

An Association of Nutritional Status and Hand Grip Strength in Female Labourers of North India

Navdeep Kaur and Shyamal Koley

*Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University,
Amritsar 143 005, Punjab, India
E-mail: drkoley@yahoo.co.uk; navdeepkaur9@gmail.com*

KEYWORDS Nutritional Status. Handgrip Strength. Female Labourers. India

ABSTRACT The present study examines the association of nutritional status with handgrip strength of female labourers and sedentary women of Jalandhar, Punjab, India. A total of 100 female labourers and 100 sedentary women participated in this study. Age range was between 18 to 40 years. Selected anthropometric measurements were taken and nutrition indices were calculated using standard equations. Handgrip strength was measured using a digital handgrip dynamometer. The findings of the present study indicate highly significant differences ($P < 0.001$) in following nutritional status indicators: BMI ($t = 9.73$), triceps skin fold ($t = 5.93$), arm circumference ($t = 10.69$) and arm muscle area ($t = 8.63$) between right hand dominant female labourers and the sedentary females. Also, the right hand dominant female labourers (20.67 kg) have lesser mean handgrip strength than their sedentary counterparts (22.75 kg). It could be concluded that despite of their higher level of physical activity, female labourers had both lower handgrip strength and lower values of nutritional indices than their sedentary counterparts because of their poor nutritional status.

INTRODUCTION

Handgrip strength is a measure of strength of several muscles in the hand and the forearm (Bassey and Harrie 1991). It is measured in either kilograms or Newtons by squeezing a handgrip strength dynamometer with one's maximum strength (Bassey 1990). 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 biokinetic conditions (Richards et al. 1996; Bohannon 1997). The estimation of hand grip strength is of immense importance in determining the efficacy of different treatment strategies of hand and also in hand rehabilitation. The hand muscles play a vital role in the performance of day to day activities of normal life such as using tools or transferring from one position to another, such as rising from a chair (Skelton et al. 1994). The relationship between handgrip strength and a number of variables included morbidity (Klidjian et al. 1980), mortality (Phillips 1986), the risk of falling (Wickham et al. 1989), anthropometric traits (Ross and Rösblad 2002; Malina et al. 1987; Koley et al. 2009), a range of functional ability variables (Hughes et al. 1997; Hyatt et al. 1990) and nutritional status (Guo et al. 1996) have been reported. It is of great use as a functional index of nutritional status (Brozek 1984; Vaz et al. 1996;

Jeejeebhoy 1998). 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 1998, 2001) which confirmed that those in lower BMI category had lower mean handgrip strength. Poor nutritional status, defined by low BMI and low arm muscle area, emerged as a significant determinant of impaired handgrip strength (Pieterse et al. 1998). This study, therefore, was initiated to test the hypothesis that poor nutritional status is associated with poor functional ability (as measured by handgrip strength) as a first step towards understanding the role of nutrition in the livelihoods of female labourers.

MATERIAL AND METHODS

The present study is based on purposely selected 100 women (mean age 28.57 years $\pm$ 7.67) those who are working as labourers in different constructional sites in and around of Jalandhar city, Punjab, India. Also, 100 sedentary women (mean age 29.85 years $\pm$ 8.56) of same place were considered as controls. Age range was between 18 to 40 years. The data collection was undertaken under natural environmental conditions, in residential areas and construction sites situated in and around Jalandhar city, Punjab,

India and with the consent of the subjects. The study was approved by the local ethics committee.

Anthropometry

All anthropometric measurements, viz., height, weight, BMI, triceps skinfold, mid-upper arm circumference (MUAC), arm muscle girth, arm muscle area, arm fat area and arm fat index were measured on each subjects by NK using standard methodologies (Chilima and Ismail 1998; Lohmann et al. 1988). All variables except height and weight were measured on the right side of the body in triplicate with the median value used as the criterion.

The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. Triceps skinfold (to the nearest of 0.1 mm) was measured by Harpenden skinfold caliper (British Indicators Ltd., West Sussex, UK). BMI was then calculated using the formula weight (kg)/height² (m)². Arm muscle girth, Arm-muscle area, arm fat area and arm fat index were calculated using standard methodologies (McArdle et al. 2001) as shown below:

Arm muscle girth (cm) = G arm – (π Skin fold triceps)

Arm muscle area, cm² = [G arm - (π Sf tri)] / 4 π

Arm fat area, cm² = arm area – arm muscle area

Arm fat index, % fat area = (arm fat area / arm area)

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 maximum value was recorded in kilograms. All anthropometric equipment and hand grip dynamometer were calibrated before the assessment.

Data Analysis

Descriptive statistics (mean $\pm$ standard deviation) were determined for all directly measured and derived variables. Comparisons between labourers and controls for all the measured variables were made using an independent t-test. Data were analyzed using SPSS (Statistical Package for Social Science) version 7.5. A 5% level of probability was used to indicate statistical significance.

RESULTS AND DISCUSSION

The descriptive statistics of female labourers with right hand dominant and controls are presented in table 1. The female labourers were shorter in height (3.48%), lighter in weight (35.68%), with less BMI (26.76%), triceps skinfold (43.67%), arm circumference (22.21%), arm muscle girth (18.66%), arm muscle area (42.08%), arm fat area (64.34%), arm fat index (12.80%), right handgrip strength (10.01%) and left handgrip strength (10.62%) then the right hand dominant sedentary females.

Table 2 shows the descriptive statistics of left hand dominant female labourers and controls. The female labourers were shorter in height (0.05%),

Table 1: Descriptive statistics of female labourers and sedentary counterparts with right hand dominance

Variable	Female labourers (n = 90)			Sedentary females (n =94)			t – value
	Mean	SD	Variance	Mean	SD	Variance	
Height (cm)	148.90	5.39	29.05	154.09	5.84	34.11	6.27*
Weight (kg)	43.44	6.77	45.83	58.94	11.05	122.10	11.53*
BMI (kg/m ²)	19.58	2.68	7.18	24.82	4.45	19.80	9.73*
Triceps skinfold thickness (mm)	15.64	3.56	12.67	22.48	10.57	111.72	5.93*
Arm circumference (cm)	23.41	2.41	5.81	28.61	4.03	16.24	10.69*
Arm muscle girth (cm)	18.48	1.79	3.20	21.94	3.28	10.76	8.91*
Arm muscle area (cm ²)	27.56	5.49	30.14	39.16	11.77	138.53	8.63*
Arm fat area (cm ²)	16.63	5.09	25.91	27.34	7.52	56.55	11.35*
Arm fat index	36.56	8.11	65.77	41.24	4.04	16.32	4.93*
Hand grip strength Right (kg)	20.67	3.28	10.76	22.75	3.89	15.13	3.92*
Hand grip strength left (kg)	19.01	3.61	13.03	21.03	3.75	14.06	3.73*

**indicates P d<0.001

Table 2: Descriptive statistics of female labourers and sedentary counterparts with left hand dominance

Variable	Female labourers (n = 10)			Sedentary females (n = 6)			t – value
	Mean	SD	Variance	Mean	SD	Variance	
Height (cm)	153.85	4.62	21.34	153.93	5.02	25.20	0.03
Weight (kg)	45.30	7.83	61.31	59.67	12.53	157.0	2.53*
BMI (kg/m ²)	19.13	3.18	10.11	24.97	3.54	12.53	3.31**
Triceps skinfold thickness (mm)	15.00	4.00	16.00	22.17	5.34	28.51	2.84*
Arm circumference (cm)	23.00	2.69	7.24	28.41	4.69	21.99	2.58*
Arm muscle girth (cm)	18.29	1.53	2.34	21.45	3.08	9.49	2.34*
Arm muscle area (cm ²)	26.79	4.64	21.53	37.27	10.19	103.84	2.37*
Arm fat area (cm ²)	15.85	6.23	38.81	28.49	9.91	19.82	2.81*
Arm fat index	33.27	12.27	150.55	42.48	4.31	18.58	2.16*
Hand grip strength Right (kg)	19.37	3.94	15.52	23.63	2.13	4.54	2.80*
Hand grip strength left (kg)	22.21	3.95	15.60	25.00	3.05	9.30	1.58

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

lighter in weight (31.69%), with less BMI (30.47%), triceps skinfold (47.73%), arm circumference (23.52%), arm muscle girth (17.27%), arm muscle area (39.11%), arm fat area (79.74%), arm fat index (27.62%), right handgrip strength (21.99%) and left handgrip strength (12.56%) than the left hand dominant sedentary counterparts.

Figs. 1-10 presents the scatter plot of right hand grip strength of female labourers by different variables studied. In right hand dominant female labourers, grip strength has positively significant differences with height only, but considerably positive correlations were noted with other

nutritional indicators, viz., BMI, triceps skinfold, upper arm circumference and arm muscle area.

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. It is also reported that hand grip strength determines the muscular strength of an individual (Foo 2007). The present study indicates that female labourers have lower mean values in all variables measured including lower mean values of grip strength of both hands as

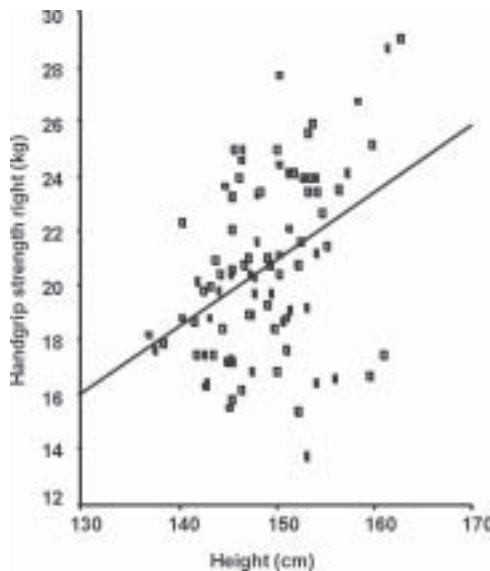


Fig. 1. Scatter plot of hand grip strength (right) of female labourers by height

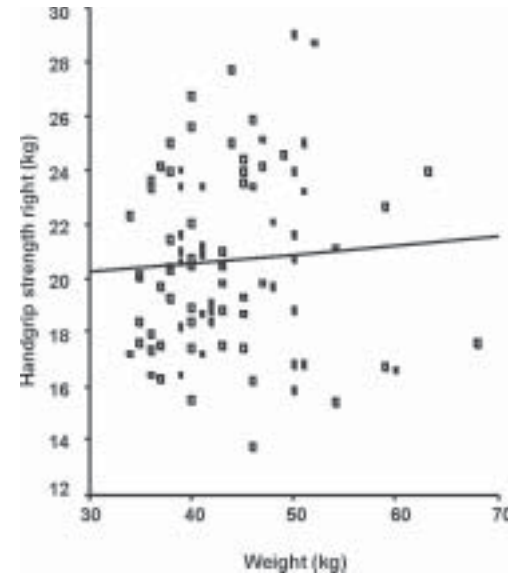


Fig. 2. Scatter plot of hand grip strength (right) of female labourers by weight

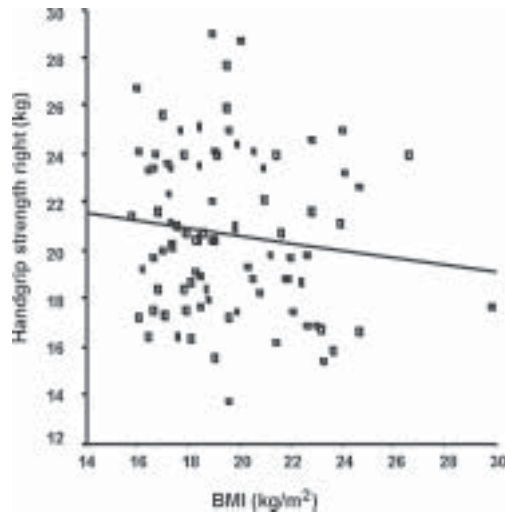


Fig. 3. Scatter plot of hand grip strength (right) of female labourers by BMI

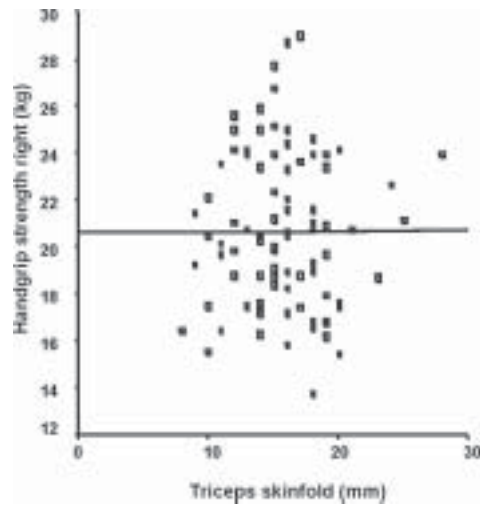


Fig. 4. Scatter plot of hand grip strength (right) of female labourers by triceps skinfold

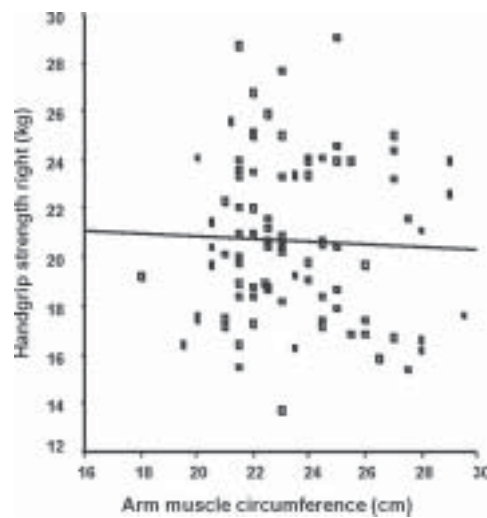


Fig. 5. Scatter plot of hand grip strength (right) of female labourers by arm muscle circumference

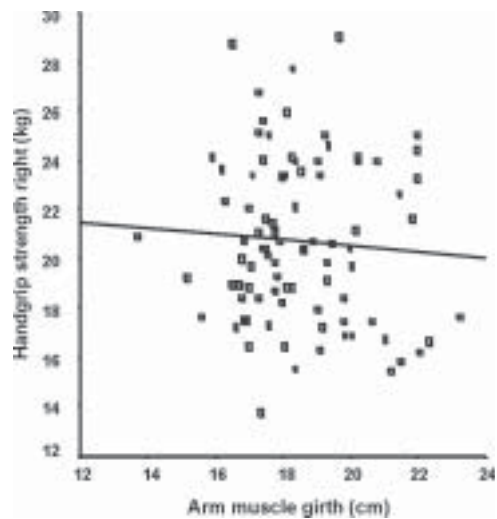


Fig. 6. Scatter plot of hand grip strength (right) of female labourers by arm muscle girth

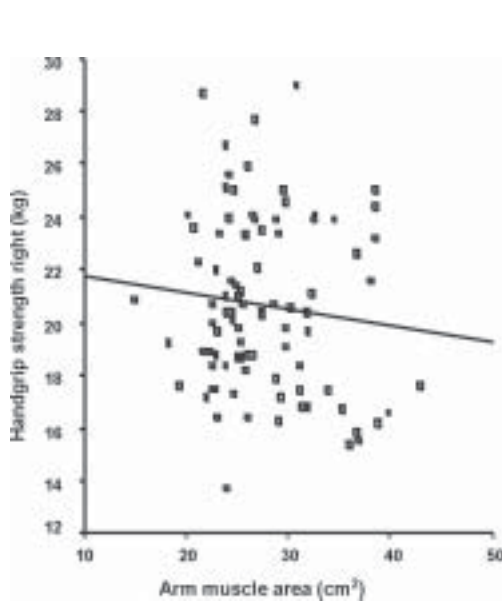


Fig. 7. Scatter plot of hand grip strength (right) of female labourers by arm muscle area

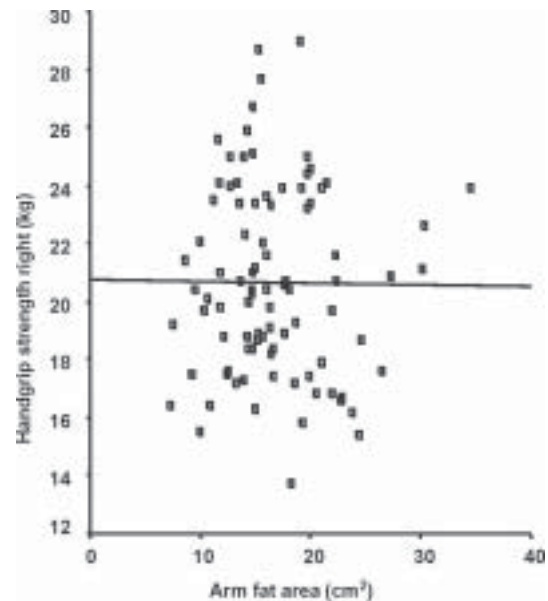


Fig. 8. Scatter plot of hand grip strength (right) of female labourers by arm fat area

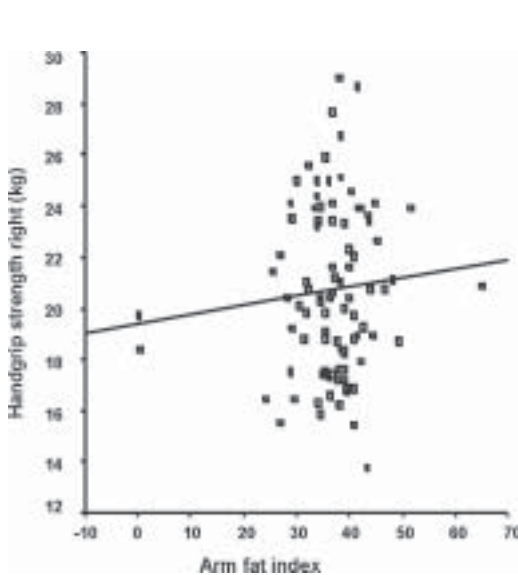


Fig. 9. Scatter plot of hand grip strength (right) of female labourers by arm fat index

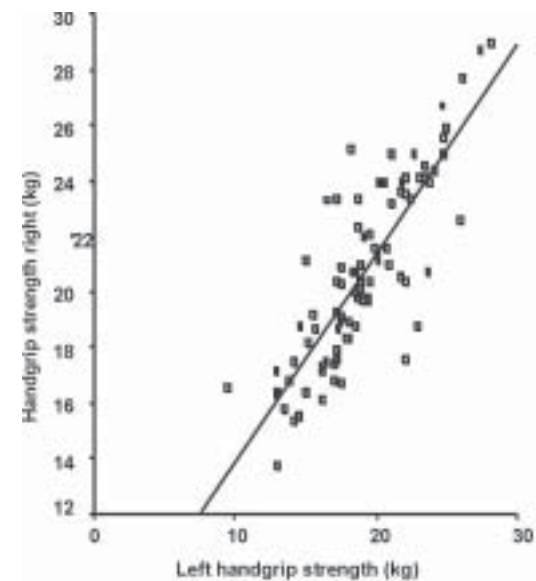


Fig. 10. Scatter plot of hand grip strength (right) of female labourers by Left handgrip strength

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. Therefore, the poor nutritional status is associated with poor functional status as assessed by 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 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. Thus, the results of the present study indicate that female labourers have lower mean values in all variables used as nutritional indicators and also they have lower values of handgrip strength as compared to sedentary females, lend support to the findings that handgrip strength is positively associated with nutritional status as reported in Japan by Guo et al. (1996), in central Malawi by Chilima et al. (2001) and in Rwanda (north Tanzania) by Pieterse et al. (2002).

Women working in different constructional sites have poor nutritional status due to their lower socio-economic 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. Conversely, sedentary women possess comparatively higher nutritional status, whereas they require less energy per day as they are not doing any strenuous physical work. That makes for a very complicated situation from two angles. Firstly, the sedentary women are suffering from obesity and its related diseases. Secondly, the constructional workers are suffering from malnutrition and diseases related to it.

One's nutritional status would lead to specific levels of body mass, which in turn has been found to correlate directly to grip strength. This simple method of non-invasive measurement may provide nutritionists and medical professionals with valuable screening data, prior to further more invasive testing.

CONCLUSION

Despite their higher level of physical activity, female labourers had both lower handgrip strength and lower values of nutritional indices than their sedentary counterparts because of their poor nutritional status. Thus, the results of this study supports the hypothesis that poor nutritional status is associated with poor handgrip strength. Further studies in this line are required to determine whether improved nutritional status can strengthen the handgrip of an individual.

REFERENCES

- Bassey EJ 1990. *Tests of muscle strength*. In: KJ Collins (Ed.): *Handbook of Methods for the Measurement of Work Performance, Physical Fitness and Energy Expenditure in Tropical Populations*. London: International Union of Biological Sciences, Medical Research, pp. 59-65.
- Bassey EJ, Harries UJ 1991. Normal values for handgrip strength in 920 men and women aged over 65 years, and longitudinal changes over 4 years in 620 survivors. *Clin Sci*, 84: 331-337.
- Bohannon RW 1997. Reference values for extremity muscle strength obtained by handheld dynamometer from adults aged 20 to 79 years. *Arch Phys Med & Rehab*, 78: 26 – 32.
- Brozek J 1984. *The assessment of motor functions in adults*. In: J Brozek, B Schurch (Eds.): *Malnutrition and Behavior: Assessment of Key Issues*. Nestle Foundation Publication Series, Lausanne: Nestle Foundation), 4: 268 – 279.
- Chilima DM, Ismail SJ 1998. Anthropometric characteristics of older people in rural Malawi. *Eur J Clin Nutr*, 52: 643-649.
- Chilima DM, Ismail SJ 2001. Nutrition and handgrip strength of older adults in rural Malawi. *Pub Health Nutr*, 4: 11 – 17.
- Foo LH 2007. Influence of body composition, muscle strength, diet and physical activity on total body and forearm bone mass in Chinese adolescent girls. *Br J Nutr*, 98: 1281-1287.
- Guo C, Zhang W, Ma D, Zhang K, Huang J 1996. Hand grip strength: An indicator of nutritional state and the mix of post-operative complications in patients with oral and maxillofacial cancers. *Br J Oral Maxillofac Surg*, 34: 325-327.
- Hyatt RH, Whitelaw MN, Bhat A, Scott S, Maxwell JD 1990. Association of muscle strength with functional status of elderly people. *Age & Ageing*, 19: 330-336.
- Hughes S, Gibbs J, Dunlop D, Edelman P, Singer R et al. 1997. Predictors of decline in manual performance in older adults. *J Am Geriatr Soc*, 45: 905-910.
- Jeejeebhoy KN 1998. Nutritional assessment. Gastro-intest. *Clin N Am*, 27: 347 – 369.
- Klidjian AM, Foster KJ, Kammerling RM, Cooper A, Karran SJ 1980. Relation of anthropometric and dynamometric variables to serious post-operative complications. *Br Med J*, 281: 899-901.

- Koley S, Kaur N, Sandhu JS 2009. Association of handgrip strength and some anthropometric traits in female labourers of Jalandhar, Punjab, India. *J Life Sci*, 1: 57-62.
- Lohmann TG, Roche AF, Martorell R 1988. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics Books.
- Malina RM, Zavaleta AN, Little BB 1987. Body size, fatness, and leanness of Mexican American children in Brownsville, Texas: Changes between 1972 and 1983. *Am J Pul Health*, 77: 573-577.
- McArdle WD, Katch FI, Katch VL 2001. *Exercise Physiology*. Baltimore: Lippincott Williams and Wilkins.
- Phillips P 1986. Grip strength, mental performance and nutritional status as indicators of mortality risk among female geriatric patients. *Age & Ageing*, 15: 3-56.
- Pieterse S, Manandhar M, Ismail SJ 2002. The association between nutritional status and handgrip strength in older Rwandan refugees. *Euro J Clin Nutr*, 56: 933 – 939.
- Richards L, Olson B, Palmiter TP 1996. How forearm position affects grip strength. *Am J Occup Therap*, 50: 133 – 139.
- Ross CH, Rösblad B 2002. Norms for grip strength in children aged 4–16 years. *Acta Paediatrica*, 91: 617-625.
- Skelton DA, Greig CA, Davies JM, Young A 1994. Strength, power and related functional ability of healthy people aged 65 - 89 years. *Age & Ageing*, 23: 371-377.
- Smith T, Smith S, Martin M, Henry R, Weeks S 2005. Grip Strength in Relation to Overall Strength and Functional Capacity in Very Old and Oldest Old Females. *Phys Occup Ther Geriatr*, 24: 63 - 78.
- Vaz M, Thangam S, Prabhu A, Shetty PS 1996. Maximal voluntary contraction as a functional indicator of adult chronic under nutrition. *Br J Nutr*, 76: 9 – 15.
- Wickham C, Cooper C, Margetts BM, Barker DJP 1989. Muscle strength, activity, housing and the risk of falls in the elderly people. *Age & Ageing*, 18: 7-51.