ANTHROPOMETRY SURVEY OF NIGERIA PARAPLEGICS

S. P. Ayodeji, S.B. Adejuyigbe and A.K. Abiola-Ogedengbe
Department of Mechanical Engineering,
Federal University of Technology,
P. M. B. 704,
Akure, Nigeria

ABSTRACT
Measurements of body features and other physical parameters of the human body were taken by the authors of Nigeria paraplegics. Several anthropometric measurements, both static and dynamic categories were taken ranging from height, forward reach to Mid Upper Arm Circumference (MUAC). Data collected were analyzed using percentile basis for the 5^{th}, 50^{th} and 95^{th} percentile. The result of this survey as presented will serve as a guide and provide anthropometric databank for designers of utilities, workspace and equipments for Nigeria paraplegics.

Keywords: *Anthropometry, Paraplegics, Survey, Nigeria*

INTRODUCTION

People with lower limb deformities, hitherto called paraplegics depend on mobility aids and other essential utilities to carry out certain important human activities. Such mobility aids includes wheel chair, callipers, crutches, to mention a few. However, for any of such utilities to effectively serve them, proper anthropometry of target users must be taken.

The importance of anthropometry to designs of facilities, workspace and equipments for human use can not be overemphasized. This has necessitated a lot of researchers to carry out activities in this field. To mention a few, Haslegrave (1979) compared British and American drivers' anthropometrics and observed that British drivers (male and female) were taller. Omotade (1989) constructed anthropometrics for measuring facial dimensions of new babies. He compared 252 body dimensions of whites in Cardiff with 256 similar dimensions of black babies in Ibadan, Nigeria. He noticed that the phalpebral fissure lengths were significantly different between white and black population. Goswami et al (1987) 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. Other anthropometry survey works include those undertaken by Oxford (1969), Joan and Kirk (1970), Langdons (1965), Lippert (1962) and Ighoanugo et al (2002).

Just as human anthropometry follows some anthropographic distribution, ditto those of human paraplegic populations ipso facto. Thus, anthropometry distribution of Nigeria paraplegics would differ from those of other nationals. However, utilities and equipments used by Nigeria paraplegics are usually imported from other countries whose anthropometry distribution differs from ours. Efforts to source anthropometry data of Nigeria paraplegics were unsuccessful. The principal way to achieve good design is through the application of anthropometric data. In order to be effective, however, the data must not only be appropriate to the design at hand but must also be descriptive of the target user population (Bradtmiller and Annis, 1997).

Anthropometry data of Nigeria population was thus taken for various age distributions ranging from 0 to 60 years. A sample size of 100 was taken and 40 different body dimensions were measured using anthropometers, some of which we designed and constructed, while some were bought out. Reliability of the constructed anthropometers was ensured by proper calibration.

METHODOLOGY

Questionnaires were used to obtain anthropometric data from respondents in Benin, Edo State and Warri, Delta State. These cities are the nucleus of the old Mid-West (later Bendel) state. They are home to varieties of ethnic groups in Nigeria (both minority and majority) partly due to their strategic location and being main source of crude oil; Nigeria's chief export commodity and largest income earner. These cities demography are thus seen as reflective and representative of the Nigerian population.

A sample population of 100 was taken of both male and female respondents. For each respondent, anthropometers designed and constructed for this purpose was used to obtain their data. The calibration of the designed anthropometers in centimetres was carefully done. The weighing scale used is calibrated in Kilogramme (kg). Age measurements were taken verbally or from respondents record with organisations they belonged to.

Forty anthropometric parameters were measured. These parameters and their possible areas of application for designs of both equipments and workspaces are shown in Table 1.

ANTHROPOMETERS USED

Anthropometers used for this survey includes the following:

1. wooden venier calliper
2. standiometer
3. tape rule
4. weighing scale

Description of Anthropometers

The anthropometers used during the survey are:
Wooden Venier Calliper: This is T-shaped wooden equipment. It has a wooden slider running along the longer arm of the Tee. Calibrations in cm were provided along the longer arm of the Tee where the readings shall be read from the calliper.

Standiometer: This is made of wood with cm caliberations provided at one end. It is a long standing rod where respondents are made to stand to the maximum height they can reach, while the measurement is read.

Tape Rule: The tape rule is a purchased item. It is made of latex material and has calibrations in centimeter and inches on opposite sides. Its flexibility allows it to be used for different measurements like waist circumference, head circumference, hip circumference (Standing), Middle Upper Arm Circumference (MUAC), etc. The tape rule has a range of 150cm. See figure 1c.

The weighing scale: The weighing scale was purchased as manufactured from the store. It has a flat surface on which subject can stand while the scale calibrated in Kilogram can be read to ascertain the weight of subject. The capacity of the scale is 120Kg

Reliability of Anthropometers

The anthropometers used were carefully calibrated and readings during the survey were re-

peatedly taken to ensure correctness. Most readings taken remained unchanged during the repeat measurement to confirm the reliability of the antropometers.

Table 1: Anthropometry parameters and possible area of applications

Category	Possible Area of Application (Industrial and domestic equipment & workspace designs)
Age	
Height	Vertical standing clearance
Weight	Seat design
Sitting height	Vertical sitting clearance
Forward reach	Horizontal grasping reach
Maximum body width	Lateral Clearance
Eye height sitting	Placement of visual display
Mid shoulder height	Garments design
Buttock to popliteal	Establishment of seat length
Buttock to knee length	Horizontal leg room
Popliteal height (sitting)	Seat height
Knee height (sitting)	Vertical leg room
Thigh clearance (sitting)	Seat and lower clearance
Elbow to fingertip	Operator control clearance
Chest circumference	Garments design
Shoulder circumference	Garments design
Hip (buttock) circumference	Garments design
Head breadth	Head gear design
Head circumference	Head gear design
Inter pupilliary breadth	Eye goggle design
Waist circumference	Garments design
Waist depth	Waist strap, Garments design
Buttocks to heel length	Leg clearance
Shoulder breadth	Width for central working area, wheel chair, garments design, etc
Hip breadth	Seat breadth
Forearm to forearm breadth	Back rest with lateral clearance
Head height	Head gears
Head length	Head gears
Eye to top of head length	Head gears, protective helmet design
Chin to eye height	Protective helmet strap design
Neck circumference	Garments design
Hand length	Hand protectors and grip
Hand breadth at metacarpal	Hand protective gears
Hand breadth at thumb	Hand protective gears and lateral hand clearance
Hand thickness at metacarpal	Hand protective gears
Foot length	Foot wears
Ball of foot width	Foot wears
Mid Upper Arm Circumference	Arm strap, Garments design
Abdominal girth	Garments design
Mid-thigh circumference	Callipers design, Trousers design

ANTHROPOMETRY PARAMETERS

Forty anthropometry parameters were measured and they are hereby illustrated graphically in Figures 1a-ap

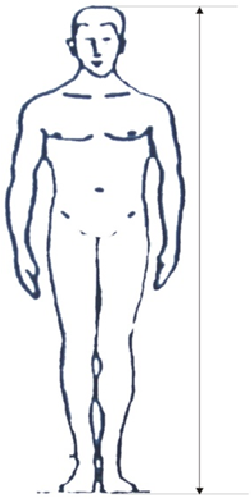

Fig. 1a: Height

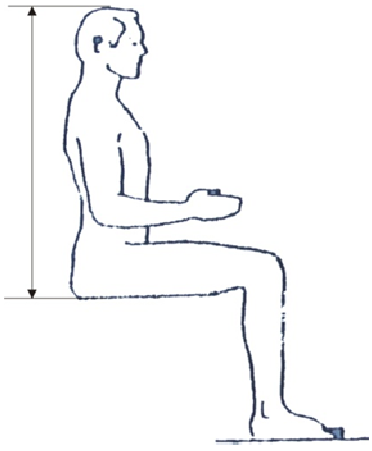

Fig. 1b: Sitting Height

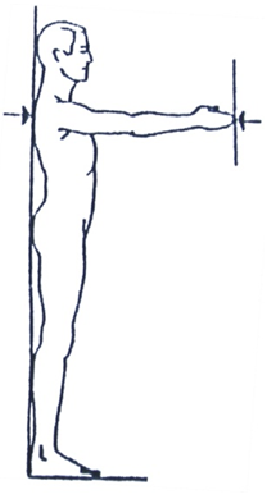

Fig. 1c: Forward Reach

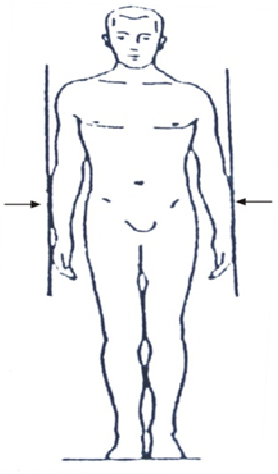

Fig. 1d: Maximum Body Width

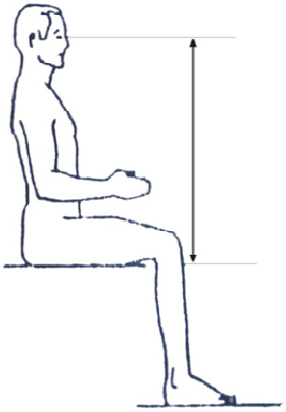

Fig. 1e: Eye Height Sitting

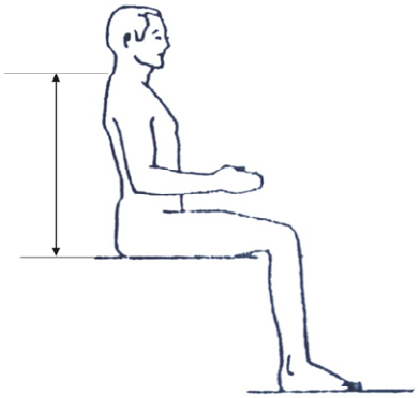

Fig. 1f: Mid Shoulder Height

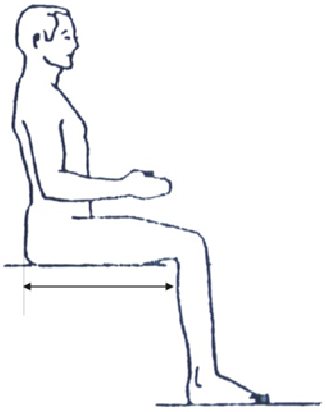

Fig.1g: Buttock To Popliteal

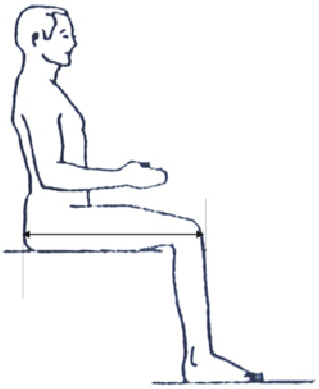

Fig 1h: Buttock To Knee

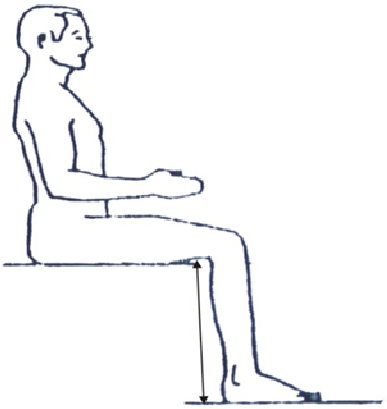

Fig 1i: Popliteal Height

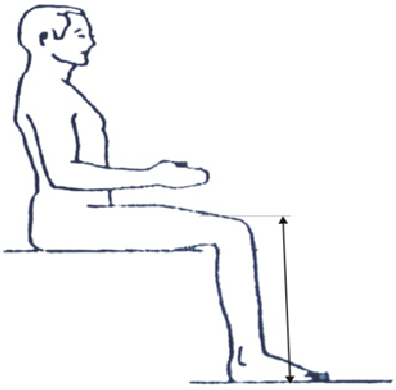

Fig. 1j: Knee Height

Fig. 1k: Chest Circumference

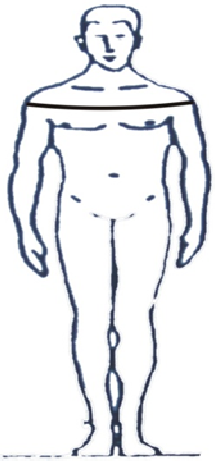

Fig. 1l Shoulder Circumference

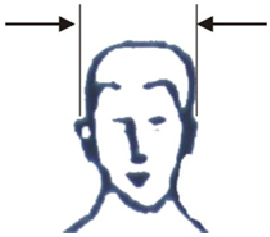

Fig. 1m: Head Breadth

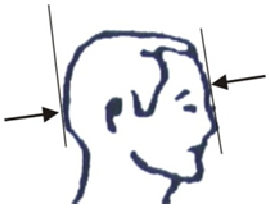

Fig. 1n: Head Length

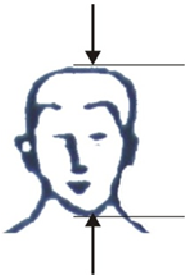

Figure 10: Head Height

Fig. 1p: Hip Circumference

Fig. 1r: Waist Circumference

Fig. 1s: Head Circumference

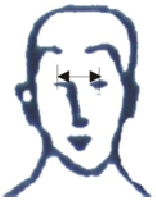

Fig. 1t: Inter-Pupilliary Breadth

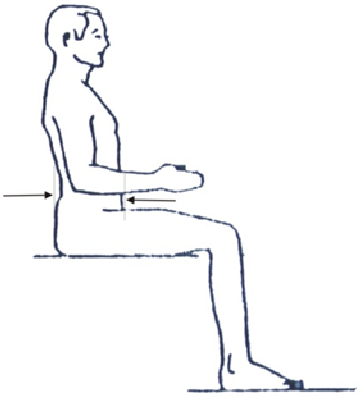

Fig. 1w Waist Depth

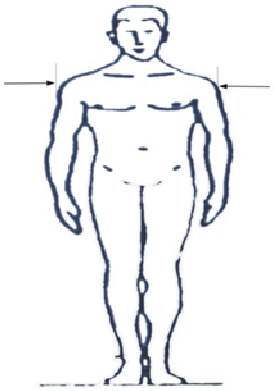

Fig. 1x: Shoulder Breadth

Fig. 1y: Buttock To Heel Length

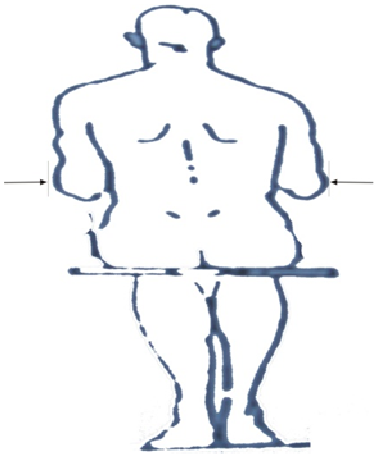

Fig. 1z: Forearm To Forearm Breadth

Fig. 1aa: Abdominal Girth

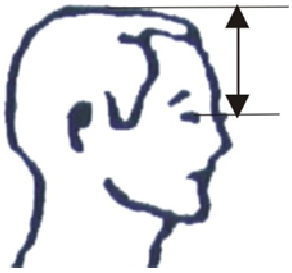

Fig. 1ab: Eye To Top Of Head Length

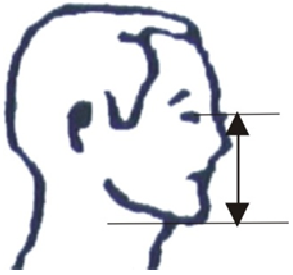

Fig. 1ac: Chin To Eye Height

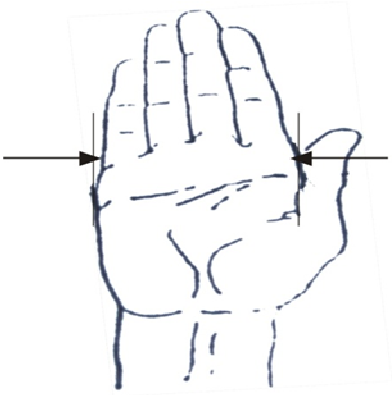

Fig. 1ae: Hand Breadth At Metacarpal

Fig. 1ad: Neck Circumference

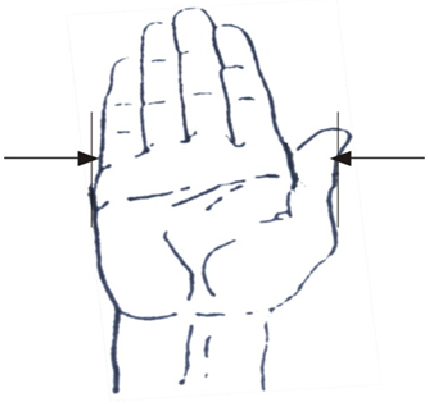

Fig. 1af: Hand Breadth At Thumb

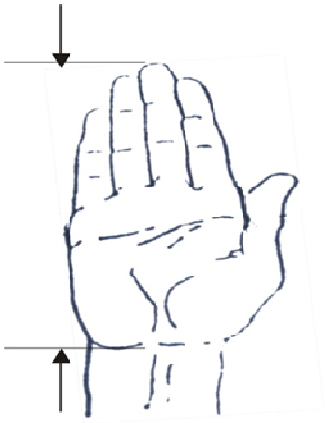

Fig 1ag: Hand Length

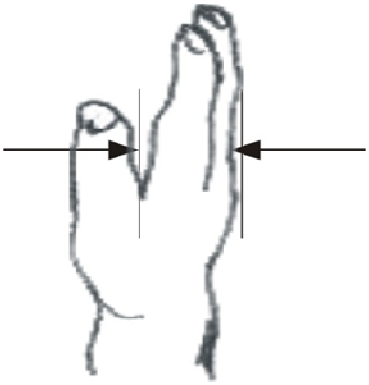

Fig. 1ah: Hand Thickness At Metacarpal

Fig. 1aj: Muac

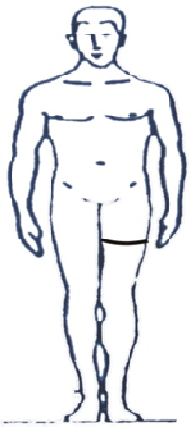

Fig. 1ak: Mid-Thigh Circumference

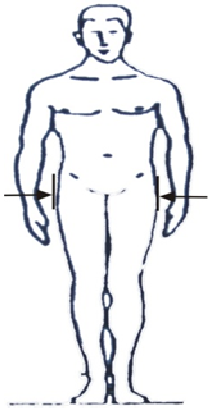

Fig. 1am: Hip Breadth

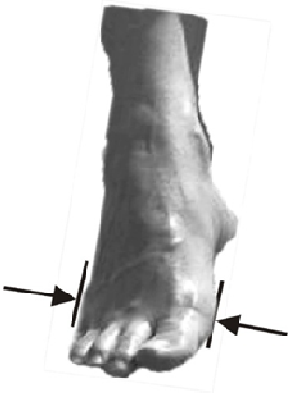

Fig. 1an: Ball Of Foot Width

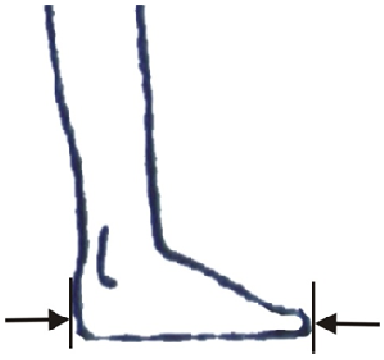

Fig. 1ap: Foot Length

RESULTS AND DISCUSSION

The anthropometric parameters measured were all in centimetres and the analysis presented in tables and figures above reveal similarities in the body sizes of paraplegic male and females except that males have generally higher values than females except in certain physical features which are more prominent in females. These ones include chest circumference, hip (buttock) circumference and hip breadth. This survey 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

Table 2: Percentile Distributions for Male Paraplegics

Category	5^{th} percentile	50^{th} percentile	95^{th} percentile
Age	8	24	46
Height	118.21	148	163.5
Weight	20	45	56.2
Sitting height	57.45	69.5	78.875
Forward reach	61.225	75	90
Maximum body width	29	40	55
Eye height sitting	49.45	63	70
Mid shoulder height	41.45	52.25	60
Buttock to popliteal	29.725	37.5	44
Buttock to knee length	36	44.25	54
Popliteal height (sitting)	31	41	50.11
Knee height (sitting)	37	50.5	62.1
Thigh clearance (sitting)	8	9	12
Elbow to fingrtip	36.225	44	51.775
Chest circumference	62.225	82	101.3
Shoulder circumference	71.45	96.5	118.375
Hip (buttock) circumference	56.15	75	87.7
Head breadth	15	17	21
Head circumference	51	55	63.695
Inter pupilliary breadth	7	8.75	10.775
Waist circumference	57	69.1	85.55
Waist depth	16	20	24.1
Buttocks to heel length	67.45	94.5	106.55
Shoulder breadth	31	36.5	45.1
Hip breadth	20.45	27.5	32
Forearm to forearm breadth	32	40	49
Head height	19	22	27
Head length	20	24	28
Eye to top of head length	7	10	14.055
Chin to eye height	11	13	15
Neck circumference	27	34	41.55
Hand length	14	18	23.55
Hand breadth at metacarpal	6	10	11
Hand breadth at thumb	8	12	14
Hand thickness at metacarpal	2	3	4
Foot length	16	22	25.06
Ball of foot width	6	10	12.955
MUAC	17	22.8	34.275
Abdominal girth	53	65.05	85.1
Mid-thigh circumference	21	29	40.6

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 which could be regarded as cases of abnormality. Table 2 shows the percentile distribution of male paraplegic population while Table 3 presents those of the female population.

Table 3: Percentile Distributions for Female Paraplegics

Category	5^{th} percentile	50^{th} percentile	95^{th} percentile
Age	5.45	19.5	46.55
Height	116.45	137	155.55
Weight	18.45	38.5	55
Sitting height	57	68	74.825
Forward reach	58	69	81
Maximum body width	27.725	37.5	51.55
Eye height sitting	50	60.25	67
Mid shoulder height	42.45	52	59
Buttock to popliteal	29.45	35	42.275
Buttock to knee length	35	41.5	49
Popliteal height (sitting)	30	36.5	44.55
Knee height (sitting)	34.725	42.35	50.55
Thigh clearance (sitting)	8	9	12
Elbow to fingertip	34	39	49.55
Chest circumference	60.45	91	103.1
Shoulder circumference	71.45	96.5	108.65
Hip (buttock) circumference	56.725	86	94
Head breadth	16	22	27
Head circumference	51.725	55	59.55
Inter pupilliary breadth	7	8.8	10.275
Waist circumference	57	70	82.55
Waist depth	16	18	22.55
Buttocks to heel lengt	61	71.5	84.605
Shoulder breadth	31.45	40	44
Hip breadth	22	29	35
Forearm to forearm breadth	33	41.5	46
Head height	18.225	22	24.55
Head length	18.45	21	23.5
Eye to top of head length	8	9.25	11
Chin to eye height	9	11	12
Neck circumference	26	31	41.55
Hand length	15	19	23
Hand breadth at metacarpal	6.225	9	11
Hand breadth at thumb	8	11	13
Hand thickness at metacarpal	2	3	3
Foot length	16	20.25	23
Ball of foot width	6	9	11.275
Muac	17	27.5	32.55
Abdominal girth	55.45	76	82
Mid-thigh circumference	21.45	29	33.55

CONCLUSION

Following the collection of anthropometric data of Nigeria paraplegics, efforts have been made to analyse this data

The analysis on percentile basis will be useful to designers for the Nigerian and African market in taking care of the needs of the paraplegics in this region. The 5^{th} and 95^{th} percentile presented will ensure the designs could be made to accommodate large percentage of paraplegic populations in this region.

Local manufacturers in Nigeria are implored to tap into the resource established by this job to design and manufacture for the Nigeria paraplegics. Major tools and utilities used by the paraplegics in Nigeria, currently being imported will be manufactured within.

Aside cost reduction, the local manufacturers stand a competitive advantage by achieving better user friendliness of their products through the use of this resource. Thanks to several non-governmental organisations, the Nigeria paraplegic populations which are mostly found on the streets un-catered and with no resources of their own are now being housed and catered for. Thus the local manufacturers will definitely have a market for their products.

ACKNOWLEDGEMENT

The authors wish to appreciate the following people for their contributions in the course of this research especially during the field survey. Mr. Abiola F. Ogedengbe for taking us round the locations. Mr. Ben Onoshemo, Miss Juliet and Hon. Solomon Ighrakpata of the Solomon Ighrakpata Foundation. Major Joy Umoh and Captain John of the Salvation Army Rehabilitation Centre, Benin, Nigeria

REFERENCES

Bradtmiller Bruce and Annis James (1997). *Anthropometry for Persons with Disabilities: Needs for the 21st Century* prepared for U.S. Architectural and Transportation Barriers compliance board under contract no. qa96001001 retrieved from http://www.access-board.org/research/anthropometry for persons with disabilities.htm

Goswami, A., Ganguli, S., and Chatterjee, B. B. (1987). *Anthropometric Characteristics of Disabled and Normal Indian Men***.** *Journal of Ergonomics.* 30(5):817-823.

Haslegrave, C. M. (1979). Anthropometric profile of the British Car Driver. *Journal of Ergonomics.* 22(2): 145-153

Igboanugo, A. C., Egharevba, F. and Ibhadode, A. O. A. (2002). Anthropometric survey of Nigeria Adult Working Class. *Nigerian Journal of Engineering Management.* 3(2): 7-20.

Joan, W. and Kirk, N. S. (1970). The Relation between some Anthropometric Dimensions and Preferred working surface height in kitchens. *Journal of Ergonomics.* 22(2):123-139.

Langdons, J. F. (1965). The Design of Card Punches and the Sealing Operator. *Journal of Ergonomics* 8: 61-68.

Lipperts (1962). Ergonomics Needs in Developing Country. *Journal of Ergonomics*. 10(5): 617-626.

Omotade, O. V. (1989). Facial Measurements in the New Born (Forward Syndrome). *Journal of Medical Genetics.* 1:67-80.

Oxford, H. W. (1969). Anthropometric studies in Swedish Industrial works when Standing and Sitting. *Journal of Ergonomics.* 12(2): 883-902.