

DATA FOR DESIGNING HAND TOOLS FOR FEMALE CRAFT WORKERS

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ABSTRACT

This paper reviews the anthropometric and strength data collected on women which can be used to redesign tools to permit the female workers to successfully function in the craft areas. Data was collected on women currently working in the craft areas for a large United States corporation. The workers were located at facilities in three major cities. The geographic dispersion of these cities help assure a balance in any regional variations in ethnic groups.

The data from this study was compared to data from other studies and it was found that the female craft technicians measured in this study were substantially different than the women measured in the other studies. The craft technicians were taller and stronger than the comparison groups.

INTRODUCTION

Anthropometric and strength data were collected on female craft technicians of a major United States corporation to use in redesigning tools. Measurements taken included: stature, overhead reach height, forward reach, leg lift, torso lift, arm lift, overhead push strength, arm strength with arm abducted from the body approximately 75°, grip span and grip strength. Since the measurements were taken in several locations in the country, a test apparatus was constructed to hold a plastic scale to measure the anthropometric variables and to provide attachment points for the force transducers used in the strength measurements.

THE MEASUREMENTS

Stature And The Reaches

The stature of the subjects and the reaches were determined by having the subject enter the metal support box and place her shoulders against a metal bar perpendicular to the plastic sheet with the scale on it. One of the experimenters than measured the stature and gave the subject a felt tip pen. The subject was instructed to keep her shoulder blades against the metal frame and to reach as high above her head as she could and make a mark on the plastic. Following this measurement, the subject was instructed to rotate her arm to a horizontal position and with both of her shoulder blades against the metal frame, to reach as far forward as possible and mark the plastic. Then the subject was instructed that she could move her right shoulder blade from the metal frame but had to keep her left shoulder blade against the metal while she attempted to extend her reach as far as possible.

Arm Strength

Two measures of arm strength were made. The first, called push strength, was made with the hand over-head and the arm extended at approximately 45° from the horizontal position. The second, called arm strength, was measured with the arm abducted approximately 75° from the side of the body. Both positions were selected from positions commonly found in the work performed.

Grip Span and Strength

Grip span was measured by a anthropometer such that the second joint of the index finger could flex around the edge of the device. Grip strength was measured in four different configurations. The four configurations were combinations of dynamometer arrangement and position of the arm. The grip of the dynamometer was set-up such that: (1) the two parts of the handle were parallel or (2) the back portion of the handle formed an angle of approximately 20° with the front portion. The lower arm was positioned either horizontal or vertical with the angle at the elbow of 90°.

Lifting Strengths

Lifting strength measurements were made using procedures developed by Chaffin, Herrin, Keyserling and Foulke (1977). The subjects lifted either a 15" x 7" or a 8" x 7" metal frame attached to the bottom of the support box by means of a chain and load cell. Three positions were used: (1) the arm lift where the force was created by the arms and the legs and back were straight, (2) the torso lift where the force was created by attempting to straighten the back with the arms and legs straight and (3) the leg lift where the force was created by attempting to straighten the legs with the arms and back straight. The smaller frame was used in the leg lift and the larger

frame in the other two lifts.

THE SUBJECTS

The subjects were 96 women employed as craft technicians. The duration of employment in this capacity ranged from trainee level to three years. All subjects were volunteers and were paid by the company to participate in this study.

THE DATA

The data collected is summarized in Table 1. When the stature data was compared with data collected by Clauser, Tucker, McConville, Churchill Laubach and Reardon (1972) on Air Force women, there was a difference of approximately two inches in the mean height. The Air Force women worked primarily in the clerical and medical areas. A comparison of the lifting strengths in this study with the data collected by Chaffin, Herrin, Keyserling and Foulke (1977) shows that there was a significant difference between the female workers measured in the two studies. The differences for the arm, leg and torso lifting strengths were 5.0, 35.7 and 33.8 pounds respectively. For the leg and torso lifting strength the women measured in this study demonstrated lifting strengths that were 38 to 56% greater than the Chaffin study. The reason for this difference cannot be stated, since no difference was expected and the study was not designed to investigate for possible differences in the characteristics of the two groups.

A clear result of this study is the reminder that data gathered on a population of workers will not necessarily describe other groups. In neither group compared with the female craft technicians is there any obvious reasons to think there would be significant differences. In fact, a priori the female workers in Chaffin's study would be expected to be stronger, since lifting is important to their work.

TABLE 1

A Summary Of The Data Collected
On Female Craft Technicians

	Percentile Categories					SD
	5 th	10 th	50 th	90 th	95 th	
Stature (in.)	61.9	62.8	65.6	68.6	70.1	2.5
Overhead Reach (in.)	74.4	75.1	79.1	83.3	85.0	3.3
Clenched Hand Reach (in.)	24.8	25.6	27.9	31.0	31.9	2.0
Clenched Hand						
Reach, Extended (in.)	29.1	29.5	31.7	34.4	35.5	1.9
Arm Strength (lbs.)	7.2	8.2	12.8	18.5	21.0	4.9
Overhead Push						
Strength (lbs.)	39.0	45.7	72.7	109.7	117.7	25.5
Grip Span (in.)	2.4	6.3	6.7	7.8	7.9	0.23
Grip Strength (lbs.):						
Parallel Handles - Forearm Horizontal	58.8	61.5	74.6	97.3	104.0	14.3
Parallel Handles - Forearm Vertical	56.5	63.5	79.3	99.0	106.0	14.4
20° Handle Angle - Forearm Horizontal	54.5	57.5	69.1	89.0	94.0	12.4
20° Handle Angle - Forearm Vertical	54.6	57.5	69.8	90.0	95.0	12.4
Arm Lifting Strength (lbs.)	32.7	34.6	48.7	63.2	67.5	12.9
Leg Lifting Strength (lbs.)	89.8	100.4	127.1	164.5	192.5	29.1
Torso Lifting Strength (lbs.)	48.0	55.5	92.7	125.2	131.7	24.9

References

Chaffin, D.B., Herrin, G.D., Keyserling, W.M. and Foulke, J.A., "Preemployment Strength Testing in Selecting Workers for Materials Handling Jobs", NIOSH Contract No. CDC-99-74-62, May, 1977.

Clauser, C., Tucker, P.E., McConville, J.T., Churchill, E., Laubach, L.L. and Reardon, J.A. "Anthropometry of Air Force Women", USAF Report AMRL-TR-70-5, April, 1972.