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Fitting Workplace Furniture Ergonomics to Human Anthropometric Characteristics for Decent Work Systems Among Nigerian University Employees

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Abstract

Introduction: Access to a comfortable furniture in the office is a right enforceable by the worker, but it cannot be achieved without personal anthropometric data. This study aims to ameliorate the paucity of a representative anthropometric database on which furniture designs and procurement orders would have been based for workers. The specific objectives were to determine seating anthropometrical body parts dimensions for university staff; develop a databank of measured data; and calculate basic anthropometric indices for decent work benchmarks. Methods: In achieving these objectives, both quantitative and qualitative systematic research methods were employed. In addition, structured questionnaires with imbedded relevant ergonomic queries were administered on respondents through participatory survey method. This study developed an anthropometric database and determined some indices. Results: For perfect decision situations, the percentiles of the indices were calculated. The calculated metrics aligned with standard guidelines in both 5th and 95th percentile values for seat height (40 cm – 55cm), seat depth (49.8cm maximum), seat width (45 cm) and armrest height (17.3 – 27 cm) requirements for optimal comfort depending on body stature of adult user sitting upright. In addition, 70 % of the sampled staff experienced body discomfort after using their office furniture. This issue constitutes a serious ergonomic concern necessitating holistic ergonomic assessment and interventions. Conclusion: The findings of this study will benefit the university by providing information on anthropometric data for furniture procurement.

Keywords: Anthropometric Data, Decent Work, Ergonomic Furniture, Musculoskeletal Disorder, University Employee.

Resumen

Introducción: El acceso a mobiliario cómodo en la oficina es un derecho exigible por el trabajador, pero no puede garantizarse sin contar con datos antropométricos personales. Este estudio tiene como objetivo subsanar la escasez de una base de datos antropométrica representativa, sobre la cual se fundamenten el diseño y la adquisición de mobiliario destinado a los trabajadores. Los objetivos específicos fueron: determinar las dimensiones antropométricas de las partes del cuerpo relevantes para el asiento en el personal universitario; desarrollar un banco de datos a partir de las mediciones obtenidas; y calcular índices antropométricos básicos que sirvan como referencia para garantizar un trabajo digno. **Métodos**: Para alcanzar estos objetivos, se emplearon métodos de investigación sistemática tanto cuantitativos como cualitativos. Además, se administraron cuestionarios estructurados —que incluían preguntas ergonómicas pertinentes— a los participantes mediante un método de encuesta participativa. En el marco de este estudio, se desarrolló una base de datos antropométrica y se determinaron diversos índices. **Resultados:** Con el fin de facilitar la toma de decisiones óptima, se calcularon los percentiles de los índices obtenidos. Las métricas calculadas se alinearon con las directrices estándar, tanto en los valores del percentil 5 como en los del percentil 95, respecto a los requisitos de altura del asiento (40 cm – 55 cm), profundidad del asiento (49,8 cm como máximo), anchura del asiento (45 cm) y altura de los reposabrazos (17,3 cm – 27 cm), con el fin de asegurar un confort óptimo en función de la estatura corporal del usuario adulto sentado en posición erguida. Asimismo, el 70 % del personal encuestado manifestó experimentar molestias corporales tras utilizar el mobiliario de su oficina. Esta problemática constituye una seria preocupación ergonómica que exige la realización de evaluaciones e intervenciones ergonómicas de carácter integral. **Conclusión:** Los hallazgos de este estudio beneficiarán a la universidad al proporcionar información fundamentada en datos antropométricos para la adquisición de mobiliario.

Palabras Clave: Datos Antropométricos, Trabajo Digno, Mobiliario Ergonómico, Trastornos Musculoesqueléticos, Empleado Universitario.

Introduction

There is growing trend of jobs demanding long periods of sitting at workplaces. Today in the industry, both workers and the International Standards Organisation (ISO) share the concerns about mapping the quality of work environment to anthropometric characteristics of a workforce. Nonetheless, office furniture set is the simplest device through which the mapping goal can be achieved. This research is significant because fitting the ergonomic characteristics of office furniture to the user's anthropometric limitations guarantees support to the activity being done (Springer, 2010). It also provides for the worker's safety (NIOSH, 2015), ensures healthy work life by risk prevention through design, and increases productivity by enhanced comfort (Taifa and Desai, 2016; Realvvasquez et al., 2020). Aside being essential because of recent growing practices at workplaces such as coding and data analytics using computer, advanced manufacturing technologies and evolving new work order (Nwanya and Achebe, 2023) requiring long hours of sitting and repetitive tasks, fitting the office furniture ergonomic attributes to human features will add up with other relevant human factors to create and manage a decent work system, particularly among university staff.

Work systems are comprised of humans, the tasks they do, the tools and technologies they use, the organization of the work, and the work environment (IEA,2010). A decent work system is one of the targets of sustainable development goals (SDGs), especially SDG 8 with its major pillars being the protection of labour rights and promotion of safe working environments through reduction in occupational injuries. Since comfortable furniture increases capacity to reduce occupational injury and by implication access to it is a right enforceable by the worker, but cannot be achieved without personal anthropometric data. According to Wang et al. (1999) as reported in (Deros et al., 2009), anthropometry is considered as one of the foundations of ergonomics discipline concerned with resolving the dilemma of "fitting people to machines". The aforementioned ergonomic identities cover any decent work system including the university system. It has been reported by (Ismaila, 2021) that where work tasks and equipment do not preclude ergonomic principles in their designs, workers are susceptible to undue physical stress, strain, and overexertion. This study focused on measurement of anthropometric data for design of workplace equipment used by university employees, where Fidelis et al. (2018) has evidently shown that the employees suffer discomfort and pains from ill-fitted poorly designed furniture.

The university system was chosen among other workplaces for strategic reasons. The staff population of universities in Nigeria represents a significant proportion of the productive workforce and deserves a safe and comfortable work environment. The university staff, comprising academic staff, professional staff, academic middle managers and educational administrators, besides making a contribution to education and national development, constitutes a great asset that helps universities achieve success (Kallenberg, 2020). Nigeria has 73 Federal, 57 state and 99 private universities (NUC, 2025) and the staff employed in those workplaces spend a good portion of the working period either reading, writing or conducting research in a sitting position. The university staff belong to an ISO population category whose anthropometric data are intended for use in conjunction with ISO standards for equipment design and safety (ISO/TR 7250-2:2010). Since majority of office work is performed from a seated position, understanding and correctly applying the ergonomics of office seating is critical to delivering work environments that are safe and support performance (Springer, 2010). The choice of seat furniture ergonomics in this research was because seat is the most common equipment found in organizations including a university. Workplace chair provides critical interface to relate anthropometrics of the worker with the job working conditions.

In view of the aforementioned importance, the consequences of using ill-fitted furniture include predisposing the staff to ergonomic risks factors, bad posture and work-related musculoskeletal disorders (WMSDs) problems. WMSDs are injuries or pains experienced in the joints of the body, muscles, ligaments, tendons, nerves, and structures that support limbs, back and neck (Baharampour et al, 2013; Sambo et al., 2023) which lead to impairments of normal body structure. Risk factors, as it relates to ergonomics, are things that increase the chances of negative results (Nwanya & Ukoha, 2025). For instance, a sedentary lifestyle is a risk factor for the development of heart disease.

In today's digital technology age, prolonged sitting with eyes glued to the computer is a trademark and never an option, but fitting the job, tools, work environment and furniture to the worker's attributes has increasingly been neglected. Results of various previous studies have associated WMSDs with wrong work posture and ill-designed work facilities including chairs, tables and pews which affect a worker's structural characteristics (Odunaiya, et al, 2014; Onawumi, et al, 2016a; Isapka, and Omorodion, 2019). The major impediment to solving this worrisome situation in the Nigerian context is the paucity of a user's anthropometric data for seat furniture design and evaluation of its compliance to standard usage guidelines. The prolonged non-availability of a user's anthropometric data has created immediate and potential impacts on the staff. For example, it is quite common to see some university staff wearing clavicle attachment, which consequently restrains productivity. This trend is rising at an exponential proportion and priority attention is inevitable.

A number of anthropometric surveys of Nigerian scenarios on the present subject exist in literature, but in pockets of research outputs with little or no consideration for implementation (Odunaiya, et al., 2014). For example, the study by (Ugbenyen and Ajayi, 2023) was designed to test the reliability of using some anthropometric indices in predicting obesity among undergraduate students. Taiwo and Thanni (2022) analysed the body mass, waist circumference and waist-to-hip ratio anthropometric characteristics and found prevalence of obesity among secondary and undergraduate students. Mbagwu et al (2025) assessed the variation in anthropometric dimensions estimated from stature and limb parameters of adolescent Nigerian secondary school students; Ekechukwu et al. (2021) conducted a survey among 108 infants recruited from a health centre in Enugu East Local Government Area on anthropometric variables- weight-age, height-age and weight-height for assessment of their nutritional status. Isamila (2009) studied hand, ear and foot anthropometric data of Nigerian university students for the design of related products. These aforementioned studies were deficient of how the obtained metrics could be used to improve workplace environment or furniture design, but focused on other baseline anthropometric data applications for health, nutritional and obesity controls, which do not in any way suggest their superiority over workplace ergonomic design and comfort.

However, the few extant literatures by (Odunaiya, et al, 2014; Onawumi, et al, 2016a; Isapka, and Omorodion, 2019) that focused on the present study have limited applications and found the furniture in the lecture theaters ergonomically unsuitable for the students. In the transport sector, Onawumi et al. (2016b) conducted a survey to address the need for ergonomically designed workplaces tailored to suit Nigerian bus drivers. Even, elsewhere in the world anthropometric survey has become a tool for national policy. In addition, Goleij, (2024) has shown that anthropometric dimensions of human body do change based on economics and family income, social conditions, health and nutrition. Hence for compatibility, the changes necessitate review or redesign of work environments and equipment like office furniture according to the new anthropometric data (Lee, 2014). Kang, et al. (2025) described an investigation of changes in body dimensions over time as crucial for user-friendly product design and preventing hazards caused by faulty products. Sadly, there is a dearth of information on the ergonomic sizing system of educational furniture, especially in the institutions of higher learning in Nigeria (Fidelis, 2018). According to Onawumi et al., (2016a), ergonomic intervention in the past has been by using reactionary participatory ergonomic intervention approach to mitigate the prevalence of musculoskeletal disorder experienced by pupils. In this regard, the present study is a proactive measure aimed at creating anthropometric data for university staff, which would be available in the literature. Solving the identified paucity of native anthropometric resource data is imperative and innovative to this paper. To the best knowledge of the current authors, this study is relevant and has not been carried out in the extant Nigerian literature.

This research aimed to obtain anthropometric dimensional data and demonstrate their compliance level with approved standards for improving comfort, safety and productivity of employees. The specific objectives were to: determine anthropometric dimensions of some university staff for design of office desks and chairs; estimate mean and standard deviation of basic anthropometric parameters; analyse and estimate effects of mismatched dimensions of furniture based on impacts on body parts of the staff; and evaluate staff body dimensions in conformance to ISO and other approved requirements. This study covered the University of Nigeria, Nsukka. The research involved physical measurements and theoretical studies conducted using integrated multiple technologies.

Materials and Methods

This study was designed with University of Nigeria Nsukka as a study area. The anthropometric dimensions of one hundred and two regular staff who consented to participate were physically measured in-situ by moving from office to office. The research involved a combination of quantitative and qualitative methods where physical body measurements and behaviour-based surveys as well interviews were carried out. For anthropometric data collection, the study adopted a random sampling, measurements of body parts, and a cross-sectional survey

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approach on a sample population of staff having some common environment. Data collected focused on gaining an understanding of the human anthropometrics for office furniture design. The equipment used in the study include structured pretested questionnaire tool and pre-calibrated measuring instruments like stadiometer, segmometer and sliding calliper were used to obtain physical body anthropometric data. The questionnaire was used to capture personal information of the respondent and experience of the employees. Two sets of three enumerators were trained on human anthropometric measurements and used to conduct the survey. The study adopted procedures that aligned with the ISO-7250 /IEC Directives, which stipulates ergonomic procedures for human measurement, for technological designs (ISO Technical Committee 159- Ergonomics, 2025).

The measured anthropometric body dimensions were expressed in centimetres (cm) and related to sitting position included: body stature (1), sitting height (2), shoulder height (3), popliteal height (seat height or lower leg length from floor to thigh (4), seat/hip breadth (5), Elbow rest height (6), buttock-popliteal length (7), buttock-knee length (8), thigh clearance (9), eye-sitting height (10), shoulder breadth (11) and knee height 12) as shown respectively in Figure 1. Personal data of each respondent corresponding to these variables were recorded in a form prepared for this study.

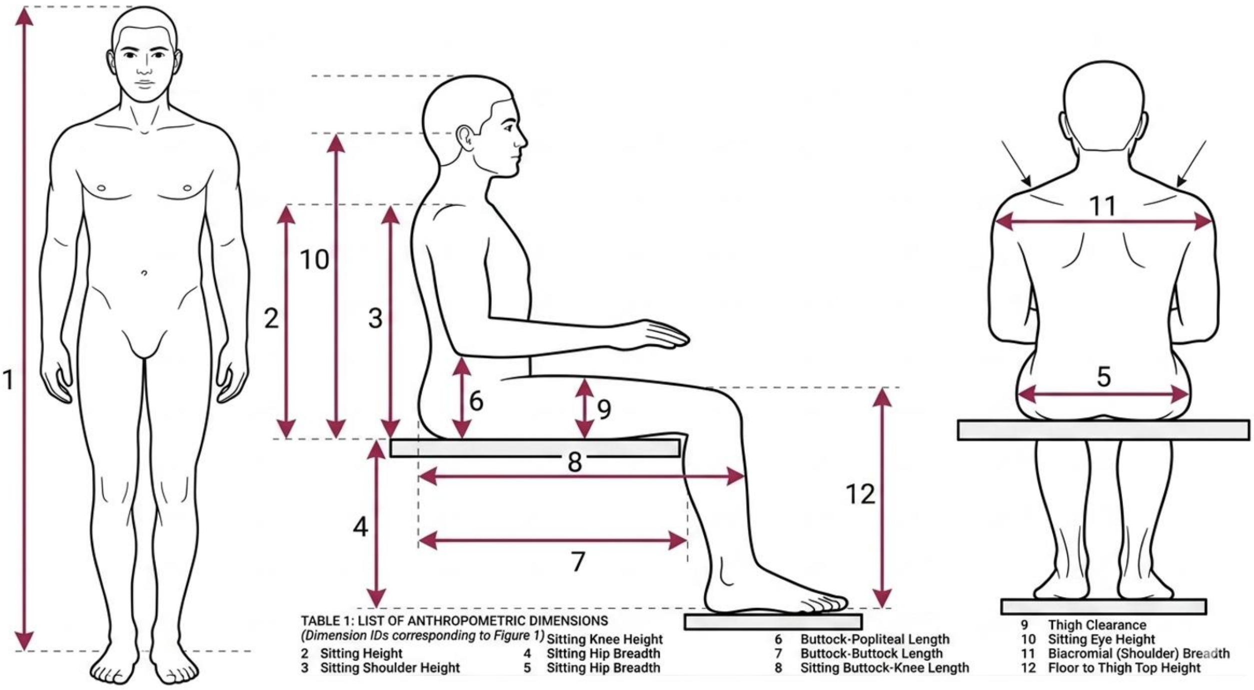

Figure 1. Anthropometric body measurements for sitting position

For decision making under conditions of uncertainty, the mean, standard deviation, 5th, 25th, 75th and 95th percentiles of the measured data were calculated. The statistical sample standard deviation (α) was calculated as shown in equation (1), while the mean value at desired percentiles of the normal distribution data set were calculated as expressed in equations (2) to (5), respectively,

$$\text{Standard deviation, } \alpha, = \sqrt{\left(\frac{\sum(x_i-\mu)^2}{n}\right)} \quad (1)$$

$$\text{5th percentile } (P_5) = \mu - 1.645\alpha \quad (2)$$

$$25^{th} \text{ percentile } (P_{25}) = \mu - 0.674\alpha \quad (3)$$

$$75^{th} \text{ percentile } (P_{75}) = \mu + 0.674\alpha \quad (4)$$

$$95^{th} \text{ percentile } (P_{95}) = \mu + 1.645\alpha \quad (5)$$

Where μ = mean value of each dimension variable, α = standard deviation, constants (-1.645, -0.674, +0.674 and +1.645) = z-scores corresponding to desired respective percentiles, and n = total number of data points in the mean set. It is possible to find a wide variation in dimensions of people; hence the mean calculation is applied here.

After the analysis, the obtained results were correlated for compliance to different types of standards such

IEA, ILO and ISO-7250 /IEC 2010 Directives relevant to work systems and seating posture. This is essential because of the interrelatedness of human, socio-technical, environmental components and work system design changes to a worker's sustainability and resilience. The impact on a worker due to a furniture's noncompliance to standards is here expressed as discomfort percentage and was calculated as shown in equation (6),

$$\text{Percentage Discomfort} = \frac{\textit{number of yes from participant for a particular parameter}}{(\textit{total number of participants})\ x\ 100\%} \qquad (6)$$

Results

A total of 102 respondents in the University of Nigeria, Nsukka were assessed, out of which nine responses were filtered out and for the sake of confidentiality, the names of these respondents were not recorded here. In terms of gender composition of sample population, there were 40 Females and 60 males. These persons consented to participate in the survey when approached as they are known to sit for long periods during their workdays. In considering these long hours of seating by staff and the fact that they use ill-designed furniture with dimensions incongruent with their body characteristics, which suggests predisposition to WMSDs risk factors, this study determined level of discomfort each respondent experienced in a seated position. In addition, twelve body dimensions relating to staff seat characteristics were measured and categorized for a body mapping analysis in order to pinpoint body parts most affected by seat discomfort. The mapping was conducted using a research question, "do you experience discomfort in some parts of the body during and after a period of work?" and it was a yes or no response evaluation.

The results of the percentage of discomfort estimated in equation (6) for each body parts count were as follows: Neck = 60.5%, Upper back = 64.7%, Lower back = 63.3%, Shoulder = 42.8%, Elbow = 39.4%, Wrist/ Hand = 47.8%, Hip / thigh = 47.8%, Knees = 40.8% and Ankle / feet = 42.2%.

From the statistical analysis it can be inferred that majority of respondents experienced musculoskeletal syndrome problems at various body parts while using their office chairs/furniture. The high percentages of the mapping results implied that the employees were under threat of insidious risk linked to WMSDs which should need urgent redress. This high prevalence of body pains can be used to determine either the participants are making use of chairs with poor support for the various components of the body, or they are making use of chairs with very little ergonomics. For example, a good head rest would support the neck and thereby reduce neck discomfort level during long hours of work, a chair with hindsight good back rest and foam for cushioning effect would best support the upper back, a good lumbar support would do same for the lower back, likewise a good arm rest with cushioning effect would reduce the elbow pain, if the arm rest is adjustable, it would help reduce the shoulder discomfort and so on. These parameters when they are lacking in a chair can create discomfort for the user.

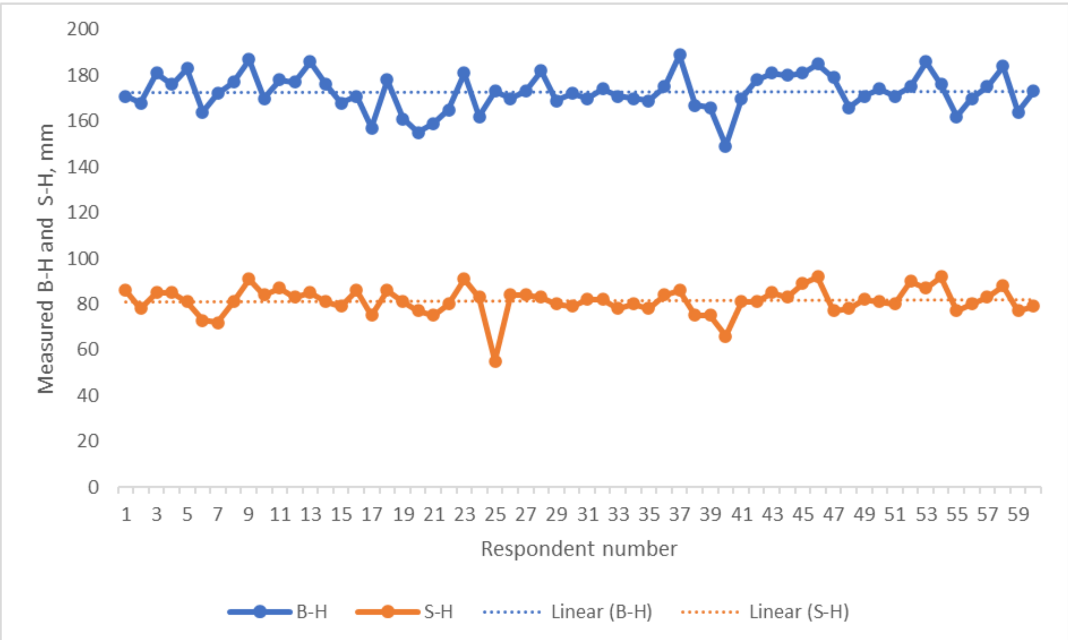

Figure 2. Standing and sitting heights relationship

Also, the scores for 13 anthropometric dimensions are located on a profile chart alongside percentile values. In addition, body height (B-H) and sitting heights (S-H) from the raw measured data were compared as shown in Figure 2. Another human dimensional metrics related to posture and sitting comfort are shoulder height and buttock knee length which influence the body trunk-thigh angle and trunk orientations. The respondents shoulder height (Sh- H) and buttock knee length (B-K-L) measurements in sitting position were compared and the relationship between them was shown by Figure 3.

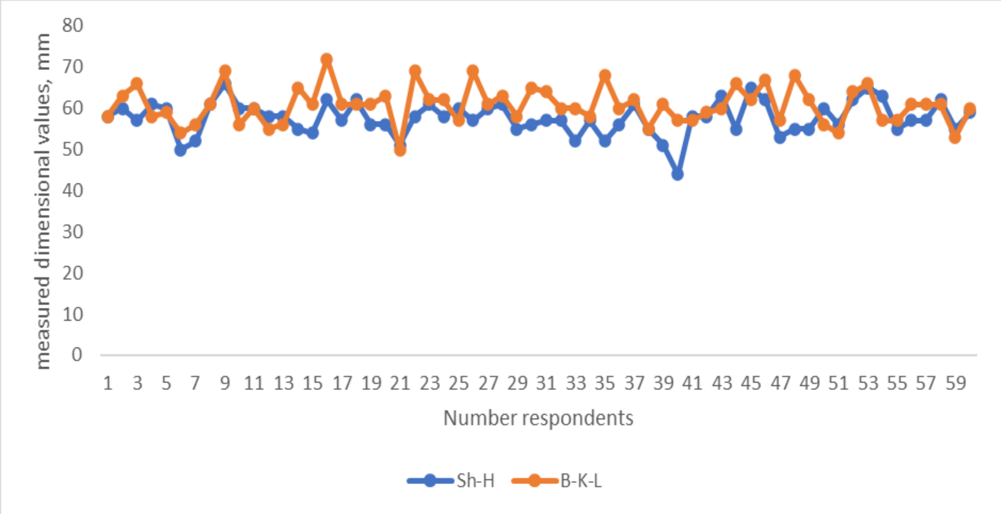

Figure 3. Shoulder height – buttock knee length

These values are directly related to the measurements of each person's perfect chair dimension and have comprehensive engineering design implications. This implies that with the value for a particular person, the chair fitting for the persons' body size and structure can be easily constructed. This study, also, synchronized popliteal height and thigh thickness. The reason being that for a comfortable seating and productive prolonged hours, the seat height should be close to the popliteal height of the user with both having direct correlation with thigh thickness. Figure 4 shows the relationship between measured popliteal (lower leg length) and thigh tolerance.

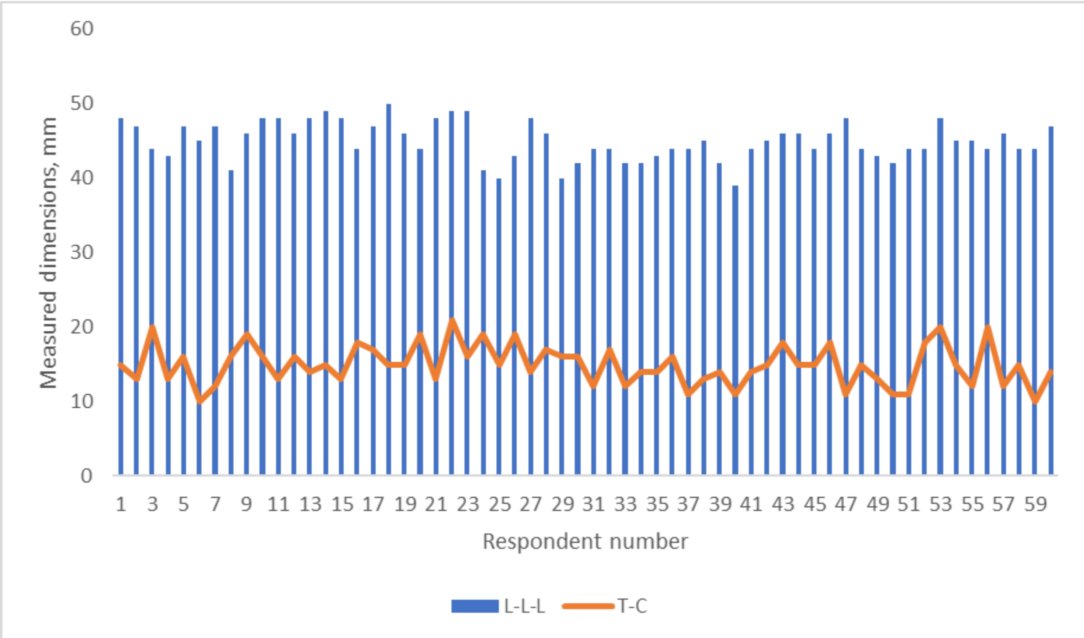

Figure 4. Popliteal height correlated with Thigh tolerance (thickness)

To help understand the context of this study, the above findings were discussed. For example, the body mapping result showed an indication of widespread discomfort, implying high staff vulnerability to risks of WMSD likely due to poor ergonomics (seat, desk, tools or environment) of the workplace. Figure. 2 showed a symmetric relationship between standing and sitting heights as well as functional similarity, though stature/sitting height ratio. In anthropometric context, the shoulder height – buttock knee length data are near-equal measurements implying symmetry and ambidextrous in their functions. For works demanding long hours, the popliteal height and knee length provide comfort when the seat height allows user's feet to vertically rest on the floor.

Discussion

With respect to expectations from human anthropometric characteristics/dimensions for a good fit to furniture features, the present study was compared with previous studies of other authors. Among the authors, there is common agreement that gathering human anthropometric data precedes, in importance and priority, the ergonomic requirements and characteristics for comfortable work chairs. Implying that for comfort and adaptability, the furniture's dimensions and control features should be such that they meet the anthropometric characteristics of at least 90% of the potential users (Occhipinti, 1993). According to BIFMA (2025), the following guidelines were in agreement to the study results: seat height = 40 cm – 55cm, seat depth (buttock-popliteal length) = 49.8cm maximum, seat width (hip breadth) = 45 cm and armrest height (elbow rest height) = 17.3 – 27 cm can ensure optimal comfort depending on body stature of adult user sitting upright. The anthropometric measurements from this study aligned with the guidelines for both 5th percentile (minimum) and the 95th percentile (maximum) values. According to Saha et al. (2024), popliteal height and seat height are typically connected, with popliteal height higher than seat height (SH) (Parcells, 1999). However, the SH should be less than 40 cm, or 88% of the popliteal height, to prevent excessive pressure on the buttocks (Molenbroek, 2003). Fig. 4 shows that there is no direct correlation between popliteal height (L-L-L) and thigh tolerance (T-C) since the trend line is almost flat. This study is limited by geographical coverage. However, this study provides a reference anthropometric and framework for management to procure and improve seating comfort in the university.

Conclusion

This study established a context-specific anthropometric database for university employees and demonstrated its value for ergonomically informed workplace furniture design and procurement. Measurements obtained from 102 staff members showed that key seating-related body dimensions correspond to standard design benchmarks, particularly for seat height, seat depth, seat width, and armrest height within the 5th to 95th percentile range. Despite this alignment, the survey also revealed a substantial ergonomic burden, with 70% of respondents reporting bodily discomfort associated with current office furniture use. The highest discomfort levels were observed in the neck, upper back, and lower back, indicating a strong likelihood of mismatch between existing furniture characteristics and user anthropometry. These findings confirm that inadequate furniture fit remains an important occupational health concern with potential implications for posture, musculoskeletal well-being, comfort, and productivity. The study therefore underscores the urgent need for evidence-based furniture selection, ergonomic assessment, and workstation redesign within the university system. Although geographically limited to one institution, this work provides a practical reference framework for institutional decision-making and offers baseline anthropometric data to support future ergonomic interventions, multicentre studies, and policy development for healthier, safer, and more decent work systems.

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Conflicts of Interest

There is no competing interest whatsoever on the part of the authors.

Data Availability Statement

We, the Authors confirm that the data supporting the findings of this study are available within the article, and they can be provided as appendices. It has to be shared upon request.

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