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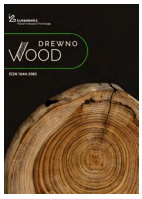

Dimensional Analysis of Seating Furniture from the 1960s and 1970s Intended for Redesign

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Furniture is a group of objects that accompany us in everyday life. Therefore, it is important to choose appropriate dimensions, tailored to the human body, which will ensure comfort during use. In this study, the dimensions of seating furniture from the 1960s and 1970s were analyzed from an ergonomic perspective. This choice of period is not accidental, as it has been observed that furniture from that era is often renovated or redesigned. Such items are found not only in homes, but also in public spaces such as cafes, schools, and cultural venues. Based on collected literature, particular specimens were described and then used as a basis for further research. Ten armchairs and twelve chairs were measured, and the dimensions obtained were analyzed. The results were compared with guidelines characterizing ergonomic seating. Additionally, percentile models for sitting positions were analyzed, and conclusions drawn. From the measurement and analysis of dimensions of chairs and armchairs from the 1960s and 1970s, it was found that the overall dimensions and functional measurements of importance for ergonomic seating deviate significantly from the applicable standards.

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Introduction

During the 1960s and 1970s in many European countries, the dimensions of furniture were strongly dependent on the size of apartments. Furniture had to be adapted to small spaces, which was challenging due to the destruction or adaptation of many prewar furniture production facilities. Designers had to reconcile customer expectations with manufacturing limitations. During this period, emphasis was placed on new solutions and modernity, which were widely desired. New minimalist designs brought freshness and replaced heavy and bulky furniture (Kozina 2015). They were made mainly of wood, a material that provides durability and stability to furniture. In the case of ergonomic furniture, wood can be used for frames, legs or seats, providing adequate stability. It is important that wooden seating furniture have the right height, angle and width to support proper body posture.

In recent years, there has been an increase in the popularity of furniture from the 1960s and 1970s. The selection of armchairs and chairs is very large. They can be found online – on websites related to industrial design, in advertisements, on sales pages – as well as in vintage furniture stores. Analysis of trends in furniture-making shows that inspirations from the period of the 1950s to 1980s are noticeable. Polish companies are taking action to revive the production of specific models. These designs were often not realized, and so the companies that restore them to life are

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commemorating well-known designers in this way (Hübner-Wojciechowska 2014).

Redesign and restoration treatments are also very popular methods for restoring lost splendor to classics. Such processing is an effective way to give household objects an individualized character. Redesigning is an excellent means of diversifying the interior style (Kozina 2015).

The well-known designs of chairs and armchairs from that period are undoubtedly timeless and are often appreciated for their appearance, but it is worth examining their dimensional features. An interesting approach is to analyze these pieces of furniture from an ergonomic and anthropometric perspective. Knowledge of human measurements is a mandatory component in the design process, allowing for proper dimension selection. A properly designed piece of furniture should be adapted to 90% of the population, or consumers whose measurements fall within the 5th and 95th percentiles. Seating furniture should be designed using the 50th percentile values (Smardzewski 2008).

In Poland in the 1960s and 70s, furniture ergonomics were closely linked to the social, political and economic context of the time, which influenced the design and production of furniture. Furniture in Poland in those decades was not ergonomic; however, attention was paid to certain aspects of comfort and functionality, which became the standard in later years. As already mentioned, in the 60s, simple, functional forms dominated, while in the 70s, the principles of ergonomics began to be applied in office furniture. At that time, designers were inspired by the Scandinavian style (functional and comfortable); in the case of Poland, this was also implemented in furniture designed for mass production.

The ergonomics of seating furniture has been mainly discussed for school (Samira et al. 2018), office, and special-purpose furniture related to specific activities (Silvana et al. 2021). Furniture in the classrooms of schools and universities (Taifa et al. 2017; Musa 2011) is used by students for most of the day (Taifa et al. 2017; Agha 2012; Abdoli Eramaki 1994; Dianat et al. 2013) According to research, there are significant discrepancies between the anthropometric characteristics of students and the dimensions of school furniture. The dimensions of school furniture such as chairs and desks are not adapted for students; most often they are too high (Panagiotopoulou 2004; Gouvali 2006; Bayatkashkoli 2012; Dianat et al. 2013; Falahati 2013). Despite many projects and designs of school furniture focusing on ergonomic and anthropometric properties (Mokdad 2009; Thariq et al. 2010; Taifa et al. 2017; Kashif 2004; Oyewole 2010), there is a noticeable issue of equipment mismatch for individual students.

The situation is different with residential furniture. There is a lack of studies regarding residential furniture, which seems extremely significant in the context of changes in people's anthropological dimensions over the past years and future projections. Because furniture pieces are increasingly subjected to renovation or redesign, it is worth analyzing their dimensions and, consequently, their usefulness in furnishing the interiors of future generations.

It is accepted that armchairs and sofas serve a leisure function, while chairs and stools are used for work, study, and meals. Both groups have separate dimensional requirements. One of the fundamental elements in designing seating furniture is the seat itself. Proper selection of the seat has a positive impact on the user's well-being, health, and comfort. The furniture in use should combine aesthetic and functional qualities. Therefore, this study examines whether seating furniture from the 1960s and 1970s, characterized by simple construction and original shape, was also safe and comfortable for users (Smardzewski 2008).

After reviewing available literature sources and examining samples of seating furniture from the 1960s and 1970s, it was decided to undertake an analysis of the dimensions of selected models in terms of ergonomics and anthropometrics. In this study, individual types of furniture were classified and characterized, enabling an individual approach to be taken to each of the two groups, namely armchairs and chairs.

Methods and materials

In accordance with the main objective of the work, it was decided to classify and characterize seating furniture from the 1960s and 1970s. Two types of dimensional patterns were created: for armchairs (Fig. 1a) and chairs (Fig. 1b). Both overall dimensions and functional dimensions of importance for ergonomic seating were taken into account. A schematic representation of an appropriately designed seat, which allows safe use of the furniture, was used to assess the parameters of individual pieces of furniture (Fig. 2). The study focused on the most popular furniture items from that period, which are most often chosen by designers and redesigners. Furniture by outstanding designers such as Rejmund Hałas and Henryk Lis enjoys great recognition among contemporary designers, which is reflected in the 'red dot' and 'must have' awards, appreciated even a quarter of a century after the original designs, which were mainly influenced by the changes in the political system in Poland. Many pieces of furniture from this period are referred to as icons of Polish design and can be admired in the National Museum in Warsaw, including the 366 armchair by Józef Chierowski and the Płucka chair by Maria Chomentowska. As mentioned earlier,

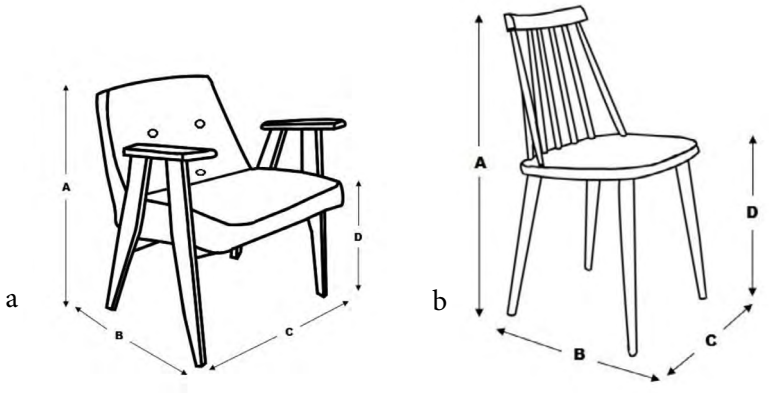

Fig. 1. Standard dimensions: a) armchair, b) chair

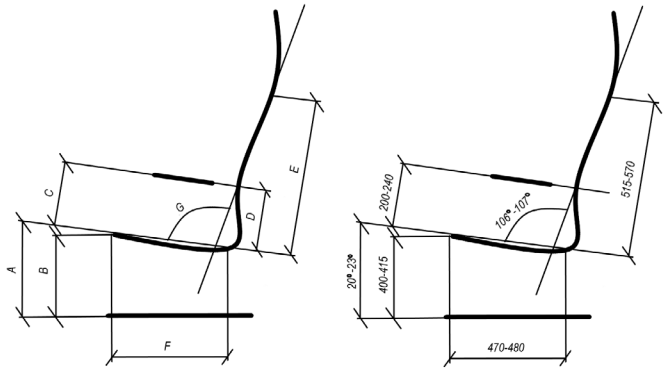

Fig. 2. Dimensions and important functional measurements for an ergonomic seat: A – seat angle of inclination, B – seat height, C – armrest height, D – lumbar support height, E – height of arm support, F – seat depth, G – backrest angle of inclination in the lumbar region. Seat width 550–600 mm (source: authors' work based on Smardzewski 2010)

some models are also produced today. There is a lack of information in the literature regarding these pieces' dimensions, and so the research was conducted based on available specimens. The research sample was determined based on available copies that used original materials, faithful to the original. Copies that used modern materials and those with worn-out materials that could give misleading results were rejected. The furniture analyzed had been restored using original materials by people who worked with the designers. To assess ergonomics, ten types of chairs and twelve models of seats were dimensioned. Parameters for dimensioning chairs and seats were determined, forming the basis for a relevant characterization. Individual models were presented graphically. Subsequently, all specimens were dimensioned using a measuring tool and an electronic/digital goniometer.

The study used comparative analysis with standard values, the purpose of which is to compare the actual parameters with a previously established reference. Such analysis serves to compare a specific furniture dimension with a standard value, which is determined by the dimensions and important functional measurements of an ergonomic seat. The standard value is an established norm that indicates what dimensions the furniture should have. The analysis therefore indicates whether a given chair or armchair meets the standards.

Results and discussion

A designer of furniture for seating and relaxation must know the relationships between the dimensions of a healthy and properly formed human body, as well as the space a person occupies in a sitting position. The designer should have knowledge of how to arrange furniture so that the user can comfortably perform various activities, such as working at a desk, eating meals, or relaxing (Neufert 1995).

The data obtained were intended for subsequent ergonomic evaluation. Additionally, the dimensions of seating furniture from the 1960s and 1970s were compared with ergonomic and anthropometric requirements that designers must take into account. This served to verify whether the analyzed furniture was designed in accordance with current standards to ensure comfort, convenience, and user health.

There exist European standards that regulate the ergonomics of furniture, mainly office furniture.

The EN 1335 standard concerns office chairs, taking into account height, stability, and other ergonomic parameters. In turn, ISO 9241 refers to the ergonomics of human–computer interaction, including office furniture. There are also many publicly available guidelines for the design of seating furniture. The most commonly used standard has been PN-F-06027-03:1991, which specified functional dimensions. Today, special attention is paid to anthropotechnical dimensions, which determine the ergonomics of designed products. Anthropotechnical dimensions were included in the Atlas of Human Measures (Gedliczka 2001), and on this basis, dimensional guidelines for seating furniture were developed.

The anthropotechnical system consists of an animate part, namely the human body, and an inanimate part, which is the technical means represented by furniture (Smardzewski 2008). The dimensions of a person, called anthropometric dimensions, are the basic data needed for designing furniture and workstations in terms of usability. Using information about such dimensions enables the proper selection of furniture sizes and presentation of the optimal arrangement of furniture items relative both to each other and to the user. The fundamental dimensional parameter for seating and relaxation furniture is the seat height. This dimension must be smaller than the distance between the knee bend and the base on which the user's feet rest. When the user takes a seated position, the seat height should be located 3–5 cm below the knee bend. Improper seat placement, whether too high (compressing arteries) or too low (causing leg cramps and increased pressure on the sciatic nerve), will negatively affect the furniture's user. It may also lead to incorrect stress on the lumbar spine, especially if the seat is too deep. It is recommended that the area just below the knee protrude one-third beyond the seat (Smardzewski 2008).

Table 1. Projected average body heights up to 2020 (source: own compilation based on Gedliczka 2001)

Year	Men aged 20 to 65 years		Women aged 20 to 60 years	
	average	SD	average	SD
2000	174.8	6.5	161.4	5.7
2010	176.7	6.5	162.2	5.7
2020	177.7	6.5	162.7	5.7

Table 2. Comparison of the dimensions of women and men in a seated position for the 50th percentile: height (source: own compilation based on Gedliczka 2001)

No. 50 c	Women	Men	Description
1	84.7	90.9	**Seat height** – the distance from the seat to the top of the head set in the Frankfurt plane
2	74.1	79.2	**Eye level** – the distance from the seat to the plane of vision when the head is positioned in the Frankfurt plane
3	55.6	59.4	**Shoulder height** – the distance from the seat to the lateral edge of the scapular acromion
4	45.7	48.5	**Thoracic kyphosis height** – the distance from the seat to the highest convexity of the back
5	25.3	23.9	**Height of lumbar lordosis** – the distance from the seat to the greatest concavity of the spine in the lumbar region
6	21.9	21.7	**Elbow height** – the distance from the seat to the lower edge of the elbow when the forearm is bent at a right angle
7	40.4	43.8	**Knee height from the base** – the distance from the base to the surface of the knee when the lower leg is bent at a right angle
8	51.2	54.8	**Knee height from the base** – the distance from the base to the upper surface of the knee when the lower leg is bent at a right angle
9	62.3	65.5	**Elbow height from the base** – the distance from the base to the lower edge of the elbow when the forearm is bent at a right angle

Table 3. Comparison of the dimensions of women and men in a seated position for the 50th percentile: width, length, depth (source: own compilation based on Gedliczka 2001)

No.	Women	Men	Description
50 c			
1	22.4	24.2	**Knee width** – the distance between the tangents to the lateral surfaces at the widest point on the knees
2	36.5	35.3	**Hip width** – the distance between the lateral surfaces of the hips at the widest lower part of the torso
3	26.2	29.2	**Chest width** – measurement at the rib arches at the widest point of the chest
4	35.5	38.4	**Length: elbow–handle axis** – the distance from the back edge of the elbow to the handle axis when the forearm is bent at a right angle
5	46.2	47.2	**Seat length** – the distance between the buttocks and the bottom of the knees when the lower leg is bent at a right angle
6	57.8	60.1	**Length: buttock–knee** – the distance between the tangent to the buttocks and the tangent to the knee when the lower leg is bent at a right angle
7	25.6	28.4	**Depth: buttocks–abdomen** – the distance between the tangent to the buttocks and the tangent to the abdomen
8	14.4	14.4	**Thigh thickness** – the distance from the seat to the highest point on the thigh

In the study of dimensions of seating furniture from the 1960s and 1970s, reference was made to an anthropometric module. This included data concerning the Polish population, encompassing men aged 20–65 and women aged 20–60. Anthropometric data provided information about the Polish population in the year 2000 (Jarosz 2003). The study also considered the projected body height up to 2020 (Table 1), which is closely related to the other limb dimensions.

In the analysis of the dimensions of chairs and armchairs, percentile models for women and men in a seated position were used, encompassing measurements of body height, depth, width, and length. All dimensions are given in Table 2 and Table 3. Only data related to the 50th percentile population were utilized, in accordance with requirements for designing furniture for relaxation.

All dimensions obtainable (using the scheme in Fig. 2) are provided in Table 4 and Table 5. In the case of dimension E, the height of armrest support, the backrest height was taken into account, as it was the highest point of support, and the tested specimens did not have a headrest support function in their construction. Blue color indicates that the furniture dimensions are in accordance with the requirements shown in Figure 3.

Tables 4 and 5 contain the results of the analysis of dimensions of furniture taking into account ergonomic requirements, and indicate which of the examined specimens meet these requirements. The results are also presented on graphs (Fig. 3). The study used comparative analysis with standard values, serving to compare the actual dimensions of selected chairs and armchairs from the 1960s and 1970s with the standard values for an ergonomic seat determined on the basis of anthropotechnical data. The compilation of recommended dimensions from Fig. 2 was adopted as the standard.

The standard values matched the furniture dimensions only in a few cases. In most cases, the chairs and armchairs did not meet the conditions specified for an ergonomic seat. In the case of armchairs, the best result was achieved in the comparison of the standard with the measured value of the seat angle of inclination (Fig. 3a). In this case, six of the armchairs had dimensions within the standard range. It is also seen that in the comparison of standard and measured values of seat width (Fig. 3h), four of the armchairs had dimensions within the standard range. In the case of armrest height, only one armchair had a measured value within the standard range. In the case of chairs, the dimensions of only two chairs were within the standard range for seat height (Fig. 3b), and only one chair met the requirements for the backrest inclination angle in the lumbar section (Fig. 3g). In the remaining cases, the dimensions of chairs and armchairs did not coincide with the suggested range of standard values.

In design today, great emphasis is placed on functionality and comfort of use. Furniture is adapted to the anthropotechnical dimensions of a human, so that its long-term use does not cause health problems, such as back pain. In this respect, one can observe a great emphasis on the personalization of furniture or the possibility of adjustment, for example in the case of office furniture.

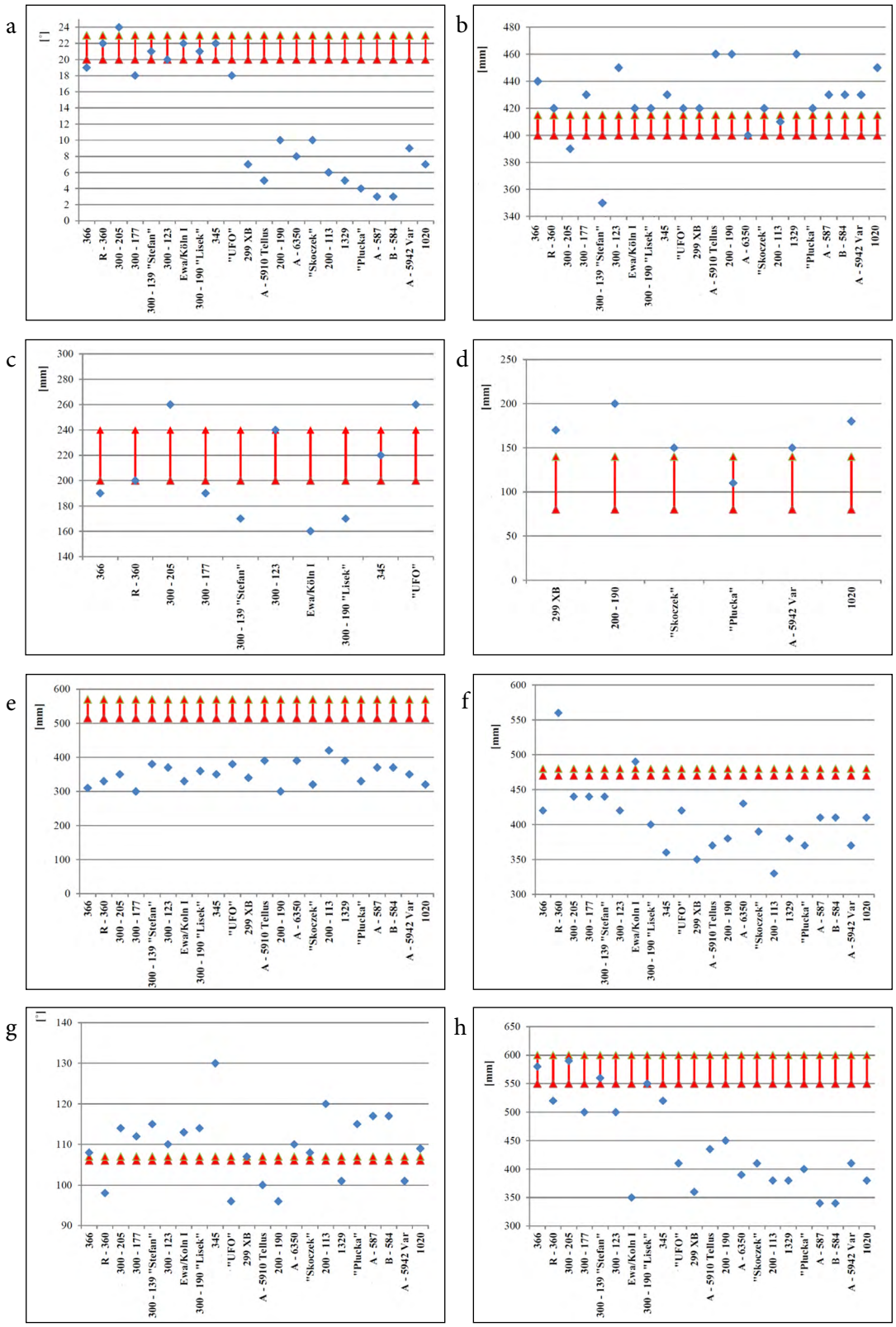

Fig. 3. Analysis of chairs and armchairs from the 1960s and 1970s in terms of ergonomics:
a) comparison of standard and measured values of the seat angle of inclination;
b) comparison of standard and measured values of the seat height;
c) comparison of standard and measured values of the armrest height;
d) comparison of standard and measured values of the lumbar support height;
e) comparison of standard and measured values of the height of arm support;
f) comparison of standard and measured values of the seat depth;
g) comparison of standard and measured values of the backrest angle of inclination in the lumbar region;
h) comparison of standard and measured values of the seat width

Table 4. Dimensions and important functional measurements of armchairs from the 1960s and 1970s, with dimensional analysis in terms of ergonomics

No.	Furniture model	Dimensional Analysis								Illustration
		seat angle of inclination **A** [°]	seat height **B** [mm]	armrest height **C** [mm]	height of arm support **E** [mm]	seat depth **F** [mm]	backrest angle of inclination in the lumbar region **G** [°]	Seat width [mm]	**Furniture height** [mm]	
1	**Upholstered armchair type 366**	19	440	190	310	420	108	**580**	750	
2	**Upholstered armchair type R-360**	**22**	420	**200**	330	560	98	520	750	
3	**Upholstered armchair Akul II type 300-205**	24	390	260	350	440	114	**590**	740	
4	**Upholstered armchair type 300-177**	18	430	190	300	440	112	500	730	
5	**Upholstered armchair type 300-139 "Stefan"**	**21**	350	170	380	440	115	**560**	700	
6	**Upholstered armchair type 300-123**	**20**	450	**240**	370	420	110	500	820	
7	**Upholstered armchair Ewa/ Köln 1**	**22**	420	160	330	490	113	350	750	
8	**Upholstered armchair type 300-190 "Lisek"**	**21**	420	170	360	400	114	**550**	780	
9	**Upholstered armchair type 345**	**22**	430	220	350	360	130	520	780	
10	**Upholstered armchair "UFO"**	18	420	260	380	420	96	410	800	

– dimension in accordance with the requirements

Table 5. Dimensions and important functional measurements of chairs from the 1960s and 1970s, with dimensional analysis in terms of ergonomics

No.	Furniture model	Dimensional Analysis								Illustration
		seat angle of inclination **A** [°]	seat height **B** [mm]	lumbar support height **D** [mm]	height of arm support **E** [mm]	seat depth **F** [mm]	backrest angle of inclination in the lumbar region **G** [°]	Seat width [mm]	**Furniture height** [mm]	
1	**Upholstered chair type 299 XB**	7	420	170	340	350	**107**	360	760	
2	**Upholstered chair type 200-190**	10	460	200	300	380	96	450	760	
3	**Upholstered chair type A-6350**	8	**400**	--	390	430	110	390	790	
4	**Upholstered chair "Skoczek"**	10	420	150	320	390	108	410	740	
5	**Upholstered chair type 200-113**	6	**410**	--	420	330	120	380	830	
6	**Upholstered chair type A-5942 Var**	9	430	150	350	370	101	410	780	
7	**Upholstered chair type 1020**	7	450	180	320	410	109	380	770	
8	**Chair type 1329**	5	460	--	390	380	101	380	850	
9	**Chair "Płucka"**	4	420	110	330	370	115	400	750	

10	**Chair type A-587**	3	430	--	370	410	117	340	800	
11	**Chair type B-584**	3	430	--	370	410	117	340	800	
12	**Chair type A-5910 Tellus**	5	460	--	390	370	100	435	850	

– dimension in accordance with the requirements

On the other hand, we are witnessing a return to furniture from the 1960s and 1970s, which is currently produced according to the original designs. It would therefore be necessary to scale up seating furniture in particular, and to adapt its dimensions to modern requirements, taking account of the increase in the body dimensions of the current population.

In developed countries, people's average height has increased by about 5–10 cm over the past 60 years, mainly as a result of better living conditions, better nutrition, and access to medical care. In developing countries, the increase is taking place at a slower rate.

Conclusions

The aim of this study was to conduct an analysis of the dimensions of items of seating furniture from the 1960s and 1970s in terms of ergonomic and anthropometric properties, leading to their classification and characterization. As a result of the work, information about seating and relaxation furniture was obtained. An analysis of literature sources enabled the classification of individual models. After the creation of a database, particular specimens were selected to serve as a starting point for examining chairs and armchairs in terms of ergonomics. The basis for dimensioning furniture was a diagram indicating overall dimensions and important functional dimensions for ergonomic seating. The furniture items were measured in terms of the parameters outlined in the diagram. Percentile models for women and men in a seated position, as well as data on body dimensions for the Polish population in 2020, also proved useful.

An additional goal was to draw attention to the phenomenon of returning to designs from past years, including redesign and renovation efforts.

Based on the measurement and analysis of dimensions of chairs and armchairs from the 1960s and 1970s, several conclusions were formulated. Considering the overall dimensions and important functional measurements for ergonomic seating, it may be stated that the examined specimens cannot be classed as such. Both the armchairs and chairs deviate from current standards. First and foremost, when analyzing the basic element, namely the seat, it is found that its height is not properly adjusted. In most cases (including in non-upholstered chairs and, after taking into account the deflection of the upholstery systems, in upholstered furniture) the seat height is greater than the distance between the knee bend and the base where the user's feet rest. An inappropriately selected seat height may pose a risk of excessive strain on the circulatory system. The depths of the seat and its width are often too small, which can cause discomfort during use. Many furniture pieces from the 1960s and 1970s do not provide lumbar support in their construction. None of the chair or armchair models have headrests. In a piece of furniture intended for relaxation or work, this parameter plays a significant role, and therefore its absence disqualifies a given model. A similar situation applies to arm support provided by the backrest. Usually, the backrests are too low and lack sufficient surface for proper support of this area, which can lead to spinal issues. Another aspect is the height of the armrests. These are present in every analyzed chair model, but only in two specimens are they positioned at the appropriate height. A positive finding is that six out of ten armchairs meet the requirements regarding the seat angle of inclination. The respective requirements for the angle of the backrest relative to the seat are not met in the case of armchairs, and in the case of chairs, only one of the models meets them.

Individual requirements are described separately, but for a piece of furniture to be considered ergonomic, it must meet all of the conditions. None of the analyzed models met the dimensional standards. Analyzing

percentile models for women and men in a sitting position in the context of furniture dimensions, it is also difficult to find positive outcomes. The furniture is not adapted to the current dimensions of the population in Poland (which seems important in the context of returning these forms to production). The average body height continued to increase until 2020, directly affecting the overall body structure and consequently the percentile models for sitting positions.

This work was driven by the growing popularity of seating furniture from the 1960s and 1970s, as well as the need to examine their ergonomics. Considering the information collected and the results of the analysis, it can be stated that these furniture products are not adapted to the dimensions of the current adult population. The dimensions of the furniture do not comply with the requirements for an ergonomic seat, which a contemporary designer should take into account. Analyzing only user comfort and consumer health, these pieces cannot currently be called relaxation furniture. Undoubtedly, a determining factor in choosing such furniture is the visual aspect. Freestanding, lightweight pieces supported by tapered legs often attract consumers. The possibility of individually adjusting upholstery and carrying out renovation while maintaining a low price is an additional advantage. In many Polish households, such furniture will be used for years, but before making a purchase, a consumer should consider whether such a chair or armchair will be comfortable to use and whether they can rest on it without causing posture problems. The present research will fill a visible gap in the literature concerning the adaptation of the dimensions of seating furniture from the 1960s and 1970s to modern users, and will thus contribute to ensuring their comfort and preventing health problems. To date, attention has been paid only to the visual aspect, which is the reason why furniture manufacturers are eager to return to these forms (including by resuming their production) and their renovation is becoming common. This research may serve as a basis for further studies in the field of biomechanics and the load on soft tissues of the human body in the context of the analyzed types of furniture.

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