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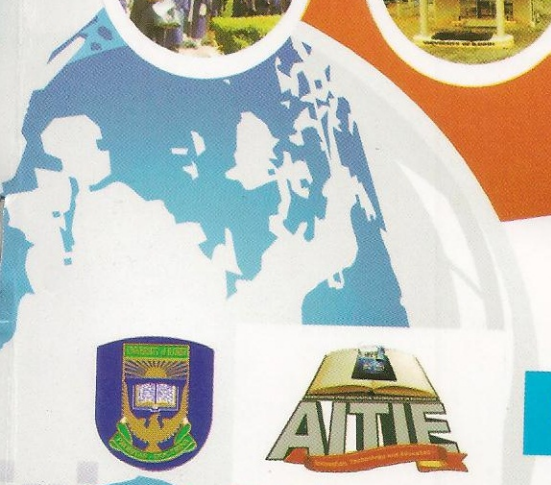

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That All May Integrate Technology forInstruction

Edited by

Dr. Nafisat A. Adedokun-Shittu
University of Ilorin, Ilorin
Hameed Olalekan Bolaji
Al-Hikmah University, Ilorin
Festus Oladimeji Olafare
University of Lagos, Lagos
Musiliu Kola Aderoju
University of Ilorin, Ilorin
Mudasiru Olalere Yusuf
University of Ilorin, Ilorin

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ANTHROPOMETRIC EVALUATION OF A NIGERIAN UNIVERSITY'S COMPUTER LIBRARIES

OLANIYI, Babarinde Isola, ALIMI, Adebayo Emmanuel & ADEGBIJA, Mosiforeba Victoria
rindeolaniyi@yahoo.com ; eaalimi@unilorin.edu.ng ; mosivic@gmail.com
Department of Educational Technology,
Faculty of Education,
University of Ilorin, Ilorin, Nigeria

Abstract

Computer library is a place where computers are kept for the safe use of learners and facilitators' in an instructional system for research and curative purpose. The conventional library consisting of physical books is being rapidly substituted by the paperless electronic-library. Students spends long period of time in the electronic library (e-library) staying in static position and posture, and as a result vulnerable to Computer-related Illnesses. The main purpose of this study therefore was to conduct an ergonomic and anthropometry evaluation of computer libraries in University of Ibadan, Oyo State, Nigeria. The dimension of the furniture in e-library were taken, so also the various body dimensions such as sitting height, knee height, popliteal height, buttock to popliteal height among others were taken from the students. 5th, 50th and 95th percentile of the data were computed and analyzed with SPSS version 21.0 statistical package. Based on the obtained anthropometric data, mismatch analyses were carried out and there were notable mismatch between the various anthropometric dimensions of the users and the furniture dimensions. It was therefore concluded that the furniture in the computer section of the library are not ergonomic enough for the students and recommended that indiscriminate use of furniture should be avoided

Keywords: Ergonomic, Anthropometric and Computer Library

Introduction

It is no more a conjecture that Information and Communication Technology (ICT) has an enormous impact on every sphere of life, as the fact that computer and other ICT appliances and gadgets will revolutionize the word had become a reality.ICT is an household term that has as many definitions as there are researchers and educators and it refers to diverse myriad of technology, technological tools and resources used to create, communicate, disseminates, store, and manage information (Hamilton-Ekeke & Mbachu, 2015). It is seen as a term that involves all types of technologies for manipulating and communicating information (Ogunlade, 2014).

Computer is the nucleus and heart of ICT and has been regarded as the hallmark of technological advancement and it has been defined as an electromechanical device that is capable of accepting data as input in a prescribed format, process the data, and give information as output (Onasanya & Adegbija, 2007). Computer varies in sizes and shapes, forms and features, purpose and versatility to include the desktop computer, laptop, portable digital assistants, and anthropomorphic computers. It has been regarded as the all-purpose machine whose usage is a trend in technological advancement and because of its versatility, it has very high applications in human life (Davari, 2013). Computers have the greatest impact on our lives becoming an epitome of modern times, being used in every aspect of life and altering the daily work of large businesses and industry which makes nearly everyone in this digital world to be spending a lot of time in front of a computer (Onasanya, Daramola, Adegbija, & Olumorin, 2012). Working with computers has become a constant in today's world with such benefit that cannot be over

emphasize(Lale, 2013). The paradigm shift in the use of computer is evident in our languages nowadays as the computer terms and technical terminologies are being added to society's vocabulary (Yusuf, 2005).

Computers because of its uses has been relevant in all aspect of human life and has a result found its way into the offices, administrative offices, schools and even homes (Wisegeek, 2015). And because of the prevalent use of computer in education, the computer is becoming more and more ubiquitous in the school, particularly in the Nigerian Universities. In the university computers are commonly found in offices for secretarial work. Large numbers of computers are usually found computer laboratory, computer rooms, ICT centres and computer libraries with computers of all types and varying sizes which are indispensable pedagogue tools in teaching-learning activities in learning environments in the universities. The integration of computer into human life has being changing the face of things and how things are done. Many institutions and processes are becoming digital, paperless and online based. The educational sector is not left out of this ICT transformation as pedagogue activities and other teaching learning activities are becoming ICT based. One of the key element in the university that has been transformed by ICT is the library.

A library has been defined as an organized collection of information resources made accessible to a defined community for reference or borrowing (Ogendengbe, 2015). It provides physical or digital access to material, and may be a physical building or room, or a virtual space, or both. A library's collection can include books, periodicals, newspaper, manuscripts, films, maps, prints, documents, microform, CDs, cassettes, videotapes, DVDs, ebooks, audio books, database and other formats (Ashaolu,& Itsekor, 2014). Libraries range in size from a few shelves of books to several million items. It is a place in which literary and artistic materials, such as books, periodicals, newspapers, pamphlets, prints, records, and tapes, are kept for reading, reference, or lending. Hence, the library can be generally described as an essential part of an institution which facilitates learning, study and research (Ogedengbe, 2015).

The computer library is a place in learning environments where computers are being place for safe and convenient use of the learners. A computer library or e-library is a cluster of computers that are usually networked and available for use by the public. University students makes use of the computer library for various research and academic purposes. Students spends long period of time in the library staying in static posture (Reddy, 2015). Computer library or the e-library is the electronic version of the old library. The old library belongs to the old economy while computer library or e-library belongs to the new economy. The e-library consists mainly of computers and it is characterized by the absence of books and papers (Ashaolu,& Itsekor, 2014).

However, poor interaction between the computer and the user can lead to health problem, such as eyestrain, backache and swollen wrist students spend a lot time in the computer library in various sitting positions (Momodu et al., 2014). Along with the expanding and arbitrary use of computer technology have come reports about adverse health challenges for computer users (Apple, 2015). As useful as these devices are, they can also be significantly damaging for users who continuously utilize these devices by impairing their musculoskeletal system as incompatible users perform repetitive tasks for extensive hours (Lale, 2013).

The various *cognate* researches from several cognoscenti researchers Lale and Korhan, (2015), Odunaiya, Owonuwa, & Oguntibeju (2014), Dunmade, Adegoke, and Ayodeji (2014), *Omondi*, Mailutha and Mukundi (2013), Lale (2013) and Johnson, Onigbinde, Onasanya, Emechete, and Gbela (2008), *editorialize that there* are concerns regarding negative consequences of computers as a result of the improper use of computers which can cause serious physical injury to the user even if the duration of use is less trivial. The literatures had adduced evident proof of ill health arising from the poor workplace design, improper use of computer, prolonged periods of computer use, can result in visual, musculoskeletal and psychological problems, being confined to awkward postures for specific task demands, at given situations or as influenced by poorly designed products over extended periods,

provokes psychophysiological stress and imposes negative effects on human mental and physical performance. Epidemiological studies such as Ogedengbe (2015), Asaolu and Itsekor (2014), Osquei-Zadeh, Ghamari, Abedi, and Shiri,(2012), and Adeyemi (2010) apprised that the ergonomic factors that affect the comfort and pleasure of library users include reading table and chair parameters, thermal factors such as relative humidity and air temperature, level of sound and noise and the light intensity.

Ogedengbe, (2015), Adeyemi (2010) and Adedoyin, Idowu, Adagunodo, & Idowu, (2004)observed that ergonomic hazards impact negatively on students and staffs in the computer library and that computer workstations in the university's' computer libraries should be designed with both the user and the task in mind so that the academic task can be performed comfortably, smoothly and efficiently. It is therefore necessary for every institution to consider ergonomics while designing its library as this would affect its overall productivity. The use of unergonomic computer workstations often results in Computer-related Illnesses (CRI) (Gupta, Arora, & Gupta, 2013).

Ergonomic has been defined as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people (International Ergonomics Association [IEA], 2003). Ergonomics is a way of designing workstation, work practices, and workflow to accommodate the capacities of workers (Zunjic, Papic, Matija, Matija, Slavonic, & Lukic, 2015). Ergonomic design reduces risk factors known to contribute to occupational injuries and illnesses, such as sprains and strains and cumulative trauma disorders (CTDs). If work is performed in awkward postures or with excessive efforts, fatique and discomfort may result. Under these conditions muscles, tendons, ligaments, nerves, and blood vessels can be damaged. Injuries of this type are known as musculoskeletal disorder (MSD) (Occupational safety & health Training [OHSAacaddemy] (2013).

Educational Ergonomics is concerned with the interdependence of Education performance and design of educational facilities. Educational ergonomics has the capacity to enhance the performance of students and educational systems to a substantial degree (Onawumi, Oyawale, & Dunmade, 2016). Educational ergonomics have been classified into four domains: physical, cognitive, neuroergonomics and social or organizational.Whereas physical ergonomics deals with human anatomical, anthropometric, physiological, and biomechanical characteristics as they are related to physical activity, cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. Organizational ergonomics deals with the optimization of sociotechnical systems, including their organizational structures, policies, and processes, while Neuroergonomics involves the application of more in-depth neurophysiological methods such as brain imaging techniques (International Ergonomics Association [IEA], 2003). Physical ergonomics shall be the focused in this study which rests on the underlying scientific field of anthropometrics.

Heiting (2015)defined computer ergonomics as a discipline which addresses ways to optimize the computer workstation to reduce the specific risks of computer related illnesses. Kerst(2011)defined computer ergonomics as the designing of the workstation characteristics to match human performance capabilities. Computer ergonomics refers to human factor related to the use computers. It is the study of the relationship between people and their working environment. Ergonomics deals with designing efficient and safe chairs, desk and appropriate work environment (Eyitayo & Eyitayo, 2010).

Computers are one example of human use of machines and the application of the principles of ergonomics to computer work station can reduce these health risks and increase comfort and efficiency. Students using computers inadequately placed or positioned can result in a wide range of injuries (Pinder 2016). Student remain seated at school for a considerable amount of time and most computer workstation (CW) did not meet standard description of CW and majority of the computers users had pain in their low back as a result (Johnson et al., 2008). Sitting, which is the work posture of students in a learning environment, should be properly done to avoid backaches, strain, fatigue and extra stress on the neck and back (Onawumi & Lucas, 2012a), (Onawumi & Lucas, 2012b). Placement of the seat should therefore permit the full range of seat adjustments, unobstructed visibility out of the front windshield, and comfortable reach of the controls and foot pedals (Onawumi, Lucas, & Adebiyi, 2012).

Ergonomically unsuitable seat gives rise to psychophysical fatigue, (Stana, Jovan, Snjezana, & Natalija, 2010). It also increases the risk of lumbar discs deformation, neck pain, back and shoulder tension and reduced blood circulation in the legs and buttocks, (Mazloumi, Fallah, & Tavakoli, 2012). Also inimical to people's health is electromagnetic pollution that computer users are being exposed to, such as electromagnetic fields and other harmful emissions which emanates from the visual display Unit (VDU), uninterrupted power suppliers (UPS) and rays emitting gadgets. the electromagnetic fields emitted by the monitors were observed to decrease the level of melatonin and increase the level of Adrenocorticotropic Hormone (ACTH) in the body (Eyitayo & Eyitayo, 2010).

Poor ergonomic while using the computer can lead to work-related musculoskeletal disorders (WRMD) and other forms of postural damage that may result in physiological illnesses that are developed due to prolonged mechanical stresses imposed on the musculoskeletal system. Varte, Rawat, Singh, and Majumdar (2015)revealed that increased exposure to computers and related workstation, uncomfortable furniture, types of jobs performed and the length of working hours in an unchanging position and general lack of movement have been identified as potential risk factors for back pain. On the other hand, ergonomically designed furniture can reduce postural discomfort and reduce musculoskeletal and postural problems (Shikdar & Al-Kindi, 2015).

Anthropometry is the scientific measurement and collection of data about human physical characteristics and the application of these data in the design and evaluation of systems, equipment, manufactured products, human-made environments, and facilities which deals with the measurement of size, mass, shape, and inertial properties of the human body. This field is interdisciplinary consisting mainly of anthropometry, mechanics, physiology, and engineering. Its applications address mechanical structure, strength, and mobility of humans for engineering purposes (Federal Aviation Administration [FAA], 2003).

The study of anthropometrics or human measurement is concerned with the physical sizes and shapes of humans. Anthropometrics is a very important branch of ergonomics in research and application. Anthropometry relies on sophisticated methods to measure physical dimensions including static and dynamic measurements of specific populations. The results obtained from these methods are statistics that can be applied in the design of products, clothing, occupational, and recreational environments. Also, anthropometric data is essential in developing biomechanical models to predict human movement, reach, force, and space requirements (Ajayeoba, 2005). Anthropometry is concerned with measurement of physical sizes and shapes of human body (Oladipo, Okoh, & Hart, 2010).

The main purpose of this study was to carry out an ergonomic and anthropometric evaluation of computer laboratories in universities in Oyo States, Nigeria. The following research questions were answered:

1. What is the anthropometric analysis of computer libraries furniture?
2. What are the anthropometric analysis of computer libraries users? and
3. What are the anthropometric mismatch between the anthropometric dimensions and the student furniture dimensions?

The major cause of musculoskeletal disorder and other forms of CRI is the posture and position of the computer user at the computer workstation. The human musculature and skeletal system as seen in figure 1 is supported by the spine. The spinal column consists of 33–34 vertebrae, 7 cervical vertebrae (C1-C5), 12 thoracic vertebrae (T1-T12), 5 lumbar vertebrae (L1 – L5), 5 sacral vertebrae (fused) (S1 – S5) secondarily fused to the sacrum and 4–5 vertebrae coccygeal that form the coccyx as seen in figure 35. The vertebrae work as a functional system and each of the vertebrae is separated by shock absorbing disks called intervertebral disc as seen in figure 1.

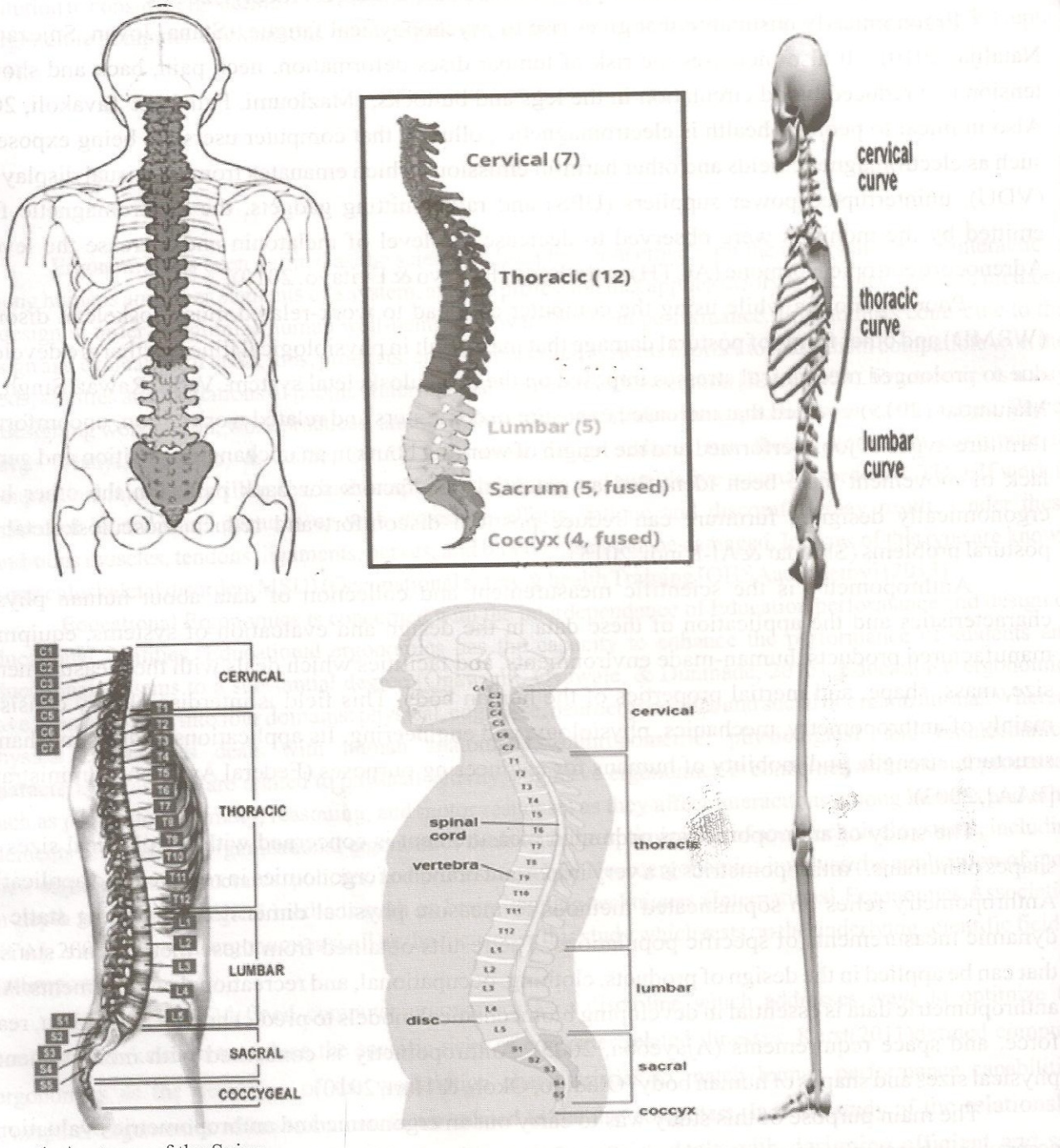

Figure 1: Anatomy of the Spine

Source: Maryfield Brain and spine (2017).

The spine is made of 33 individual bones stacked one on top of the other. This spinal column provides the main support for the human body and allows people to stand upright, bend, and twist, while protecting the spinal cord from injury. Strong muscles and bones, flexible tendons and ligaments, and sensitive nerves contribute to a healthy spine. Any of these structures affected by strain, injury, or disease while working on the CW can cause pain (Mayfield Brain and spine, 2017; IGEA Brain and spine, 2017; and Goodman Campbell Brain and Spine, 2017). An adult spine has a natural S-shaped curve and the spinal curves shape should be maintained. The spine has three natural curves that form an S-shape. The neck that is cervical spine and low back that is lumbar spine regions have a slight concave curve, and the thoracic and sacral regions have a gentle convex curve as seen in Figure 1. The curves work like a coiled spring to absorb shock, maintain balance, and allow range of motion throughout the spinal column. The five regions of the spinal column see figure 1. Strong muscles keep our spine in alignment as seen figure 1, the muscles and correct posture help in maintaining the natural spinal curves.

Good posture involves training the body to stand, walk, sit, and lie so that the least amount of strain is placed on the spine during movement or weight-bearing activities. Excess body weight, weak muscles, and other forces can pull at the spine's alignment. The normal adult spine is balanced over the pelvis, requiring minimal workload on the muscles to maintain and upright posture. Any form of posture and position while working on the computer workstation that results in spinal balance can result in strain to the spinal muscles and deformity of the spine as it attempts to maintain an upright posture. The following are postural disorder as a result of abnormal spine curve. Lordosis also called sway back, kyphosis also called hunchback, and scoliosis are skeletal disorder as a result of abnormal curve of the lumbar spine, thoracic spine and curve from side-to-side of respectively.

Any posture on the CW that alter the "S" shape of the spine will result in CRI. Chairs and tables that are not ergonomic enough will coerce the user to conform to "C" curve. A good ergonomic chair should provide backrest that will put the user in a position that supports the "S" curve of the spine, such chair should provide adjustability in the backrest, seat pan, and seat height. Armrests should be adjustable also, or else no armrest should be provided as seen in figure 2.

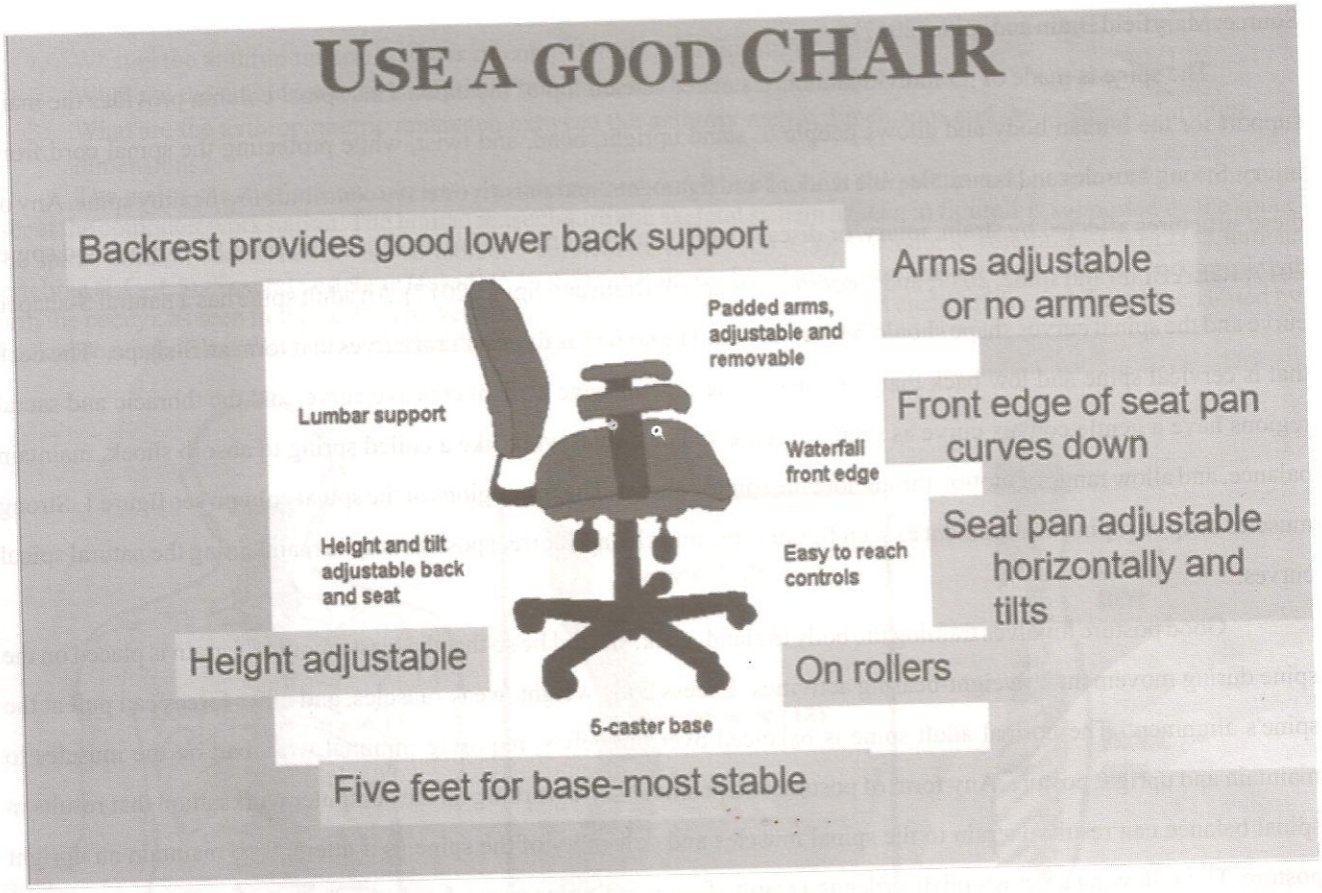

Figure 2: Features of an Ergonomic Chair
Source: Fermanich (2014)

Methodology

This study employed the anthropometric approach to ergonomics wherein anthropometric measurements which involves the body dimensions of the students and the furniture dimensions and the mismatch was conducted. Also, the assessment of chairs, tables in the laboratories' structural dimension were investigated through physical measurement of ergonomically characterized features of the items and their relative position to the pupils in the classroom.

Data Analysis and Discussions

The analysis of the data ispresented in the following Tables with the discussions Research question one: What are the anthropometric analysis of computer laboratories users? The anthropometric analysis of computer laboratories users is presented in Table 1.

Table 1:
The Anthropometric Analysis of Computer Laboratories Users

Sex	Height	Weight	Sitting Height	sitting eye height	Waist depth	Thigh clearance	Buttock to knee	Knee height	Seat length depth	Popliteal height	Seat width
NUMBERS											
MALE 502											
FEMALE 508											
TOTAL 1010											
MEAN											
MALE	68.68	81.6	109.4	20.7	47.6	57.4	47.0	47.6	46.5	30.2	169.5
FEMALE	73.8	84.0	107.5	19.5	45.8	57.8	51.6	48.0	45.4	36.9	163.0
BOTH	166.2	71.3	82.8	108.4	19.9	46.7	57.6	49.3	47.8	46.0	33.8
MINIMUM											
MALE	55.0	63.0	100.1	16.0	20.0	50.0	20.0	42.0	42.0	20.0	141.0
FEMALE	53.3	73.5	100.0	16.0	20.0	50.0	20.0	42.4	42.0	20.9	147.4
BOTH	8.7	10.3	43.6	5.9	3.9	14.8	4.1	11.3	4.2	3.2	6.4
MAXIMUM											
MALE	96.0	92.0	132.0	32.0	63.0	65.1	61.0	61.4	57.0	45.0	191.2
FEMALE	96.0	771.0	132.0	36.0	62.3	65.0	59.1	61.4	57.0	50.0	191.2
BOTH	191.2	96.0	771.0	132.0	36.0	63.0	65.1	61.0	61.4	57.0	50.0
PERCENTILE											
5^{TH} %tile											
MALE	60.0	77.0	102.1	16.0	21.0	52.0	20.0	43.5	42.0	22.0	160.0
FEMALE	55.0	74.0	104.0	16.0	20.0	52.0	50.0	43.0	42.0	25.0	151.7
BOTH	154.0	55.0	74.0	102.7	16.0	20.0	52.0	20.0	43.0	42.0	23.7
50^{TH} %tile											
MALE	68.0	82.0	107.0	21.0	55.0	58.0	54.0	50.0	46.0	30.0	170.0
FEMALE	75.0	77.0	105.5	17.0	52.0	56.0	50.0	45.0	43.0	38.8	160.0
BOTH	166.4	69.0	79.2	106.0	20.0	52.2	56.0	51.0	45.1	46.0	32.0
95^{TH} %tile											
MALE	175.0	89.0	84.3	117.0	23.0	59.0	65.0	58.0	54.0	51.0	45.0
FEMALE	89.0	82.1	114.0	22.0	56.0	65.0	56.0	54.0	51.0	45.0	174.0
BOTH	175.0	89.0	84.30	117.0	23.0	59.0	65.0	58.0	54.0	51.0	45.0

Research question two: What is the anthropometric analysis of computer laboratories furniture? The furniture dimensions are presented in Table 2

Table 2:

s/ no	Name of Computer Laboratory	FURNITURE DIMENSIONS												
		No of Chairs	Seat Height (cm)	Seat Depth	Seat Width	Backrest height	Backrest Width	Backrest Lumbar	Armrest height	Armrest Length	Distance Between Armrest	Table no	Height for Thigh	Width for thighs	Depth for knees	Sitting Height for Input Device
1.	KENNETH DIKE LAB EAST WING	1	46.0	41.0	40.0	51.5	46.0						75.0	74.0		73.5
2.	KENNETH DIKE LAB WEST WING	1	46.0	41.0	39.5	38.0	46.0						73.0			69.0

Research question three: What are the anthropometric mismatch between the anthropometric dimensions and the student furniture dimensions?
The mismatch is given in Table 3

Table 3:
Library Furniture Dimension Combination Formulas

	Dimension Combination	Formula
1	Chair Seat Height (CSH) and Popliteal Height (PH)	$(PH + 2) \cos 30 \leq CSH \leq (PH + 2) \cos 5$
2	Chair Seat Depth (CSD) and ButtockPopliteal Length (BPL)	0.80 BPL CSD 0.99 BPL
3	Chair Seat Width (CSW) and Hip Breadth (HB)	1.1 HB CSW 1.3 HB
4	Chair Backrest Height (CBH) and Shoulder Height (SH)	0.60 SH CBH 0.80 SH
5	Table Height (TH) and Elbow-Rest Height (ERH)	CSH + ERH UTH CSH + 0.852 ERH

5	Table Height (TH) and Elbow-Rest Height (ERH)	CSH + ERH UTH CSH + 0.852 ERH + 0.148 SH
6	Underneath Table Height (UTH)	(KH + 2) + 2 UTH (PH + 2) cos 5 + 0.852 EH + 0.148 SH - 4

Source: Osquei-Zadeh et al., (2012)

Table 3:
Anthropometric Match or Mismatch Status of in the Kenneth Dike Library West Wing's furniture, University of Ibadan.

KENNETH DIKE COMPUTER LIBRARY Chair Chair Parameters								
					Kenneth Dike Computer Library East Wing		Kenneth Dike Computer Library West Wing	
s/no	Chair	Related anthropometry data	Representative Value 50%ile	Estimated Value from formula	Furniture Dimensions	Remarks	Furniture Dimensions	Remarks
1.	Chair Seat Height (CSH)	Popliteal Height (PH)	PH=42.0	36.37≤CSH≤41.8	46.00	Mismatch	46.00	Mismatch
2.	Chair Seat Depth (CSD)	Buttock-Popliteal Length (BPL)	BPL=52.00	41.60≤CSD≤51.8	41.0	Mismatch	41.0	Mismatch
3.	Chair Seat Width (CSW)	Hip Breadth (HB)	HB=45.00	49.50≤CSW≤58.50	40.00	Mismatch	39.50	Mismatch
4.	Chair Backrest Height (CBH)	Shoulder Height (SH)	SH=65.01	38.5≤CBH≤51.8	48.00	Match	48.00	Match
5.	Backrest width	Waist breadth	HB=45.0		48.0	Mismatch	48.0	Mismatch
6.	Armrest Height	Elbow rest height/thigh clearance	ERH=55	5th percentile of sitting elbow height=thigh clearance	No arm rest		No arm rest	
7.	Distance between armrest	hip breadth/seat width	HB=31.0		No arm rest		No arm rest	

Table

Table Parameters				Kenneth Dike Computer Library East Wing		Kenneth Dike Computer Library West Wing	
8.	Table Height (TH)/ height for thigh	Elbow-Rest Height (ERH)(thigh clearance)	KH=59.0	75.0	Mismatch	73.0	Mismatch
9.	Depth for knees	buttock to knee	BTK=65.000	55.50-19.000 =36.500	Mismatch		mismatch
10.	Width for thigh	seat width/hip breadth	SW=38.80	74.0	Mismatch		mismatch
11.	Sitting height for input	popliteal height + elbow rest height	TC=52.0	73.50	Mismatch	69.0	mismatch

Table 3 revealed there is a mismatch in most the furniture dimensions in Kenneth Dike Library (West and East) Wing's furniture. There are notable mismatch in the various body dimensions of the users and the furniture dimensions in the Kenneth Dike computer library.

Conclusions and Implications

This study employs anthropometric knowledge to evaluate a Nigerian University library and it is recommended based on this study that adjusted furniture both chairs and table should be provided, and the promiscuous use of furniture should be avoided. The chairs should make provision for adjustability in the seat height, seat width, seat edge and backrest so as to ensure that users are not affected by various computer-related illness. The implications for this study is that CRI is inevitable if ergonomic factors are not considered and ergonomics might be a solution to CRI

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