An Association of Hand Grip Strength with Height, Weight and BMI in Boys and Girls aged 6-25 years of Amritsar, Punjab, India

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Citation

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Abstract

The present study is based on the association of hand grip strength (both left and right) with height, weight and BMI on randomly selected 600 normal healthy individuals(300 boys and 300 girls) aged 6-25years of Amritsar, Punjab. The findings of present study indicate a strong association of right and left hand grip strength with height (r=0.925 and 0.927 respectively in boys and r=0.800 and 0.786 respectively in girls), weight (r=0.882 and 0.878 respectively in boys and r=0.698 and 0.690 respectively in girls) and with BMI (r=0.636 and 0.632 respectively in boys and r=0.477 and 0.472 respectively in girls).

INTRODUCTION

Hand grip strength is a physiological variable that is affected by a number of factors including age, gender and body size among others. The power of hand grip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal biokinetic conditions. Strong correlations between grip strength and various anthropometric traits, (weight, height, hand length etc.) were reported earlier [1,2]. In fact, 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 [3]. Right and left hand grip strength was positively correlated with weight, height and body surface area [4]. In case of relationships of hand grip strength with stature, weight, arm and calf circumferences and various subcutaneous skinfolds, it was found that boys attained greater values for these anthropometric variables and also had greater hand grip strength values than their girl counterparts [5]. It was found too, that age dependent increase of hand grip strength in boys and girls as well as inter-gender differences were strongly associated with changes of fat free mass during their childhood [6]. Hand grip strength is found to be a significant determinant of bone mineral content and bone area at the forearm sites and has a positive correlation with lean body mass and physical activity. It determines the muscular strength of an individual [7]. Hip/waist circumferences measurement is a good marker of fat mass, bone mineral content and lean mass which are strongly correlated with maximum isometric grip force [8]. The assessment of hand grip strength assumes importance in a number of situations. It may be used in the investigation and follow – up of patients with neuromuscular disease [9]. It is also of use as functional index of nutritional status [10,11,12] and can predict the extent of complications following surgical intervention in hospitalized patients [13]. The information regarding the association of hand grip strength and height, weight and BMI is scanty from India, especially covering vast age groups, so the present study was planned.

MATERIALS AND METHODOLOGY

The present study is based on the sample of 600 normal, healthy individuals (300 boys and 300 girls) aged 6–25 years of Amritsar, Punjab, India. The subjects in each age group were selected randomly, with 15 boys and 15 girls in each age group from D.A.V Public school and Guru Nanak Dev University, Amritsar, Punjab, India. The age of the subjects were recorded from the records of their respective institutes, the subjects were divided in such a way that <>, for instance refers to the children aged 5 years and 6 months through 6 years and 5 months and 29 days.

Three anthropometric traits, viz. height, weight and BMI, and right and left hand grip strength were taken on each subject. The height (to the nearest 0.1 cm) and weight (to the nearest 0.1 kg) of the subjects were measured using the techniques provided by Weiner and Lourie [14]. 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. Student's t test and Pearson's coefficient of correlation were used for statistical analyses.

RESULTS AND DISCUSSION

The distribution of mean values and standard deviations of height in boys and girls of Amritsar aged 6-25 is shown in Table 1. In boys, the maximum mean value (176.05cm) was noted in age group 20+ years and the minimum (113.19 cm) in age group 6+ years. Whereas, in girls, the maximum mean value (159.63cm) was observed in age group 19+ years and the minimum (118.08 cm) in age group 6+ years. Highly significant differences ($p<0.001$) were found in age group 15+ years (t=4.90), 16+ years (t=6.45), 17 years (t=6.89), 18+years (t=11.24), 19+years (t=7.07), 20+years (t=8.40), 21+years (t=5.24), 22+years (t=6.51), 23+ years (t=7.45), 24+years(t=8.75) and 25+years (t=7.30) and statistically significant differences ($p< 0.05$) were noted in age group 6+ years (t=2.31) between boys and girls.

The distribution of mean values and standard deviation of weight in boys and girls of Amritsar aged 6-25 is shown in Table 2. In boys, the maximum mean value (71.42 kg) for this trait was noted in age group 24+ years and the minimum (18.86 kg) in age group 6+ years and in girls, the maximum mean value (54.37 kg) was recorded in age group 25+ years and the minimum (18.47 kg) in age group 6+ years. Highly significant differences ($p<0.001$) were found in the age group 17+ years (t=4.91), 18+ years (t=4.12), 19+ years (t=4.06), 20+ years (4.13), 22+ years (t=3.66), 23+ years (t=4.74), 24+years (t=5.90) and 25+years (t=4.07) and statistically significant differences ($p< 0.05$) in age group 16+ years (t=2.66) and 21+years (t=3.22) among them.

Table 3 shows the distribution of mean values and standard deviation of BMI in boys and girls of Amritsar aged 6-25 years. In boys, the maximum mean value (24.00 kg/m ^{2}) was recorded in age group 24+ years and the minimum (12.92 kg/m ^{2}) in age group 9+ years. In girls, the maximum mean value (21.80 kg/m ^{2}) was observed in age group 25+ years and the minimum (12.42 kg/m ^{2}) in age group 9+ years. However, statistically significant differences ($p<0.05$) were found only in age group6+ years (t=2.87) and 24+ years (t=2.79) among them.

Figure 1

Table 1: Distribution of mean values and standard deviations of height (in cm) in boys and girls of Amritsar aged 6-25 years.

Age group (Years)	Boys Mean	S.D.	Girls Mean	S.D.	t -value
6 +	113.19	3.72	118.08	7.30	2.31*
7+	118.85	4.62	119.13	5.30	0.15
8+	122.99	5.22	123.73	6.96	0.33
9+	127.90	6.96	129.42	6.86	0.60
10+	132.57	5.17	134.28	6.33	0.81
11+	139.03	5.75	142.16	7.17	1.32
12+	144.15	5.60	147.55	7.83	1.37
13+	152.41	7.54	148.70	4.27	1.66
14+	159.02	8.20	155.62	5.35	1.34
15+	168.20	7.61	156.83	4.74	4.90**
16+	171.36	5.98	156.16	6.89	6.45**
17+	172.48	4.57	157.23	4.35	6.89**
18+	174.21	4.91	158.89	5.12	11.24**
19+	172.70	6.27	159.63	5.05	7.07**
20+	176.05	5.65	156.01	8.72	8.40**
21+	170.00	6.84	159.26	5.75	5.24**
22+	171.22	7.74	158.21	3.99	6.51**
23+	170.82	7.27	155.70	5.03	7.45**
24+	172.59	6.15	158.07	3.81	8.75**
25+	172.72	7.26	157.15	5.79	7.30**

* Indicates P≤0.05 ; ** indicates P≤0.001

Figure 2

Table 2: Distribution of mean values one standard deviations of weight (in kg) in boys and girls of Amritsar aged 6-25 years.

Age group (Years)	Boys Mean	S.D.	Girls Mean	S.D.	t -value
6+	18.86	2.42	18.47	3.09	0.39
7+	20.40	2.29	20.6	3.31	0.19
8+	21.33	3.13	24.40	6.63	1.62
9+	21.40	6.85	20.6	4.99	0.36
10+	25.53	3.40	28.73	7.50	1.50
11+	29.20	6.88	31.53	6.96	0.92
12+	33.2	6.68	32.13	9.26	0.36
13+	40.27	9.35	37.40	7.89	0.91
14+	43.4	8.69	43.07	7.55	0.11
15+	53.87	15.21	48.4	13.57	1.04
16+	56.73	10.94	45.4	8.09	2.66*
17+	61.11	6.78	49.23	5.43	4.91**
18+	65.34	12.49	51.00	6.59	4.12**
19+	69.68	11.21	52.50	13.28	4.06**
20+	65.47	11.32	53.95	8.70	4.13**
21+	64.37	10.54	54.32	8.60	3.22*
22+	66.37	13.78	53.79	5.88	3.66**
23+	67.43	10.89	53.32	7.03	4.74**
24+	71.42	11.76	52.63	7.36	5.90**
25+	67.34	12.25	54.37	6.53	4.07**

* Indicates P≤0.05; ** indicates P≤0.001

The distribution of mean values and standard deviation of right hand grip strength in boys and girls of Amritsar is shown in Table 4. In boys, the maximum mean value (43.27 kg) was noted in age group 24+ years and the minimum (8.21 kg) in age group 6+ years. In girls, the maximum mean value (24.96 kg) was observed in age group 21+ years and the minimum (8.78 kg) in age group 6+ years. Highly significant differences ($p<0.001$) were found in the age groups 12+ years (t=5.19), 14+ years (t=4.69), 15+ years (t=7.13), 16+ years (t=14.40), 17 years (t=8.67), 18+years (t=9.40), 19+years (t=8.17), 20+years (t=12.21), 21+years (t=11.33), 22+years (t=6.05), 23+ years (t=13.41), 24+years (t=11.56) and 25+years (t=9.07) and statistically significant differences ($p<0.05$) were noted in age group 11+ years (t=2.33) between boys and girls.

Figure 3

Table 3: Distribution of mean values one standard deviations of BMI (in kg/m2) in boys and girls of Amritsar aged 6-25 years.

Age group (Years)	Boys Mean	S.D.	Girls Mean	S.D.	t-value
6+	14.67	1.27	13.24	1.47	2.87*
7+	14.40	0.91	14.45	1.51	0.12
8+	14.10	1.99	15.71	2.94	1.76
9+	12.92	2.79	12.42	2.57	0.50
10+	14.53	1.81	15.80	3.36	1.30
11+	15.19	2.28	15.59	2.18	0.50
12+	15.92	2.82	14.53	2.81	1.36
13+	17.23	3.49	16.86	3.16	0.31
14+	17.05	2.51	17.78	2.54	0.79
15+	18.79	4.13	19.32	4.80	0.32
16+	19.72	3.47	18.53	2.48	1.08
17+	20.35	3.69	19.61	2.30	1.02
18+	22.21	3.40	22.21	1.97	.00
19+	23.42	3.09	20.97	4.62	1.91
20+	21.96	2.67	21.30	3.05	.71
21+	22.62	3.07	21.54	3.31	1.05
22+	22.54	3.67	21.49	2.46	1.03
23+	23.05	3.14	22.02	3.12	1.01
24+	24.00	3.78	20.96	2.89	2.79*
25+	22.76	3.29	21.80	2.02	1.09

* Indicates P≤0.05; ** indicates P≤0.001

Figure 4

Table 4: Distribution of mean values one standard deviations of right hand grip strength (in kg) in boys and girls of Amritsar aged 6-25 years.

Age group (Years)	Boys Mean	S.D.	Girls Mean	S.D.	t -value
6+	8.21	2.27	8.78	1.55	0.81
7+	9.54	1.73	9.44	0.85	0.20
8+	10.93	2.21	11	2.61	0.08
9+	13.05	2.40	12.77	2.24	0.33
10+	14.15	2.61	13.41	3.11	0.71
11+	16.62	3.13	14.09	2.80	2.33*
12+	19.75	3.07	14.45	2.49	5.19**
13+	18.4	3.87	18.3	3.29	0.08
14+	27.32	5.3	19.55	3.6	4.69**
15+	33.6	5.52	19.65	5.19	7.13**
16+	37.24	3.40	20.05	3.13	14.40**
17+	38.11	3.42	21.52	3.55	8.67**
18+	38.64	6.34	22.76	3.75	9.40**
19+	40.31	6.96	24.13	5.11	8.17**
20+	40.41	4.69	22.76	4.21	12.21**
21+	40.24	5.10	24.96	2.91	11.33**
22+	37.51	9.27	23.83	3.34	6.05**
23+	41.15	4.15	23.79	3.81	13.41**
24+	43.27	7.46	21.85	3.10	11.56**
25+	40.08	6.99	23.59	3.73	9.07**

* Indicates P≤0.05; ** indicates P≤0.001

Figure 5

Table 5: Distribution of mean values one standard deviations of left hand grip strength (in kg) in boys and girls of Amritsar aged 6-25 years.

Age group (Years)	Boys Mean	S.D.	Girls Mean	S.D.	t -value
6+	7.35	1.66	8.63	1.40	2.27*
7+	8.83	1.01	8.64	0.86	0.53
8+	10.06	1.94	9.81	2.62	0.30
9+	11.6	2.48	11.27	1.91	0.41
10+	12.97	2.25	12.09	2.85	0.95
11+	15.56	2.92	12.49	2.68	2.99*
12+	18.35	3.34	12.96	2.33	5.13**
13+	17.77	3.86	16.1	2.48	1.41
14+	25.09	4.83	17.03	3.23	5.37**
15+	30.9	5.05	17.09	4.58	7.85**
16+	34.78	2.90	18.35	2.52	16.56**
17+	36.28	3.51	19.33	3.62	8.53**
18+	38.11	5.90	20.91	2.89	11.41**
19+	39.13	7.28	21.95	4.32	8.84**
20+	39.89	4.56	20.55	4.09	13.76**
21+	38.06	5.69	21.71	3.29	10.83**
22+	38.27	8.03	22.26	3.33	8.02**
23+	39.34	4.73	22.08	3.67	12.56**
24+	42.26	7.64	20.45	3.43	11.36**
25+	37.85	7.06	21.28	3.43	9.20**

* Indicates P≤0.05; ** indicates P≤0.001

Table 5 shows the distribution of mean values and standard deviation of left hand grip strength in boys and girls of Amritsar. In boys, the maximum mean value (42.26 kg) for this trait was noted in age group 24+ years and the minimum (7.35 kg) in age group 6+ years. In girls, the maximum mean value (22.26 kg) was observed in age group 22+ years

Figure 6

Table 6: Correlation coefficient (r) of right and left hand grip strength with height, weight and BMI in boys and girls of Amritsar aged 6-25 years.

Parameters	Right hand Grip strength Boys	Girls	Left hand Grip strength Boys	Girls
Height	0.925	o.800	0.927	0.786
Weight	0.882	0.698	0.878	0.690
BMI	0.636	0.477	0.632	0.472

All the correlation coefficient (r) values are statistically positively significant at 0.01 levels.

and the minimum (8.63 kg) in age group 6+ years. Nevertheless, highly significant differences ($p<0.001$) were found in age group 12+years (t=5.13), 14+ years (t=5.37), 15+ years (t=7.85), 16+ years (t=16.56), 17+ years (t=8.53), 18+years (t=11.41), 19+years (t=8.84), 20+years (t=13.76), 21+years (t=10.83), 22+years (t=8.02), 23+ years (t=12.56), 24+years (t=11.36) and 25+years (t=9.20) and statistically

significant differences ($p<0.05$) were noted in age group 6+ years ($t=2.27$) and in 11+ years ($t=2.99$) between boys and girls.

The correlation coefficient (r) of right and left hand grip strength with height, weight and BMI in boys and girls of Amritsar is shown in Table 6. Highly significant positive correlations ($p<0.001$) were observed between right and left hand grip strength with height ($r=0.925$ and 0.927 respectively in boys and $r=0.800$ and 0.786 respectively in girls), weight ($r=0.882$ and 0.878 respectively in boys and $r=0.698$ and 0.690 respectively in girls) and with BMI ($r=0.636$ and 0.632 respectively in boys and $r=0.477$ and 0.472 respectively in girls).

It was reported earlier that physical performance had a strong association with body strength, shape, size, form and structure of an individual [1,2]. The findings of the present study follows the same direction highlighting a highly significant positive correlation between all the three anthropometric traits measured and right and left hand grip strength in both boys and girls. It was earlier reported by Sartorio et al. [6] that age dependent increase of hand grip strength in boys and girls were strongly associated with changes of muscle mass during their childhood. In case of height, a positive correlation with the hand grip strength can be the result of various factors such as with greater heights that would lead to longer arms, with greater lever arm for force generation, resulting in an efficient amount of force. Chatterjee and Chowdhuri, [4] concluded in the same direction that right and left hand grip strength was positively correlated with weight, height and body surface area. It is also reported that hand grip strength determines the muscular strength of an individual [7]. So, an increase in hand grip strength determines the physical strength of an individual. The findings of the present study would be helpful to search the talents in sports, diagnose various musculoskeletal deformities especially related to upper extremities and many other related fields.

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