

A study of automotive workers anthropometric physical characteristics from Mexico Northwest

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Abstract. Due to the lack of anthropometric information in northwest Mexico, we did an anthropometric study that represents the population physical characteristics and that is reliable for the design or redesign of workstations. The study was divided in two phases. The first one was the anthropometric study of 2900 automotive industry workers in northwest of Mexico. The study includes 40 body dimensions of 2345 males and 555 females personalized to be used in future researches. Second phase includes compared anthropometric characteristics of population reported in four Mexican studies and a Colombian study against the current study. Benefits of this project are: a reliable database of anthropometric characteristic of automotive industry population for workstations design or redesign that match with the users, increase product quality and reduce economic, medical and union complains.

Keywords: Work design; workstation design; populations comparison

1. Introduction

The main tool for designers of workplaces is anthropometric data which provide information on critical body dimension, unfortunately, in Mexico there are a few anthropometric studies and are too regionalized, the sample size is too small and only provide information for men or women. This is the case in Avila et al [1] presented a study at Guadalajara, Mexico metropolitan area. Lavander et al [2] presents a study of 21 anthropometric measures on 87 female workers in maquiladora industry in the Mexico - U.S.A. border. Liu et al [3] presents a study of only 12 anthropometric measures on 110 female workers in the maquiladora industry in the Mexico - U.S.A. border. These last two studies were conducted in Mexico northeast zone.

This paper presents results of 40 anthropometric measurements of automotive industry workers, males and females. These data are compared with anthropometric characteristics of some population

reported in Guadalajara, Leon Guanajuato, Mexico City and Colombia.

2. Methods

2.1. Subjects

The mean age and standard deviation were 30.24 and 7.04 year for female and 33.51 and 8.19 year for male respectively. The mean and standard deviation of the weight of the participants were 81.21 Kg and 12.24 Kg for male and 69.52 Kg and 11.73 Kg for female res respectively. The sample presented in the present study seems to be representative of the employees of the automotive industry at northwest of Mexico

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2.2. Apparatus

Standard tools for anthropometric measurement, including calipers and anthropometers, were used for length and breadth measurements of various body segments. A graduated cone was used to measure the grip diameter of the dominant hand. Maximum grip strength was measured using a hand dynamometer with the handle width set to 5 cm. Weight was measured using a physician's scale. Circumferences were measured with a plastic tape graduated in millimeters.

2.3. Procedures

2,345 male and 555 female operators were selected to participate in the survey. All were employees at an automotive industry facility in Mexico northwest. Thus, sample was limited to a regional population segment. All employees were measured wearing work clothes and safety shoes, where measurements were made on the right side of the body. Data were obtained for each of the measures defined in Table I. Where dimensions measured were consistent with those summarized by NASA [4]. Test statistics were conducted with Minitab®.

3. Results

Table 1 summarizes the anthropometric characteristics of the sample by gender. The mean and standard deviation of stature from this sample were 173.47 cm and 6.52 cm for male and 163.29 cm and 5.87 cm for female respectively with shoes on. Table 2 also provides the values of each body dimension at the 5th, 50th and 95th percentile.

3.1 Comparison with other populations

By making a comparison of data from current study with data from other populations, with the subject standing, it shows that there is a significant difference among data. Tables 2 and Table 3 show the data used to make comparisons between different populations

4. Discussion

This paper presents 40 measures anthropometric essentials for the design of workstations, tools, clothing or personal protective equipment. Based on the results of the comparisons with other studies with populations of Mexico, we can conclude that workers in northwestern Mexico are higher and the fact that measures have been taken with no shoes affects the comparison with other studies. Finally, the range and average age of this study, 18 to 61 years and 32.89 years is similar to other studies presented here.

References

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Table 1
Anthropometric characteristics

	MALE				FEMALE			
	average	std dv	5%	95%	average	std dv	5%	95%
Stature	173.47	6.52	162.84	184.00	163.29	5.87	153.94	172.50
Eye height	162.58	6.50	152.50	173.30	151.86	5.68	142.50	160.50
Shoulder height	144.75	6.39	135.70	154.10	135.79	5.21	127.57	144.06
Elbow height	111.69	4.80	104.30	119.50	105.23	4.97	98.50	112.40
Waist height	104.29	5.84	95.00	114.00	99.01	5.77	89.50	108.23
Buttocks height	78.50	4.39	71.50	85.60	74.46	3.93	68.04	80.83
Height to the wrist	86.20	4.49	79.60	93.30	81.94	4.12	75.27	88.23
Middle finger height	67.57	3.76	61.70	73.70	64.66	3.47	59.57	70.13
Span	176.46	7.13	164.70	188.48	161.89	6.50	151.57	172.00
Elbows width with the hands on the center chest.	82.68	7.86	71.20	94.60	75.40	7.24	64.77	86.30
Arm reach from wall	87.60	4.26	80.72	94.68	81.05	3.93	75.14	87.60

Table 1. Continuation.

	MALE				FEMALE			
	average	std dv	5%	95%	average	std dv	5%	95%
Arm reach from wall with closed hand	77.96	4.05	71.60	84.60	72.11	3.80	66.10	78.10
Chest circumference	102.76	8.35	90.00	117.16	96.49	7.13	86.00	108.00
Waist circumference	96.05	9.65	81.00	112.96	88.99	11.09	72.00	109.00
Buttock circumference	103.56	6.75	93.00	115.00	104.96	8.34	93.00	120.00
Hand length	18.82	0.88	17.40	20.20	17.48	0.79	16.20	18.80
Palm length	10.77	0.66	9.80	11.70	10.00	0.56	9.10	11.00
Hand breadth	8.79	0.50	8.00	9.60	7.81	0.51	7.10	8.70
Grip diameter	48.11	3.87	42.00	54.00	45.62	3.63	40.00	52.00
Sitting height	89.58	3.21	84.30	94.80	85.26	3.08	80.07	90.23
Eye height	78.77	3.65	72.80	84.70	73.92	3.21	68.94	78.90
Shoulder height	61.27	3.32	56.20	66.58	58.27	2.84	54.00	63.06
Elbow rest height	26.55	2.96	21.62	31.20	26.77	2.77	22.10	31.30
Thigh clearance height	15.09	1.79	12.40	18.10	14.76	2.10	11.50	18.20
Vertical arm reach from seat	134.21	5.32	125.60	143.00	124.96	4.49	117.47	132.30

Table 1. Continuation

	MALE				FEMALE			
	average	std dv	5%	95%	average	std dv	5%	95%
Vertical arm reach from seat with closed hand	124.20	5.07	115.92	132.48	115.84	4.29	108.87	122.80
Sitting height	132.28	4.33	125.30	139.50	125.77	4.43	118.20	132.63
Seat height	42.32	2.40	38.40	46.28	40.37	2.69	36.00	44.50
Buttock to popliteal length seated	47.94	3.23	43.00	53.20	47.34	3.25	42.50	52.46
Buttock knee length seated	59.41	3.61	53.82	65.10	57.60	3.51	52.07	63.43
Popliteal height	44.31	3.10	39.60	49.78	42.68	2.74	38.47	46.76
Knee height	53.74	3.10	48.82	58.88	51.31	2.89	47.00	55.73
Forearm and hand length	46.96	2.21	43.50	50.50	43.13	2.39	40.10	46.40
Shoulders breadth	43.77	2.71	39.50	48.30	39.31	2.30	35.70	43.50
Hips breadth	36.77	2.84	32.40	41.40	39.04	3.61	33.60	45.00
Thigh breadth	32.82	3.24	27.90	38.10	35.10	4.37	28.27	42.10
Vertical arm reach with closed hand	214.77	9.80	199.12	232.00	196.66	8.36	184.00	211.00
Vertical arm reach	110.49	10.17	94.80	126.00	97.68	8.18	86.57	112.30
Hand force	46.03	7.88	32.00	58.04	27.50	8.16	12.00	39.00

Table 2. Comparison among male in the current study with other populations

Dimension	STANDING					SITTING			
	current study n=2,345	Colombia Estrada n=487	Guadalajara Avila n=396	Leon Avila n=509	Mexico city, Avila n=974	current study n=2,345	Colombia Estrada n=487	Guadalajara Avila n=396	Leon Avila n=509
stature	Media 173.47	170.1	167.5	164.37	164.758	89.58	89	87.6	85.59
	SE 6.52	6.52	6.28	6.03	5.644	3.21	3.31	3.117	1.22
Eye height	Media 162.58	159.1	155	152.73	154.75	78.77	78.6		74
	SE 6.5	6.36	6.18	5.91	5.873	3.65	3.31		3.17
Shoulder Height	Media 144.75	138.6	138	135.92	137.269	61.27	58.8	58.1	57.15
	SE 6.39	5.72	5.849	5.52	5.634	3.32	2.78	2.763	2.85
Elbow Height	Media 111.69	107	106.8	101.06	103.119	26.55	23.6	24.6	22.22
	SE 4.8	8.7	5.502	4.59	4.951	2.96	2.42	2.836	3.02

Table 3. Comparison among female in the current study with other populations

Dimension	STANDING					SITTING		
	Current Study n=555	Colombia, Estrada n=233	Guadalajara, Avila n=204	Lavander n=87	Liu n=110	Current Study n=555	Colombia, Estrada n=233	Guadalajara, Avila n=204
stature	Media 163.29	156.9	156.7	156.3	153.5	85.26	83.7	83.2
	SE 5.87	5.8	5.292	5.2	5.5	3.08	2.8	2.742
Eye height	Media 151.86	146.3	144.9	145.1	142.8	73.92	73.4	
	SE 5.68	5.665	5.242	4.9	5.6	3.21	2.82	
Shoulder Height	Media 135.79	128	129.1	129.5		58.27	55.4	55.1
	SE 5.21	5.05	4.917	4.7		2.84	2.3	2.295
Elbow Height	Media 105.23	98.9	100.4	97.2	95.6	26.77	23.3	25
	SE 4.97	4.04	3.889	4.1	3.8	2.77	2.06	1.52