

36 - ANTHROPOMETRY AND ERGONOMICS ANALYSIS IN THE ACADEMIC ENVIRONMENT

ANA CELIA VIDOLIN
 RENATA ALVES CORREIA
 RODRIGO EDUARDO CATAI
 Universidade Tecnológica Federal do Paraná (UTFPR)
 Curitiba - Paraná – Brasil
 anavidolin@alunos.utfpr.edu.br

doi:10.16887/90.a1.36

1. INTRODUCTION

The academic environment as well as the work environment requires attention regarding the conditions of anthropometry and ergonomics for the users; and according to and Luder and Rice (2008); Parvez et al. (2019) college students spend most of their time in class in a sitting position. Prolonged sitting periods in inadequate furniture results in poor posture and causes musculoskeletal disorders (MSD); and according with Harreby et al. (1995) and Siivola et al. (2004), signs of MSD in youth are evidences of important risk of development in old age. Agreeing to Thariq et al. (2010), inadequate furniture favors a poor sitting posture among students.

The main objective of this paper was to analyse anthropometry and ergonomics, relating the real and recommended dimensions of tables and chairs with the height of students due to their naturalness. The furniture is used by strictu and latu sensu graduate students at university in southern Brazil.

2. LITERATURE REVIEW

2.1. Ergonomics

Ergonomics is a very new science when compared to other sciences, due the end of World War II, it began to be developed and its applications have wide spectrum of activity not being restricted to the scope of work, but participating in several practical applications like cognitive ergonomics, physical and organizational (FAZON, 2018; IIDA and GUIMARÃES, 2018).

According to the Brazilian Association of Ergonomics (ABERGO), ergonomics or human factors is the scientific discipline is related with the understanding of relationships between people and other elements or systems. It involves applying design theories, principles, data and methods to optimize human well-being and overall system performance. Therefore it collaborates with the planning, design and evaluation of tasks, products, environment in which they perform their activities, in order to make them compatible with skills, demands and limitations, managing damage, physical, mental and social wear (ABERGO, 2000).

For Fazon (2018), ergonomics is the study of relationship between people, objects and other components in the application of theories, methods for the welfare of human beings and the

Achievement of performance; for lida and Guimarães (2018), ergonomics incorporates situations that have the productive condition for goods or eservices, not being limits to the physical scope, but also organizational.

For Grandjean (1998); and lida and Guimarães (2018); the objective of ergonomics is to study the factors that influence the production system, reducing the harmful effects; soon the efficiency will be a result of this condition. Thus ergonomics studies the initial conditions and their

relationship between man, machine and environment throughout the activity. And physical ergonomics is responsible for anthropometric measurements, with themes related to posture at work, physical arrangement, safety and health; however, ergonomics is situated in a certain duality; with the organization demanding higher productivity, and the human being of another requesting safety, comfort, health, interest in the work, among others (FAZON, 2018).

lida and Guimarães (2018), reiterate that there is a cost-benefit analysis in ergonomics; however, there are intangible factors, not monetarily quantifiable, with effects in the medium and long term, which have consequences on people's motivation, morale and commitment.

2.2 Anthropometry

Human measures are dealt with by anthropometry, in order to know people and better present options for market demands; and can be classified into static, functional and dynamic. With the evolution of anthropometry, we noticed the variations of measurements between genders, ages, regions. Ethnicities, time and profession can be applied to projects and workplaces, equipment, vehicles, furniture to avoid anthropometric inadequacy that causes discomfort to the user (IIDA, 2005; IIDA and GUIMARÃES, 2018).

The purpose of the study of the human body at work, the idealization of jobs and the search for the definition of statistical plots is the responsibility of anthropometry, a fact corroborated by RIOS and PIRES (2001). Furniture design considers student anthropometric measurements, produces a more comfortable environment, reduces the likelihood of MSD, and contributes to learning (AZUAN et al., 2010; ADU et al., 2014).

However, if the user of anthropometry on furniture design is not taken into account, inadequate furniture is produced, causing adverse effects among students (ROSYIDI et al., 2016). For Hartono (2018) anthropometry presents the challenge of maintaining consistent measurement; and the tools and environmental factor help the researcher; and note that the data will not always be the same; and inconsistency in anthropometric data may be due to time, physical activity, nutrition, lifestyle and ethical group.

3. METHODOLOGY

The research used the quantitative method. Furniture measurements such as classroom chair and table were taken and studies. The length of stay in the environments were also taken into account; as the study room is for fellows with a weekly workload of 40 hours on the university premises; while the other students stay in the classroom for about 4 hours a day.

To measure furniture, direct measurements were made using a standard measuring tape; and these were also used to

reproduce furniture using Adobe Illustrator software.

For the chairs were measured: total chair height, floor height to chair seat, seat width and length, backrest width and length. For the table the following measures were considered: table height from the floor to the table, table length and width and table depth. The colors of the real estate were also observed, with the chairs available in blue, and the table in medium density fiber (MDF) in beige. Both tables and chairs did not have the possibility of any adjustments, such as height, inclination.

Student data provided by the university and consultation on furniture manufacturing standards for school and / or office environments were analyzed; as well as access to research data provided by organizational bodies. The data provided by the university were processed so that it was possible to identify the state of Brazil of origin, gender; and thus relate the different anthropometric profiles of users based on research conducted by IBGE. The survey took place with secondary data; thus, there was no direct contact with students. Results were compared to regulatory standards

3.1 Hypotheses regarding the conditions of anthropometry and ergonomics

For the development of this paper, three hypotheses were established regarding the anthropometry and the ergonomics of the university academic environment in question.

H1 – Furniture consisting of table and chair are meeting the definitions of ergonomic standards.

The proper design of equipment, furniture suitable for the human body, respecting the social, cultural and economic demands presents the greatest benefit; being crucial for students who stay long periods using these furniture (KAHYA, 2019).

The study of furniture in terms of dimensions is to investigate whether in terms of standards for study furniture, they are within the stated parameters.

H2 – Furniture consisting of table and chair and meet the demands of anthropomorphic.

Studies attest that the incompatibility between anthropometric measurement and the dimensions of furniture and equipment is a representative factor that promotes health problems and accidents, including MDE and cumulative trauma (IMRHAN et al., 1993; PRADO-LEÓN et al., 2001).

Lack of compatibility creates discomfort and pain for the user, reduces productivity and can lead to accidents. The results of disorders are acquired over the years and are established later (DOMLJAN and GRBAC, 2008).

H3 – Furniture do not meet the ergonomics and anthropomorphic parameters.

Both parameters of ergonomics and anthropomorphic could not be meet after the analysis; and this situation could bring to the students at minimum attention to avoid health issues.

4. RESULTS AND DISCUSSIONS

lida et al. (1999) suggested 05 chair functions: technical, functional, labor, ergonomic, aesthetic, functional, ergonomic, semantic and symbolic. This paper addresses the practical issue, which is related to physical ergonomics, the use of the product and its purpose. The main comparative tool used in this step is the standards established by ABNT NBR 13966: 2008.

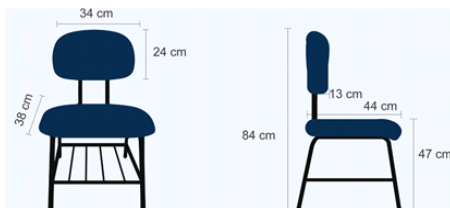
The real estate measurement results are presented in Tables 1 and 2. Table 1 shows the chair measurements (Figure 1) available to all students.

Table – Standard Chair Measurements

Fonte: the authors (2019)

The chair analyzed in academic spaces is represented in Figure 1.

Figure – Illustration of the standard chair



Fonte: the authors (2019)

ABNT NBR 13962: 2008 was established, which establishes maximum and minimum height values for office chairs and desks. Length of stay in study rooms may exceed 8 hours per day and in classrooms up to 4 hours per class. Table 2 presents some of ABNT's recommendations addressed in this research. It can be seen from Table 02 that the maximum surface height to the seat should not exceed 460 mm. In the available university chair this value was exceeded by 10 mm, thus, it is observed that this chair is in non-conformity, and may be a risk factor for the health of its users.

Table – Recommendations ABNT 13966:2008

Fonte: The authors (2019)

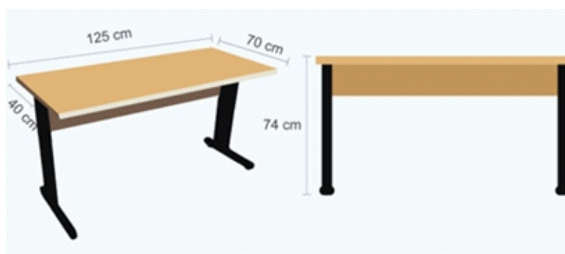
Table 3 presents the measurements of the table that is the object of this study. Featuring 760 mm height, 1250 x 500 mm top with 400 mm knee depth.]

Table – Standard table size

Fonte: The authors (2019)

The table studied in the academic spaces is represented in Figure 2. The measurements obtained were compared with ABNT NBR 13966:2008 as presented in table 4.

Figure – Standard table illustration



Fonte: The authors (2019)

It is observed that under the aspect of the Brazilian technical standard, the table meets the requirement maximum height, reaching 740 mm and width with 1250 mm; however, the knee depth is 50 mm below the minimum depth.

Table – Recommendations ABNT 13966:2008

Fonte: The authors (2019)

4.1. Audience Characterization

The goals of the target audience characterization is to draw a theoretical profile of the users' anthropometric profile using the average height requirement to verify the adequacy of the furniture. The NBR 14600: 2008 establishes 08 sets of recommendations for manufacture and use of school furniture having as main parameter the height of users that varies from zero set (white) for children from 0.8m to 0.95m to set 07 (brown). Which sets the lower height limit at 1.74m and the upper at 2.07m. For each set dimensions for chairs and tables are pointed.

The table 5 presents the stratification of the student body, with a population of 148 students, presenting the following distribution, with the southern region with 89.19% of the students; and the northeast with the lowest representation with 0.68%:

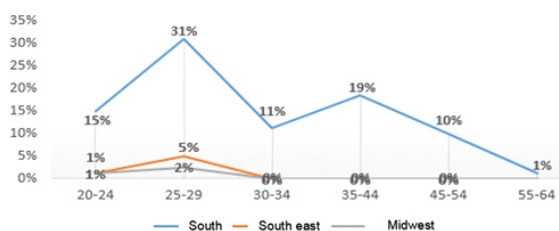
Table – Students by the state of Brazil

Fonte: The authors (2019)

With the average height data by region, it is known the concentration of users by region and taking NBR 14006: 2008 as a reference. In terms of the analysis of stricto sensu students, by gender and age by region of the country, figure 03 identifies the most representative values: with the south, southeast and central west regions being the most representative.

It is observed that 31% of the male population belongs to the south, 5% from the southeast and 2% from the west center and are concentrated in the age group between 25 and 29 years and 19% of the southern region in the age group between 35 and 44 years. For the other regions such as the North and Northeast there was the presence of 01 student in the northern region in the age group of 20 to 24 years and another in the age group of 35 to 44, while in the northeast 01 student in the age group of 25 to 24 years. 29 years.

Figure 3 – Population Concentration by Region – Male



Fonte: The authors (2019)

The average height of the male population in the different regions of Brazil and the national average is presented in

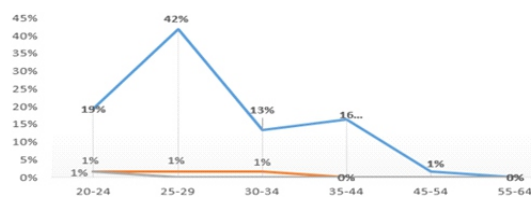
table 06. The average height of the southern region for the age group with the highest concentration of users (25 to 29 years old) is 1.75 m while the national average is 1.735 m, according to data provided by IBGE (2008).

Table –Average height male population by region and national average

Fonte: IBGE (2008)

Regarding the female population, the highest concentration of women in the southern region was observed in the 25-29 age group, followed by the 20-24 age group, with 19% and 16% in the 35-44 age group. The other regions as southeast and central west with 1%.

Figure 4 Population Concentration by Region – Female



The height of the female population in the different regions was surveyed according to data from IBGE (2008), shown in table 07.

Table 7 – Female Population

Fonte:IBGE (2008)

Based on data from NBR 14006: 00 considering the height of the population as the main criterion to define the group of parameters that the furniture should meet, it can be concluded that there is a need for chairs that meet 02 distinct groups.

Table 8 - Recommendations ABNT NBR 14006 for chair

Fonte: ABNT NBR 14006

The chair provided by the educational institution does not have height adjustment, which makes it unable to fully meet the 2 groups presented in Table 8, regarding both sexes.

For the table, the dimensions indicated for the blue and brown group are presented in table 9. It is observed that the table offered by the educational institution to its users does not meet the height dimension, being 2 cm lower than the recommended for the blue group (76 cm) and 8 cm below the recommended height for the brown group. In relation to the width the table studied is 10 cm more than the dimensions proposed by the two groups, neither does it meet the depth for the knees that should be 50 cm and not 40 cm. Free leg width is the only dimension that complies, but will only meet the standard if the user does not share the table with anyone else.

Table 9 - ABNT 14006 Table Recommendations

Fonte: the authors (2019)

5. CONCLUSIONS

The activity performed by users requires continuous contraction of some muscles, to maintain a certain position so it can be considered a static activity. Improper furniture can cause numerous long term problems. Once the dorsal muscles and legs to maintain standing position; Shoulder and neck muscles to keep the head tilted forward and so on use up energy and can cause continuous tension, strangulation of blood circulation, and even deformation of the spine.

The standards presented by ABNT 13966: 2008 are based on a daily use of 8 hours, by people up to 110kg, and with height between 1.51m and 1.92m; Since ABNT 14006 considers the height of users as the main dimension to be considered when defining furniture in a classroom, it is concluded in relation to the norms that university environments, especially in the strict sense mode, where the user spends both time sitting and standing, working would have to be thought of with the help of other tools and not just the standards.

Regarding the furniture available and analyzed, it is suggested that both the tables and chairs studied, as far as possible, be rethought, to make the environment more comfortable for users, focus of this study, ensuring that they can fully meet the ABNT 14006. For example, chairs and possibly also height-adjustable tables are recommended to make the workstation more ergonomic.

REFERENCES

- ABERGO – Associação Brasileira de Ergonomia. O que é Ergonomia. 2000. Disponível em: http://www.abergo.org.br/internas.php?pg=o_que_e_ergonomia. Acesso em: 24/10/2019.
- ADU, G., ADU, S.; EFFAH, B.; FRIMPONG-MENSAH, K.; DARKWA, N. A. Office Furniture Design– Correlation of Worker and Chair Dimensions. *International Journal of Science and Research* 3 (3): 709–715. 2014.
- ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 13962: Móveis para escritório –Cadeiras. Rio de Janeiro, 2002. 30 p.
- ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 13966: Móveis para escritório–Mesas. Rio de Janeiro, 1997. 5 p.
- ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 14006:2008 - Móveis escolares; assentos e mesas para instituições educacionais; classes e dimensões. 1997.
- AZUAN, M., ZAILINA, H.; SHAMSUL, B.; ASYIQIN, N.; AZHAR, M.; AIZAT, I. S. Neck, Upper Back and Lower Back Pain and Associated Risk Factors among Primary School Children. *Journal of Applied Sciences* 10 (5): 431–435. doi:10.3923/jas.2010.431.435.2010.
- DOMLJAN, D., GRBAC, I.. Classroom Furniture Design–Correlation of Pupil and Chair Dimensions. *Collegium Antropologicum* 32 (1): 257–265.2008.
- FAZON, P.. Ergonomia.2. ed. São Paulo: Blucher, 2018.
- GRANDJEAN, E. Manual de Ergonomia, 4ª Ed., 1998.
- HARREBY, M., K. NEERGAARD, G. HESSEISØE; Kjer, J. Are Radiologic Changes in the Thoracic and Lumbar Spine of Adolescents Risk Factors for Low Back Pain in Adults? A 25-Year Prospective Cohort Study of 640 School Children. *Spine* 20 (21): 2298–2302. doi:10.1097/00007632-199511000-00007.1995.
- HARTONO, M. Indonesian anthropometry update for special populations incorporating Drillis and Contini revisited. *International Journal of Industrial Ergonomics*. 64 89 -101. doi.org/10.1016/j.ergon.2018.01.004 0169-8141.2018.
- IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Disponível em: <https://sidra.ibge.gov.br/tabela/2645>. Acesso em 27/10/2019.
- IIDA, I.; GUIMARÃES, L. B. M. Ergonomia: projeto e produção. 3 ed. São Paulo: Blucher, 2018.
- IMRHAN, S. N., NGUYEN, M.T.; NGUYEN, N.N.. Hand Anthropometry of Americans of Vietnamese Origin. *International Journal of Industrial Ergonomics* 12 (4): 281–287. doi:10.1016/0169-8141(93)90098-X.1993.
- KAHYA, E. Evaluation of the Classroom Furniture for University Students. *Eskişehir Osmangazi Üniversitesi Mühendislik ve Mimarlık Fakültesi Dergisi* 26 (1): 20–29. doi:10.31796/ogummf.330136.2018.
- LUEDER, R.; RICE, V.J.B. Ergonomics for Children New York: Taylor & Francis. 2008
- PARVEZ, M.S.; RAHMAN, A.; TASNIM, N. Ergonomic mismatch between students anthropometry and university classroom furniture, Theoretical Issues in Ergonomics Science. *Journal Theoretical Issues in Ergonomics Science*. 20:5, p. 603-631. doi:10.1080/1463922X.1617909.2019.
- PRADO-LEÓN, L. R., AVILA-CHAURAND, R.O.; GONZALEZ-MUNOZ, E.L. Anthropometric Study of Mexican Primary School Children. *Applied Ergonomics* 32 (4): 339–345. doi:10.1016/S0003-6870(01)00009-6.2001.
- RIO, R. P.; PIRES, L.. Ergonomia: fundamentos da prática da ergonômica. 3.ed. São Paulo: LTr, 2001
- ROSYIDI, C. N., SUSMARTINI, S.; PURWANINGRUM, L.; MURAKI, S.. Mismatch Analysis of Elementary School Furniture in Several Regions of Central Java, Indonesia, and Redesign Recommendations. *SAGE Open* 6 (3): 2158244016664386. doi:10.1177/2158244016664386. 2016.
- SIIVOLA, S. M.; LEVOSKA, S.; LATVALA, K.; HOSKIO, E.; VANHARANTA, H.; KEINÄNEN-KIUKAANNIE, I., S. Predictive Factors for Neck and Shoulder Pain: A Longitudinal Study in Young Adults. *Spine* 29 (15): 1662–1669. doi:10.1097/01.BRS.0000133644.29390.43.2004.
- THARIQ, M. M.; MUNASINGHE, H.; ABEYSEKARA, J. Designing Chairs with Mounted Desktop for University Students: Ergonomics and Comfort. *International Journal of Industrial Ergonomics* 40 (1): 8–18. doi:10.1016/j.ergon.2009.10.003. 2010.

ANTHROPOMETRY AND ERGONOMICS ANALYSIS IN THE ACADEMIC ENVIRONMENT

The study of ergonomics and anthropometry in the academic environment is important because students have long journeys in this environment, due to the study activities. The aim of this paper is to analyze the dimensional patterns of furniture (table and chair) of an educational institution, with standards recommend by the norms and the anthropometry of the academics. The research was applied and with quantitative method. The student's activity requires continuous contraction of some muscles to maintain a certain position; therefore, it can be considered a static activity. The analyses by the standards ABNT 13966:2008 and ABNT 14006:2008, concludes that in relation to the norms that university environments, especially in the stricto and lato sensu modality, where the user spends time sitting as much as would spend working should be thought with the aid of other tools, and not just the norms. Regarding the available and analyzed furniture, it is suggested that both the tables and chairs studied, as far as possible should be rethought.

Keywords: Anthropometry, ergonomics; furniture.

ANALYSE ANTHROPOMETRIE ET ERGONOMIQUE AU MILIEU ACADEMIQUE

L'étude de l'ergonomie et de l'anthropomorphie au milieu universitaire est importante car les étudiants effectuent de longues journées dans cet environnement, en raison des activités d'étude. Le but de cet article est d'analyser les modèles dimensionnels du mobilier (table et chaise) d'un établissement d'enseignement, avec les paramètres recommandés par les normes et la question de l'anthropomorphie des universitaires. La recherche a été appliquée et avec une méthode quantitative. L'activité de l'étudiant nécessite de la contraction continue des certains muscles pour maintenir une certaine position; par conséquent, cela peut être considéré comme une activité statique. L'analyse selon les normes ANNT 13966:2008 et ABNT 14006:2008 conclut que, en ce qui concerne les normes, les environnements universitaires, en particulier dans les modes stricto et lato sensu, où l'utilisateur passe autant des temps assis qu'il le ferait à travailler devraient être pensés à l'aide d'autres outils, et pas seulement les normes. En ce qui concerne le mobilier disponible et analysé, il est suggéré de repenser autant que possible les tables et les chaises étudiées.

Mots-clés: Anthropométrie, ergonomie, mobilier.

ANTROPOMETRÍA Y ANÁLISIS ERGONÓMICO EN EL ENTORNO ACADÉMICO

El estudio de la ergonomía y la antropometría en el entorno académico es importante porque los estudiantes tienen largos períodos en este entorno, debido a las actividades de estudio. El objetivo de este trabajo es analizar los patrones dimensionales de los muebles (mesa y silla) de una institución educativa, con estándares recomendados por las normas y la cuestión de la antropometría de los académicos. La investigación es aplicada y con método cuantitativo. La actividad del usuario requiere una contracción continua de algunos músculos para mantener una determinada posición, por lo tanto, puede considerarse una actividad estática. El análisis según los estándares ANBT 13966:2008 y ABNT 14006:2008, concluye que en relación con las normas que los entornos universitarios, especialmente en la modalidad de stricto y lato sensu, donde el usuario para el tiempo sentado tanto como pasaría trabajando debería pensarse con la ayuda de otras herramientas y no solo normas. Con respecto a los muebles disponibles y analizados, se sugiere repensar tanto las mesas como las sillas estudiadas, en la medida de lo posible.

Palabras claves: Antropometría, ergonomía, muebles.

ANÁLISE DA ANTPOMETRIA E ERGONOMIA NO AMBIENTE ACADÊMICO

O estudo da ergonomia e antropomorfia no ambiente acadêmico é importante, pois os alunos tem longas jornadas nesse ambiente, devido as atividades de estudo. O objetivo desse artigo é analisar os padrões dimensionais do mobiliário (mesa e cadeira) de uma instituição de ensino, com padrões recomendados pelas normas e o quesito altura da antropomorfia dos acadêmicos. A pesquisa foi aplicada e com método quantitativo. A atividade desempenhada pelos usuários exige contração contínua de alguns músculos, para manter uma determinada posição; por isso pode ser considerado uma atividade estática. As análises pelas normas ABNT 13966:2008 e ABNT 14006, conclui que em relação as normas que ambientes universitários, especialmente na modalidade stricto e lato sensu, onde o usuário passa tempo sentado quanto passaria trabalhando deve ser pensado com o auxílio de outras ferramentas e não apenas das normas. Em relação aos mobiliários disponíveis e analisados, sugere-se que tanto as mesas como as cadeiras estudadas, dentro do possível sejam repensadas.

Palavras chaves: antropometria, ergonomia, mobiliário.