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Correlation of Different Anthropometric Measurements of Hand and Grip Strength in the Adult Female Bangladeshi Garment Workers

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Abstract

Context : *A reliable and valid measurement of hand anthropometry is important for designing dimensionally compatible hand tools, gloves and hand-held devices. Hand grip strength is accepted as an objective index for the functional integrity of upper extremity. The estimation of hand grip strength is of immense importance in determining the efficacy of different treatment strategies, treatment outcome and hand rehabilitation. The present study was planned to determine the various dimensions of hands, average hand grip strength of adult Bangladeshi female garment workers and the relationship between hand grip strength and different anthropometric measurements of hand.*

Material and Methods: *Two hundred female garment workers of 20-25 years of age were selected by purposive non-random sampling from five different garment factories of Dhaka and Narayangonj city. Different dimensions of both hands were measured directly with the help of digital slide caliper and flexible wire. Hand grip strength of both hands was measured by Smedley's Hand Grip Strength Dynamometer.*

Result : *Body height, weight, BMI, hand length and hand breadth of adult Bangladeshi garmentsworkers showed positive correlation with hand grip strength, but only significant positive correlation was found between hand length and grip strength of right hand ($r=+0.197$, $P<0.05$) and left hand ($r=+0.405$, $P<0.001$).*

Key words : *Hand anthropometry, grip strength, female garments worker.*

Introduction:

Human hand is endowed with grasping, precision movements for skilled works and acts as a chief tactile apparatus. The opposition of thumb to the index finger and other digits is highly evolved in mankind for grasping and finer movements. This is contributed by high degree of neuromuscular co-ordination and larger cortical representation of hand in the sensory and motor cortex of the brain.[1] The skeleton of the hands consists of carpal bones in the wrist, metacarpal bones in the hand proper and phalanges in the fingers.[2]

Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of the human body and skeleton. Anthropometry is a traditional and basic tool of biological anthropology and effectively being used in forensic medicine. Jantz[3] in 1992 developed regression equations to predict stature from metacarpal bones. Fingerprints on the other hand plays important role in identifying persons. Thus, hand plays a very important role in forensic medicine in achieving personal identity.[3]

Inconsistency exists in the literature over the relationship between hand grip strength and BMI. Many researchers claim that there is a positive relationship between grip strength and BMI in both genders and all ages, while other researchers found

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no relationship.[4] Hand grip strength also depends on nutritional status of individual. Like BMI, other nutritional status indicators such as various arm and calf circumferences and various subcutaneous skinfolds are related with grip strength.[5]

From sports like cricket, wrestling, tennis, football, basketball, and baseball to daily activities such as carrying laundry, turning a doorknob, sewing, cutting, cleaning and vacuuming, some degree of grip strength is necessary. Hand grip strength has long been thought as a possible predictor of overall body strength. Many of the research studies correlated grip strength with performance, overall body strength, nutritional status and fatigue. Often overlooked or taken for granted, the strength of ones grip plays a key role in injury prevention and rehabilitation.[5] In medicine hand grip strength can be used as a screening tool for women at risk of osteoporosis. Hand grip strength can be used to compare and evaluate treatments and progression of muscle strength.[6]

Anthropometric data are one of essential factors in designing machines and devices.[7] Chandna et al[8] mentioned that lack of properly designed machines and equipments may lead to lower work performance and higher incidence to work related injuries. Thus anthropometric measurements of hand and hand grip strength can play an important role to design workplace, hand tools, and access spaces for the hand and many products for human use.

Materials and methods:

This cross sectional, analytical type of study was carried out in the department of Anatomy, Dhaka Medical College, Dhaka from July 2011 to June 2012, to determine the various hand anthropometry and grip strength of adult Bangladeshi female garment workers. Two hundred female garment workers of 20-25 years of age were selected from five different garment factories of Dhaka and Narayangonj city. Ages of the participant were determined by their national ID card. The entire participants were right hand dominant. Hand anthropometry and power grip strength of all participant were measured. The participants were divided into two groups as control and case group.

Operational definition:

a) **Nonproduction (Control) Group (n=100):** Garment workers who are not directly related to the production.

- **Supervisors:** Supervisors are those who supervises various operations of garmentswork like controlling the work of the operators, maintaining compliance and production quality, human resource management, controlling the inventory, thus helping smooth production.
- **Quality control staffs:** Quality control staffs are those who carry out a range of technical, investigative and quality control work to ensure the end product performs to specification.

b) **Production (Case) group (n=100):** Garment workers who were directly related to production.

- **Cutting operator:** Cutting operator are those who cut various garments like shirts, trousers, pyjamas, skirts etc with various cutting instruments like scissors, knives, straight knife and circular knife machines as per specification.
- **Sewing operator:** Sewing operators are those who sew various designs and operations like necklines, collars, cuffs, loops, button holes using various power machines like double needle machine.

Procedures for studying the morphological variables:

BMI: BMI was calculated by dividing the body weight in KG by the square of the height in meters.[9]

BMI=weight in kg/height in meter^2

Procedures of various hand measurements:

a. **Hand length (Figure 1):** Length of hand was measured from the midpoint of the distal transverse wrist crease to the most distal point at the tip of the middle finger along the long axis of the hand.[7,10]

b. **Palmar length (Figure 2):** This palm length was measured along the long axis of the hand from the midpoint of distal transverse wrist

crease to the midpoint of metacarpophalangeal joint of the middle finger across the proximal digital crease.[11]

c. **Hand breadth (Figure 3):** For the measurement of the hand breadth, subject was asked to sit comfortably on a chair and to place her hand on a flat wooden table. Hand was extended, palm facing up and fingers adducted except the thumb. This dimension was measured by sliding calipers as a straight distance from the radial side of the second metacarpophalyngeal joint to the ulnar side of the fifth metacarpophalyngeal joint.[11]

d. **Hand grip strength (Figure 4):** Hand grip strength Dynamometer (Smedley's, Tokyo, Japan)was used to measure the grip strength while the subject sitting on a chair with the elbow flexed at 90^{o} and forearm in semi-pronation lying on an arm-rest. Subject was asked to squeeze the Dynamometer three times with each hand. To overcome the fatigue subject was given one minute resting period between each squeeze. Mean value of three squeezes were taken into account.[12]

Ethical Clearance :

This study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

Results:

Non significant positive correlation in right hand with average hand grip strength and body weight was found in both nonproduction (r= +0.166, P>0.05) and production (r= +0.154, P>0.05) related garment workers group (Table I). Left hand showed non significant positive correlation with average hand grip strength and body weight in nonproduction (r= +0.159, P>0.05) related garment workers group but significant positive correlation was observed in production (r= +0.368, P<0.001) related garment workers group.

Significant positive correlation of right hand with average hand grip strength and body height was observed in nonproduction (r= +0.304, P<0.01) related garment workers group, but production (r= +0.154, P>0.05) related garment workers group showed no significant positive correlation (Table I).

Left hand showed significant positive correlation with average hand grip strength and body height in nonproduction (r= +0.234, P<0.05) and production (r= +0.210, P<0.05) related garment workers group.

Right hand showed non significant positive correlation with average hand grip strength and body mass index (BMI) in both nonproduction (r= +0.039, P>0.05) and production (r= +0.069, P>0.05) related garment workers group (Table-I, Figure 5). Left hand showed non significant positive correlation with average hand grip strength and body mass index in nonproduction (r= +0.071).

P>0.05) related garment workers group but significant positive correlation was observed in production (r= +0.266, P<0.01) related garment workers group (Figure 5).

The study showed that the right hand had significant positive correlation with average hand grip strength and length of hand in both nonproduction (r= +0.295, P<0.01) and production (r= +0.197, P<0.05) related garment workers group. Left hand showed significant positive correlation with average hand grip strength and length of hand in both nonproduction (r= +0.205, P<0.05) and production (r= +0.266, P<0.001) related garment workers group (Table I).

It was observed that the right hand showed significant positive correlation with average hand grip strength and length of palm in nonproduction (r= +0.259, P<0.01) related garment workers group, but production (r= +0.164, P>0.05) related garment workers group showed no significant positive relationship (Table I). Left hand showed non significant positive correlation with average hand grip strength and length of palm in nonproduction (r= +0.124, P>0.05) related garment workers group but significant positive correlation was observed in production (r= +0.264, P<0.01) related garment workers group.

Non significant positive correlation was found in case of right hand with average hand grip strength and breadth of hand in both nonproduction (r= +0.178, P>0.05) and production (r= +0.049, P>0.05) related garment workers group (table-I). Left hand showed non significant positive correlation with average hand grip strength and breadth of hand in nonproduction (r= +0.195, P>0.05) related garment workers group but strongly significant positive correlation was observed in production (r= +0.405, P<0.001) related garment workers group.

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Table I

Relationship between different variables and average handgrip strength of the right and left hand of the nonproduction (Control) and production (Case) related garment workers

Parameters	Right hand		Left hand	
	r	P	r	P
Body weight		>0.05^{ns}		>0.10^{ns}
Nonproduction (Control)	+0.166		+0.159	
related garment workers		>0.10^{ns}		<0.001***
Production (Case) related	+0.154		+0.368	
garment workers				
Body height		<0.01**		<0.05*
Nonproduction (Control)	+0.304		+0.234	
related garment workers		>0.05^{ns}		<0.05*
Production (Case) related	+0.174		+0.210	
garment workers				
Body mass index		>0.50^{ns}		>0.10^{ns}
Nonproduction (Control)	+0.039		+0.071	
related garment workers		>0.10^{ns}		<0.01**
Production (Case) related	+0.069		+0.266	
garment workers				
Length of hand		<0.01**		<0.05*
Nonproduction (Control)	+0.295		+0.205	
related garment workers		<0.05*		<0.001***
Production (Case) related	+0.197		+0.405	
garment workers				
Length of palm		<0.01**		>0.10^{ns}
Nonproduction (Control)	+0.259		+0.124	
related garment workers		>0.10^{ns}		<0.01**
Production (Case) related	+0.164		+0.264	
garment workers				
Breadth of hand				
Nonproduction (Control)		>0.05^{ns}		>0.05^{ns}
related garment workers	+0.178		+0.195	
Production (Case) related	+0.049	>0.50^{ns}	+0.405	<0.001***
garment workers				

Pearson correlation tests done to show relationship between different parameters with average handgrip strength of right and left hand, ns = not significant, */**/*** = significant

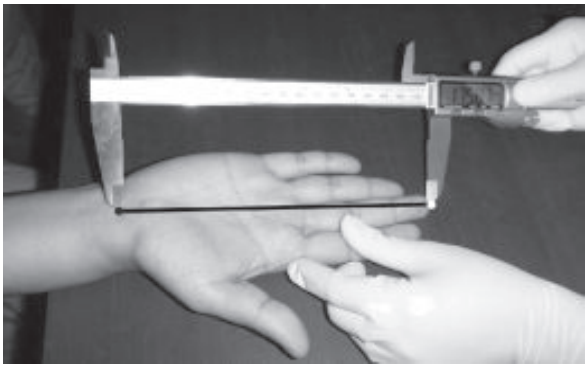

Fig. - 1: *Photograph showing the measurement of hand length by using digital sliding calipers. Black dot = Midpoint of distal transverse wrist crease; white dot = Most distal point at tip of middle finger*

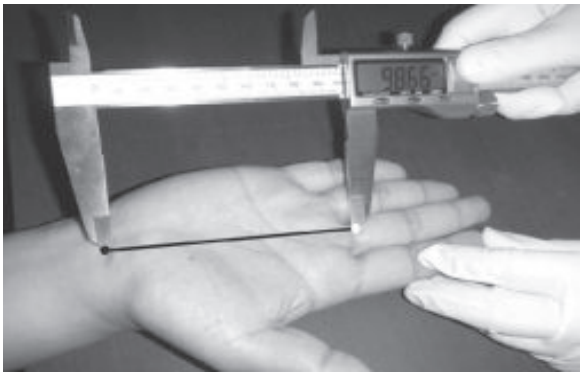

Fig.- 2: *Photograph showing the measurement of palmar length by using digital sliding calipers Black dot = Midpoint of distal transverse wrist crease; white dot= Midpoint of* metacarpophalangeal joint crease of middle finger, Black line= Palm length

Fig. - 3: *Photograph showing the measurement of hand breadth by using digital sliding calipers. Black dot = Radial side of second metacarpophalangeal joint; White dot= Ulnar side of fifth meta-carpophalangeal joint and Black line= Hand breadth*

Fig.- 4: *Photograph showing the procedure for measuring hand grip strength*

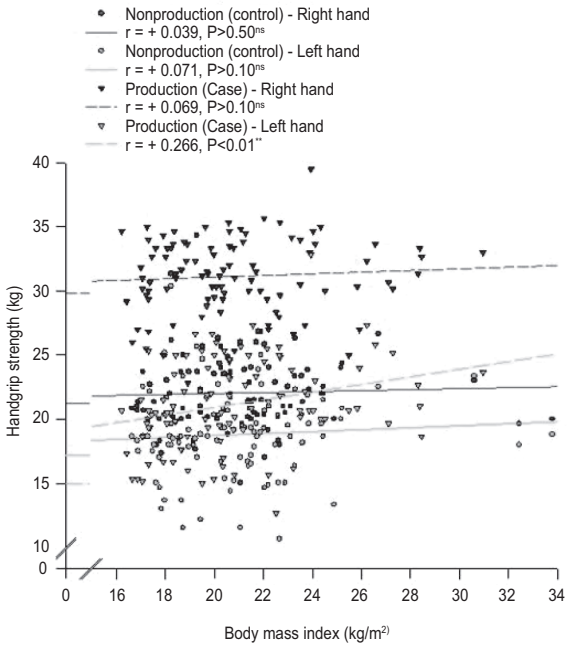

Fig.-5: *Relationship between body mass index (BMI) and handgrip strength of right and left hand of the nonproduction (Control) and production (case) related garments workers.*

Discussion :

In the present study right hand grip strength showed non significant positive correlation (r=+0.154) with body weight where as the left hand grip strength showed significant positive correlation (r=+0.368) with body weight. In contrary to these, Kamarul et al[13] and Koley et al[14,15] reported significant positive correlation in right hand grip strength and left hand grip strength with body weight.

In the present study, both right (r=+0.174) and left (r=+0.210) hand grip strength showed positive but

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nonsignificant correlation with body height. In contrary to these Koley et al[14,15] and Kamarul et al[13] found significant positive correlation in right hand grip strength and left hand grip strength with body height.

Right hand grip strength didn't show significant positive correlation (r=+0.069) with body mass index whereas the left hand grip strength showed significant positive correlation (r=+0.266) with body mass index (Table I,Figure 5). In contrary to these Koley et al[14] in 2011 found significant positive correlation in right hand grip strength (r=+0.23) but the left hand grip strength didn't show significant correlation (r=+0.14) with body mass index. Koley et al[15] in 2009 found significant positive correlation in right hand grip strength (r=+0.401) and left hand grip strength (r=+0.374) with body mass index. Kamarul et al[13] in 2006 didn't report any significant correlation in right hand grip strength and left hand grip strength with body mass index (BMI). In the present study both right (r=+0.197) and left (r=+0.405) hand grip strength showed significant positive correlation with hand length. Koley et al[14] in 2011 also found significant positive correlation with hand length.

It was found that the right hand grip strength didn't show significant positive correlation (r=+0.49) with hand breadth whereas the left hand grip strength showed significant positive correlation (r=+0.405) with hand breadth. In contrary to these Koley et al[14] found significant positive correlation in right hand grip strength (r=+0.21) but the left hand grip strength didn't show significant correlation (r=+0.13) with hand breadth.

Conclusion:

The present study findings revealed both significant and nonsignificant differences in various hand anthropometry and power grip strength. Right hand showed significantly higher grip strength than left hand. The study findings suggest that hand dominance and work load have influence over grip strength. Body height, weight, BMI, hand length and hand breadth showed positive correlation with hand grip strength, but only significant positive correlation was found between hand length and grip strength on both hand.

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