. Salles and Gye [10] also conducted a study on personalized footwear which can be advantageous for population growth including older individuals, people with arthritis or diabetic foot problems. Personalized footwear can potentially provide a perfect fit for the wearer. Previous studies that also focused on foot measurements include [11-12]. On the area of gender differences, Hong et al. [13] concluded that women showed significantly smaller values of foot dimensions in girth, width and height than men. A total of nineteen foot variables were obtained through video filming, including, width, girth, height, length and angle variables. Also, de Castro et al. [14] identified differences between the anthropometric foot variables of older men and women. They concluded that there were differences between some of the anthropometric foot variables of older women and men that must be considered during their footwear design/manufacture. Samaila et al. [15] measured the anthropometric parameters of foot of adult males and females Ga'anda people, in order to find out racial characteristics of their own, determine their difference and to classify their foot shapes. Abdurrahman et al. [16] described foot anthropometric data of high school students in Bandung for the purpose of manufacturing good fitting shoes. Other studies namely, [17-19] focused on: Foot dimensions of a young adult Nigerian, Enugu Campus within the age bracket of 20-28 years; Sexual dimorphism in foot dimensions among adult Nigerians their age ranged between 18 years and above, resident in Port Harcourt; foot anthropometry of the Igbos in Nigeria aged 16-45 years respectively. It is evident from the foregoing that there is a balance of literature especially in the area of

assessment of baseline foot demographic data for Nigerian adult Population. Previous studies focused attention more on the estimation of stature (height), prediction of footwear fit, as well as gender (sex), from foot dimensions/measurements. The aim of this research therefore is to develop a robust, up to date male and female demographic data in Nigeria that can help bridge the gap caused by demographic differences and serve as baseline for the design of prosthesis and footwear.

2. MATERIALS AND METHODS

2.1. Materials

The different anthropometric dimensions were obtained with the following anthropometric tools; A-226 standiometer, small height rod, adjustable rule, sliding caliper, soft metric tape. The weight was in kilogram (kg) while the length, breadth and height dimensions were in centimeters (cm). The data for the study were sourced from University of Benin, Benin-City, Edo State. The University of Benin is well situated and has a good quota sample of the parent population. Twenty – seven (27) foot anthropometric dimensions were obtained excluding age and weight. These measurements were from a total of 400 male and female subjects. Below is the list of the dimensions: Age, Weight, Stature (height), Waist height, Waist thigh length, Thigh girth, Crotch height, Knee height, Knee girth, Calf height, Calf girth, lateral malleolus, medial malleolus, Ankle girth, Foot length, Foot breadth, Heel height, Heel girth, Bimalleolar breadth (BMB), Heel breadth, Joint/ball girth, Foot waist girth, Instep girth, Instep height, Instep length, Ball height, Toe length, Toe height, Toe girth.

2.2. Methods

A total of four hundred (400) adult subjects were measured which included 200 male and 200 female by five (5) notable researchers who are well trained in the field of anthropometry. A pilot study was first conducted where each body dimensions was measured 3 times and the average taken before the final measurement of the region was made. The participants were within the age bracket of 18-55 years and from the University of Benin, Benin-City, Nigeria. Stratified random sampling technique was employed in selecting the subjects to be measured. The following groups of people were excluded from the study: Foreigners, Pregnant Women, Children, Individuals with musculoskeletal disorders (MSDS) and Subjects below 18 and above 55 years. The measurements were done by using standard anthropometric instruments and techniques. The descriptive statistics of the resulting data were analyzed using SPSS version 16. The subjects were required to take off their shoes and stockings. They also showed willingness to partake in the study by consenting to be measured in order to obtain the desired data. The measurements were taken at specific period of the day from 9:00am to 3:00pm to avoid diurnal error. Some of the individual foot diagrams are depicted in Figure 1.

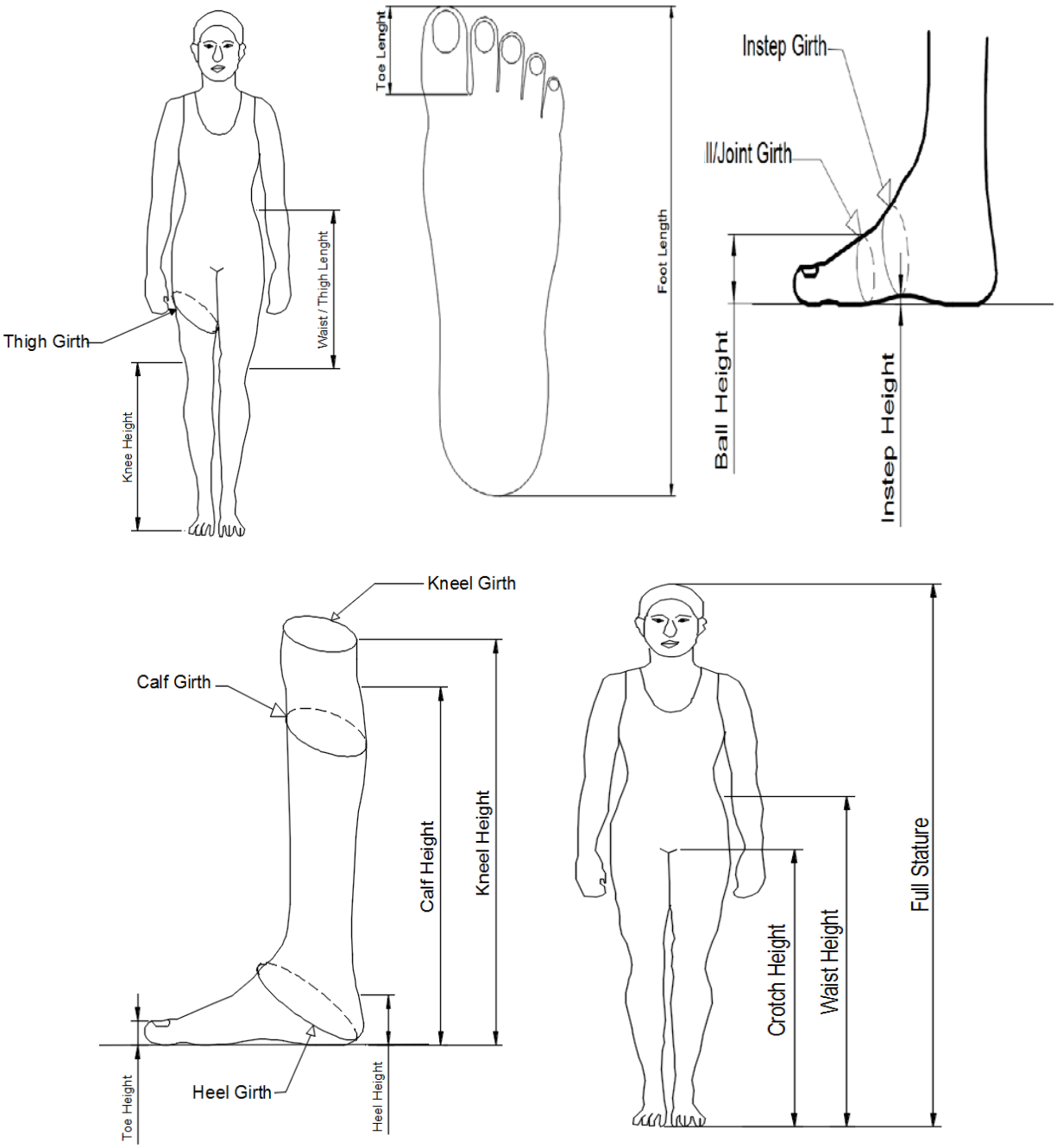

Figure 1. Diagrams showing some of the anthropometric dimensions.

3. RESULTS AND DISCUSSION

The characteristics of the subjects concerning demographic data are presented in Tables 1, 2 and 3. In addition paired sample t- test was employed to compare the variables between male and female variables as shown in Table 4.

Table 1. Descriptive statistics of females Adult Population.

					Percentiles				
MEASUREMENTS (Female)	**MEAN**	**SD**	**MIN**	**MAX**	**5th**	**25th**	**50th**	**75th**	**95th**
Age	24.74	7.43	18	55	18	20	23	27	44.9
Weight	58.15	13.29	27	120	42.05	49	56	64	79.95
Stature	164.59	6.34	150	182	154.5	160	164	168.2	176.74
Waist Height	103.89	5.1	94.2	119	97	100	104	107.22	112.4
Waist Thigh Length	25.35	3.79	17	38	20	22	25	28	32
Thigh Girth	56.66	7.8	42.5	92	46.05	51.5	55	61	71
Crotch Height	77.09	4.66	65.5	88.5	70.5	73.25	77	79.5	85.5
Knee Height	48.44	3.2	35.5	59.9	44.5	46.6	48.5	50	52.5
Knee Circumference	38.06	4.11	24.5	55	32.52	35.12	38	40.5	45.47
Calf Height	34.85	2.89	29	43	30.02	33	34.55	36.47	40.5
Calf Circumference	35.13	3.54	26	48.5	30	32.5	35	37.5	40.95
lateral malleolus	6.78	0.66	5.5	8	5.8	6.22	6.9	7.3	8
medial malleolus	7.78	0.72	6.4	9.4	6.5	7.2	7.8	8.2	9
Ankle Circumference	26.42	2.31	21.5	36.5	23.5	25	26	27.5	29.97
Foot Length	24.71	1.24	21.54	28.39	22.7	23.09	24.88	25.5	27.24
Foot Breadth	9.29	0.6	7.76	10.86	8.17	8.99	9.26	9.72	10.26
Heel Height	5.23	0.74	3.5	7.4	4	4.8	5.25	5.7	6.4
Heel Circumference	33.19	1.84	28	38	30	32.5	33	34.5	36.19
Bimolleolar Breadth (BMB)	6.48	0.42	5.36	7.67	5.73	6.2	6.49	6.76	7.24
Heel Breadth	5.57	0.53	4.15	6.91	4.61	5.24	5.61	5.86	6.5
Joint/Ball Girth	23.07	1.36	19.7	27	20.8	22.22	23	23.7	25.49
Foot Waist Girth	22.77	1.43	19.3	27	20.5	21.85	22.85	23.5	25.8
Instep Girth	24.01	1.55	19.5	28.5	21.5	23	24	25	26.5
Instep Height	4.17	0.55	2.5	5.8	3.3	3.8	4.2	4.5	5
Instep Length	18.67	1.1	16.5	22	17	18	18.5	19.3	20.5
Ball Height	3.11	0.37	2.2	4.2	2.6	2.9	3	3.4	3.89
Toe Length	7.01	0.56	6	9	6.2	6.5	7	7.3	8
Toe Height	1.92	0.22	1.5	3	1.6	1.8	2	2	2.3
Toe Girth	8.51	0.61	7	10.5	7.5	8	8.5	9	9.4

Table 2. Descriptive statistics of pooled sample (both gender together).

						Percentiles				
MEASUREMENTS	**N**	**MEAN**	**SD**	**MIN**	**MAX**	**5th**	**25th**	**50th**	**75th**	**95th**
Age	400	26.47	7.64921	18	55	18.0	21.0	25.0	29.0	43.0
Weight	400	63.4025	14.0704	27	138	45.0	54.25	62.0	71.0	89.0
Stature	400	170.518	8.8246	150	193	157.0	163.85	169.5	177.0	185.0
Waist Height	400	106.560	5.82363	94.2	122.5	97.5	102.325	106.0	110.0	117.975
Waist Thigh Length	400	28.4987	4.74322	17	40	21.0	25.0	28.5	32.0	36.0
Thigh Girth	400	55.8212	6.76822	42.5	92	46.5	51.5	55.0	60.0	69.0
Crotch Height	400	76.48	4.80879	65.5	89.5	69.025	72.92	76.35	79.475	85.475
Knee Height	400	49.85	3.42422	35.5	60	44.52	47.5	50.0	52.0	55.5
Knee Circumference	400	37.7635	3.53029	24.5	55	33.0	35.0	37.0	40.0	44.0
Calf Height	400	35.3637	3.02851	29	44.5	30.51	33.5	35.0	37.0	41.38
Calf Circumference	400	35.47	3.37956	23.9	48.5	30.515	33.0	35.5	37.5	40.5
lateral malleolus	400	7.052	0.8375	5.5	10.5	5.905	6.5	7.0	7.5	8.5
medial malleolus	400	8.129	0.85525	6.18	11	7.0	7.5	8.0	8.675	9.5
Ankle Circumference	400	27.29	2.5052	21.5	39	24.0	26.0	27.0	28.2	31.975
Foot Length	400	25.8	1.7018	21.54	30.25	22.99	24.762	25.72	27.035	28.61
Foot Breadth	400	9.8728	0.823	7.76	11.8	8.5	9.24	9.86	10.4375	11.23
Heel Height	400	5.515	0.76611	3.5	7.5	4.0	5.0	5.5	6.0	6.8
Heel Circumference	400	34.769	2.51454	28	44	30.5	33.0	34.5	36.5	39.0
Bimolleolar Breadth (BMB)	400	6.816	0.58007	5.36	8.1	5.96	6.4125	6.77	7.2575	7.74
Heel Breadth	400	5.74	0.57615	4.15	7.36	4.85	5.38	5.72	6.0875	6.77
Joint/Ball Girth	400	24.28	1.80841	19.7	28.2	21.2	23.0	24.2	25.5	27.2
Foot Waist Girth	400	23.97	1.84296	19.3	28	21.0	22.8	24.0	25.5	27.0
Instep Girth	400	25.2625	2.021	19.5	30	22.0	24.0	25.0	26.5	29.0
Instep Height	400	4.239	0.59267	2.5	6	3.3	3.9	4.2	4.6	5.2
Instep Length	400	19.61	1.53411	16.5	25	17.3	18.5	19.5	20.7	22.0
Ball Height	400	3.20925	0.42848	2.2	4.8	2.6	3.0	3.1	3.5	4.0
Toe Length	400	7.32125	0.71186	4.6	9.5	6.2	7.0	7.2	7.8	8.5
Toe Height	400	1.99	0.24949	1.5	3.3	1.7	1.8	2.0	2.0	2.5
Toe Girth	400	9.01175	0.781	7	11.2	8.0	8.5	9.0	9.5	10.295

Table 3. Descriptive statistics of males Adult Population.

					Percentiles				
MEASUREMENTS (male)	**MEAN**	**SD**	**MIN**	**MAX**	**5th**	**25th**	**50th**	**75th**	**95th**
Age	28.19	7.49	18	55	19	23	26.5	30	42.95
Weight	68.65	12.84	46	138	54	60	65	74.75	90
Stature	176.45	6.72	159.5	193	166.2	171.17	176.2	180.87	187.97
Waist Height	109.22	5.27	98	122.5	101	105	109	112.57	118.6
Waist Thigh Length	31.64	3.29	24	40	26	29.25	31.25	34	37
Thigh Girth	54.98	5.43	43	70.5	46.5	51.5	54.5	58.5	64
Crotch Height	75.88	4.89	67	89.5	68	72.27	75.5	79.27	85
Knee Height	51.26	3.05	44.3	60	46.71	48.62	51.4	53.4	56
Knee Circumference	37.47	2.82	32	44.5	33.5	35	37	39	43
Calf Height	35.88	3.08	29	44.5	31	33.5	35.5	38.15	41.4
Calf Circumference	35.82	3.18	23.9	47.5	31.5	33.77	35.5	38	40.5
lateral malleolus	7.32	0.91	5.6	10.5	6	6.7	7	8	8.99
medial malleolus	8.48	0.83	6.18	11	7.1	8	8.5	9	10
Ankle Circumference	28.15	2.4	23.4	39	25	26.5	28	29	32
Foot Length	26.89	1.37	22.99	30.25	24.37	26.1	26.89	27.7	29.49
Foot Breadth	10.45	0.57	8.34	11.8	9.56	10.09	10.41	10.86	11.42
Heel Height	5.8	0.68	4	7.5	4.5	5.4	5.9	6.27	7
Heel Circumference	36.34	2.07	31.5	44	32.71	35	36.2	37.6	39.98
Bimolleolar Breadth (BMB)	7.15	0.52	5.5	8.1	6.3	6.79	7.21	7.57	7.87
Heel Breadth	5.91	0.57	4.26	7.36	5.11	5.47	5.87	6.33	6.89
Joint/Ball Girth	25.49	1.33	22.3	28.2	23.4	24.5	25.4	26.5	28
Foot Waist Girth	25.18	1.36	21.8	28	23	24.1	25.1	26	27.5
Instep Girth	26.52	1.62	23.1	30	24	25.2	26.5	28	29
Instep Height	4.31	0.62	2.6	6	3.4	3.9	4.3	4.77	5.4
Instep Length	20.56	1.3	17.8	25	18.5	19.5	20.5	21.3	23
Ball Height	3.31	0.46	2.2	4.8	2.7	3	3.25	3.5	4
Toe Length	7.63	0.71	4.6	9.5	6.7	7.2	7.7	8	8.89
Toe Height	2.07	0.26	1.7	3.3	1.7	1.9	2	2.2	2.5
Toe Girth	9.51	0.59	8	11.2	8.5	9	9.5	10	10.5

Tables 1, 2 and 3 depict the descriptive statistics of foot measurements of the female, pooled and male sample of the population. The mean age was 24.74 ± 7.43 in females, 28.19 ±7.49 in males and 26.47 ± 7.65 for the pooled sample. The tables also showed the mean weight to be 58.15 ± 13.29, 68.65 ± 12.84 and 63.40 ± 14.07 for the female, male and both genders together respectively. Similarly, the mean stature in female group was 164.59 ± 6.34 while in male group was 176.45 ± 6.72 and for the pooled sample, 170.52 ± 8.82. The results showed that stature is significantly higher in males than in females which coincide with the result obtained by [11]. For the foot dimensions, the mean foot length for the female was 24.71 ± 1.24 while for male was 26.89 ± 1.37, with the foot length larger in males than in females as compared to that

obtained by [8, 15]. In Table 1, the 50th percentile female was 164cm tall and the stature span was 32cm, from the range of 150cm to 182cm. The 50th percentile male was 176.2cm tall. The tallest male was 193cm, while the shortest was 159.5cm, giving a stature difference of 33.5cm. Also, the 50th percentile for both gender, gave 169.5cm, from 150cm to 193cm with a range of 43cm. The weight was 62kg, with a span of 111kg ranging from 27kg to 138kg. Similarly, the age for the 50th percentile was 25years with a span of 37years from 18years to 55years. The 50th percentile female had a body weight of 56kg from 27kg to 120kg and a span of 93kg. Also the male had a weight of 65kg, the distribution of body weight ranged from 46kg to 138kg and a span of 92kg. For the foot measurements, the 50th percentile female had a foot length of 24.88cm, which ranged from 21.54cm to 28.39cm having a span of 6.77cm. Also, a foot length of 26.89cm was recorded for the 50th percentile male with a span of 7.26cm which ranged from 22.99 cm to 30.25cm compared to 26.92 ± 0.13 and 24.75 ± 0.17 obtained by [18] as well as 27.1 ± 1.3 cm and 25.1 ± 1.1 cm gotten by [17]. For the pooled sample, the foot length had a value of 25.72cm, having a span of 8.71cm ranging from 21.54cm to 30.25cm. The Mean±SD for bimolleolar breadth of the foot 74.47±4.11 obtained by [8] in Iranian men with ages ranging from 18 to 25 differs significantly from 7.15±0.52 obtained in this study in Nigerian Men with ages 18 to 55 years.

Table 4. Comparison of variables between males and females in foot anthropometry

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Age Male - Age Female	3.45000	10.91942	.77212	1.92741	4.97259	4.468	199	.000
Pair 2	Weight Male - Weight Female	1.05050E1	19.01652	1.34467	7.85337	13.15663	7.812	199	.000
Pair 3	Stature Male - Stature Female	1.18620E1	9.65483	.68270	10.51575	13.20825	17.375	199	.000
Pair 4	Waist Height Male - Waist Height Female	5.32850	7.50504	.53069	4.28201	6.37499	10.041	199	.000
Pair 5	Waist Thigh Lenght Male - Waist Thigh Length Female	6.28750	4.63774	.32794	5.64082	6.93418	19.173	199	.000
Pair 6	Thigh Girth Male - Thigh Girth Female	-1.68250	9.96764	.70482	-3.07237	-.29263	-2.387	199	.018
Pair 7	Crotch Height Male - Crotch Height Female	-1.20600	6.68676	.47283	-2.13839	-.27361	-2.551	199	.012
Pair 8	Knee Height Male - Knee Height Female	2.82050	4.53277	.32051	2.18846	3.45254	8.800	199	.000
Pair 9	Knee Circumference Male - Knee Circumference Female	-.58800	5.16046	.36490	-1.30757	.13157	-1.611	199	.109
Pair 10	Calf Height Male - Calf Height Female	1.02950	4.09812	.28978	.45807	1.60093	3.553	199	.000

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Calf Circumference Male - Calf Circumference Female	.68450	4.87585	.34477	.00462	1.36438	1.985	199	.048
Pair 2	lateral malleolus Male - lateral malleolus Female	.53350	1.10118	.07786	.37995	.68705	6.852	199	.000
Pair 3	Medial malleolus Male – Medial Malleolus Female	.70590	1.06472	.07529	.55744	.85436	9.376	199	.000
Pair 4	Ankle Circumference Male – Ankle Circumference Female	1.72350	3.44357	.24350	1.24333	2.20367	7.078	199	.000
Pair 5	Foot Length Male - Foot Length Female	2.18365	1.83981	.13009	1.92711	2.44019	16.785	199	.000
Pair 6	Foot Breadth Male - Foot Breadth Female	1.15830	.80030	.05659	1.04671	1.26989	20.468	199	.000
Pair 7	Heel Height Male - Heel Height Female	.57300	.97185	.06872	.43749	.70851	8.338	199	.000
Pair 8	Heel Circumference Male - Heel Circumference Female	3.15200	2.88825	.20423	2.74927	3.55473	15.434	199	.000
Pair 9	Bimolleolar Breadth Male - Bimolleolar Breadth Female	.67410	.66053	.04671	.58200	.76620	14.433	199	.000
Pair 10	Heel Breadth Male - Heel Breadth Female	.33520	.78254	.05533	.22608	.44432	6.058	199	.000

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Joint Ball Girth Male - Joint Ball GirthFemale	2.41300	1.87832	.13282	2.15109	2.67491	18.168	199	.000
Pair 2	Foot Waist Girth Male - Foot Waist Girth Female	2.40700	1.91643	.13551	2.13978	2.67422	17.762	199	.000
Pair 3	Instep Girth Male - Instep Girth Female	2.50800	2.13095	.15068	2.21086	2.80514	16.644	199	.000
Pair 4	Instep Height Male - Instep Height Female	.14000	.85906	.06074	.02021	.25979	2.305	199	.022
Pair 5	Instep Length Male - Instep Length Female	1.89550	1.67627	.11853	1.66176	2.12924	15.992	199	.000
Pair 6	Ball Height Male - Ball Height Female	.19550	.57627	.04075	.11515	.27585	4.798	199	.000
Pair 7	Toe Length Male - Toe Length Female	.62550	.83009	.05870	.50975	.74125	10.657	199	.000
Pair 8	Toe Height Male - Toe Height Female	.14200	.33240	.02350	.09565	.18835	6.042	199	.000
Pair 9	Toe Girth Male - Toe Girth Female	.99850	.87152	.06163	.87698	1.12002	16.203	199	.000

3.1. Statement of Hypothesis

H_0: There are no significant differences between the male and female foot anthropometric dimension.

H_1: There are significant differences between the male and female foot anthropometric dimensions.

3.2. Interpretation of Selected Results

3.2.1. Ankle circumference

Since t-value obtained is 7.078 and falls outside the lower critical value of 1.243 and upper critical value of 2.204, we therefore reject the null hypothesis and infer that there are significant differences between the male and female ankle Circumference.

3.2.2. Heel circumference

Since t-value obtained is 15.434 and is above the lower critical value of 2.749 and higher critical value of 3.555, we therefore reject the null hypothesis and accept the alternate hypothesis that there are significant differences between the male and female heel Circumference.

3.2.3. Foot length

Since t-value obtained is 16.785 which fall outside the lower critical value of 1.927 and the upper critical value of 2.440, we therefore reject the null hypothesis and accept the alternate hypothesis that there are significant differences between the male and female foot length. Our result showed that foot length in males are significantly higher than that of females, same with the result gotten by [15].

3.2.4. Foot breadth

Since the t-value obtained for the foot breadth is 20.468 and this falls outside the two critical values of 1.047 and 1.270, we therefore reject the null hypothesis and conclude that there are significant differences between the male and female foot breadth which also falls within the result obtained by [15, 18].

3.2.5. Calf height and calf circumference

Since the t-value obtained for calf height (1.985) and calf circumference (3.553) falls outside the lower critical value of 0.005 and upper critical value of 1.364 for calf height and a lower critical value of 0.458 and upper critical value of 1.601 for calf circumference, we reject the null hypothesis and accept the alternate hypothesis and conclude that there are significant differences between the male and female calf height and calf circumference. This result can be compare to the one obtained by [4] who stated that after normalization of the measurements by foot length, men and women were found to differ significantly in two calf, five ankle, and four foot shape variables.

Arising from the foregoing, results of the t-test showed that there are significant differences between male and female foot anthropometric dimensions, therefore designs of foot wears and prosthesis should be made differently.

Table 5 and 6 shows the abridged body and foot anthropometric dimensions for Male and Female adults in Nigeria from 18 to 55 years.

Table 5. Abridged Body and Foot Anthropometric Dimensions for male

S/N	SEX	AGE	WEIGHT	STATE OF ORIGIN	STATURE	WAIST HEIGHT	WAIST THIGH LENGTH	THIGH GIRTH	-	-	-	TOE HEIGHT	TOE GIRTH
1	M	36	83	ANAMBRA	179.6	111.8	35	48	-	-	-	2	9
2	M	19	69	DELTA	177.6	114	36.5	54	-	-	-	2.2	10
3	M	30	77	OYO	175	107	32	60	-	-	-	2.3	10
4	M	29	71	ENUGU	170	107.5	34.5	55	-	-	-	2.3	9
5	M	30	92	DELTA	193	122.5	40	60	-	-	-	2	10
6	M	30	74	ANAMBRA	171	108	35	58	-	-	-	1.8	8.5
7	M	42	83	EDO	173	108	37	63	-	-	-	3.3	10
8	M	39	65	EDO	168	104	36	61	-	-	-	1.7	9
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
198	M	26	55	OYO	165	103.5	28	47	-	-	-	2	8.8
199	M	29	62	EKITI	167	106	28	56	-	-	-	2.4	9.9
200	M	24	66	LAGOS	162	102	30	60.5	-	-	-	2.1	9

Table 6. Abridged Body and Foot Anthropometric Dimensions for Female

S/N	SEX	AGE	WEIGHT	STATE OF ORIGIN	STATURE	WAIST HEIGHT	WAIST THIGH LENGTH	THIGH GIRTH	-	-	-	TOE HEIGHT	TOE GIRTH
1	F	25	57	ANAMBRA	159.5	97.5	30.5	55	-	-	-	2	8
2	F	25	55	IMO	169.5	109.5	28	53	-	-	-	2	8
3	F	20	40	DELTA	157	97	22.5	47	-	-	-	1.8	8.5
4	F	19	62	DELTA	166	108.6	28.5	63	-	-	-	2	9
5	F	28	49	SOKOTO	175	106.5	19	47.2	-	-	-	1.7	8.5
6	F	19	49	ONDO	168.2	107.3	22	47	-	-	-	1.9	7.6
7	F	27	55	DELTA	157.5	98	26	55	-	-	-	1.9	9.4
8	F	20	61	DELTA	164.2	109	32	52.5	-	-	-	2.1	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
198	F	25	75	EDO	181.5	112	22	62.5	-	-	-	3.2	8
199	F	22	60	CROSS RIVER	167	105	26	63.5	-	-	-	3.4	6.2
200	F	20	69	DELTA	171.5	108	25.5	62	-	-	-	3	6.7

4. CONCLUSION

This study has been able to identify the basic demographic differences between male and female adult population in Nigeria from the age bracket of 18-55 years. The pooled demographic changes between the male and female population were also analyzed. It is evident from this study that the anthropometric body dimensions for males and females differ significantly which could be attributed to so many factors such as ethnic and genetic compositions, nutrition, age among others. However, such factors should be critically taken into consideration while designing footwear and prosthesis.

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