Development of Anthropometric Database for Paraplegics in Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author BAT carried out the field works under the supervision of author OAO. The main manuscript text was written and organized by authors OAH and OGS conducted necessary data analysis. All authors discussed the results and substantially contributed to the manuscript.

Original Research Article

ABSTRACT

Aims: The main goal of this research is to develop a fresh anthropometric database for disable population in Nigeria.
Methodology: Adequate survey of anthropometric data of Nigeria paraplegics in South-Western Nigeria was carried out with a 31:19 male-female ratio. Suitable and reliable anthropometers were used to collect data on a well-structured questionnaire. Thirty nine (39) body parts of the paraplegics' population sample were measured and the analysis of the relevant anthropometric measures was carried out using the SPSS Software.
Results: Results show that there are variations in female and male body parts measurements. Based on the need to accommodate at least 90% of the paraplegic population of Nigeria, this paper

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proposes facilities/workstation design dimensions for waist circumference (50 cm-84 cm), hip-buttock circumference (41 cm-89 cm), waist depth (15 cm-25 cm) for female paraplegics while for male paraplegics are waist circumference (49.6 cm-83.2 cm), hip-buttock circumference (56.76 cm-88.80 cm), waist depth (14.20 cm-24.80 cm) among others.

Conclusion: The information presented from the data analysis will be useful for design engineers in designing equipment, workspace and facilities for Nigeria Paraplegics.

1. INTRODUCTION

Generally, anthropometry is the study of measurement of human dimension, which refers to the measurement of living human individuals for the purposes of understanding human physical variation. Over the centuries, there have been remarkable changes in anthropometric measurements due to geographical, cultural genetic and environmental factors as well as worldwide mingling of races [1]. As reported by few studies, human laterality, gender, age and race/ethnicity were mentioned as contributing factors to anthropometric variability [2,3]. Anthropometry is very helpful in variety of professions which include medical, engineering and a host of other professions that provide services and materials for human use. Anthropometry is known to influence physical user-product interactions, and is vital in assessing the fit, safety, comfort, satisfaction, etc. of users [4,5]. Anthropometry is used as design product guideline for heights, clearance, grips, and reaches of workplace and equipment. Examples are the dimensions of workstations for standing or seated work, production machinery, and hand tools for the workforce including men and women who are tall or short, large or small, strong or weak, as well as those who are physically handicapped or have health conditions that limit their physical capacity [6].

Paraplegia or paralysis of lower extremities is caused mainly by disorders of the spinal cord and the cauda equina. They are classified as traumatic and non-traumatic. Traumatic paraplegia occurs mostly as a result of traffic accidents and falls caused by lateral bending, dislocation, rotation, axial loading, and hyperflexion or hyperextension of the cord. Non-traumatic paraplegia has multiple causes such as cancer, infection, intervertebral disc disease, vertebral injury and spinal cord vascular disease [7,8].

Anthropometry data of Paraplegics is however not common. Attempts had been made in times past to obtain these data and have been discovered to come with several variations. Dimension definitions and measurement techniques vary from study to study and, in many cases, samples were very small. In a previously published review of the anthropometry of people with disabilities [9,10] examined six international studies of people with lower limb disorders and discovered that, for a combined total of 58 body size descriptors measured in the studies, not a single dimension was found in common. The annual reported paralysis of lower extremities as disorders of the spinal cord varies from 2.3 per million in a Canadian study to 83 per million in Alaska. The prevalence among men to women varied from 0.9 in Taiwan to 12.0 in Nigeria with the most frequent cause of the injury been traffic accidents and falls. The largest preponderance of men was found among spinal cord injury in studies from Nigeria with ratio 11 – 12:1 [11,12].

In Africa, measuring human body dimensions was given limited attention. Hence Africa is been challenged with unfit products, machines, equipment e.t.c. Ismaila et al. [13] conducted anthropometric dimensions of pupils in Nigeria primary schools. The results of the study showed that all the anthropometric dimensions of the males differ significantly from those of the females with the exception of the elbow hand grip. Hattingh et al. [14] examined anthropometric and biochemical profiles of black South African women. It was reported that most women had a waist-hip ratio less than 0.8 and that the higher percentage of younger women were overweight than the older ones. Ayodeji et al. [15] conducted study on Nigeria paraplegics describing them as neglected set of people and pointed the need for manufacture of tools and utilities used by Nigeria paraplegics to use anthropometric data related to them. Nigeria paraplegics however presents a class of people who as a result of the society and economy, find themselves mostly neglected. A common sight is to see a lot of them by roadsides and public places soliciting for alms. Mobility aids such as wheelchairs, callipers, crutches, walking frames and other facilities are usually imported from

other countries. It is pertinent to note that these facilities were only manufactured in such countries after a detailed collection and analysis of the anthropometric data of users in such countries. According to Gopal [16], when user of a product is able to interact with it in ways that are comfortable and safe, then the user is considered accommodated by the design of the product. In Nigeria, these imported facilities are mostly not accommodated by the users due to variation in anthropometric sizes. Thus, these facilities may present more harm than good in most cases causing secondary deformities since they might not suit the user's comfort, safety, efficiency and productivity.

1.1 Causes and Classifications of Paraplegia

Any disease process affecting the pyramidal tract of the spinal cord from the thoracic spine downward may lead to paraplegia. Forms of paraplegia may be spastic and rarer. Spastic results in an increased tone in the affected limbs. Causes range from trauma to myelitis transverse and multiple sclerosis. While rarer is the type which is caused by damage to the nerves supplying the legs. Several bacterial, viral, mycobacterial, fungal and parasitic infections can also lead to paraplegia. Table 1 shows the classification of paraplegics based on medical and physical conditions [17-19].

Table 1. Categories of paraplegia based on physical and medical conditions

Category	Physical and medical condition
1	Arthritis
2	Organic nervous disorder
3	Cerebral vascular disease
4	Bone injuries and/or deformities
5	Lower limb amputation
6	Cerebral palsy
7	Traumatic paraplegia
8	Respiratory and cardiovascular disease
9	Obesity, congenital errors, spinal injuries

(Source: Bradtmiller and Annis, [18])

The spinal column is comprised of 33 bones; these bones are referred to individually as vertebrae. This includes 7 cervical vertebrae in the neck, 12 thoracic vertebrae in the upper back corresponding to each pair of ribs, 5 lumbar vertebrae in the lower back, sacral vertebrae which are fused together to form 1 bone called

the sacrum and 4 coccygeal vertebrae that are also fused together to form the coccyx or tailbone. It is reported that any spinal cord injury below the drawn line in Fig. 1 will result in paraplegia [20,21].
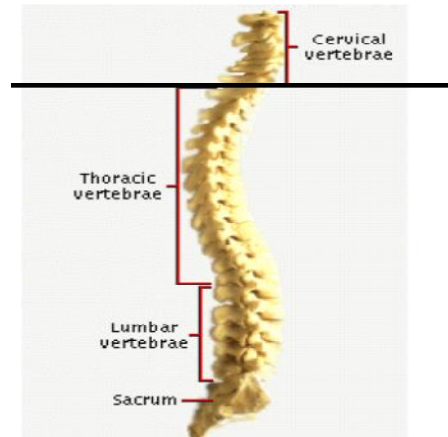

Fig. 1. The human spinal cord

1.2 Disability and Complications in Paraplegia

While some people with paraplegia can walk to a degree, many are dependent on wheelchairs or other supportive measures. Due to the decreased movement and inability to walk, paraplegia may cause numerous medical complications, many of which can be prevented with good nursing care. One engineering approach to help the race of paraplegics is to design ergonomics equipment to enhance their movement from one place to the other and also help in their workstations [22]. However accurate and recent anthropometry data is required to achieve this. Hence the objectives of this paper are to obtain anthropometric measurements of paraplegics in selected parts of Nigeria; develop appropriate anthropometric database that relates to the paraplegic in the region for the purpose of designing to suit their needs; find out if the median values of male subjects are significantly different from the median values of the female counterparts, help designers and manufacturers of paraplegic materials to obtain relevant data which will be useful for medical practitioners.

2. MATERIALS AND METHODS

This study involved an extensive case study design of paraplegics conducted during the period of 2014-2015 at The National Orthopaedic Hospital, in South-West Nigeria. The choice of

this study domain was because of availability of large number of the group of people in the area. At the initial survey, all the anthropometric and clinical findings were recorded from a total of 100 paraplegics. At the end of the 7th month, measurement of subjects' dimensions which included body measurements, weight, and other physical features, comprised male and female in the ratio of 31:19 were completed. Data from different age groups among the paraplegics as listed in Table 2 were also collected through verbal response of the subjects. Participants' consents were taken orally because majority of them were not literate. However all potential volunteers agreed to have the procedure performed after they were informed that their participation in the study was voluntary. The purpose of the study and the confidentiality of the information provided were emphasized.

Two extra trained personnel were used to assist in data recording to avoid parallax when taking readings and to aid the participants especially due to their physical conditions. Data were collected by using well-structured questionnaire for parameters such as name, age, physical and health conditions. Observation method was used to obtain the gender parameters. The subjects were then measured both by sitting and standing. Standardized guidelines for anthropometric measurements and recording, as stated by NHANES [23], were adopted. Measurements were recorded to the nearest tenth of a centimeter. Participants were convinced to wear light clothing so as to avoid high deviation from actual body measurements. All measuring instruments were inspected before the commencement of measurement, cleaned with alcohol wipes and were properly placed for accessibility.

Table 2. Age groups and description of sample population

Age (years)	Description
0-6	Infants
6-12	Children
12-18	Teenagers
18-45	Working age
45-60	Medium age
60 Above	Old age

2.1 Anthropometry Parameters

The parameters measured include: Age, weight, Height, Sitting height, Forward reach, Eye height (Sitting), Mid shoulder height, Mid shoulder height, Buttock to knee Length, Knee height (sitting), Buttock to heel length, Head height, Head length, Hand length, Hand, Popliteal height (sitting), Hand breadth at metacarpal, Hand breadth at thumb, Elbow to finger-Tip, Chin to eye height, Maximum body Width, Chest Circumference, Waist Circumference, Shoulder Circumference, Hip (buttock) Circumference, Head breadth, Head Circumference, Neck circumference, Inter papillary Breadth, Waist depth, Shoulder breadth, Hip breadth, Forearm to forearm breadth, Eye to top of head length, thickness at metacarpal, Foot length, Ball of foot width, Mid upper arm circumference, Abdominal girth and Mid thigh circumference. Several age groups were measured in the categories listed [24].

2.2 The Tools used Include

2.2.1 Standiometer

This is made of wood with cm calibrations. It is a long standing rod where subjects are made to stand while the measurement is read.

2.2.2 Tape rule

The tape rule is made of latex material and has calibrations in centimetre. Its flexibility allows it to be used for different measurements. The tape rule has a range of 150 cm.

2.2.3 The weighing scale

The weighing scale has a flat surface on which subjects can stand. The capacity of the scale is 120 Kg. The scale is calibrated in Kilogram.

2.2.4 Wooden venier calliper

This is T-shaped wooden equipment. It is calibrated in cm along the longer arm of the Tee where the readings are read from the calliper.

Others include steel measuring tape, head circumference tape among others. The data collected on the anthropometry measurements were analyzed with SPSS software using nonparametric equivalents of the between-subjects t test – the Mann-Whitney U test. This test allows to determine if the median of a variable for participants in one group is significantly different from the median of that variable for participants in a different group [25]. The 5th, 50th and 95th percentile of the various anthropometry parameters were calculated.

3. RESULTS AND DISCUSSION

Detail of statistical description and percentiles of 31 male paraplegias is shown in Table 3, while Table 4 reported that of the 19 Female counterparts. The anthropometric parameters measured were all in centimeters and the analysis presented in Tables 5 reveal the combined body sizes of paraplegic male and females.

The analysis shows that the mean weight of female (52.87 kg) is 11.4% more than that of the male counterparts which is 47.45 kg. In all other measurements, the mean values of female are higher than that of the male except for Height, Mid shoulder height, Hand breadth at Metacarpal and Ball of foot width. In all these parts, Ball of foot width had the highest percentage of about 4%. Prominent among the parts of body with that of female at least 7% more the male include; Mid Upper arm circumference, Head height, Hip height, Hand thickness and weight. In all, Hand thickness has the highest percentage of 52.3% followed by weight which is about 11.4%.

Table 3. Percentile distribution for male studied paraplegics

Descriptions	Statistics				Percentiles		
	Total	Mean	Median	Mode	5	50	95
Age	31	26.97	24.00	18	6.20	24.00	57.00
Weight	31	47.45	49.00	37	19.20	49.00	67.60
Height	31	147.18	149.00	130	116.0	149.00	173.2
Sitting height	31	69.04	70.00	68	55.40	70.00	79.60
Forward reach	31	74.14	74.00	73	57.80	74.00	89.80
Maximum body reach	31	39.71	38.00	38	26.80	38.00	56.20
Eye height sitting	31	61.71	63.20	66	46.60	63.20	71.20
Mid shoulder height	31	52.01	52.30	49	41.00	52.30	61.60
Buttock to popliteal	31	37.08	38.00	38	27.92	38.00	43.20
Buttock to knee length	31	43.10	43.00	42	27.00	43.00	55.90
Popliteal height sitting	31	39.79	39.90	35	29.40	39.90	53.10
Knee height sitting	31	48.66	48.50	41	37.96	48.50	63.40
Thigh clearance sitting	31	9.80	9.30	9	7.16	9.30	13.00
Elbow to finger tip	31	43.94	44.00	36	34.56	44.00	52.60
Chest circumference	31	79.45	80.00	90	61.00	80.00	101.6
Shoulder circumference	31	91.61	90.00	100	71.32	90.00	117.6
Hip Buttock circumference	31	73.68	76.00	78	56.76	76.00	88.80
Head breath	31	18.20	18.20	18	11.92	18.20	24.60
Head circumference	31	56.30	56.00	54	47.40	56.00	64.20
Inter pupillary breadth	31	9.04	9.00	9	5.00	9.00	12.52
Waist circumference	31	69.16	69.00	65	49.60	69.00	83.20
Waist depth	31	19.23	19.00	18	14.20	19.00	24.80
Buttocks to heel length	31	88.26	94.00	99	64.80	94.00	103.8
Shoulder breadth	31	37.04	36.00	34	28.20	36.00	44.26
Hip breadth	31	26.86	28.00	23	17.00	28.00	34.40
Forearm to forearm breadth	31	39.39	40.00	34	31.30	40.00	48.40
Head height	31	23.01	23.70	26	16.38	23.70	29.00
Head length	31	21.77	22.00	26	16.80	22.00	26.20
Eye to top of head length	31	10.22	10.20	10	6.36	10.20	13.70
Chin to eye height	31	12.46	13.50	14	3.86	13.50	17.00
Neck circumference	31	32.04	32.00	26	20.20	32.00	42.80
Hand length	31	19.08	20.00	20	11.68	20.00	23.58
Hand breadth at metacarpal	31	8.95	9.10	7	5.52	9.10	16.36
Hand breadth at thumb	31	11.11	11.30	13	7.80	11.30	14.36
Hand thickness at metacarpal	31	3.10	3.00	3	1.69	3.00	5.02
Foot length	31	21.20	22.00	22	13.20	22.00	28.40
Ball of foot width	31	10.02	9.20	7	5.36	9.20	20.64
Mid upper arm circumference	31	24.02	25.00	27	14.40	25.00	32.20
Abdominal girth	31	67.07	68.10	67.00	51.22	70.75	85.25

From Table 5, four (4) out of the total 39 body parts measured representing 10.3% had its values of females dimensions different from that of the corresponding male by 1%. In a similar manner, 3 regions (7.7%) by 9% and above, 13 parts (33.3%) by 4-8% and 19 out of the 39 (48.7%) recorded difference of between 1-3%. Some degree of similarity recorded were found in Forward reach, Buttock To Knee Length, Head circumference and Head length of which the

differences of male from female counterparts are less than 1.0 cm.

Fig. 2 is a column chart which compares mean values across the male and female measured means. In more than 89% of the various body parts measured, females mean values are higher than that of their male counterpart. However, in the remaining 11% of the total body region, the mean measured values of male are little more than that of the female.

Table 4. Percentile distribution for female studied paraplegics

Descriptions	Statistic				Percentiles		
	Total	Mean	Median	Mode	5	50	95
Age	19	32.16	31.00	8	8.00	31.00	58.00
Weight	19	52.87	57.50	52	25.00	57.50	66.00
Height	19	145.21	143.00	143	120.00	143.00	168.00
Sitting height	19	70.21	70.00	70	58.00	70.00	80.00
Forward reach	19	74.37	73.00	70	59.00	73.00	90.00
Maximum body reach	19	41.94	38.20	37	33.00	38.20	54.00
Eye height sitting	19	62.69	63.10	62	44.00	63.10	71.00
Mid shoulder height	19	51.42	52.00	51	28.00	52.00	62.00
Buttock to popliteal	19	38.06	37.00	37	32.00	37.00	42.00
Buttock to knee length	19	43.34	43.00	42	32.00	43.00	56.00
Popliteal height sitting	19	41.13	40.00	37	32.00	40.00	53.00
Knee height sitting	19	49.91	49.00	46	42.00	49.00	63.00
Thigh clearance sitting	19	10.13	10.20	12	6.80	10.20	12.00
Elbow to finger tip	19	44.69	44.00	42	36.00	44.00	54.00
Chest circumference	19	82.32	80.00	80	60.00	80.00	102.00
Shoulder circumference	19	96.17	99.00	99	72.80	99.00	117.00
Hip Buttock circumference	19	75.45	77.00	77	41.00	77.00	89.00
Head breath	19	18.78	18.00	18	12.00	18.00	26.00
Head circumference	19	56.64	57.00	58	48.00	57.00	64.00
Inter pupillary breadth	19	9.32	9.00	10	7.40	9.00	12.00
Waist circumference	19	72.84	75.00	75	50.00	75.00	84.00
Waist depth	19	20.22	20.00	18	15.00	20.00	25.00
Buttocks to heel length	19	92.16	96.00	92	70.00	96.00	104.00
Shoulder breadth	19	38.44	39.00	40	31.00	39.00	45.00
Hip breadth	19	28.94	30.20	32	20.00	30.20	34.00
Forearm to forearm breadth	19	40.43	40.00	40	33.80	40.00	48.00
Head height	19	24.96	25.00	22	17.00	25.00	39.00
Head length	19	21.88	21.00	21	16.50	21.00	26.60
Eye to top of head length	19	10.53	11.50	12	6.30	11.50	13.00
Chin to eye height	19	13.08	13.80	14	2.80	13.80	19.00
Neck circumference	19	32.94	32.00	22	22.00	32.00	43.00
Hand length	19	19.96	21.00	21	13.10	21.00	23.00
Hand breadth at metacarpal	19	8.84	9.00	8	6.10	9.00	12.00
Hand breadth at thumb	19	11.46	11.80	13	8.00	11.80	14.20
Hand thickness at metacarpal	19	4.72	3.10	3	2.20	3.10	31.00
Foot length	19	21.58	21.00	21	14.00	21.00	28.00
Ball of foot width	19	9.63	8.90	9	5.20	8.90	13.00
Mid upper arm circumference	19	25.95	27.00	28	16.10	27.00	33.00
Abdominal girth	19	70.56	72.00	72	52.00	72.00	84.00

However, on the result of test statistics on median differences between female and male subjects, Mann-Whitney U test shows P-value of 0.857 (at P<0.005 significant level). Hence this outcome shows that the median values of male populations are not significantly different from that of the female populations.

Based on the need to accommodate at least 90% of the paraplegic population, this study proposes facilities/workstation design dimensions for waist circumference in the range of 50 cm to 84 cm, hip-buttock circumference between 41 cm and 89 cm, waist depth in the scope of 15 cm to 25 cm, buttock-heel length for 70 cm to 104 cm and hip breadth between 20 cm and 34 cm for female paraplegics. However for male paraplegics, waist circumference (49.6 cm-83.2 cm), hip-buttock circumference (56.76 cm-88.80 cm), waist depth (14.20 cm-24.80 cm), buttock-heel length (64.80 cm-103.80 cm) and hip breadth (17 cm-34.40 cm).The study also submitted, for any facilities/workstation design proposed for both male and female paraplegics, the corresponding values for each body region between the 5th to the 95th percentile dimensions as stated in the Table 5.

Anthropometric sizes for each subject are classified by size and depict as percentiles. The mean values for male and female paraplegics suggest that there exists a remarkable difference in their anthropometric dimensions. It further reveals that the human anthropometry does not necessarily follow a particular pattern. Someone with long legs may not necessarily have long arms and vice versa. Also, an older person may also not necessarily have higher anthropometric values than a younger person. There were also subjects which were found to have unusual anthropometry features. This is probably a case of abnormality. A typical example is found in a 5 year old male whose body sizes were larger than older persons' anthropometry.

Ergonomics design will exceptionally accommodate the extremes cases as it will be difficult to adapt every user in design. However, anthropometric measurements are a guide for design as against assumptions of normality commonly made by some designers in tool designs. A range of user dimensions, typically from a 5th percentile woman to a 95th percentile man, which will takes care of about 9.5 out of 10 users is usually considered. According to the database, tools and equipment designed based on the data can effectively be utilized by both sex of paraplegics for various body dimensions where values do not vary considerably for male and female. However in the other parts where there are significant variations, there must be considerations in the design for the group of people most especially in height, weight and grip dimensions among others.
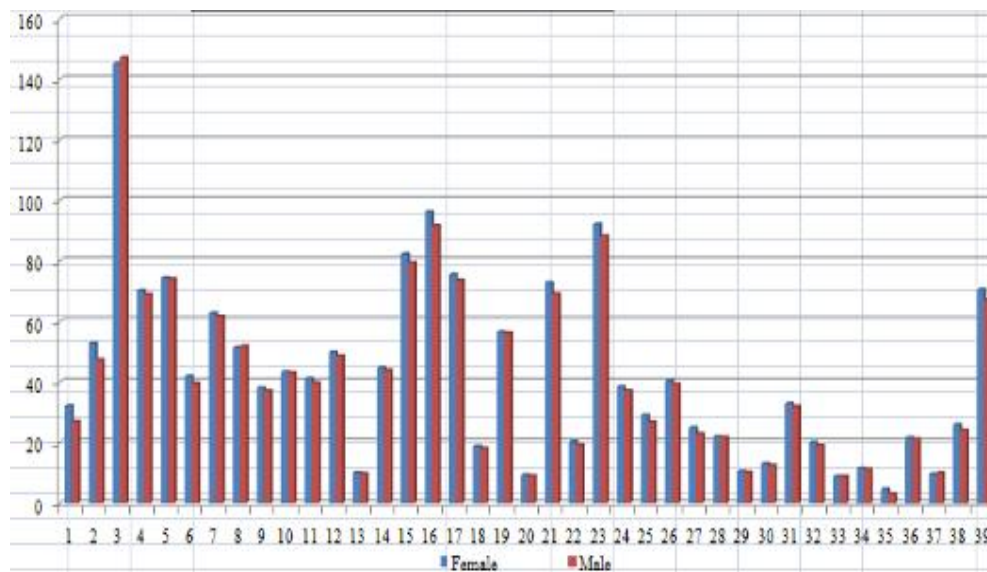

Fig. 2. Descriptions of variations between the male and female measured means values of body parts for 50 paraplegics

Table 5. Percentile distribution for both male and female studied paraplegics

Descriptions	Mean		Percentiles		
	F	Mean	5th	50th	95th
Age	50	28.94	7.00	30.00	58.00
Weight	50	49.5080	22.7500	52.5000	66.0000
Height	50	146.434	119.100	148.500	170.000
Sitting....height	50	69.4840	57.5500	70.0000	80.0000
Forward...reach	50	74.2280	59.0000	73.5000	89.4500
Maximum...body...reach	50	40.5580	27.8250	38.1000	54.4500
Eye...height...sitting	50	62.0840	45.5500	63.2000	71.0000
Mid...shoulder...height	50	51.7860	34.4000	52.1500	62.0000
Buttock...to...popliteal	50	37.4560	28.0000	38.0000	42.0000
Buttock...to...knee...length	50	43.1900	28.6500	43.0000	55.4500
Popliteal...height...sitting	50	40.3020	31.5500	39.9500	53.0000
Knee...height...sitting	50	49.1340	39.5500	48.7500	63.0000
Thigh...clearance...sitting	50	9.9260	6.9100	9.6500	12.8900
Elbow...to...finger...tip	50	44.2280	36.0000	44.0000	53.5600
Chest...circumference	50	80.5360	61.0000	80.0000	102.000
Shoulder...circumference	50	93.3420	71.7300	95.5000	117.000
Hip...Buttock...circumference	50	74.3540	56.7300	76.0000	88.4500
Head...breath	50	18.4220	12.0000	18.0000	25.4500
Head...circumference	50	56.4280	48.0000	56.1500	63.4500
Inter...papillary...breadth	50	9.1460	5.9900	9.0000	12.0000
Waist...circumference	50	70.5580	50.0000	71.0000	83.4500
Waist...depth	50	19.6040	15.0000	19.0000	24.7250
Buttocks...to...heel...length	50	89.7400	67.1000	94.6000	103.450
Shoulder...breadth	50	37.5680	29.5500	37.1500	43.9550
Hip...breadth	50	27.6520	18.1000	29.6000	34.0000
Forearm...to...forearm...breadth	50	39.7860	32.6000	40.0000	48.0000
Head...height	50	23.7480	16.5000	24.2500	29.4500
Head...length	50	21.8140	16.7750	22.0000	26.2250
Eye...to...top...of...head...length	50	10.3380	6.3550	10.3500	13.2250
Chin...to...eye...height	50	12.7000	3.4550	13.6500	17.0000
Neck...circumference	50	32.3800	21.5500	32.0000	42.4500
Hand...length	50	19.4140	12.5500	20.0000	23.1350
Hand...breadth...at...metacarpal	50	8.9100	5.8550	9.0000	12.2700
Hand...breadth...at...thumb	50	11.2438	7.9100	11.4000	14.0900
Hand...thickness...at...metacarpal	50	3.7170	1.8875	3.0500	5.0900
Foot...length	50	21.3440	14.0000	22.0000	28.0000
Ball...of...foot...width	50	9.8724	5.3650	9.1000	13.0900
Mid...upper...arm....circumference	50	24.7540	16.0550	26.0000	32.8900
Abdominal...girth	50	67.4740	51.2200	70.2500	84.0000
Mid...thigh...circumference	50	38.6100	17.0000	41.9000	49.0000

Since there is no such thing as the average person because someone with short legs may not necessarily have short arms. However, thorough analysis needs to be made by the designer before deciding to design for the average. In this case, 50th percentile or the mean values which are very close to each other could be considered. Designing for maximum population value is appropriate if a given high value of some design feature should accommodate all or virtually all people. This is also applicable to designing for minimum population if a given low value of some design feature should accommodate all or virtually all people. In this type of design, the main raw measurements can be used to obtain the dimensions for individuals needed to be considered. However there are some users among the paraplegics that will find such equipment not comfortable to use and this may lead to secondary injuries. In some equipment design which target is to accommodate all ranges or classes of the population by adjusting their parameters, it is the practice to provide for

the adjustment range to accommodate from the 5th percentile female to the 95th percentile male. Generally, design for the adjustable range will be the preferred method of equipment design for paraplegics such as will ergonomically fix into the users' needs without putting undue stress on their body.

Prior to this study, there has been some scarcity of recent anthropometry database for Nigeria paraplegics. Major tools and utilities which were designed and manufactured outside Nigeria may not be accommodated by the group of users. With this present database, the same manufacturer can now redesign by making use of this recent developed anthropometric database. Local manufacturers can also tap into the resource established by the outcome of this study for their design for Nigeria paraplegics.

The proper emphasizes on the purpose of this study and the confidentiality assurance information provided notwithstanding, some subjects declined participation. This limited the selected study populations. Difficulty in measurement of certain anthropometric characteristics, because of their physical state, was another limitation recorded in the course of this study. Some of the immeasurable parameters included standing height and hip circumference (standing). However further survey may be needed to complement the results of this finding, especially in other regions of the Country not covered.

4. CONCLUSION

The anthropometric database which contrasts paraplegics of distinctive ages and professions in the South-western Nigeria had been developed from percentile distribution of measurements generated through the raw data obtained from this study. The study also proposed facilities/workstation design dimensions for various body regions. How recently data were collected is important in the use of anthropometric measurements in ergonomics design. This study presents an up-to-date data as obtainable in the current population in the study areas for use in paraplegias equipment design. The analysis on percentile basis will be easily accessible to designers of utilities, equipment and workspace for the group of people. Medical practitioners will equally find the information useful in rendering their services. It is also hoped that this will take care of the lack of

reliable anthropometric database for paraplegic population in the part of the country.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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