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A Study on Hand Grip Strength in Female Labourers of Jalandhar, Punjab, India

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ABSTRACT The present study is based on the association of left and right hand grip strength with five anthropometric traits, viz. height, weight, body mass index, hand breadth and hand length on purposively selected 100 women those who are working as labourers in different constructional sites situated in and around Jalandhar city, Punjab, India and 100 sedentary women of the same place. The findings of the present study indicate highly significant differences ($p < 0.001$) in height ($t = 6.27$), weight ($t = 11.53$), BMI ($t = 9.73$), hand length ($t = 5.79$), hand breadth ($t = 4.49$), right handgrip strength ($t = 3.92$) and left handgrip strength ($t = 3.73$) between right hand dominant female labourers and their sedentary counterparts. However, in left hand dominant female labourers and the sedentary women, highly significant differences ($p < 0.001$) were noted in BMI ($t = 3.31$) and statistically significant differences ($p < 0.05$) were found in weight ($t = 2.53$) and right handgrip strength ($t = 2.80$).

INTRODUCTION

Handgrip is a measure of strength of several muscles in the hand and forearm. These muscles play a vital role in the performance of day to day activities of normal life such as using tools etc. Grip strength is the force applied by the hand to pull on or suspend from objects. The power of grip is the result of forceful flexion of all finger joints with a maximal voluntary force that the subject is able to exert under normal bio kinetic conditions (Richards et al. 1996 and Bohannon 1997). Hand grip strength is a physiological variable that is affected by a number of factors including age, gender and body size etc. The grip strength was reported to be higher in dominant hand with right handed subjects, but no such significant differences between sides could be documented for left handed people (Incel et al. 2002). Right and left hand grip strength was positively correlated with weight, height and body surface area (Chatterjee and Chowdhuri 1991). It is of great use as a functional index of nutritional status (Brozek 1984; Vaz et al. 1996; Jeejeebhay 1998). Hand grip strength was found to be a significant determinant of bone mineral content and bone area at the forearm sites and had a positive correlation with lean body mass and physical activity. It determines the muscular strength of an individual (Foo 2007). Grip strength has been used to assess general strength in order to determine work capacity, for extent of injury and disease processes and the potential for progress in rehabilitation. Handgrip strength is necessary for performing activities of daily living which in turn, are required to maintain functional autonomy. The relationship between handgrip strength and a number of variables include morbidity, mortality, risk of falling, a range of functional ability variables and nutritional status have been extensively studied in some older populations. The hand grip strength is positively associated with nutritional status, even after controlling for potential confounders including health status and socioeconomic conditions (Chilima and Ismail 2001). This study confirms that those in lower BMI category had lower mean handgrip strength. Keeping the view in mind, in the present study an attempt has been made to investigate the association of various anthropometric variables with handgrip strength in female labourers. Our study was the first of its kind regarding the handgrip strength of female construction workers of north India.

MATERIALS AND METHODS

The present study is based on purposively selected 100 women (mean age 28.57 years ± 7.67) those who are working as labourers in different constructional sites situated in and around Jalandhar city, Punjab, India and 100 sedentary women (mean age 29.85 years ± 8.56) of same place. Age range was between 18 to 40 years.

The data collection was undertaken under natural environmental conditions, in residential areas and construction sites in and around Jalandhar city. In this cross-sectional study, the age of the subjects were recorded as per the respondents reply. The subjects were divided in such a way that "age 18", for instance, refers to the female labourers aged 17 years and 6 months through 18 years and 5 months and 29 days. The study was approved by the local ethics committee.

Six anthropometric traits, viz. height, weight, body mass index, hand length, hand breadth, right and left hand grip strengths were taken on each subject. The height (to the nearest 0.1 cm), weight (to the nearest 0.1 kg), hand length and hand breadth of the subjects were measured using the techniques provided by Lohmann et al. (1988). BMI was then calculated using the formula weight (kg)/height $(m)^2$. The grip strength of both right and left hands was measured using a standard adjustable digital hand grip dynamometer (Takei Scientific Instruments Co., Ltd, Japan) at standing position with shoulder adducted and neutrally rotated and elbow in full extension. The subjects were asked to put maximum force on the dynamometer thrice from both sides of the hands. The average value was recorded in kilograms.

Data were analysed using SPSS (Statistical Package for Social Science) version 7.5. Student's t test was applied for the comparison of all the variables between female labourers and controls. Pearson's correlation coefficients were applied to establish the correlations of dominant hand grip strength with other variables in female labourers. Linear regression analyses were carried out with hand grip strength (separately) as a dependent variable and rest of the anthropometric variables as independent. A 5% level of probability was used to indicate statistical significance.

RESULTS AND DISCUSSION

Table 1 shows the distribution of grip strength of right dominant hands and some anthropometric variables in female labourers and sedentary counterparts. Right hand dominant sedentary females have higher mean values in all variables, viz. height (154.09 cm), weight (58.94 kg), BMI (24.82 $kg/m^{2)}$, hand length (17.23 cm), hand breadth (7.67 cm), right handgrip strength (22.75 kg) and left handgrip strength (21.03 kg) than the right hand dominant female labourers (148.90 cm, 43.44 kg, 19.58 kg/m^2, 16.55 cm, 7.39 cm, 20.67 kg and 19.01 kg respectively). However, highly significant differences ($p<0.001$) were noted in height ($t = 6.27$), weight ($t = 11.53$), BMI ($t = 9.73$), hand length ($t = 5.79$), hand breadth ($t = 4.49$), right handgrip strength ($t = 3.92$) and left handgrip strength ($t = 3.73$) between right hand dominant female labourers and the sedentary counterparts.

The distribution of grip strength of left dominant hand and some anthropometric variables in female labourers and sedentary counterparts is given in Table 2. Left hand dominant sedentary females have higher mean values in height (153.93cm), weight (59.67 kg), BMI (24.97 kg/m^2), hand breadth (7.52cm), right handgrip strength (23.63 kg) and left handgrip strength (25.00 kg) than the left hand dominant female labourers (153.85 cm, 45.30 kg, 19.13 kg/m^2, 7.43 cm, 19.37 kg and 22.21 kg respectively) and have lesser mean values in hand length (17.18 cm) than the left hand dominant female labourers (17.33 cm). However, highly significant differences ($p<0.001$) were noted in BMI ($t = 3.31$) and statistically significant differences ($p<0.05$) were found in weight ($t = 2.53$) and right handgrip strength ($t = 2.80$) between left hand dominant female labourers and the sedentary counterparts.

Table 3 shows the correlation coefficients (r)

Table 1: Descriptive statistics of grip strength of right dominant hands and some anthropometric variables in female laborers and sedentary counterparts

Variables	*Female labourers (n = 90)*			*Sedentary females (n =94)*			*t value*
	Mean	*SD*	*SE*	*Mean*	*SD*	*SE*	
Height (cm)	148.90	5.39	0.57	154.09	5.84	0.60	6.27**
Weight (kg)	43.44	6.77	0.71	58.94	11.05	1.14	11.53**
BMI (kg/m2)	19.58	2.68	0.28	24.82	4.45	0.45	9.73**
Hand length(cm)	16.55	0.82	8.69	17.23	0.78	7.98	5.79**
Hand breadth (cm)	7.39	0.39	4.05	7.67	0.41	4.25	4.49**
Hand grip strength Right (kg)	20.67	3.28	0.34	22.75	3.89	0.40	3.92**
Hand grip strength Left (kg)	19.01	3.61	0.38	21.03	3.75	0.39	3.73**

**indicates P<0.001

of dominant right and left handgrip strength with various anthropometric variables in female laborers and sedentary females. Highly significant positive correlations ($p<0.01$) were found both in female labourers and sedentary females with right handgrip strength and height ($r = 0.403$ and 0.322 respectively), hand length ($r = 0.331$ and 0.376 respectively) and hand breadth ($r = 0.287$ only in female labourers) and statistically significant correlation ($p<0.05$) was found between right handgrip strength and hand breadth ($r = 0.205$ only in sedentary females) (Fig. 1-6).

A total of 35 muscles are involved in movement of the forearm and hand. Many of these are involved in gripping activities. In gripping activities, the flexor muscles in the hand and forearm create the grip strength, while the extensor muscles of the forearm stabilize the wrist (Waldo 1996). Anatomically, there are four major joints in the hand, namely carpometacarpal, intermetacarpal, metacarpophalangeal, and interphalangeal joint, with nine extrinsic muscles that cross the wrist and ten intrinsic muscles with both of their attachments distal to the wrist (Hall 2007). These muscles include the pronator radii teres, flexor carpi radialis, flexor carpi ulanris, flexor sublimes digitorum, and palmaris longus on the extrinsic layer and the flexor profundus digitorum, flexor policus longus, pronator quadratus, flexor pollicus brevis, and abductor pollicus brevis on the intrinsic layer. Each of these muscles is active during gripping activities. According to German Sports Scientist Jurgen Weinick (1990), the characteristic structure of the hand is related to its function as a grasping tool. Grasping ability is made possible by the fact that the thumb can be opposed to the fingers. The fingers and the thumb act as a versatile pair of pliers. They need the palm of the hand as a flat base, on which the object grasped can be held. From this statement, it could be concluded that the anatomy of the hand is more geared toward flexion than extension. Further proof lies in the research of Li et al. (2001) on the strength of finger flexor vs. finger extensor musculature during isometric tasks. Their findings revealed the flexor mechanism of the fingers to be 62% stronger than the extensor mechanism.

Grip strength has long been thought of as a possible predictor of overall body strength. But little information is available regarding this. Smith et al. (2005) found a direct correlation in grip strength and overall body strength in elderly female populations. Fry et al. (2006) also found a correlation between grip strength and performance in American junior male weightlifters. It is also reported that hand grip strength determines the muscular strength of an individual (Foo 2007). The findings of the present study indicate that female labourers have lower mean

Table 2: Descriptive statistics of grip strength of left dominant hands and some anthropometric variables in female laborers and sedentary counterparts.

Variables	*Female labourers (n = 10)*			*Sedentary females (n =06)*			*t value*
	Mean	*SD*	*SE*	*Mean*	*SD*	*SE*	
Height (cm)	153.85	4.62	1.46	153.93	5.02	2.04	0.03
Weight (kg)	45.30	7.83	2.48	59.67	12.53	50.12	2.53*
BMI (kg/m2)	19.13	3.18	1.0	24.97	3.54	1.44	3.31**
Hand length(cm)	17.33	0.71	0.22	17.18	0.64	0.26	0.42
Hand breadth (cm)	7.43	0.47	0.15	7.52	0.48	0.19	0.35
Hand grip strength Right (kg)	19.37	3.94	1.25	23.63	2.13	0.87	2.80*
Hand grip strength left (kg)	22.21	3.95	1.25	25.0	3.05	1.24	1.58

*indicates P<0.05; **indicates P<0.001

Table 3: Correlation coefficient (r) of dominant right and left handgrip strength with various anthropometric variables in female laborers and sedentary females.

Variables	*Female labourers*		*Sedentary females*	
	Right hand dominant	*Left hand dominant*	*Right hand dominant*	*Left hand dominant*
Height	0.403**	0.123	0.322**	-0.075
Weight	0.068	0.155	0.122	-0.120
BMI	- 0.126	0.121	- 0.004	-0.093
Hand length	0.331**	0.730*	0.376**	0.547
Hand breadth	0.287**	0.461	0.205*	0.790

*indicates P<0.05, ** indicates P<0.001

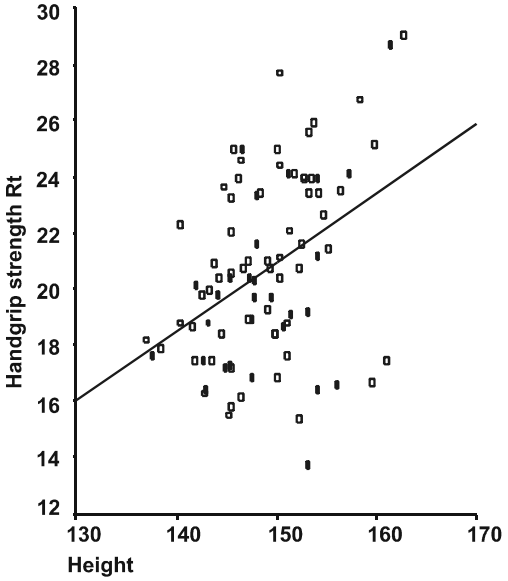

Fig. 1. Scatter plot of hand grip strength (right) of female labourers by height

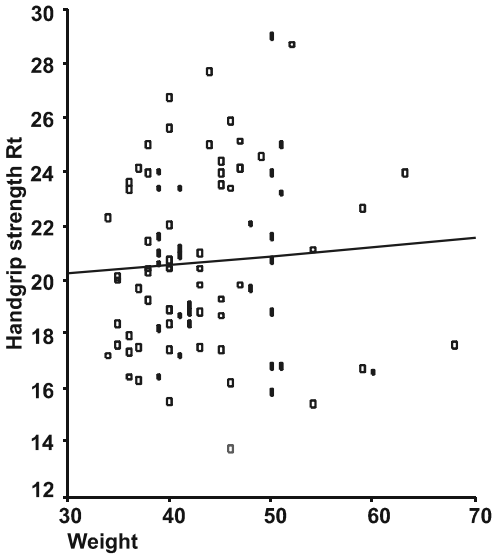

Fig. 2. Scatter plot of hand grip strength (right) of female labourers by weight

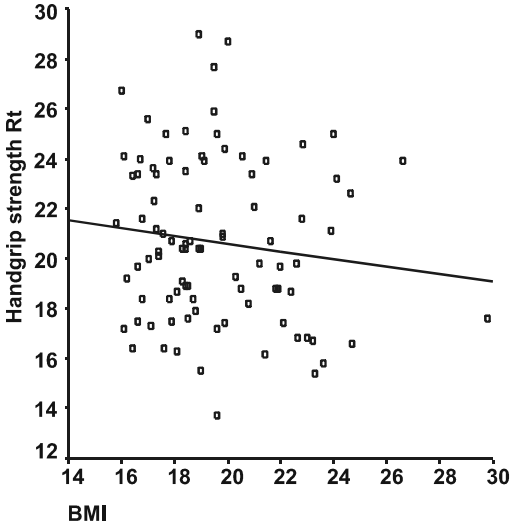

Fig. 3. Scatter plot of hand grip strength (right) of female labourers by BMI

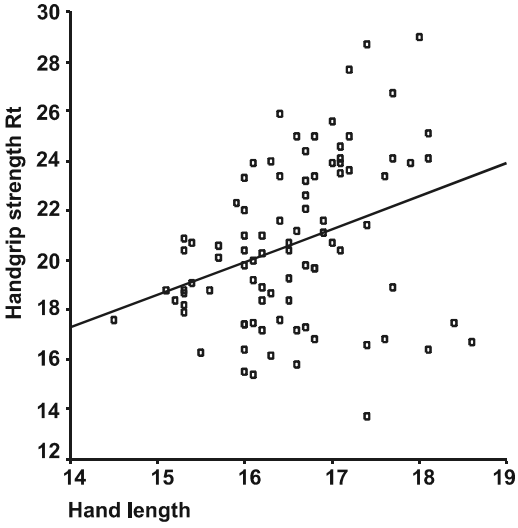

Fig. 4. Scatter plot of hand grip strength (right) of female labourers by hand length

values in all variables measured including lower mean values of grip strength of both hands as compared to sedentary females. In fact, Chilima and Ismail (2001) reported that hand grip strength was positively associated with nutritional status, even after controlling for potential confounders including health status and socioeconomic conditions. Their study also confirmed that those in lower BMI category had lower mean handgrip strength. Pieterse et al. (2002) also reported that poor nutritional status, defined by low BMI and low arm muscle area, emerged as a significant

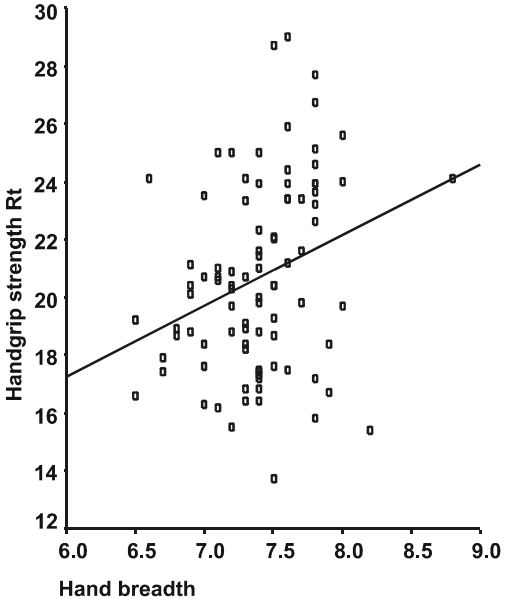

Fig. 5. Scatter plot of hand grip strength (right) of female labourers by hand breadth

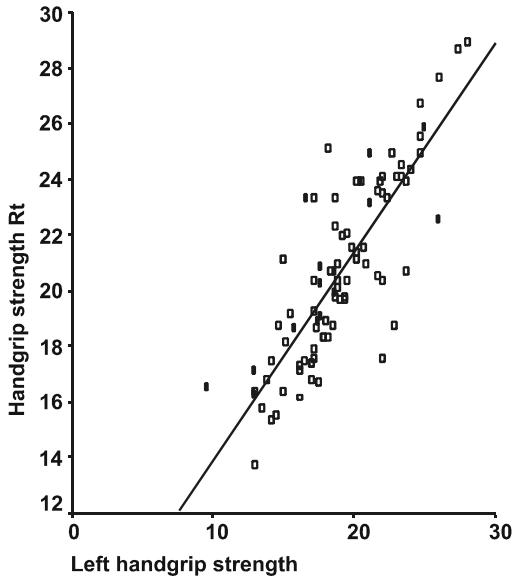

Fig. 6. Scatter plot of hand grip strength (right) of female labourers by left handgrip strength

determinant of impaired handgrip strength. In the present study too, female labourers have lesser mean values for BMI (26.76% in right dominant and 30.47% in left dominant hand) than controls. Highly significant positive correlations ($p<0.01$) noted in female labourers with right handgrip strength and height ($r = 0.403$), hand length ($r = 0.331$) and hand breadth ($r = 0.287$) followed the directions of Chatterjee and Chowdhuri (1991) where they reported positive correlations of right and left hand grip strength with weight, height and body surface area.

Nevertheless, females working in different constructional sites have poor nutritional status due to their lower socioeconomic conditions but they require more physical strength i.e. handgrip strength to perform their daily work efficiently. Quite naturally poor nutritional status fails to provide adequate handgrip strength to them affecting their skills. More researches are required in this direction to draw a generalized statement.

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