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Evaluation of Male and Female Chairs for Administrative Staff in Public Institution

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Abstract

Objectives: To evaluate the suitability of the male and female chairs for administrative staff in Kumasi Technical University in Ghana. **Methods/Analysis:** The male and female chairs were used as seats by the administrative staff in doing office work. The evaluation exercise was conducted in 47 selected offices in the administrative block at Kumasi Technical University. Effectively, each administrative staff from the gender groups was given six hours evaluation session. Questionnaires on good seat points and chair feature evaluation checklists were administered at the end of the session of which data were recorded. **Findings**: The majority - 75.51% males and 85.71% females - found it easy in entering and leaving the chairs upon sitting on them to do office work. None of the male and female administrative staff experienced pain at the back of their knees while using the chairs in the working environment. Also, 65.30% males and 80.00% females reported that they felt comfortable in using their respective office chairs. With respect to participants' view about the chair feature checklists, 67.35% - 81.63% males agreed that the male chair was constructed using ergonomic principles, whilst 68.57% - 100.00% females agreed that the female chair was constructed using ergonomic principles. **Application**: Importantly, none of the users experienced restriction to movement and circulation of blood since their knees did not get into contact with the underside of their desks. Finally, the methodology for the evaluation of the two chairs was found to be simple and effective by providing information to the institutional head and users.

Keywords: Evaluation, Anthropometry, Chair Measurement, Good Seat Point, Chair Feature Evaluation Checklist, Kumasi Technical University

1. Introduction

From previous studies, significant differences were observed in some of the anthropometric parameters for the male and female[1-3]. The aim of this study was to judge the fitness of the two chairs (male and female chairs) as sitting items in the office environment in public institutions. It is acceptable that, every evaluation process has to be suitable and dependable. The methodology was not to compare the male and female chairs directly with other chairs[4], but to evaluate them in an office environment. An evaluation procedure must be both valid and reliable. Published standard accepts participants to evaluate chairs in either a laboratory or at the actual workplace. The application of statistical analysis to address chair evaluations for single adjustable chair, ten ergonomic office chairs and the limitations and constraints in using tabloid chairs were discussed in some previous studies[5-7].

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However, no literature was obtained on the evaluation of male and female chairs which are fixed or not adjustable in offices in the public institutions.

The objective of the study was to evaluate the suitability of the male and female chairs for office workers in Kumasi Technical University. The male and female chairs were used as seats by 84 (49 males and 35 females) administrative staff in the selected offices in the administrative block. Effectively, each administrative staff from the two different groups (males and females) was given six hours session to patronize his or her respective chair. Questionnaires which were designed according to two subjective methods (good seat points and chair feature evaluation checklists) were administered and data recorded at the end of the sixth hour working session. This procedure was followed and data recorded as each of the chairs was moved from one office to another. Descriptive statistics (frequencies, percentage) was employed.

Anthropometric data are used to determine the relative furniture measurements of chairs which are not adjustable[8]. The use of an appropriate chair is critical to working efficiently. In the study of ergonomics, designers apply measurements of users to design furniture, equipment, workplaces and clothing[9-11]. In fact, when the body measurements are applied ergonomically, they turn to advance the users welfare, fitness, comfort and feel safe in product usage[12-13].

According to[14], seat height is one of the most important dimensions of seating. A too low seat puts the posture of the user at forward crouch with most seating benefits lost. For too high seat, the user's body will slide forward by not making use of the seat's depth and backrest.

The minimum seat depth (back of knee to buttock) measurement of women is about 406mm, and the maximum measurement (seat depth) of a man is about 508mm or more. To sum it, 381mm is suitable as a guide for seat depth[14]. A seat depth has to be enough to ensure the use of the chair backrest and allows 50 - 102mm between knees back and chair front[15]. Correct seat depth ensures that the legs are positioned without compression at the back of the knee with the buttocks placed in order to make full use of the backrest[16]. A seat which is very long will cause the chair front to push knees back to reduce blood flow into legs and feet[17]. The gap between knees back and chair front helps the user's knees to bend in order to rise out of a chair and for leg movements[18].

Generally, to sit for lengthy period, width of seat should not go below 432mm[14]. A seat width of 432mm - 508mm is the standard[15]. A correct seat width ensures that a reasonable range of the population get into and out of the chair easily[19].

Seat angle or slope is the angle the seat makes with the horizontal. The seat slopes slightly backward to stop the user slipping out of the chair. Chairs which are upholstered with padding materials such as breathing cloth fabrics extend the working periods of users in the working environment[15].

A good chair allows for easy entry and egress from users or change in sitting posture and space for easement to enhance best sitting posture for a lengthy period. A good chair should be comfortable in service[20]. A comfortable chair supports a user to execute at desk with ease and the chair being strong enough to bear the weight of the user[21]. Discomfort is measured using bodily pain that stems from the posture and effort involved from a specific task[4].

A well-designed backrest is important since it gives rigid support to the thorax and pelvis and also maintains the angle of the spine between the vertebrae[14]; or it supports the lumbar region (middle portion of the user's back) above the sacral region so that backache will not be felt[22].

2. Materials and Methods

2.1 Sampling Design

The studied population was Kumasi Technical University (study area) in Kumasi metropolis. Forty seven offices were found in the administrative block. The procedure

was that, the 47 offices were visited and these offices recorded 84 administrative staff of which their body measurements were taken to form their anthropometric data.

2.2 Approval Needed to Gain Access to Kumasi Technical University

The approval to use Kumasi Technical University for the study was sought from the Registrar. The Registrar is responsible for the participants in the administration block. The Registrar had to be persuaded that the anthropometry survey had proper and useful purpose and those participants would not be harmed, unnecessarily inconvenienced or subjected to any breach of confidentiality. To maintain confidentiality of workers, office code was used. It was also necessary to establish that, the presence of researchers taking measurements would not disrupt the daily routine of the Kumasi Technical University staff. Before the use of the data sheets, the researchers explained to participants individually how to become comfortable with the exercise and the research. Recording started immediately after the explanation. Participants were contacted during working hours from 8.00am to 5.00pm within the five (5) working days. All of the participants approached took part in the research out of their own free will.

2.3 Study Area

Kumasi Technical University was started as Kumasi Technical Institute in 1954 to offer craft courses. It was then raised to a Polytechnic status (non-tertiary) by the Ghana Education Service to offer diploma and sub-professional courses in addition to the technician courses in 1963.

The Polytechnic Law, 1992 (PNDC L.321) raised the status of the Polytechnic to a tertiary institution to produce high caliber skilled manpower for manufacturing, commerce, science and technology to facilitate technological development. As a Polytechnic it was one of the famous, elegant and vibrant Polytechnics in Ghana.

The Technical University Act 2016, (Act 922) converted Kumasi Polytechnic to the present Kumasi Technical University with the aim of providing higher education in engineering, applied arts, science and technology as well as technical and vocational training.

It is a spectacularly beautiful institution which is sited at the heart of Kumasi, the Garden city of West Africa, the capital city of the Ashanti Region of Ghana. It has within the period of its existence become an important centre for the training not only for Ghana but also for other African countries.

2.4 Anthropometry and Designing for a Population

Anthropometrics is the study of human body dimensions that relates to the initial measure and sizes of a piece of furniture[23]. The essential and significant anthropometrical variables considered in chair design followed what was reported by[3] in Table 1. Ergonomics design of the male and female chairs require some anthropometric data[24]. The sampled anthropometric data of the male and female participants were used in constructing the male and female chairs. The anthropometric data of the participants were calculated in 5^{th}, 50^{th} and 95^{th} percentile classifications to sizes of the chair constructions according to[25] and reported in Table 2.

2.5 Anthropometric Data and Percentile Values in Kumasi Technical University

The anthropometric data of the male and female participants from Kumasi Technical University were sampled and reported during the anthropometric survey. The data were used in constructing the male and female chairs. Table 3 describes the descriptive statistics on administrative staff, whose most important body measurements, Popliteal to Floor Height (PFH), Buttock to Popliteal Length (BPL), Elbow to Seat Height (ESH), Sitting

Table 1. List of anthropometrical variables considered in chair furniture design

Dimension	Application
Popliteal-floor height	This is decisive for defining seat height, with both feet kept on the floor.
Buttock-popliteal length	This is used for establishing the maximum seat depth that a chair can have.
Elbow-seat height	Useful as a reference for determining desk table height.
Sitting shoulder height	This has no direct relationship with the furniture. The height of the chair backrest should not exceed this dimension.
Knee height	This is used for defining the minimum height of the under part of the working surface. There must be a free space between the desk and the knee. There must always be space between the desk and the knee in order to permit movement of the legs.
Width of bitrochanter	Useful for determining the minimum width of the seat.

Table 2. Percentile classification of some key anthropometric dimensions applicable in design problem

Dimension	Percentile examples of applications to design problem
Popliteal-floor height	50^{th}
Buttock-popliteal length	5^{th}
Elbow-seat height	50^{th}
Sitting shoulder height	50^{th}
Knee height	95^{th}
Width of bitrochanter	95^{th}

Table 3. Mean, Std. Dev. and key percentiles of anthropometric dimensions in millimetres for gender categories of the administrative staff

Dimension	Males				Females			
	Mean ±Std. Dev	5th	50th	95th	Mean ±Std. Dev	5th	50th	95th
PFH	483 ±29.44	439	480	530	483 ±29.44	386	468	539
BPL	496 ±35.40	430	490	553	504 ±34.57	436	510	552
ESH	189 ±10.73	170	190	205	189 ±9.29	169	190	205
SSH	522 ±37.19	458	520	605	509 ±34.57	432	510	555
KH	615 ±31.71	568	612	670	594 ±41.50	496	595	677
WOB	373 ±40.65	300	365	435	397 ±56.81	289	395	504

Table 4. Proposed dimensions in millimeters for male and female chairs for administrative staff in Kumasi Technical University

Dimension	Male chair	Female chair
Seat height	480 + heel height (25mm)	468 + heel height (40mm)
Seat depth	430	436
Armrest height	190	190
Backrest height	520	510
Desk clearance	670	595
Seat width	435	504

Shoulder Height (SSH), Knee Height (KH) and Width of Bitrochanter (WOB) were used in the construction of the two office chairs.

2.6 Conversion of Anthropometric Data to Sizes of the Two New Office Chairs

The conversion of the anthropometric data was based on percentile classification of measures applicable in design problem[26]. The design specifications of the two chairs such as seat height, seat depth, armrest height, and back-rest height and seat width are presented in Tables 4.

2.7 Orthographic Projections for the Male Chair

Figures 1-3 show the representations of the orthographic projections for the male chair.

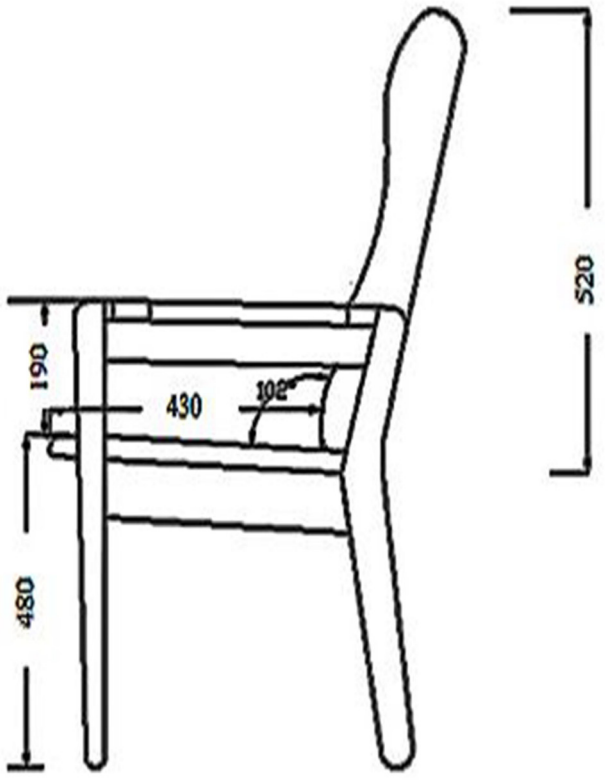

Figure 1. Illustration of the side view of the male chair.

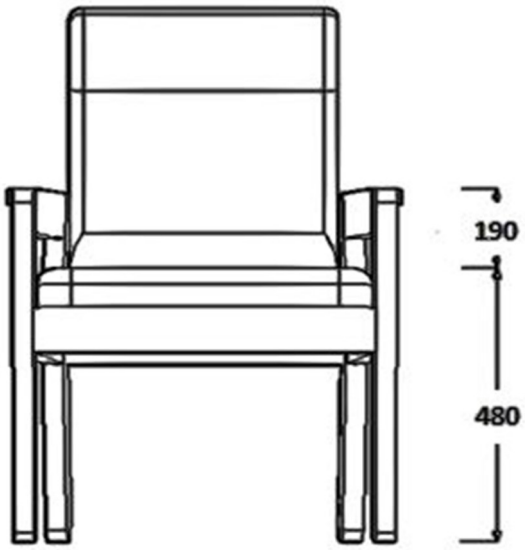

Figure 2. Illustration of the front view of the male chair.

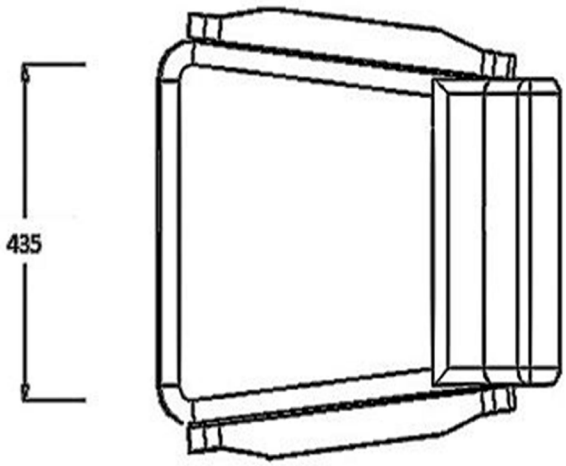

Figure 3. Illustration of the plan view of the male chair.

2.8 Orthographic Projections for the Female Chair

Figures 4-6 show the representations of the orthographic projections for the female chair.

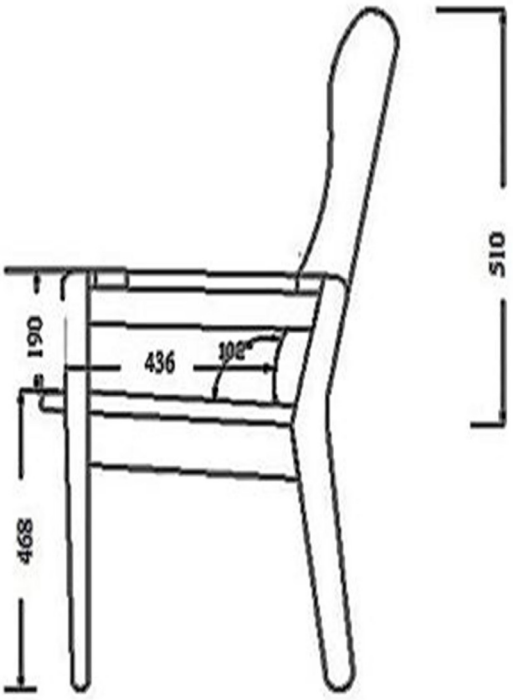

Figure 4. Illustration of the side view of the female chair.

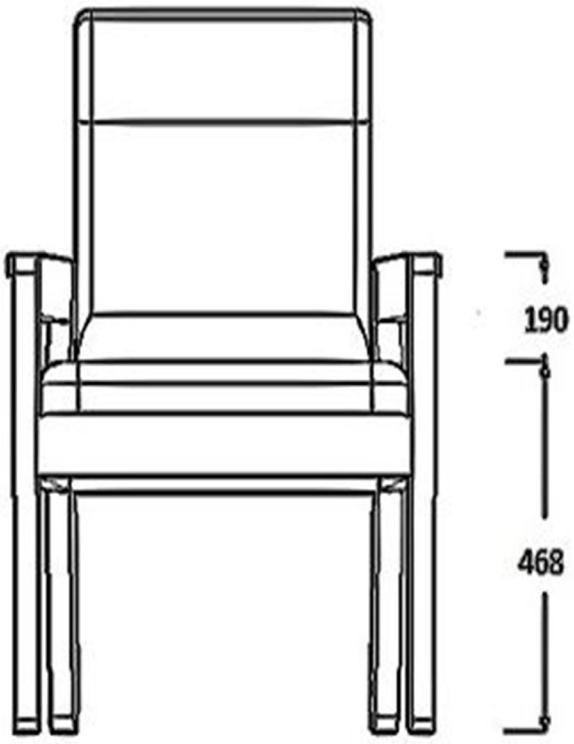

Figure 5. Illustration of the front view of the female chair.

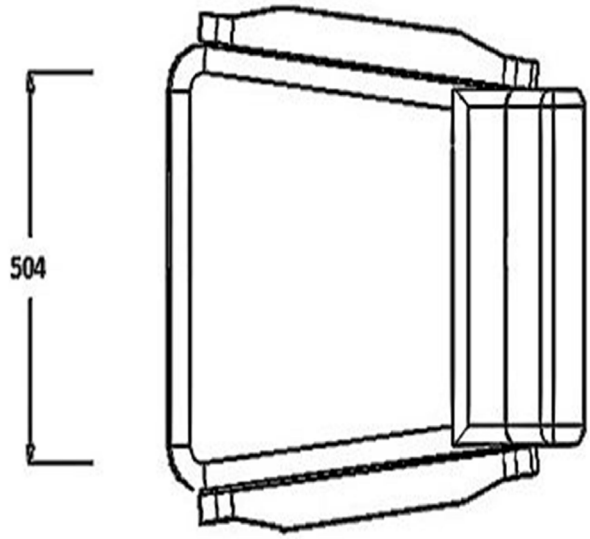

Figure 6 Illustration of the plan view of the female chair.

2.9 Evaluation of the Male and Female Chairs for Administrative Staff

In this section, 84 administrative staff (49 males and 35 females) participated in the evaluation exercise. The chairs were evaluated using two (2) different subjective methods: good seat points and chair feature evaluation checklist. The evaluation exercise was conducted in offices in the administrative block of Kumasi Technical University. Effectively, each user from each group was given evaluation session of 6 hours in the evaluation exercise. Questionnaires on subjective methods were administered at the end of the sixth hour working session for each user. Descriptive statistics (frequencies, percentage) was employed.

2.10 Good Seat Points

In this study, researchers assessed whether the seat was good or not. Variables considered include entry and egress from seat, feeling of pain at the back of the knees and user comfortability in using the chair to work in the office environment. According to[5], user comfortability used scale which conformed to the three (3) point scales (uncomfortable, average and comfortable).

2.11 Chair Feature Evaluation Checklists

The researchers asked questions such as whether Seat Height (SH) is correct, whether Seat Depth (SD) is correct, whether Seat Width (SW) is correct, whether Seat Slope (SS) is correct and whether Moulded Backrest (MB) fits well. The study provided a detailed five-point scale which to this study was appropriate [1 = Strongly Agree (SA), 2 = Agree (A), 3 = Neutral (N), 4 = Disagree (D) and 5 = Strongly Disagree (SD)]. To determine the results of the assessment of chair feature evaluation checklists for subjects who patronized the chairs, descriptive statistics (frequencies, percentage) were employed.

3. Results

3.1 Good Seat Points

Majority - 37 (75.51%) males and 30 (85.71%) females - of participants found it easy in entering the male and female chairs to do office work (Figure 7). Similarly, the same percentages were recorded with the ease of participants leaving those chairs (Figure 8). In fact, none of the participants experienced any pain at the back of their knees while using those chairs (Figure 9). Furthermore,

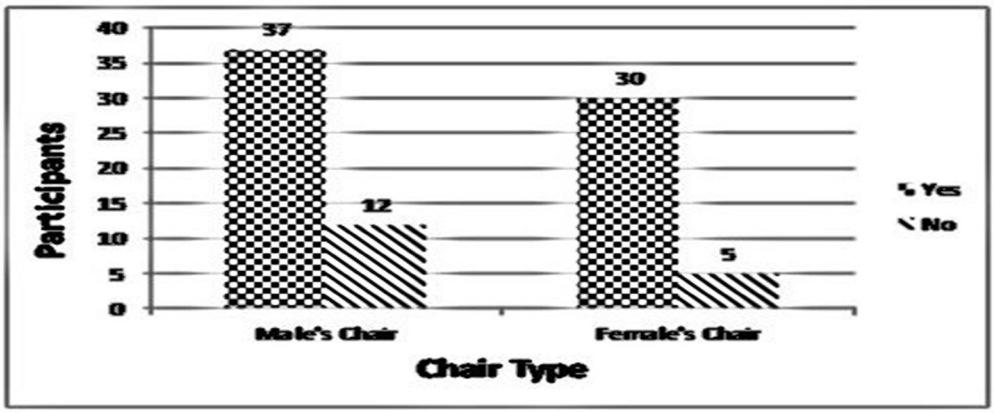

Figure 7. Response of male and female participants who found it easy in entering their chair types.

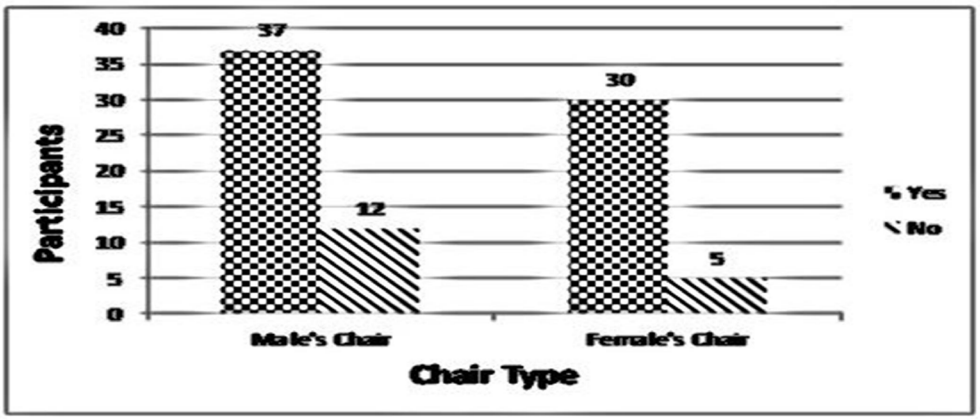

Figure 8. Response of male and female participants who recorded with ease of leaving their chair types.

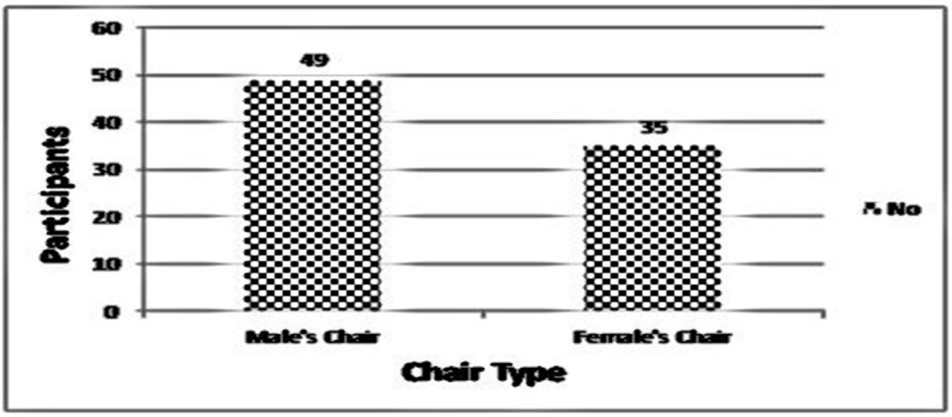

Figure 9. Response of participants who did not record any pain at the back of their knees.

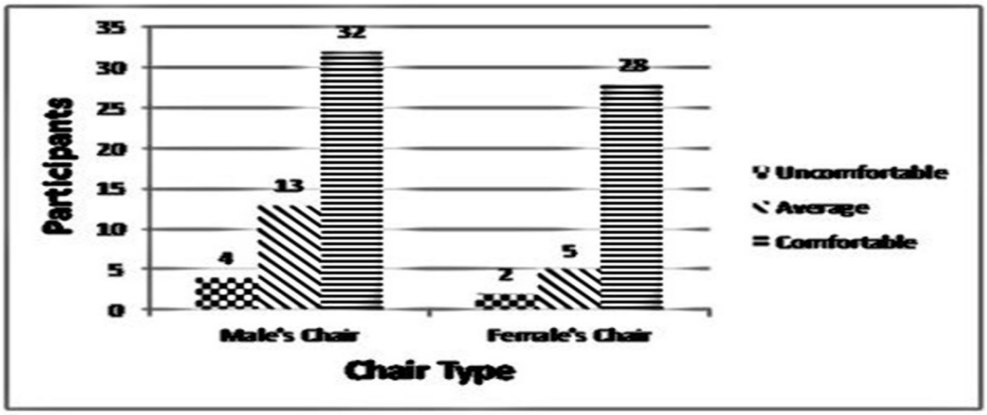

Figure 10. Response of male and female participants who felt comfortable in their respective chair type.

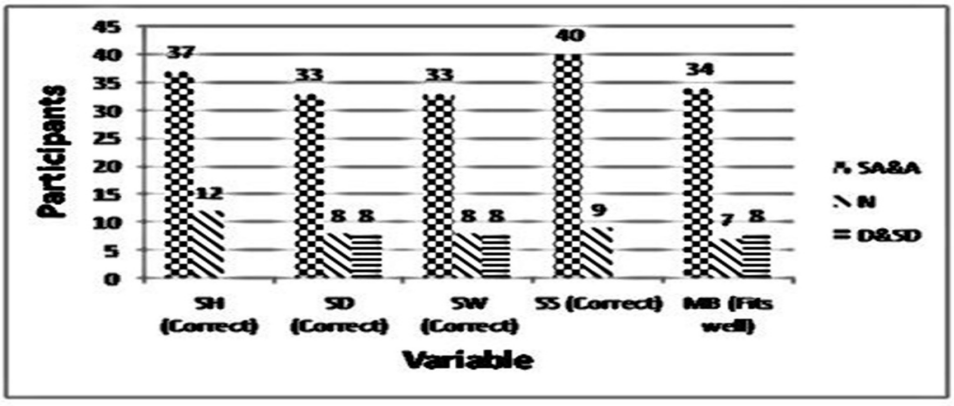

Figure 11. Response of male participants who responded to the variables considered under chair feature evaluation checklist.

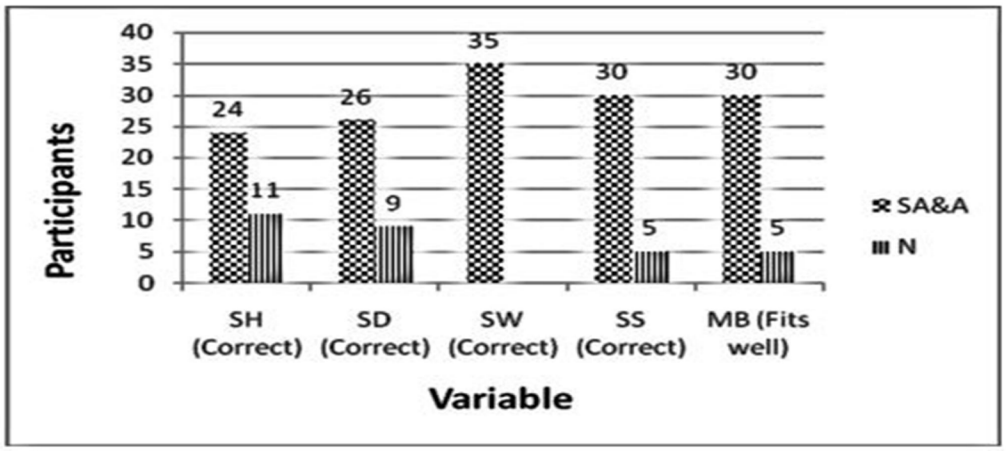

Figure 12. Response of female participants who responded to the variables considered under chair feature evaluation checklist.

32 (65.30%) males and 28 (80.00%) females felt comfortable in using those chairs to do office work (Figure 10).

3.2 Chair Feature Evaluation Checklists

With respect to participants' view on the chair feature evaluation checklists, male participants who agreed that the male chair was produced based on ergonomic principles ranged between 33 (67.35%) and 40 (81.63%) (Add Strongly Agree and Agree together) (Figure 11). Similarly, female participants who agreed that the female chair was produced based on ergonomic principles ranged between 24 (68.57%) and 35 (100.00%) (Figure 12).

4. Discussion

The furniture sizes (Table 4) used in the construction of the two chairs followed the percentile values of the most important body measurements reported (Table 2). High seat causes unnecessary pressure under the front part of the thighs to bring about pain and discomfort. Supply tissues in the distal and posterior region of the thigh are compressed and the front edge of seat acts like tourniquet to the blood supply of the legs. A height which is acceptable should allow a small space under the distal portion of the thigh, which will act as hanging space for soft tissue.

As the back of the knee has relatively sensitive skin, it is important that the construction of the seat depth should be slightly shorter than the buttock to the back of the knee dimension. A too long seat prevents the backrest from being used to support the lower back. This gives the back a pronounced rearward curvature and will lead to discomfort. Discomfort could be reduced if the person in the seat moves forward. Shallow seat depth will make the user feel like falling off the front of the chair and there will be no support of the lower thighs. The seat depth dimensions for both male and female chairs did not agree to what was reported by[14] that female is about 406mm and male is about 508mm and more. All the two chairs reported values above 432mm. Seat width is one of the most crucial measures that will ensure that users are free to move and adjust their posture at any time, to relieve postural loading[16].

Orientation of the backrest can be upright, reclining or semi-reclining. In slightly tilted backrest, the lumbar section is fully used and participants' settle comfortably in the chair. This prevents a gradual slide forward of the body. A tilting backrest avoids unnatural flattening and strain on the intervertebral lumbar discs and ligaments.

The high recorded values of the chair feature checklists (correct seat height, correct seat depth, correct seat width, correct seat slope and the fitting well of moulded back) in both chairs were clear indications that they were designed according to ergonomic principles and fitted

the anthropometric dimensions of the male and female administrative staff[9-11].

Furthermore, there were free movements into and out of the chairs by the participants[19]. This enabled the participants to move and adjust their postures at any time in their seats to relieve postural loading[16]. With moulded backrest, the lumbar section was fully used and participants settled comfortably in the chair with no indication of backache[22]. The study addressed the evaluation of male and female chairs without adjustable mechanisms in the designs. Thus, the chair evaluations were suitable for the male and female participants.

For maximum and general participation of the male and female chairs by public institutions, the study recommends the use of desk clearance with the help of knee height as related components in furniture design to produce male and female desks to match their respective chairs. Seat slope of 20° to the horizontal and inclination of backrest of 102° to the seat pan are important recommendations to check buttocks sliding forward and backrest supporting the lower back, respectively.

5. Conclusion

Each of the two chairs elicited large proportion of responses, with no complaints of pain. The constructed male and female chairs enhanced the sitting positions of all the participants. Also, the evaluation exercise confirmed the purpose that, both chairs (male and female chairs) can be used as sitting items in the office environment in public institutions. The outcome is the provision of new office chairs that will support the development of healthy and comfortable posture for administrative staff. The methodology was found to be simple and effective when applied to the chairs, providing information to the institutional heads and users.

6. Acknowledgements

The offices used for the study were from Kumasi Technical University in Ghana. The authors are grateful to all the participants who took part in the research out of their own free will. The authors express gratitude to Mr. Paul Inkum who helped in the construction of the male and female chairs used in the evaluation exercise.

7. References

1. Diep NB. Evaluation of fitness between school furniture and children body size in two primary schools in Haiphong, Vietnam. Master's Thesis, Department of human work sciences division of industrial ergonomics - Lulea University of Technology. 2003; p. 1-66.
2. Yu-Cheng L, Mao-Jiun JW, Eric MW. The comparisons of anthropometric characteristics among people in East Asia. Applied Ergonomics. 2004; 35:173-8. Crossref. PMid:15105079.
3. Mirmohammadi SJ, Mehrparvar AH, Jafari S, Mostaghaci M. An assessment of the anthropometric data of Iranian University Students. International Journal of Occupational Hygiene. 2011; 3(2):85-9.
4. Vergara M, Page A. Relationship between comfort and back posture and Mobility in sitting-posture. Applied Ergonomics. 2002; 33(1):1-8. Crossref.
5. Drury CG, Coury BG. A methodology for chair evaluation. Applied Ergonomics. 1982; 13(3):195-202. Crossref.
6. Helander MG, Czaja SJ, Drury, CG, Cary JM. An ergonomic evaluation of office chairs. Office Technology and People. 1987; 3(3):247-62. Crossref.
7. Corlett EN, Bishop RP. A technique for assessing postural discomfort. Ergonomics. 1976; 19(2):175-82. Crossref. PMid:1278144.
8. Openshaw S, Taylor E. Ergonomics and Design: A Reference Guide. Allsteel. 2006.
9. Bridger RS. Introduction to Ergonomics. St. Louis: McGraw-Hill Inc. New York. 1995. Crossref.
10. Kayis B, Ozok AF. The anthropometry of Turkish army men. Applied Ergonomics. 1991; 22(1):49-54. Crossref.
11. Jeong BY, Park KS. Sex differences in anthropometry for school furniture design. Ergonomics. 1990; 33(12):1511-21. Crossref. PMid:2286197.
12. Pheasant S. Bodyspace: Anthropometry, Ergonomics and the Design of Work. 2nd Edition. London: Taylor and Francis. 1996; p. 1-260.
13. Barroso MP, Arezes PM, Costa LG, Miguel AS. Anthropometric study of Portuguese workers. International Journal of Industrial Ergonomics. 2005; 35(5):401-10. Crossref.
14. Croney J. Anthropometric for designers. 1st Edition. London: B.T. Batsford Ltd. 1971; p. 1-176.

15. Office chair: choosing the right ergonomic office chair. Available from: https://www.spine-health.com/wellness/ergonomics/office-chair-choosing-right-ergonomic-office-chair. Date accessed: 07/02/2004.
16. British Standards 3044. Office Furniture: Guide to ergonomics principles in the design and selection of office furniture. London: British Standard Institute. 1990.
17. Panero J, Zelnik M. Human dimension & interior space: A source book of design reference standards. 6th Edition. New York: Whitney Library of Design. 1979; p. 75-9.
18. Diffrient N, Tillet A, Bardagjy J. Human scale 1/2/3. Cambridge, Massachusetts: The MIT Press; 1978.
19. Chair. Available from: https://en.wikipedia.org/wiki/Chair. Date accessed: 01/04/2018.
20. ChestofBooks.com: Read Books Online for Free. Available from: http://chestofbooks.com/. Date accessed: 27/05/2018.
21. Hammond JJ, Donnelly ET, Harrod WF, Rayner NA. Woodworking Technology. Massachusetts: McKnight Publishing Company. 1980.
22. Kennedy CA, Amick III BC, Dennerlein JT, Brewer S, Catli S, Williams R, Serra C, Gerr F, Franzblau A, Evanoff B, Rempel D, Irvin E, Mahood Q, Van Eerd D. Systematic review of the role of occupational health and safety interventions in the prevention of upper extremity musculoskeletal symptoms, signs, disorders, injuries, claims and lost time. Journal Occupational Rehabilitation. 2010; 20(2):127-62. Crossref. PMid:19885644.
23. Deros B, Mohamad D, Ismail AR, Soon OW, Lee KC, Nordin MS. Recommended chair and work surfaces dimensions of VDT tasks for Malaysian citizens. European Journal of Scientific Research. 2009; 34(2):156-67.
24. Ivelic Z, Grbac I, Ljuljka B, Tkalec S. Office furniture design according to a human anthropometric data. DS 30: Proceedings of Design, the 7th International Design Conference. Dubrovnik. 2002; p. 791-6.
25. Anthropometric data. Available from: http://www.arh.ukim.edu.mk/afwebnova/urban/metric%20Handbook/MHB5-Anthropometric%20data-pdf. Date accessed: 01/11/2010.
26. Parcells C, Stommel M, Hubbard RP. Mismatch of classroom furniture and student body dimensions: empirical findings and health implications. Journal of Adolescent Health. 1999; 24(4):265-73. Crossref.