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Office Chairs:
An Overview of Ergonomic Standards

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Executive Summary

This report was commissioned to examine the industry standards and guidelines pertaining to office chair measurements and features. The main focus of the report is to give guidance on key measurements that need to be taken into consideration when selecting a non-task intensive chair. The following is an overview of four guidelines and standards from four independent groups and datasets.

Out of the four guidelines taken into consideration, the BIFMA G1_2013 guideline is deemed the most relevant, as it is developed from the most recent dataset, and the most representative of today's office worker population as dimensions have been taken from a civilian population, versus a military population in the other three guidelines and standards. A recent dataset is important as there is an increasing trend in obesity rates in North America, and office furniture guidelines and standards need to consider these changes in body dimensions. Two of the most affected stature dimensions are the forearm-to-forearm breadth (affecting inter-armrest distance) and the seated hip breadth (affecting seat pan width)[4].

It is important to adhere to guidelines for chair specifications. A properly fitted seat with respect to height, depth, and width, will reduce pressure on the soft tissues of the legs, ensure the user can sit properly in the chair to receive the full benefits of the back support, ensure users can easily enter and exit the chair, and provide users with an evenly distributed surface to support their weight. A properly sized backrest will support the curves of the spine. With the curves of the spine properly supported, the risk of developing back pain is reduced through a decrease in required muscular activity[2] and loading on the back[3]. Properly fitted armrests are an essential mechanism to rest the arms, alleviating the workload of the upper shoulders and back. The presence, and proper height, of armrests allow users to easily enter and exit the chair, this is particularly important for users with reduced muscular strength, excessive weight, and joint problems.

Therefore, because of the importance of a properly fitted chair, it is very important to adhere to the standard dimensions overviewed in Table 1, as they will accommodate an appropriate fit for the majority of the population. In cases where chairs are to be used by multiple users, such as in a conference room setting, it is critical chairs can provide a proper fit for all users. Furthermore, because of the wide variety of users, the presence of armrests is critical in order to accommodate those who have difficulty entering and exiting chairs. *When considering a chair that is to be used within an office setting for short meetings the chair will likely have limited adjustability as oppose to a task-intensive chair. The report provides measurements to be considered for both fixed and adjustable chairs.*

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***Table 1**. Summary of Recommended Chair Dimensions*

Chair Characteristic	Recommendations – Metric	Recommendation – Imperial
Seat Height	37.6 cm – 51.2 cm	14.80 in – 20.16 in
Seat Depth	Fixed: Max 41.5 cm Adjustable: should include a depth of 41.5 cm or less	Fixed: Max 16.4 in Adjustable: should include a depth of 16.4 in or less
Seat Width	Min. 48.9 cm*	Min. 19.25 in*
Seat Pan Angle	0^0 – 4^0 rearward	
Backrest Height	Min. 35.4 cm from compressed seat height	Min. 13.94 in from compressed seat height
Backrest Width	Min 36.0 cm	Min 14.17 in
Lumbar Support	15.0 cm – 25.0 cm from compressed seat height	5.9 in – 9.84 in from compressed seat height
Torso-Thigh Angle	Fixed: Min 90^0 (vertical) Adjustable: range of $>15^0$	
Armrest Height	37.6 cm – 51.2 cm	14.80 in – 20.16 in
Inter-Armrest Distance	Fixed: 49.3 cm Adjustable: Min. 49.3 cm	Fixed: 19.41 in Adjustable: Min. 19.41 in

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Office Chairs – An Overview of Ergonomic Standards

Introduction

The following report overviews the ergonomic standards regarding the client meeting chair used in offices, but information is also provided that can guide the selection of task intensive computer chairs. A comparison of four major ergonomic standards summarizes different standards with respect to various components of a chair. When taking into consideration which guidelines to adhere to, it is important to consider the relevance of the dataset in which these guidelines were developed. There has been an increasing trend in obesity in North America and the changing population needs to be accurately represented in datasets used in the design of office furniture. Regression equations that have been developed from old military datasets and civilian obesity statistics have estimated ergonomic variables that are most affected by increasing obesity rates4. The stature dimensions that are estimated to be most affected by increasing obesity rates are the forearm-forearm breadth, and hip breadth in sitting4. This estimation places an emphasis on the importance of armrest width and seat pan width guidelines with respect to chair designs.

Figure 1. Inter-armrest Distance

Figure 2. Seated Hip Breadth

Out of the four guidelines/standards included in this comparison, the BIFMA G1-2013 may be the most accurate representation for today's population. Whereas most standards use a military dataset, this guideline was released in 2013 and used a civilian anthropometric dataset called the Civilian American and European Surface Anthropometry Resource (CAESAR). Not only is this database more recent, it is more representative of today's typical office workers as it was taken from a civilian population. The other three standards included in this comparison use older datasets taken from military populations such as the Natick 1988 Anthropometric Survey of US Army Personnel (Dataset for the CSA-7412 and the ANSI_HFES 100-2007), the DOD-HDBK-743A: Anthropometry of U.S. Military Personnel in 1991 (Dataset from the MIL-STD-1472F).

The Seat

Proper seat height is an important parameter to consider when fitting a chair. The appropriate height for the seat pan is determined by the distance between the floor and the back of the knee (popliteal fossa) height, plus the thickness of footwear (Figure 3). A proper seat height is critical in reducing pressure on the soft tissue of

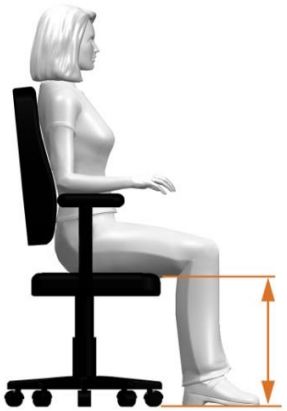

Figure 3. Seat Height (vertical distance between floor and back of the knee)

Figure 4. Seat Depth (horizontal distance between the buttock and the back of the knee)

the back of the thigh (if seat is too high)[3] and in reducing pressure on the hip bones (ischial tuberosities), a consequence of a small torso-to-thigh angle (if seat is too low)[2]. Overall, a proper height while seated will help to promote good blood flow and decrease discomfort to the lower limbs.

The appropriate seat depth for a chair is determined by measuring the horizontal distance between the buttock and the back of the knee (popliteal fossa) (Figure 4). Seat depth is important to provide full support to the thighs, as well as ensure the user is seated properly in the chair in order to get appropriate back support. A space of at least 10mm (0.4inches) needs to be present behind the knees to prevent compression of the unprotected vessels behind the knee.

The width of a seat pan should be wider than the width of the hips during sitting. This guideline for seat pan width ensures users can easily enter and exit the chair, and allows users to evenly distribute their weight across the seat, while giving a small allowance for movement within the seat[2,3]. The BIFMA guidelines are based on the most recent dataset available (CAESAR data source) for a civilian population. The previous BIFMA recommendations from BIFMA G1-2002 guidelines reported a 45.7cm (18.0”) standard for seat width for up to the 95th percentile female and the 99th percentile male. According to the most recent CAESAR dataset, this measurement only accommodates up to the 75th percentile female and the 97% percentile male hip breadths. Therefore, to accommodate for the increasing reported hip breadths, the standard seat pan widths should now be a minimum of 48.8cm (19.2”) to accommodate at least the 90th percentile female and the 97th percentile male hip breadth[2]. The CSA, MIL, and ANSI guidelines outlined below are from older anthropometric datasets and may not accurately represent today’s increasing trend towards obesity. Therefore, it is more appropriate to follow the guidelines stated in the BIFMA report.

Figure 5. Appropriate seat pan angle

Seat pan angles are responsible for providing users with support through a variety of different seated postures (Figure 5). It is important to have a variety of postures available so that blood flow can be promoted and loads and the spine can be altered[3]. Appropriate seat pan angles are important to avoid users sliding forward and out of the chair (angle too far forward) and to avoid compromised lumbar curvatures (angle too far rearward creating a small torso-to-thigh angle), and compression of soft-tissue behind the knees[2]. See table 2 for guidelines on seat requirements for work chairs.

Table 2. Overview of Chair Seat Pan Standards and Guidelines

Ergonomic Characteristic	Measurement Unit	Recommended Dimensions and Ranges*			
		BIFMA G1-2013	CSA-Z412	MIL-STD-1472F	ANSI_HFES 100-2007
Seat Height	Centimeters (cm)	37.6-51.2	**Low**: ≥38.0-≤45.0 **Standard**: ≥42.0 - ≤51.0	38-54 (increments of 3.0)	38-56 (adjustable over a min. range of 11.4)
	Inches (in)	14.8-20.2	**Low**: ≥15.2-≤18 **Standard**: ≥16.8 – ≤20.8	15-21 (increments of 1.0)	15-22 (adjustable over a min. range of 4.5)
Seat Depth	Centimeters (cm)	**Fixed**: Max. 41.5 **Adjustable**: should include a depth of 41.5 or less	**Shallow**: ≥38.0-≤42.0 **Medium**: ≥42.0 - ≤46.0 **Deep**: ≥ 46.0 **Adjustable**: at least 5cm including 42.0-46.0	≤40	**Fixed:** ≤ 43 **Adjustable:** include a depth of 43
	Inches (in)	**Fixed**: Max. 16.3 **Adjustable**: should include a depth of 16.3 or less	**Shallow**: ≥15.2-≤16.8 **Medium**: ≥16.8-≤18.4 **Deep**: ≥18.4	≤16	**Fixed:** ≤ 16.9 **Adjustable:** include a depth of 16.9
Seat Width	Centimeters (cm)	Min. 48.9**	≥ 45.0	38-46	Min. 45.0
	Inches (in)	Min. 19.2**	≥18.0	15-18	Min. 17.7
Seat Pan Angle	Degrees (°)	0°-4° rearward	Min. 3° forward and 4° rearward	0° - 7° rearward tilt	Min. range of 4°, including 3° in rearward position

* The standards in this table are appropriate for the 5% female to the 95% male stature

** Accommodates at least the 90% female and 97% male hip breadths

Figure 6. Example of a properly fitted lumbar support.

The Backrest

It is important to provide chair users with an appropriately sized backrest to ensure the back is supported in a variety of seated postures (Figure 6). Both backrest height and width are contributors to ensuring the spine is properly supported. With the curves of the spine properly supported, the risk of developing back pain is reduced through a decrease in required muscular activity[2] and static loading[3]. The recommendations from BIFMA G1-2013 indicate that different backrest height and width, while not regulated, may be more appropriate for different tasks. For example, high backrests are more appropriate for chairs with reclining functions in order to provide the user with support in the upper back when in a reclined position. With respect to backrest width, narrow backrests provide greater unrestricted movement, but may not provide adequate support to the upper back. Wide backrests may provide appropriate support to the upper back but not allow for as much movement. The tasks of a user should be taken into consideration when recommending the width of a backrest. See table 2 for guidelines on backrest height and width requirements.

Figure 7. Example of an appropriate torso-to-thigh angle

The purpose of the lumbar support in the chair is to provide support to the lumbar curvature of the spine and minimize back strain during sitting. The amount of lumbar support is dependent on a multitude of factors such as gender, age, and body mass[2]. An increased lumbar curvature (increased Lordosis) is found in females (versus males) suggesting females will often need a more prominent lumbar support in chairs. As people age, the lumbar curvature will tend to decrease, and users may want less support in the lumbar area. Finally, there is a trend showing that the higher a user's BMI, the higher their preferred lumbar support height[2]. This is likely caused by an increase in soft tissue in the buttocks and thigh regions will increase a person's height while seated[2]. See table 3 for guidelines on lumbar support requirements. A torso-to-thigh angle should be no less than 90° (Figure 7), any angle smaller has been shown to increase loading on the structures of the spine, the muscles of the back, and pressure on the thighs[1]. Appropriate torso-to-thigh angles as well as a properly fitted lumbar support are essential to decrease the stress on a user's spine[1].

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Table 3. Overview of Chair Backrest Guidelines and Standards.

Ergonomic Characteristic	Measurement Unit	Recommended Dimensions and Ranges*			
		BIFMA G1-2013	CSA-Z412	MIL-STD-1472F	ANSI_HFES 100-2007
Backrest height	Centimeters (cm)	Min. 35.4 from compressed seat height	**Standard**: ≥45.0 - ≤55.0 from upper seat cushion **High Back**: ≥ 75.0	--	Min. 45 from compressed seat height
	Inches (in)	Min. 13.9 from compressed seat height	**Standard**: ≥18.0-≤22.0 from upper side of seat cushion **High Back**: ≥30 higher than standard back	--	Min. 17.7 from compressed seat height
Backrest width	Centimeters (cm)	Min. 36.0	≥35.0	30-36	Min. 36.0
	Inches (in)	Min. 14.2	≥14.0	12-14	Min. 14.2
Lumbar Support	Centimeters (cm)	15.0-25.0 from compressed seat height	**Fixed**:15.0-25.0 **Adjustable:** at least 5cm within 15.0-25.0	--	**Fixed:** 15.0-25.0 from compressed seat height **Adjustable**: be adjustable between 15.0-25.0
	Inches (in)	5.9-9.8 from compressed seat height	**Fixed**: 6.0-10.0 **Adjustable**: at least 2.5 within 6.0-10.0	--	**Fixed:** 5.9-9.8 from compressed seat height **Adjustable**: be adjustable between 5.9-9.8
Torso-Thigh Angle	Degrees (°)	**Fixed**: Min. 90° (vertical) **Adjustable:** range of ≥15° of which at least 15° falls between 90°-120°	**Fixed**: >93° - <103° **Adjustable**: 93°-113°	100°-115° recline	Adjustable: range of ≥15° of which at least 15° falls between 90°-120°

* The standards in this table are appropriate for the 5% female to the 95% male stature

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Armrests

Armrests on chairs provide two very important functions. First, armrests are available to support the muscles of the upper body musculature, including the muscles of the neck, and shoulder. Second, armrests are an essential mechanism to assist users to enter and exit a chair safely[3]. Assistance from the armrests is more crucial in circumstances where the user may have an increased difficulty entering and/or exiting a chair due to other factors such as, joint problems, excessive weight, or weak leg strength.

Figure 8. Armrest height (vertical distance between the seat pan height and the seated elbow height)

Armrest height should be placed at the height of the elbow while sitting, and should not cause the users' shoulders to shrug during use (Figure 8). The length of the armrests should be long enough to support at least part of the forearms but not so long that it prevents the user from getting close enough to the work surface. When determining the distance between armrests (inter-armrest distance) it is essential that there is adequate space so that the seated hip breadth of the user can easily move between the armrests to allow easy entry and exit from the chair (Figure 1). However, if the armrest width is too wide, users will end up resting their elbows far away from the sides of the trunk and this will likely end in shoulder discomfort[1]. In cases where the hip breadth is much wider than the shoulder width, it is recommended to use armrests that are width adjustable so that entry and exit from the chair is easy, but the armrests can be brought closer together to provide adequate forearm support[2]. See table 4 for armrest recommendations.

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Table 4. Overview of Armrest Guidelines and Standards.

Ergonomic Characteristic	Measurement Units	Recommended Dimensions and Ranges*			
		BIFMA G1-2013	CSA-Z412	MIL-STD-1472F	ANSI_HFES 100-2007
Armrest height	Centimeters (cm)	Fixed: N/A Adjustable: 19.5-28.9	Fixed: ≥19.0 - ≤25.0 Adjustable: Min. 5.0, including 19.0-25.0	19-28	Fixed: ≥18.0 - ≤27.0 from the seat pan Adjustable: 17.0-27.0 from the seat pan
	Inches (in)	Fixed: N/A Adjustable: 7.7-11.4	Fixed: ≥7.6- ≤10.0 Adjustable: Min. 2.5 including 7.6-10.0	7.5-11	Fixed: ≥7.1 - ≤10.6 from the seat pan Adjustable: 6.7-10.6 from the seat pan
Armrest length & position	Centimeters (cm)	--	Length: ≥18.0 Width: ≥4.5 Position: Min 15.0 from front of seat	Width: ≥5 cm Length: ≥20 cm	--
	Inches (in)	--	Length: 7.2 Width: 1.8 Position: Min. 6.0 from front edge of seat	Width: ≥2 Length: ≥8	--
Inter-armrest distance	Centimeters (cm)	Fixed:49.3 Adjustable: Min. 49.3	Min. 45.0	Min. 46.0	Min. 46.0
	Inches (in)	Fixed:: Min. 19.4 Adjustable: 19.4	Min. 18.0	Min. 18.1	Min. 18.1

* The standards in this table are appropriate for the 5% female to the 95% male stature

Conclusion

In summary, all four guidelines and standards overviewed in this report should be taken into consideration while considering the component needs of a chair. The BIFMA G1-2013 report provides very applicable guidelines for the present day office-worker population. It is based on a more recent dataset than the other two guidelines and takes into consideration the trend of overall increasing body mass of today's population. Furthermore, the BIFMA G1-2013 guidelines are derived from a dataset that consists of a civilian population whereas the other two standards have been derived from military datasets. Developing standards from military datasets can cause a few discrepancies between guidelines and actual users because of the natural tendency of military personnel to be more fit than the average civilian office-worker.

References

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