



ERGONOMIC ANALYSIS OF THE CHILD'S OPTICS RESIDENCE

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Abstract

The period of childhood is where the human body changes the most, and part of that time is experienced within your home. This fact, which raises the need for this space to be ergonomically correct and adapted to receive it, to provide full growth and body development. However, it is observed that many houses lack a good ergonomic structure and present several situations that can be harmful for this process. Thus, the present work seeks to score, analyze, and discuss what are the problems and risks that exist in homes and propose possible solutions and improvements in order to raise the housing quality of these spaces.

Keywords: Child Ergonomic. Child Anthropometry. Residential Ergonomic.

1. INTRODUCTION

When reflecting on the division of time throughout a child's childhood, it is found that a good part of it is experienced between school and home. The fact is that, although ergonomics is currently widely debated, when the object of study is the children, the works are limited to school spaces, lacking research related to the ergonomics of the house where the child is inserted.

This, when analyzed from an ergonomic point of view, presents a series of unsatisfactory situations, which are harmful to the full development of the child over time, even triggering physical pathologies. Thus, the present work aims to provide inputs for the improvement of housing conditions related to children, identifying and analyzing the main ergonomic deficiencies to which children are exposed in the residential environment, as well as possible solutions, in order to avoid future complications.

To achieve the outlined objective, bibliographic research was used as a methodology for the conception of this study. Based on the work developed by Panero & Zelnik (2002) related to human ergonomics and anthropometry, one of the main theoretical references in the area. It establishes the child's anthropometric patterns, as well as the dimensions ergonomically appropriate to the house and the activities performed in it. To establish a model of residence to be studied, since it is impossible to physically analyze all existing residences, the Brazilian

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Standards – NBRs, prepared by the Brazilian Association of Technical Standards – ABNT, referring to the standardization and standardization of furniture and residential spaces, were used, in order to define a common model for existing housing.

2. ANTHROPOMETRY AND ERGONOMICS IN INTERIOR DESIGN

There are several definitions of anthropometry, according to Panero & Zelnik (2002), it is the science that studies the measurements of the human body in the search to differentiate individuals. For Álvarez (2009), anthropometry, or description of the human body through measurements, is an application of physical-scientific methods for the conception of design patterns. In short, the studies aim to collect data such as height, weight, circumferences, among other measurements, to assess the size, shape, and composition of the human body. However, Panero & Zelnik (2002) point out that this science cannot be taken as exact, since the human body dimension is very diverse and many variables can influence these numbers, such as ethnicity, sex, age, socioeconomic status, diet, among others.

Ergonomics, on the other hand, studies the relationships between man and his surroundings, seeking greater efficiency and safety in the way both interact. According to the International Ergonomics Association (IEA) (2000):

"Ergonomics (or Human Factors) is the scientific discipline that deals with the understanding of the interactions between human beings and other elements of a system, and the profession that applies theories, principles, data and methods, to projects that aim to optimize human well-being and the overall performance of systems." - (IEA, 2000, p. 1).

The IEA (2000) also comments that ergonomics can be divided into three competencies to be studied, Physical Ergonomics, related to the anatomical and anthropometric characteristics of the individual, Cognitive Ergonomics, which extends to the mental processes of the human being, and Organizational Ergonomics, referring to the optimization of systems and processes in the corporate environment. In the field of Interior Design, the concepts of ergonomics must be applied to ensure safety, comfort and efficiency of living for those who inhabit the designed environment (Panero & Zelnik, 2002). For this, anthropometric studies act as pillars of this analysis, being widely used, especially in physical competence.

Although there are many scientific studies in the area of ergonomics and its applications to everyday activities, the vast majority are based on the characteristics of adult individuals, especially in the age group above twenty years, as discussed by Panero & Zelnik (2002), because according to them, this is the period in which the individual reached the peak of his



growth, unlike children, who are in a phase of continuous growth and the elderly who, after maturity, tend to gradually decrease their height.

However, when designing, we work with a diverse range of body dimensions. To express this vast amount of anthropometric data, we used percentiles, defined by Panero & Zelnik (2002), as the percentage of individuals, within a group studied, who have a certain body size equal to or less than a certain size. The Anthropometric Source Book, published by the National Aeronautics and Space Administration – NASA (1978), exemplifies the concept of percentile as follows: a measure of percentile "k" – between 1 and 99 – is a value higher than each of the smaller k% and less than 100% - k. The authors conclude that the 50th percentile is where we find the median values, dividing the study group into 2, where 50% have larger measurements and 50% have smaller dimensions than this value.

However, Panero & Zelnik (2002) warn that, although the 50th percentile mathematically reflects the average value of the dimension studied, for this group, it is a serious mistake to use it as an ideal design in a project. Since, a certain measure, meets the needs of only 50% of the group to which it applies, excluding the other half.

Álvarez (2009) reinforces the idea that the "average man" does not exist, adding that, in ergonomics, the statistical man is considered, taking into account the extreme values of a given measure analyzed and that its application should cover 90% of the population studied, located between the 5th and 95th percentiles, ensuring that the design choice meets the majority of this population. The author adds that, for situations of space for circulation and openings, the measurements of the 95th percentile are considered, because, in the case of a sufficiently dimensioned space for an individual of greater stature or body width to transit, there will be no obstacles for a person located in a lower percentile.

Regarding reach situations, the 5th percentile is considered, since the effort requirement is lower for a taller person to bend down to take an object, when compared to an individual of smaller stature trying to pick it up above his reach. Such ideas will guide the following ergonomic analysis.

3. CHILDREN'S GROWTH AND HEIGHT

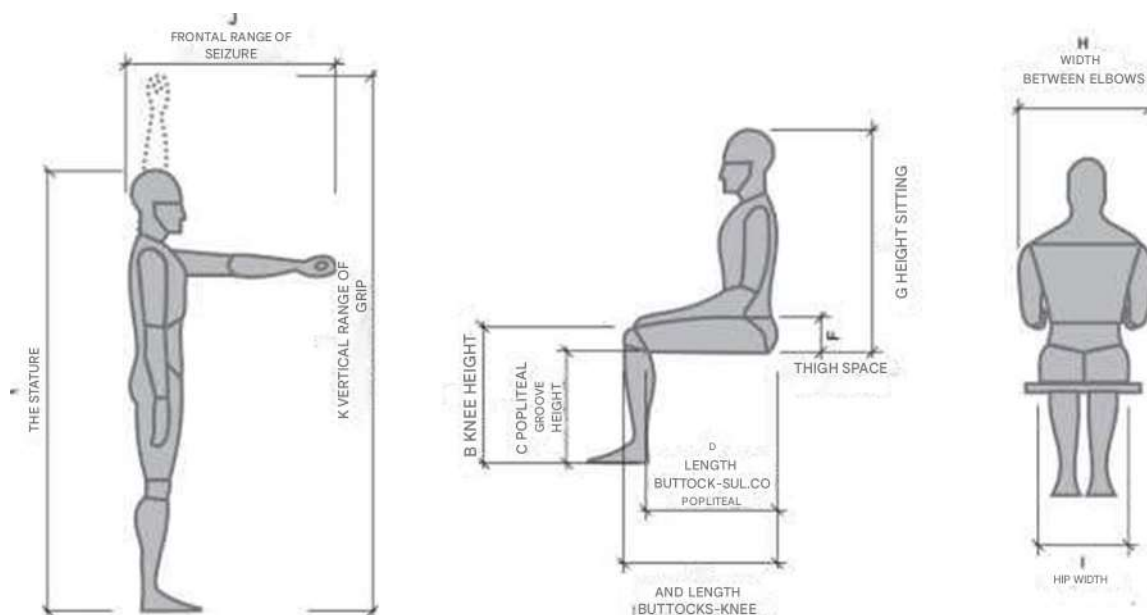
The child population is constantly growing, De Aquino (2011) defines growth as a continuous process of tissue multiplication and hypertrophy, which occurs throughout the individual's life. For her, this phenomenon is one of the main signs of quality in the child's development, where environmental, pathological, social and genetic factors exert a strong influence on this process.

The author addresses that, throughout the first 5 years of life, the growth rate is extremely high, and in the first two, it can reach about 36 cm and 8.5 kg. This period is the most conducive to the emergence of growth disorders that, when occurring, can reduce or even cease the speed of growth, which reinforces the need for vigilance and maintenance of the individual's conditions and quality of life.

This index tends to stabilize in the school period, between 5 and 11 years old, where the growth speed becomes almost constant, between 5 and 6 cm/year, increasing again in the spurt phase, close to 11 years old in boys and 13 years old in girls.

This constant body modification, together with the various factors that influence it, become an obstacle to establishing anthropometric standards, however, Panero & Zelnik (2002), based on other studies, present some of the main anthropometric dimensions of the human being, as shown in figure 1. The authors also point out some body measurements related to adults, aged between 18 and 79 years, and children, referring to an 11-year-old child, allowing the comparison between these measurements, as shown in Chart 1.

Figure 1 - Main anthropometric measurements



Source: Adapted from Panero & Zelnik (2002).

Chart 1 - Comparison between the body dimensions of an adult and a child

	PERC.	Measurements expressed in centimeters.									
		The	B	C	D	And	F	G	H	I	J

ADULT MALE	95	188,6	60,3	47,8	55,1	65,4	17,5	99,0	50,5	40,4	88,9	224,8
	5	172,8	52,1	40,4	52,7	62,0	10,9	91,5	34,8	31,0	75,4	195,1
ADULT FEMALE	95	168,2	54,3	44,2	46,4	56,4	17,5	88,5	40,9	43,4	80,5	213,4
	5	152,3	46,7	37,8	43,7	53,3	10,4	81,2	31,2	31,2	67,6	185,2
11-YEAR-OLD BOY	95	157,0	50,9	41,3	48,3	53,7	14,7	80,6	37,3	30,6	*	*
	5	134,6	41,7	33,7	36,9	42,2	9,3	70,1	25,6	22,1	*	*
11-YEAR-OLD GIRL	95	159,7	51,2	41,7	50,5	55,9	14,9	83,4	37,4	33,8	*	*
	5	135,4	42,1	33,3	38,1	43,7	9,4	69,7	24,5	22,3	*	*

* Measurements not obtained.

Source: Adapted from Panero & Zelnik (2002).

Thus, it is possible to conjecture that, for almost all cases, a child's body measurements will be similar to or lower than those of an adult, located in the 5th percentile. This prognosis is of paramount importance when analyzing the ergonomics of a residence, which is the objective of this study.

4. THE STRUCTURE AND DIMENSIONING OF THE HOUSE

Over the years, housing patterns have changed, the basic housing needs of man from centuries ago are no longer the same as today. Due to a great evolution of technologies and socioeconomic conditions, the view of housing has been transformed, as Neufert (1976) says. According to him, the houses or fortresses, surrounded by immense stone walls and steel gates, present in the fifteenth century, evolved over time, giving rise to large openings and inviting entrances, found in the twentieth century. Neufert (1976, p.34) also adds that "for modern man, the house is not a fortress to protect against enemies, thieves and demons, but rather a pleasant, useful and intimate picture for their experience."

Thus, it is difficult to establish a standard typology of housing, since it originates from a complex convergent process of social, economic and technical factors, as Garcez (2014) explains. However, it is possible to define environments common to all types of housing and the activities that take place in them. Panero & Zelnik (2002) classify them as: dining areas, living areas, rest areas, kitchen and bathroom, however, for this analysis, we will also include areas dedicated to circulation. Thus, addressing these spaces, we will cover almost all existing housing typologies.

4.1. Dining area

In the areas intended for meals, the most common action is to sit at the table for the meal. For Panero & Zelnik (2002), the height of the chair must allow the feet to be completely



supported on the floor, otherwise the region behind the knees and near the thighs will be compressed, generating discomfort to the user and, in the long term, blood circulation problems. However, a seat that is too low can cause body imbalance and take away the support of the lumbar region, even so, the author states that it is more comfortable for a larger individual to sit in a lower chair, for a person of smaller stature to settle in a seat that is too high. Therefore, for the action of sitting, we must take into account the height of the popliteal groove and the buttock-popliteal sulcus length of the child, which, in the 5th percentile, is 33.3 cm and 36.9 cm, respectively.

Another relevant point for the authors is the height between the top of the chair and the bottom edge of the table, where there should be enough space for the thighs and the necessary movements, so as not to limit them. To do so, we used the dimensions of the free space of the thighs in the 95th percentile, of 14.9 cm, because, considering the individuals with greater width, we also included those with the lowest percentiles.

Finally, Panero & Zelnik (2002) highlight the height of the table in relation to the chair, since in scenarios where too high can overload the shoulders and become uncomfortable for the meal, while too low can generate an overload in the lumbar region. For this, the authors suggest the height of the table, in relation to the floor, between 73.7 cm and 76.2 cm.

NBR 9050 (2015), called "Accessibility to buildings, furniture, spaces and urban equipment", suggests the minimum height of a chair, for an obese person, of 41 cm and a maximum of 45 cm and depth between 47 cm and 51 cm. Regarding the height of the tables, the standard recommends that it be between 75 cm and 85 cm and the minimum free height, from the floor to the bottom of the top, of 73 cm.

4.2. Living area

For the living and leisure areas, there are numerous activities that can be carried out, the most resulting are also associated with the action of sitting, for short and long intervals of time (on sofas, chairs, armchairs or other seats). In order for the use of this furniture to serve a diverse range of people, the same principles used in dining chairs will be applied, observing the height of the popliteal groove and the buttock-popliteal groove length in the 5th percentile, of 33.3 cm and 36.9 cm, respectively (Panero & Zelnik, 2002).

However, ABNT 15164 (2004), a standard that regulates and standardizes the production of armchairs and sofas in Brazil, recommends that the furniture be at least 42 cm



high from the floor to the top of the seat and 47 cm of useful depth to the backrest, although pieces with larger dimensions are found on the market.

4.3. Dorms

The bedroom is the space intended for rest, according to Panero & Zelnik (2002), the most important furniture in this environment is the bed, where the action of sleeping is performed, and must completely encompass the individual's body. The most relevant body measurements for this action are the child's height and body width in the 95th percentile (159.7 cm and 37.4 cm, respectively). The author also points out that, for the analysis, the measurements presented consider the body fully upright, however, during sleep, we perform several variations of movements.

There is no standard that limits the width and length of the bed, however Grimley & Love (2016) comment that there is a wide variety of mattress sizes available on the market, ranging from cribs of 60 cm x 130 cm to "*super king size*" beds of 193 cm x 203 cm, covering practically all possible body dimensions of a person.

4.4. Kitchens

The kitchen is the space for preparing meals, as well as the storage of groceries and utensils. It is not usual, nor recommended, for children to stay in this place. According to the Non-Governmental Organization (NGO) Criança Segura Brasil (2018), the kitchen is the room that offers the most danger to children, as it has objects that can cause serious accidents: such as sharp objects (knives, glass), chemicals (cleaning products) and that can combust and cause burns (lighters, matches and alcohol-based products).

In this area, the furniture stands out are the cabinets, stove, sink and refrigerator, with the reach actions being the most practiced. Regarding ergonomics, Panero & Zelnik (2002) highlights the height of the workbench and cabinets because, when too low, they can cause discomfort, overload and pain in the back region. In scenarios where it is very high, it makes it difficult to reach objects or carry out activities, triggering accidents, falling objects, in addition to increasing the chances of injuries when climbing chairs and stairs.

Thus, the most important measure to be considered is the vertical range of apprehension, in the 5th percentile, which, for an adult, is 185.2 cm. In the research, no references of this size were found for children, however, when comparing the height of a woman in the 5th percentile and an 11-year-old child in the 95th percentile, 152.3 cm and 159.7 cm, respectively, it is possible to conjecture that, in most cases, the lower the percentile in which the child is situated,



the lower the total range of the child and the greater the difficulties in picking up the highest objects.

According to NBR 14033 (2005), the suggested height for the worktop, in relation to the floor, is between 80 and 95 cm. The total height of the furniture is not limited, leaving it to the discretion of the industry or the designer.

4.5. Bathrooms

The bathroom is the environment intended for personal hygiene and physiological needs, whose basic furniture in this environment are: the toilet, the washbasin and the shower. Panero & Zelnik (2002) recommend that the washbasin depth for children should be between 40 cm and 45 cm, and the height should be between 66 cm and 81.3 cm. However, such measurements become uncomfortable for an adult, even at the lowest percentile, which is between 48.3 cm to 61 cm deep and 81.3 cm to 91.4 cm high. Thus, the author states that the final decision of the depth and height of the washbasin should be made by the designer, based on the users of the space.

Regarding the toilet bowl, the principles are the same as those used for the other seats, the height of the popliteal groove and the buttock-popliteal groove length, in the 5th percentile (33.3 cm and 36.9 cm, respectively). Regarding the shower, Panero & Zelnik (2002) suggest that a free space of 137.2 cm × 91.4 cm is sufficient for an individual to move freely during the shower, considering the dimensions of an adult, in the 95th percentile.

NBR 9050 (2015) says that, for the bathroom to be accessible to all, the height of the toilet, with the seat, must be less than 46 cm, in relation to the finished floor. Regarding the washbasin, the recommended height is between 78 cm and 80 cm, and the depth to the faucet is a maximum of 50 cm. Regarding the shower, the standard suggests a minimum measurement of the shower area of 90 cm × 95 cm.

4.6. Circulation spaces

In addition to the correct sizing of furniture, it is important to analyze other important aspects within a residence. One of the most cited in ergonomic references is the circulation areas. According to Boueri (2008), the minimum space for an adult person to circulate between obstacles in a private space is 60 cm, although the adequate width for traveling freely or carrying objects is 80 cm. Panero & Zelnik (2002) suggest that the dimension of 76.2 cm is comfortable, considering the body width of an adult, in the 95th percentile, of 57.9 cm. The authors reinforce



that, to determine the spaces for the circulation of people, we should use the highest percentile as a reference.

5. FINAL CONSIDERATIONS

Analyzing the environments, with regard to dining areas, the national standard stands out, which meets the recommendation of the experts, although it is allowed at the dining table, a height up to 10 cm above that suggested in the ergonomic references. However, in relation to the chairs, the dimensions of the furniture suggested by the standards are at the limit or are inappropriate for children, even in the highest percentile. The identified dimensions are approximately 4 cm above the 95th percentile of a child, this suggests that the younger and smaller the child, the more uncomfortable and harmful the furniture becomes. The same problems are found in living areas, where the measurements suggested by the standard are 9 cm higher than ideal for a child, and this difference can be even greater in certain cases.

Regarding the bedroom, few negative situations could be pointed out, due to the diverse range of options in the market, and the appropriate choice of furniture by the designer and/or the owner is enough. Unlike the kitchen, which, although it is the environment where the child uses the least, is the one that offers the most risks to the physical integrity of the children. Even though there are no major ergonomic impacts in the long term, the space provides a wide range of situations that can lead to domestic accidents. The fact that there is no parameterization of the height of the cabinets leaves it up to the professional and the industries to make the decision. However, this process is often based on needs, commercial and business strategies, where those who decide are not always thinking about the particular needs of those who use them.

As for the bathroom, although there is a highly comprehensive and inclusive standard, still, from the child's point of view, it is not ergonomically adequate. For both the toilet and the washbasin, the standard suggests measurements superior to those of a child in the 5th percentile, reaching a difference of 12 cm and 25 cm, respectively, between the norm and the child's anthropometric measurements. Regarding the box, although the standard suggests a lower measurement than that recommended in the references, it is considered a space suitable for the child's body dimensions, not presenting great difficulties in movement. Finally, regarding circulation, it is conjectured that, since the project follows the accessibility parameters recommended for adults, it will provide a comfortable circulation for children.

In a broad context, it is concluded that, although Brazil is ahead of many countries in the world, regarding the concern with ergonomics, there is still a large gap in the existing standards and, in some scenarios, the lack of guidelines and regulations, especially related to



children's ergonomics. It is observed that most of the suggested dimensions aim at the anthropometry of the adult, disregarding the presence and needs of the child in the residential environment.

However, the need to apply the fundamentals of ergonomics is not exclusive to adults, since the conception of an interior design does not always cover a single subject, but extends to a diverse group of users, such as: the elderly, children, male and female adults, people with special needs or with reduced mobility. Thus, it is necessary to carry out a deep analysis and reflection on the anthropometric profiles and ergonomic needs of all who enjoy the place, in order to meet their demands and add quality and functionality to the project.

Finally, we conclude that the residence has numerous ergonomic problems and offers several risks to the child. Although we know the unfeasibility of planning it exclusively for children, which would fail to serve other users of the space, simple measures and adaptations can help in the adaptation of the residence. Whether it's a footrest when sitting, a seat that adjusts the child's height in relation to the table or keeping objects, usual to them, in the lower partitions of closets and wardrobes. Such measures will bring practicality and efficiency to the execution of these activities, in addition to avoiding accidents and injuries, providing the full and healthy growth and development of the individual, minimizing the chance of complications in adulthood.

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