

"ANTHROPOMETRIC DATA OF STUDENTS OF THE UNIVERSITY OF SONORA, SONORA, MEXICO"

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RESUMEN

Las cartas antropométricas dan la información acerca de las dimensiones de una población determinada y son muy utilizadas por los diseñadores. Los expertos en diseño afirman que una ayuda física diseñada para una población específica, no es óptima para cualquier otra; ésto parece lógico, pero en nuestro país, no es posible ratificar o rectificar esta afirmación debido a que desconocemos las Cartas Antropométricas Mexicanas.

La antropometría es la determinante de las condiciones ergonómicas; por tanto, los estudios antropométricos deben referirse a una población específica y de ahí nuestro interés por conocer las medidas de los estudiantes de la Universidad de Sonora.

Se incluye un ejemplo de las tablas antropométricas por edad y por sexo de un estudio realizado a 227 estudiantes de la Universidad de Sonora, Unidad regional Centro y se describe la metodología utilizada.

ABSTRACT

Anthropometric data gives information about the dimensions of a certain population and it is used by designers. Design experts affirm that physical equipment and facilities designed for a specific population, are not good for any other one; this seems logical, but, in our country, it is not possible to ratify or to rectify this statement because many of us ignore the Mexican Anthropometric data.

In order to design ergonomic living and working conditions, anthropometric principles must be applied; therefore anthropometric studies should refer to a specific population and it is our interest to know the dimensions and some physical features of the students of the University of Sonora.

This research contains data collected in a sample of 227 students of the University of Sonora, Sonora, Mexico, from January to December, 2009; their body dimensions by age and sex, are depicted in figures 1 and 2, and the methodology used is also described.

INTRODUCTION

Nowadays, men have reached an unusual development. Tools, equipment, machines and all kind of technology that are available aim for comfort and well-being in our daily life, as well as effectiveness, adaptability, prevention and for safety at work. These advances always arrive of the hand with new models of equipment, machines, tools or vehicles, which more dissimilar, force men to adapt themselves inside of or outside of them, implying possible risks, mainly at work places (McCormick, 1982).

In all men's activities, some or a lot of physical effort is needed, and they need and will continue needing physical assistance to reduce fatigue, to improve manufactured items or to produce them more quickly; some examples are: pincers or a hammer in a shop, a typewriter in an office, a pan in the kitchen or a stairway and its handrails in a building, etc.

New scientific approaches and technological advances are key elements in designing to achieve higher productivity with almost perfect equipment and machinery. These items should eliminate the sources of risks and injuries. Designs should also take into account men's physical characteristics, limitations and capabilities who will use them; designs must adapt physical tools to users and should avoid unnecessary efforts, tasks must be performed quickly, easily and safely, since individuals are more productive being comfortable at work.

Adapting tools to users or workers should not only be bounded to the operator, but to all persons that will work with them, such it is the case of the maintenance personnel. Any internal part of equipment or machine should be accessible and be able to provide the necessary space to make any repair (Flores, 2001).

Mexican workers also have to adapt themselves to working tools and conditions, mainly for three circumstances: there is a great quantity of equipment and machinery that were bought in foreign countries, which were not designed to be operated by the Mexican population; Mexican manufacturers produce their items erroneously, they design them as they were designed in other countries and the most dramatic situation is that they don't know the physical characteristics (anthropometric data) of the Mexican population, or perhaps they have not been published.

The Mexican anthropometric data found in the literature, up to now, have little information and they were collected from certain regions.

- a. The Yucatan population's anthropometric data is a research carried out by George Dee Williams in 1927 and published in 1931 by the Bureau of International Research of Harvard University and Radcliffe College under the name of "Mayan-Spanish Crosses in Yucatan".
- b. Anthropometric measurements of some selected world populations, were presented as a report by Robert M. White during the International Symposium of Engineering of Human Factors in 1972. This report presents the dimensions of the military Air Forces of eighteen (18) Latin American countries on the whole, but the reference of the source of information is not shown.
- c. Datos antropométricos de la población de Ciudad Juárez, is a study carried out in 1986 and 1987 by the Center of Graduates of the Technological Institute of Ciudad Juárez. This investigation presents 50 anthropometric data of 987 adults, mainly from the maquiladora industry.
- d. "Estudio de ergonomía estática en una empresa textil Mexicana" was published in the journal *Condiciones de Trabajo*, in 1979.

- e. Anthropometry of female maquila workers, is a research published in the International Journal of Industrial Ergonomics in 1999 by Victor Liu, David Sanchez Monroy and Guillermo Parga. It presents twelve body dimensions of women workers in the maquiladora industry.
- f. Cartas antropométricas para la población laboral de la maquila de Ciudad Obregón, is a research conducted by Claudia Elena Mungarro Ibarra, in 2009.
- g. Cartas antropométricas de adultos con enanismo de 18 a 45 años de edad para el diseño de mobiliario, this survey was carried out in Mexico City, by Rubén Baptista Balderas, an Industrial Design graduate student at Centro Universitario UAEMéx Zumpango, who took body dimensions of adults with dwarfism among 18 to 45 years old to design different furniture.
- h. Cartas antropométricas de la población laboral del estado de Sonora, área serrana, this study gathered body dimensions of workers in the northeastern region of the state of Sonora, Mexico and it was performed by students of the Universidad de la Sierra in the state of Sonora in 2008.
- i. Cartas antropométricas de la población laboral de la República Mexicana, a research published by the Instituto Tecnológico of Hermosillo.

Some employers may perceive that since tasks are designed or redesigned, whatever the operator will need may be, carefully, taken into account, but it may increase their investment, but in the long run, investment will be recovered and the gains will be financially enlarged.

On the other hand, if an employee works comfortably when he/she is sitting down, he/she will not feel tired, will not feel any pain, and will be able to work easily and relaxed, and his/hers items quality will increase, as well as effectiveness and efficiency. In such scenario, health care costs will decrease and the employee's moral will improve.

Ergonomics principles can avoid injuries or painful illnesses that can handicap workers and make work places more comfortably safe in productive environments (McCormick, 1982).

Anthropometric data's main utilization is objects designed for human use, such as tools, furniture, work stations, facilities, etc. which optimize working and living conditions.

As it can be seen, designing for human use is a wide objective, and to achieve good results it is necessary to keep in mind that who is or will be a product's customer. That is the main reason that anthropometric data is necessary as another tool for work designers, and its gathering takes time and it is quite expensive.

OBJECTIVES

To gather anthropometric data of students of the University of Sonora, in Hermosillo, Sonora, México, for different population strata, for:

- a) Age range (3), and
- b) Sex (2)

METHODOLOGY

A group of four trained people got the anthropometric data of 227 students. Three of the investigators (M. E. P. B. and A. M. M.) trained this group; they covered techniques, devices to use; and the required theoretical and practical knowledge to carry out the necessary activities.

The trained group carried out the project with students of the University of Sonora in Hermosillo, Sonora, México. Students were asked to wear light clothing and to take off their shoes during the study.

An anthropometer, a graduated scale in kilograms, and a survey of anthropometric data to register measurements were used.

Measurements were taken by the students' right side posture, when they were standing straight up, and also sitting down, in an erect position.

1. Standing straight up. The individual remains standing straight, seeing toward the front, with the ankles together, the weight distributed equally in both feet and with his arms hanging naturally to his sides.
2. Sitting down straight. The individual remains sitting down and straight, with his/her view toward the front, the arms relaxed and hanging, forearms and hands extended forward, thighs were horizontal, and his/her feet resting in an adjusted surface so that the knees were in an angle of 90 degrees.

Data were gathered and processed in Excel software, and percentiles were later determined.

Data were grouped by sex, age and geographical regions, in the following way:

- a. for sex: women and men,
- b. for age, from 17 to 20, from 21 to 23 and from 24 years old and up.
- c. Birthplace, the Mexican Republic was divided by several areas:

North zone, for the States of Chihuahua, Coahuila, Durango, New León and Zacatecas.

Centered area that includes the States of Aguascalientes, Mexico, Guanajuato, Hidalgo, Morelos, Puebla, Querétaro, San Luis Potosí, besides Mexico Federal District.

Northern Pacific area: The states of the Northwestern area such as Sonora, Baja California, Sinaloa and Nayarit.

Center Pacific area, for the states of Jalisco, Michoacán and Colima.

South Pacific area: for the states of Guerrero, Oaxaca and Chiapas.

Gulf of Mexico area, includes the states of Tamaulipas and Veracruz.

The different areas were settled down, arbitrarily, following the approach of their geographical proximity.

In figures 1 and 2, are shown the codes used, their description and the individual's position. This code was taken from a study carried out by the NASA.



UNIVERSIDAD DE SONORA. Carta Antropométrica



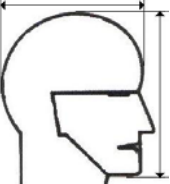
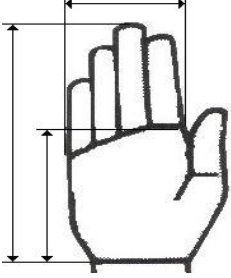
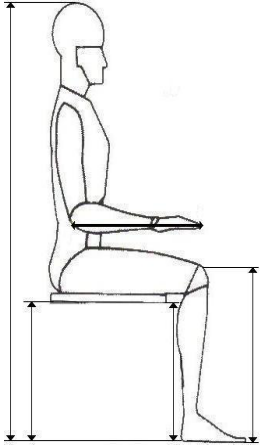
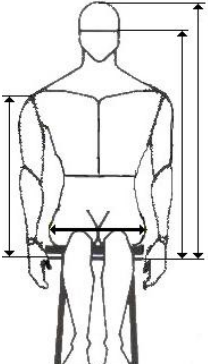

Edad: 15-20 21-30 31-40 41-50 51-60 Sexo: F M
 Lugar de Nacimiento (Estado): _____ Ocupación: _____
 Lugar de Nacimiento (Estado): Padre: _____ Madre: _____
 Analista: _____ *(Usar ropa ligera y ajustada al cuerpo)*


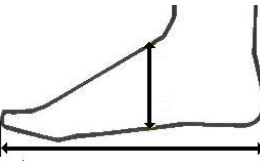
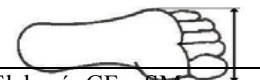
	920 Peso (Kg)		122 Ancho de hombros		
	805 Estatura		223 Ancho de pecho		
	328 Altura al ojo		457 Ancho de cadera (parado)		
	23 Altura al hombro		32 Largo de brazo		
	309 Altura al codo		67 Profundidad del pecho		
	949 Altura a la cintura (ombligo)		430 Circunferencia de la cabeza		
	398 Altura al glúteo		639 Circunferencia del cuello		
	973 Altura a la muñeca		230 Circunferencia del pecho		
	66 Altura a los nudillos		931 Circunferencia de la cintura		
	265 Altura al dedo medio		68 Circunferencia del brazo		
	797 Ancho de brazos extendidos lateralmente		178 Circunferencia de la cadera		
	798 Ancho de codos con las manos al centro del pecho		69 Circunferencia de la pantorrilla		
	80 Distancia de la pared al dedo medio		144 Distancia de oído a oído sobre la cabeza		

	752 Distancia de la pared al nudillo		165 Ancho de la cara a la altura de las patillas		
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Elaboró: GF y SM

Figure 1. Codes used, their description, and the individual's position.

	427 Ancho de la cabeza		912 Altura del asiento a los nudillos con los brazos extendidos hacia arriba	
		595 Altura de la barbilla a la parte superior de la cabeza 441 Longitud de la cabeza		
	420 Longitud de la mano		2fgm Altura desde el suelo a la cabeza (sentado)	
	656 Longitud de la palma de la mano		4fgm Altura desde el suelo al asiento	
	411 Ancho de la palma de la mano		529 Altura desde el suelo a la rodilla (sentado)	
	859 Ancho de muslos con las rodillas juntas (sentado)		678 Altura desde el suelo a la parte posterior de la rodilla (sentado)	
	758 Altura del asiento a la cabeza		70 Longitud desde el codo al dedo medio	
	330 Altura del asiento al ojo		507 Ancho de la espalda con los brazos extendidos hacia el frente	
	25 Altura del asiento al hombro		459 Ancho de la cadera (sentado)	

	312 Altura del asiento al codo a 90°		775 Longitud del pie		
	856 Altura al muslo		776 Alto del pie		
	914 Altura del asiento al dedo medio con brazos extendidos hacia arriba		777 Ancho del pie		

Elaboró: GF y SM

Figure 2. Codes used, their description, and the individual's position.

RESULTS

Six anthropometric data were obtained from a sample of 227 students, for women and men, for three group of ages from 17 to 20, from 21 to 23 and from 24 to 54 years old.

Hereby are presented two anthropometric surveys where body dimensions are described, measurements are in centimeters and weight is shown in kilograms for 5th, 50th and 95th percentiles of a women's sample (figure 3) and for a masculine sample (figure 4), both, from 17 to 20 years old. In figure 5 data shows a sample size of 227 masculine and feminine students by age range and sex.

<i>Measurement's Description</i>	5%	50%	95%	<i>Measurement's Description</i>	5%	50%	95%
Weight	37.17	66.6	96.02	Length of head	17.042	19.241	21.441
Stature	151.77	165.54	179.3	Length of hand	15.828	17.594	19.36
				Length of palm of hand	7.831	9.8366	11.842
Height standing				Width of palm of hand	4.5519	7.8598	11.168
Eye	139.97	153.73	167.5	Diameter of grabs (interior)	36.064	45.146	54.228
Shoulder	123.24	136.02	148.8				
Elbow	86.196	107.4	128.6	Heights sitting			
Waist	91.871	101.94	112	Height to head from seat	71.443	85.524	99.605
Buttock	65.34	74.432	83.52	Height to eye from seat	67.182	75.012	82.842
Wrist	53.194	82.124	111.1	Height to shoulder from seat	50.45	59.456	68.462
Middle finger	54.842	63.695	72.55	Height to elbow from seat, 90 degrees	20.364	24.951	29.538
Width of extended arms	151.27	166.63	182	Height to thigh from seat	10.891	14.046	17.202
Width of elbows to the center of chest	70.412	85.588	100.8	Height to Middle finger from seat, arms up	117.5	129.26	141.01
Length of arm extended from the wall	64.072	81.687	99.3	Height to center of fist, arms up	100.41	122.3	144.2
Length to the center of the fist from the wall	51.492	73.712	95.93	Height to head from floor sitting	121.12	131.11	141.1
Width of shoulders standing	34.828	42.038	49.25	Hight to seat from floor sitting	23.215	49.154	75.092
Width of chest standing	24.719	30.34	35.96	Popliteal to buttocks	39.537	47.641	55.746
Width of hips standing	26.245	33.701	41.16	Length from knees to buttocks	48.308	59.027	69.745
Circumferencia of neck standing	23.618	35.539	47.46	Height from floor to popliteal	35.818	43.388	50.958
Circumferencia fo chest standing	73.352	90.66	108	Height from floor to knee	40.054	52.266	64.477
Circumferencia of waist standing	55.12	79.619	104.1	Length from elbow to middle finger	40.634	44.907	49.18
Circumference of hips standing	81.893	99.361	116.8	Width of back with arms extended forward –forward reach	34.85	40.587	46.323
Circumference of head	46.695	54.395	62.1	Width of hips, sitting	32.447	38.468	44.489
Distance from ear to ear over head	26.672	34.971	43.27	Width of thighs with knees meeting	30.701	37.212	43.723
Width of face to the height of sideburns	11.977	13.563	15.15	Length of foot	21.381	24.137	26.892
Width of head	13.645	14.973	16.3	Width of foot	6.4972	8.4366	10.376
Height of chin to superior part of head	18.517	22.146	25.78	Height of instep	4.3354	6.2829	8.2305

Figure 3. Body dimensions for a feminine sample from 17 to 20 years old.

<i>Measurement's description</i>	5%	50%	95%	<i>Measurement's description</i>	5%	50%	95%
Weight	42.488	71.49375	100.49	Length of head	16.075	19.574	23.073
Stature	159.93	171.5791	183.23	Length of hand	15.673	18.054	20.435
				Length of palm of hand	8.6763	10.373	12.07
Height standing				Width of palm of hand	6.6558	8.1094	9.5629
Eye	146.22	158.5875	170.955	Diameter of grabs (interior)	41.309	47.465	53.621
Shoulder	130.06	141.2395	152.41				
Elbow	92.509	109.3958	126.28	Heights sitting			
Waist	95.292	105.0958	114.9	Height to head from seat	68.123	86.91	105.7
Buttock	54.349	79.39791	104.44	Height to eye from seat	67.85	77.194	86.538
Wrist	59.077	85.08333	111.08	Height to shoulder from seat	51.535	61.767	71.998
Middle finger	57.349	65.675	74.000	Height to elbow from seat, 90 degrees	20.315	25.654	30.993
Width of extended arms	160.06	173.7833	187.50	Height to thigh from seat	11.199	14.198	17.196
Width of elbows to the center of chest	80.408	88.92812	97.448	Height to Middle finger from seat, arms up	123.05	135.74	148.43
Length of arm extended from the wall	74.883	84.65416	94.425	Height to center of fist, arms up	113.39	126.16	138.93
Length to the center of the fist from the wall	65.872	74.74166	83.6111	Height to head from floor sitting	122.9	132.74	142.57
Width of shoulders standing	35.141	44.8	54.458	Height to seat from floor sitting	25.36	49.129	72.899
Width of chest standing	26.262	31.33333	36.4043	Popliteal to buttocks	41.01	48.425	55.84
Width of hips standing	29.324	35.1	40.876	Length from knees to buttocks	51.866	59.494	67.121
Circumferencia of neck standing	18.107	38.59791	59.088	Height from floor to popliteal	37.174	43.798	50.422
Circumferencia fo chest standing	75.157	92.11041	109.06	Height from floor to knee	45.236	52.631	60.026
Circumferencia of waist standing	62.925	84.41458	105.90	Length from elbow to middle finger	40.184	46.278	52.372
Circumference of hips standing	81.922	97.05833	112.19	Width of back with arms extended forward –forward reach	38.252	43.581	48.911
Circumference of head	46.276	56.28666	66.297	Width of hips, sitting	31.955	38.346	44.737
Distance from ear to ear over head	25.215	35.57708	45.939	Width of thighs with knees meeting	29.586	36.777	43.969
Width of face to the height of sideburns	12.364	14.04375	15.723	Length of foot	22.467	25.502	28.537
Width of head	13.581	15.52604	17.471	Width of foot	6.2461	8.6625	11.079
Height of chin to superior part of head	19.43	22.74375	26.057	Height of instep	4.812	6.5781	8.3443

Figure 4. Body dimensions of a masculine sample from 17 to 20 years old.

Estratum by age	Masculine	Feminine
17-20	48	41
21-23	85	47
24-54	3	3
TOTALS	136	91

Figure 5. Sample size, grouped by age and sex of students of the Universidad de Sonora.

CONCLUSIONS AND SUGGESTIONS

Ergonomics emerged exclusively to increase worker's productivity, with time, it has become into a multidiscipline, it looks forward to make tools more functional and spaces habitable, to improve aspects like the men's safe, comfort and health.

At present times, muscular – skeletal problems are often found in workers, "in such situations applied Ergonomics is useful because it improves adaptability of physical persons' limitations to environmental conditions and to work tools, avoiding the development of pathologies like tendinitis, cervical and lumbar injuries, among others."

Products, tools, machines, work places and furniture should be designed thinking of the activity or activities that people will carry out on them. A work place can have more than one worker and its design should be adjustable, that is why sometimes, it is necessary to build products of several sizes in such a way that someone would have the possibility to choose the one that better adapts to the user's necessities, the other one, would be to create products that are adjustable in a certain range of body dimensions, making necessary to know the benefits and costs in such a way that decisions that are taken are the correct ones.

As it can be seen, everything that is manufactured, elaborated to interrelate with man should use their dimensions, it is necessary to know human anthropometry.

The anthropometric data gathered in this research is one more effort added to those that were made previously in Mexico. Body dimensions of students of the University of Sonora, in Hermosillo, Sonora, Mexico includes male and female from 17 to 20, 21 and from 23 to 24 years old and older students; natives and non natives from Hermosillo. These sample is build of 60.87% men and 39.83% women, 100% belong to the North Pacific area and 93.52% were born in the state of Sonora.

Suggestions that can be made are: to invite researchers, education institutions and companies to develop anthropometric data of Mexican populations, aiming to design production systems that will fulfill their main goals: to increase productivity and to produce high product quality, optimizing workers' safe and comfort at the same time, so that they would allow them to compete in today's global business.

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