Anthropometric Measurements of Garment Manufacturing Workers of Tirupur, Tamilnadu

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ABSTRACT

Anthropometric data are used for proper design of workstation, equipment, furniture and many more in order to decrease awkward postures and stresses on human body due to improper design. Mismatch between anthropometric dimensions and consumer products may cause health problems such as musculoskeletal disorders, concentration deficit, and similar problems. Anthropometric data were collected from 50 male and 50 female stitching machine operators aged 18-50 years employed in garment manufacturing units. Mean and standard deviation age of the male workers were 29.8±7.9 years and female 29±8.1 years. Twelve anthropometric measurements for sitting posture were recorded. Body dimensions such as sitting height, eye height, mid-shoulder height, elbow rest height, upper lumbar, lower lumbar and popliteal height between both genders were found to be highly significant. All the body dimensions were found to be highly correlated with age of the workers except for lower lumbar and hip breadth as non significant. The anthropometry data of the present study was compared with studies carried out by Gite et al. (2009), Parimalam et al. (2007) and Kabir and Ahmed (2003). It was found to be significant for majority of the parameters.

Key words: Anthropometric measurements, ergonomic design, stitching machine operators

INTRODUCTION

Nowadays it is generally known that awkward and constrained postures result in musculoskeletal stress on the head/neck and trunk of seated operators. Ariens et al. (2000) [1] ascertained that a positive relationship between neck pain and the following work-related risk factors exists: neck flexion, arm force, arm posture, duration of sitting, twisting or bending of the trunk, hand-arm vibration, and workstation design. Moreover, numerous previous studies report about consideration musculoskeletal problems due to the static postures of sewing machine operators, which have to be maintained during the whole working period, as well as those due to the highly repetitive manual tasks performed [2], [3], [4].

The sewing operation is characterized by a static sitting posture, a forward inclined posture of the head and trunk and relatively uncomfortable ankle and knee angles. The sewing table includes simultaneous hand and arm movements, and the continuous operation of foot pedals. Therefore, the working posture is constrained by the eyes for visual control of the work, the hands for directing the sewing material, and the feet for speedy control of the work.

Poor posture of the trunk, neck and upper extremities, and the monotonous repetitive

movements result in a high prevalence of musculoskeletal complaints affecting the backs, necks and upper extremities among sewing machine operators [5]. According to [6], workers in the garment industry have higher rates of upper extremity work-related musculoskeletal disorders than those in many other industries. Similar findings, indicating that workers in machine sewing tasks have a much higher prevalence of persistent pain than hospital employees [3] and office workers [4] have been reported previously.

The solution for the above mentioned health problems would be ergonomically designed sewing workstation by taking anthropometric measurements of the workers. Three major factors must be then considered in specifying the dimensions of a workstation or design which causes variability in body size i.e., sex, age and race or ethnicity. The present study thus focuses anthropometric measurements of garment manufacturing workers.

OBJECTIVES

The main objectives of the study were to:

- determine anthropometric dimensions of male and female stitching workers for proper workstation design
- compare with other published data for other population

MATERIALS AND METHODS

The present study was taken up in Tirupur which is the seventh largest city in Tamil Nadu, India and is one of the fastest developing city in the State. Popularly referred as Dollar city or small Japan or T-Shirt city or Banian city, it excels in knitted ready-made garments [7]. The survey of workers in 13 garment industries of large, medium and small scale located in and around Tirupur were already completed. Anthropometric data were collected from surveyed workers (only workers from stitching section) who were willing to participate. Hence 50 male and 50 female stitching machine operators were considered for the study (Fig 1). All subjects were requested to wear light clothing without foot wears. For sitting dimensions, subjects

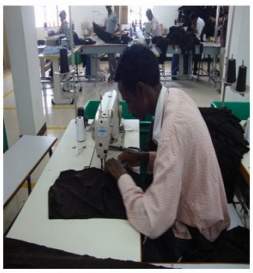

Fig 1a

Fig 1b.

Fig 1c

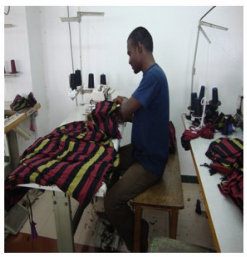

Fig 1d

Fig 1 (a-d): Stitching machine operators using conventional chair

were requested to sit erect on a chair without armrests, with knees bent 90^0, and feet flat on the surface, facing forward, and arms hanging beside the body [8]. All the measurements of each subject were taken thrice. The data was analyzed statistically using Statistical Package for the Social Sciences (SPSS) for Windows version 16.0. All the data were processed separately male and female garment workers, and descriptive values, 5^{th}, 50^{th} and 95^{th} percentile values, mean, median, mode, standard deviation and range were calculated.

RESULTS AND DISCUSSION

In the present study, 12 anthropometric dimensions of human body in the sitting posture were identified, and hence become the target anthropometric dimensions that would be measured for the ergonomic chair for stitching machine operators. The definition of anthropometric dimensions required for the present study is shown in Table 1.

Table 1: Definition of anthropometric data

Sl.No.	Anthropometric dimensions	Definition
1	Sitting height	This is the vertical distance between the seat surface and the top of the head with subject sitting erect, looking straight ahead, and knee at the right angles.
2	Sitting eye height	The vertical distance from the seat surface to the outer corner of the right eye.
3	Sitting shoulder height	The vertical distance from the seat surface to the tip (acromion) of the shoulder.
4	Elbow rest height	The vertical distance from the sitting surface to the lowest point of the right elbow, with the elbow flexed at 90 degrees.
5	Upper lumbar	The vertical distance between the first lumbar region to sitting surface with subject sitting erect.
6	Lower lumbar	The vertical distance between the sitting surface and the 5^{th} lumbar landmark with subject sitting erect.
7	Thigh clearance	The vertical distance from the sitting surface to the highest point on the top of the right thigh, with the knee flexed at 90 degrees.
8	Sitting popliteal height	The vertical distance from the floor to the underside of the thigh directly behind the right knee with the knees flexed at 90 degrees.
9	Sitting buttock popliteal height	The horizontal distance from the back of the buttocks to back of the right knee just below the thigh, when sitting with the knee flexed at 90 degrees.
10	Buttock knee length	The horizontal distance from the most posterior aspect of the right buttock to the most anterior aspect of right knee.
11	Thigh to thigh length	The maximum horizontal distance across the thighs, knees touching lightly to each other with subject sitting erect, thighs parallel and completely supported by the sitting surface.
12	Hip breadth	The maximal horizontal breadth across the hips or thighs, whatever is greater.

Anthropometric data were collected from 50 male and 50 female stitching machine operators aged 18-50 years employed in garment manufacturing units. Mean and standard deviation age of the male workers were 29.8±7.9 years and female of 29±8.1 years. Twelve anthropometric measurements for sitting posture were recorded. Table 2 shows the anthropometric measurements for sitting position of male and female stitching workers.

Table 2 : Anthropometric measurements for sitting male and female garment workers

mm	Male (N=50)									Female (N=50)									
	Mean	Median	Mode	SD	Min	Max	5th	50th	95th	Mean	Median	Mode	SD	Min	Max	5th	50th	95th	p value
1	[redacted] 849.64	852	875	48.68	749	953	761.5	852.0	926.8	793	780	764	42.06	734	911	745.45	780	871.3	≤0.01
2	[redacted] 757.1	754	853	53.51	662	884	686.4	754.0	859.1	683.76	676.5	684	38.22	604	823	642.9	676.5	754.2	≤0.01
3	[redacted] 562.48	566.5	564	41.56	454	656	501.9	566.5	628.0	523.54	527	544	34.51	451	596	475.25	527	586.2	≤0.01
4	[redacted] 250.9	248	244	29.16	201	318	204.0	248.0	297.9	227.82	230	214	25.37	181	283	192.45	230	265.1	≤0.01
5	[redacted] 336.94	333	383	42.33	261	453	276.0	333.0	404.5	305.26	303	294	37.08	222	383	244	303	371.35	≤0.01
6	[redacted] 231.54	235.5	164	47.05	143	338	162.4	235.5	302.7	204.56	215	224	36.90	114	258	130.7	215	251.3	≤0.01
7	[redacted] 169.5	169	174	35.20	119	249	126.9	169.0	221.3	171.06	173	174	24.88	116	234	129.9	173	206.55	NS
8	[redacted] 436.44	432.5	421	32.02	344	528	391.5	432.5	482.7	413.28	409	404	24.48	356	463	383.45	409	452	≤0.01
9	441.82	443.5	454	30.86	369	514	397.5	443.5	489.3	442.42	443.5	449	30.32	391	533	396	443.5	487.95	NS
10	539.16	535	546	28.30	465	606	504.9	535.0	587.5	536.98	542	552	32.07	471	606	479.15	542	584.1	NS
11	423.58	408.5	494	50.59	352	528	360.8	408.5	509.5	426.9	444	434	60.21	316	524	331.25	444	506.2	NS
12	455	443	541	51.35	379	559	389.5	443.0	541.0	459.28	472	469	60.62	343	555	362.95	472	543.55	NS

Dimension (mm):

1: Sitting height, 2: Sitting eye height, 3: Sitting shoulder height, 4: Elbow rest height, 5: Upper lumbar, 6: Lower lumbar, 7: Thigh clearance, 8: Sitting popliteal height, 9: Sitting buttock popliteal height, 10: Buttock knee length, 11: Thigh to thigh length, 12: Hip breadth

If $P = 0.05$, significant at 5%
If $P = 0.01$, significant at 1%
If $P > 0.05$, Non significant

It was found that for sitting height, sitting eye height, sitting shoulder height, elbow rest height, upper lumbar, lower lumbar, and sitting popliteal height were highly significant at one percent level of significance.The present mean values of anthropometric data were compared with [9], [10], [11]. Table 3 and 4 present the comparison of present study male worker's and female worker's anthro pometric data with earlier research studies.

Table 3 : Comparison of present study male worker's anthropometric data with earlier research studies

Anthropometric measurements	Present study Male (N=50)		Gite et al. (2009) Male (N=1000)		't' value	Present study Male (N=50)		Kabir and Ahmed (2003) Male (N=11)		't' value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Sitting height	849.64	48.68	781	83	**9.66****	849.64	48.68	834.8	98.72	**0.49**^{NS}
Sitting eye height	757.1	53.51	670	79	**10.93****	757.1	53.51	-	-	-
Sitting shoulder height	562.48	41.56	561	79	**0.23**^{NS}	562.48	41.56	-	-	-
Elbow rest height	250.9	29.16	201	25	**11.88****	250.9	29.16	247.1	27.89	**0.41**^{NS}
Upper lumbar	336.94	42.33	-	-	-	336.94	42.33	-	-	-
Lower lumbar	231.54	47.05	-	-	-	231.54	47.05	-	-	-
Thigh clearance	169.5	35.20	117	17	**10.48****	169.5	35.20	115.5	12.60	**8.62****
Sitting popliteal height	436.44	32.02	422	24	**3.14****	436.44	32.02	438.8	51.44	**0.15**^{NS}
Sitting buttock popliteal length	441.82	30.86	-	-	-	441.82	30.86	419.1	48.42	**1.49**^{NS}
Buttock knee length	539.16	28.30	540	26	**0.21**^{NS}	539.16	28.30	517.3	60.29	**1.17**^{NS}
Thigh to thigh length	423.58	50.59	-	-	-	423.58	50.59	-	-	-
Hip breadth	455.88	51.35	300	31	**21.27****	455.88	51.35	-	-	-

* (5%) = Significant
** (1%) = High significant
NS = Non-Significant

Table 4: Comparison of present study female worker's anthropometric data with earlier research studies

Anthropometric measurements	Present study Female (N=50)		Gite et al. (2009) Female (N=587)		't' value	Present study Female (N=50)		Parimalam et al. (2007) Female (N=216)		't' value	Present study Female (N=50)		Kabir and Ahmed (2003) Female (N=11)		't' value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Sitting height	793	42.06	754	63	**5.29****	793	42.06	738	30	**7.66****	793	42.06	770.1	90.90	**0.81**^{NS}
Sitting eye height	683.76	38.22	638	58	**5.77****	683.76	38.22	675	30	**1.12**^{NS}	683.76	38.22	-	-	-
Sitting shoulder height	523.54	34.51	521	67	**0.39**^{NS}	523.54	34.51	522	28	**0.25**^{NS}	523.54	34.51	-	-	-
Elbow rest height	227.82	25.37	187	21	**9.69****	227.82	25.37	172	23	**12.66****	227.82	25.37	222.9	24.54	**0.58**^{NS}
Upper lumbar	305.26	37.08	-	-	-	305.26	37.08	-	-	-	305.26	37.08	-	-	-
Lower lumbar	204.56	36.90	-	-	-	204.56	36.90	111	13	**13.94****	204.56	36.90	-	-	-
Thigh clearance	171.06	24.88	110	16	**12.16****	171.06	24.88	141	23	**5.76****	171.06	24.88	134.0	14.98	**5.51****
Sitting popliteal height	413.28	24.48	394	28	**4.13****	413.28	24.48	363	21	**10.59****	413.28	24.48	412.2	48.38	**0.07**^{NS}
Sitting buttock popliteal length	442.42	30.32	-	-	-	442.42	30.32	441	25	**0.30**^{NS}	442.42	30.32	397.2	45.51	**3.14****
Buttock knee length	536.98	32.07	525	27	**2.88****	536.98	32.07	534	27	**0.68**^{NS}	536.98	32.07	474.6	55.02	**3.66****
Thigh to thigh length	426.9	60.21	-	-	-	426.9	60.21	-	-	-	426.9	60.21	-	-	-
Hip breadth	459.28	60.62	286	24	**23.64****	459.28	60.62	230	41	**29.47****	459.28	60.62	-	-	-

* (5%) = Significant
** (1%) = High significant
NS = Non-Significant

It was observed from the table- 3 that a significant difference between the mean values at one per cent level was found in the present study and Gite et al. (2009) [9] with respect to the anthropometric measurements of male workers such as sitting height, sitting eye height, elbow rest height, thigh clearance, sitting popliteal height and hip breadth but only thigh clearance was found highly significant between present study and Kabir and Ahmed (2003) [11].

From the table 4, it is evident that a significant difference between the mean values at one per cent level was found in the present study and Gite et al. (2009) [9] with respect to the anthropometric measurements of female workers such as sitting height, sitting eye height, elbow rest height, thigh clearance, sitting popliteal height, buttock knee length and hip breadth. Also observed that when present study and Parimalam et al. (2007) [10] were compared, a significant difference between the mean values at one per cent level was found with respect to the anthropometric measurements such as sitting height, elbow rest height, lower lumbar, thigh clearance, sitting popliteal height and hip breadth. A significant difference between the mean values at one per cent level was found in the present study and Kabir and Ahmed (2003) [11] with respect to the anthropometric measurements namely thigh clearance, sitting buttock popliteal length and buttock knee length respectively.

CONCLUSION

There are significant differences in the anthropometric data of male and female garment workers among different studies, so it is justified to take anthropometric dimensions for each group.

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