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Original Research Article

Position-wise changes of Handgrip Strength in Indian Population aged 16-30 years

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Abstract

Objectives: The objective of the present study was to estimate the right dominant handgrip strength in different positions in randomly selected 180 Indian population aged 16-30 years from Amritsar, India.
Methods: For this purpose, right dominant handgrip strength was measured in four different positions, like sitting right elbow flexion and extension and standing right elbow flexion and extension from all the subjects using Jamar dynamometer. Apart from these, height, weight and BMI were estimated for correlations.
Results: In result it was found that handgrip strength with sitting right elbow flexion had the maximum mean value both in females and males. It was also found that handgrip strength with sitting right elbow extension had positive correlation only with BMI.
Conclusion: The findings of the present study will be of immense importance in methodology study regarding the estimation of handgrip strength in different age groups.
Keywords: Handgrip strength. Sitting right elbow flexion and extension, Standing right elbow flexion and extension, Indian population

1. Introduction

The handgrip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject exerts under normal biokinetic conditions [1,2]. The estimation of handgrip strength is essential in determining the efficacy of different treatment strategies of the hand and also in hand rehabilitation. It is often used as an indicator of overall physical strength [3,4], hand and forearm muscles performances [5] and as a functional index of nutritional status [6-13], morbidity and mortality [14-16], physical performance [17,18], falls and fractures [19,20]. It is included in various motor ability measurement test batteries recommended for children [21-24].

Handgrip strength is a physiological variable that is affected by a number of factors including age, gender and body size. Strong correlations between grip strength and various anthropometric traits, (weight, height, hand length etc.) were reported earlier [25-31]. Effects of socio-economic status on handgrip strength were studied by Henneberg *et al*.[32].

The assessment of handgrip strength assumes importance in a number of situations. It may be used in the investigation and follow – up of patients with neuromuscular disease [33]. Different types of dynamometer are used to estimate the handgrip strength, like Jamar dynamometer, handheld dynamometer etc. But very few studies are conducted considering the hand-positions, like sitting and standing elbow flexion and extension of the subjects to estimate the grip strength. Thus the present study was planned.

2. Material and Methods

2.1. Study Participants

The present study was based on randomly selected 180 normal, healthy individuals (90 female and 90 male) aged 16–30 years. The subjects were the students of D.A.V. Public School and the students and young teachers of Guru Nanak Dev University, Amritsar, Punjab, India. The subjects were further categorized into three age-groups, viz. age group 16-20 years (n=60, 30 females and 30 males), age group 21-25 years (n=60, 30 females and

30 males) and age group 26-30 years (n=60, 30 females and 30 males). The age of the subjects were recorded from the registers of their respective institutes. The subjects were divided in such a way that age 16 refers to the students aged 15 years and 6 months through 16 years and 5 months and 29 days. All the subjects were informed about the purpose and contents of the study and a written consent was obtained from them. The data were collected under natural environmental conditions in morning (between 8 AM. To 12 noon). The study was approved by the local ethics committee.

2.1.1 The inclusion criteria for the subjects were as followed:

- Normal healthy students of age group 16-30 years.
- Students of both the sexes were considered.

2.1.2 The exclusion criteria for the study were as followed:

- Recent injuries
- Systematic or mechanical pain.
- Involvement in any other study.

2.2 Anthropometric Measurements

Three anthropometric variables, viz. height, weight and BMI were taken on each subject. Anthropometric variables of the subjects were measured using the techniques provided by Lohmann *et al*. [34]. 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. BMI was then calculated using the formula weight (kg)/height^2 (m)^2.

2.3 Handgrip Strength

The grip strength of right dominant hand was measured using a Jamar dynamometer at sitting right elbow flexion and extension and standing right elbow flexion and extension positions. The dynamometer was held freely without support, not touching the subject's trunk. The subjects were asked to put maximum force on the Jamar dynamometer thrice from the right dominant hand. The maximum value was recorded in kilograms. Anthropometric equipment and Jamar dynamometer were calibrated before the assessment. All subjects were tested after 3 minutes of independent warm-up. Thirty seconds time interval was maintained between each handgrip strength testing.

2.4 Statistical analysis

Descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. Comparisons between female and male students for the measured variables were made using an independent t-test. For correlations linear regressions were applied where handgrip strength was considered to be the dependent variable. Data were analyzed using SPSS (Statistical Package for Social Science) version 20.0. A 5% level of probability was used to indicate statistical significance.

3. Results

Table 1 showed the descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 16-30 years. The maximum handgrip strength was estimated in sitting right elbow flexion position both in females and males (24.21 kg and 38.95 kg respectively), followed by standing right elbow flexion (23.10 kg), sitting right elbow extension (22.57 kg) and standing right elbow extension (22.10 kg) in females and sitting right elbow extension (38.30 kg), standing right elbow flexion (37.56 kg) and standing right elbow extension (37.52 kg) in males. However, statistically significant differences ($p<0.005$-0.001) were found in all variables studied, except age between the two sexes.

The descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 16-20 years were shown in table 2. In females, the maximum handgrip strength was estimated in sitting right elbow flexion position (24.33 kg), followed by standing right elbow flexion (23.67 kg), sitting right elbow extension (22.61 kg) and standing right elbow extension (22.04 kg). In males, the maximum handgrip strength was estimated in sitting right elbow extension position (37.84 kg), followed by sitting right elbow flexion (37.04 kg), standing right elbow extension (36.6 kg) and standing right elbow flexion (36.70 kg). Nevertheless, statistically significant differences ($p<0.001$) were found in all variables studied, except age and BMI between females and males.

Table 3 showed the descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 21-25 years. The maximum handgrip strength was estimated in sitting right elbow flexion position both in females and males (25.43 kg and 40.63 kg respectively), followed by standing right elbow flexion (25.00 kg), sitting right elbow extension (24.25 kg) and standing right elbow extension (23.74 kg) in females and sitting right elbow extension (39.05 kg), standing right elbow extension (38.48 kg) and standing right elbow flexion (38.22 kg) in males. Nonetheless, statistically significant differences ($p<0.039$-0.001) were found in all variables studied, except age between females and males.

Table 1: Descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 16-30 years

Variables	Females		Males		t- value	p- value
	Mean	SD	Mean	SD		
Age (year)	22.90	3.99	23.23	4.05	0.454	0.650
Height (cm)	159.07	6.25	172.63	6.40	11.745	**<0.001**
Weight (kg)	54.37	10.32	70.00	9.12	8.226	**<0.001**
BMI (kg/m^2)	21.82	3.49	23.51	2.97	2.851	**<0.005**
HGSSEF (kg)	24.21	3.87	38.95	6.12	15.776	**<0.001**
HGSSEE (kg)	22.57	4.37	38.30	6.41	15.704	**<0.001**
HGSSTEF (kg)	23.20	4.02	37.56	5.90	15.579	**<0.001**
HGSSTEE (kg)	22.10	4.17	37.52	6.38	15.664	**<0.001**

HGSSEF = handgrip strength in sitting elbow flexion, HGSSEE = handgrip strength in sitting elbow extension, HGSSTEF = handgrip strength in standing elbow flexion, HGSSTEE Handgrip strength in standing elbow extension.

Table 2: Descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 16-20 years

Variables	Females		Males		t- value	p- value
	Mean	SD	Mean	SD		
Age (year)	18.55	1.14	19.05	1.05	1.439	0.158
Height (cm)	156.55	6.15	173.15	7.33	7.759	**<0.001**
Weight (kg)	54.05	12.75	69.05	11.68	3.880	**<0.001**
BMI (kg/m^2)	21.85	4.03	23.00	3.29	0.949	0.348
HGSSEF (kg)	24.33	4.18	37.04	6.28	7.536	**<0.001**
HGSSEE (kg)	22.61	5.31	37.84	6.55	8.077	**<0.001**
HGSSTEF (kg)	23.67	4.17	36.70	5.25	8.689	**<0.001**
HGSSTEE (kg)	22.04	4.57	36.96	6.05	8.796	**<0.001**

Table 3: Descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 21-25 years

Variables	Females		Males		t-value	p- value
	Mean	SD	Mean	SD		
Age (year)	22.60	1.57	22.45	1.32	0.327	0.745
Height (cm)	160.25	7.02	172.50	5.01	6.353	**<0.001**
Weight (kg)	55.35	8.75	70.45	7.74	5.778	**<0.001**
BMI (kg/m^2)	21.58	3.35	23.71	2.93	2.142	**<0.039**
HGSSEF (kg)	25.43	3.60	40.63	5.72	10.046	**<0.001**
HGSSEE (kg)	24.25	3.68	39.05	5.27	10.293	**<0.001**
HGSSTEF (kg)	25.00	3.52	38.48	5.33	9.442	**<0.001**
HGSSTEE (kg)	23.74	4.11	38.22	4.77	10.286	**<0.001**

Table 4: Descriptive statistics of handgrip strength in different positions and anthropometric variables in Indian population aged 21-25 years

Variables	Females		Males		t- value	p- value
	Mean	SD	Mean	SD		
Age (year)	27.55	1.70	28.20	1.73	1.196	0.239
Height (cm)	160.40	4.91	172.25	6.93	6.235	**<0.001**
Weight (kg)	56.70	9.39	71.50	7.80	5.058	**<0.001**
BMI (kg/m^2)	21.99	3.21	23.81	2.75	1.931	0.061
HGSSEF (kg)	22.85	3.54	39.19	6.10	10.355	**<0.001**
HGSSEE (kg)	20.86	3.41	38.02	7.47	9.341	**<0.001**
HGSSTEF (kg)	20.93	3.37	37.50	7.10	9.424	**<0.001**
HGSSTEE (kg)	20.51	3.29	37.38	8.34	8.592	**<0.001**

Table 5: Linear regressions of handgrip strength in different positions with selected anthropometric variables in Indian population

Variables	Sitting right elbow flexion		Sitting right elbow extension		Standing right elbow flexion		Standing right elbow extension	
	Beta	Sig	Beta	Sig	Beta	Sig	Beta	Sig
Age (year)	0.098	0.167	-0.046	0.334	-0.034	0.517	0.012	0.783
Height (cm)	-0.147	0.523	0.267	0.082	-0.193	0.259	-0.076	0.604
Weight (kg)	0.241	0.449	-0.363	0.089	0.253	0.287	0.191	0.344
BMI (kg/m^2)	-0.632	0.470	1.128	**<0.053**	-0.723	0.646	-0.574	0.299

The descriptive statistics of handgrip strength in different positions and anthropometric variables aged 26-30 years were shown in table 4. In female students, the maximum handgrip strength was estimated in sitting elbow flexion position (22.85 kg), followed by standing elbow flexion (20.93 kg), sitting elbow extension (20.86 kg) and standing elbow extension (20.51 kg). In male students, the maximum handgrip strength was estimated in sitting elbow flexion position (39.19 kg), followed by sitting elbow extension (38.02 kg), standing elbow flexion (37.50 kg) and standing elbow extension (37.38 kg). However, statistically significant differences ($p<0.001$) were found in all variables studied, except age and BMI between female and male students.

Table 5 showed the linear regressions of handgrip strength in different positions with selected anthropometric variables. Nevertheless, statistically significant positive correlation ($p<0.001$) were found between handgrip strength in sitting elbow extension and BMI only.

4. Discussion

In the present study, right dominant handgrip strength was measured in four different positions, viz. sitting right elbow flexion and extension and standing right elbow flexion and extension in females and males aged 16-30 years. It was found that handgrip strength with sitting right elbow flexion was the maximum both in females and males in all the three age groups studied and the minimum was with the position of standing right elbow extension. The findings were not compared as no such earlier study was reported. The present study was methodology study in nature.

Statistically significant sex differences were noted for all the variables studied in all the age groups, except age. The findings of the present study followed the same direction with the findings of Koley and Milton [35]. Males have higher mean values in all the anthropometric variables than their female counterparts. It was, in fact, reported earlier that men possessed considerably greater strength than women for all muscle groups tested. Women scored about 50% lower than men for upper body strength and about 30% less for leg strength [36].

In the present study, significant positive correlation ($p<0.001$) was found between handgrip strength with sitting right elbow extension and BMI only. In fact, sitting and standing right elbow flexion and standing right elbow extension had negative impact with height. When height was increased by 1 cm, sitting right elbow flexion was decreased by 14.7%, standing right elbow flexion was decreased by 19.3% and standing right elbow extension was decreased by 19.1%, but sitting right elbow extension was increased by 26.7%. In case of body weight, the trend was reverse. When weight was increased by 1 kg, sitting right elbow flexion was increased by 24.1%, standing right elbow flexion was increased by 25.3% and standing right elbow extension was increased by 19.1%, whereas, sitting right elbow extension was decreased by 36.3%.

Sartorio *et al.* [37] in their study reported that age dependent increase of handgrip strength in males and females were strongly associated with changes of muscle mass during their childhood.

Small sample size was one limitation of the study. Future studies are required to validate the study.

5. Conclusion

The findings of the present study would be of great value in estimating of handgrip strength and in physical therapy treatment strategies. In order to properly diagnose various musculoskeletal deformities, especially related to upper extremities, and for their rehabilitation, the assessment of handgrip strength in different positions is essential.

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