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Original Research Article

Effects of Pubertal Age on Handgrip Strength in School going Children of North India

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ABSTRACT

Introduction: Handgrip strength is considered to be the overall physical strength of an individual. The present study was undertaken with the objectives to estimate the grip strength of adolescent school going students of north India aged 11-14 years and to search the age-wise individual contributions of some associated factors to the grip strength.
Methods: The present cross-sectional study is based on randomly selected 280 school going children (140 boys and 140 girls) aged 11–14 years from Amritsar, north India. Three anthropometric variables, viz. height (cm), weight (kg) and percent body fat and dominant right handgrip strength (kg) were measured by standard techniques.
Results: Results indicated that both boys and girls recorded an increase in the mean value of height, body weight and dominant right handgrip strength from 11 – 14 years. Significant differences ($p< 0.05$ - .001) were observed in weight (in 11 years), dominant right handgrip strength (in 12 - 14 years), height (in 11 years) and % body fat (in 11-14 years) between boy and girl students. In age groups11, 12 and 13 years, significant correlations ($p<.05$) were noted between dominant right handgrip strength and height and weight both in boys and girls.
Conclusion: The dominant right handgrip strength continued to be increased both in boys and girls from age group 11 years up to 14 years. This increase in the strength can be attributed to the hormonal changes taking place after entering the pubertal period. In boys, growth hormone and testosterone have more effects on performance levels than girls in puberty.
Keywords: Handgrip strength. Pubertal age. North Indian population. Height. Weight.

INTRODUCTION

The power of handgrip 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[1, 2] which uses several muscles in the hand and the forearm.[3] The estimation of handgrip strength is of immense importance in determining the efficacy of different treatment strategies of the hand and also in hand rehabilitation. Grip strength determines the handedness of an individual, an important field of population variation study. It is often used as an indicator of overall physical strength,[4, 5] hand and forearm muscles performances [6] and as a functional index of nutritional status,[7-12] morbidity and mortality,[13-15] physical performance.[16, 17] It is included in various motor ability measurement test batteries recommended for children.[18- 21]

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.[22- 28] Effects of socio-economic status on handgrip strength were reported.[29, 30]

It was found that boys attained greater handgrip strength values than their girl counterparts.[26, 31] It was found too, that age dependent increase of handgrip strength in boys and girls as well as inter-gender differences was strongly associated with changes of fat free mass during their childhood. [32] 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.[33]

Due to multiple advantages of handgrip strength, it becomes important to have normative values of adolescent school going children whose data is largely unreported, especially in Indian context. The previously done studies have focused on handgrip strength values of Indian adults. Thus the present study was undertaken with the objectives to estimate the grip strength of adolescent school going students of north India aged 11-14 years and to search the age-wise individual contributions of some associated factors to the grip strength.

MATERIALS AND METHODS

The present cross-sectional study is based on randomly selected 280 school going children (140 boys and 140 girls) aged 11–14 years from Janta Girls High School, Prabhakar Senior Secondary School, Amritsar, Punjab, north India. The age of the subjects were recorded from the date of birth registered in their respective institutions. A written consent was obtained from the subjects. 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.

Anthropometric measurements

Three anthropometric variables, viz. height (cm), weight (kg) and percent body fat and dominant right handgrip strength (kg) were measured following standard techniques.[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. Percent body fat was assessed using skinfold measurements taken from four sites, viz. biceps, triceps, subscapular and suprailiac using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest

0.2 mm, and using the Durnin and Womersley skinfold equation.[35]

Handgrip strength measurement

The grip strength of both right and left hands was measured using a standard adjustable digital handgrip dynamometer (Takei Scientific Instruments Co., LTD, Japan) at standing position with shoulder adducted and neutrally rotated and elbow in full extension. The dynamometer was held freely without support, not touching the subject's trunk. The position of the hand remained constant without the downward direction. 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. Anthropometric equipment and handgrip dynamometer were calibrated before each assessment. All subjects were tested after 3 minutes of independent warm-up. Thirty seconds time interval was maintained between each handgrip strength testing.

Statistical analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. One way ANOVA (analysis of variance) was tested for the comparison of data among both the sexes of the students, followed by post hoc Bonferroni test (in the case of significant differences). The results of independent variables (height, weight and percent body fat) as well as dependent variable (right handgrip strength) proved to be normally distributed as per skewness tests. Simple correlation coefficients were used to establish the correlations of dominant handgrip strength with other anthropometric variables in school going students. The individual contributions of the independent variables to the total variability of the dependent variable were calculated by standard techniques.[36] Data were analyzed using SPSS (Statistical Package for Social Science) version 17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 1 shows the descriptive statistics of four anthropometric variables in 11-14 year old boys and girls. Boys recorded an increase in the mean value of height, body weight and dominant right handgrip strength. An increase in % body fat was also observed in boys except in age group of 13 years which recorded a slight decrease. Girls also recorded an increase in the mean values of height, body weight, and % body fat. A general increase in the mean values was observed for dominant right handgrip strength, except in 12 years which showed a slight decrease. Statistically significant differences ($p< 0.05$) were observed in weight (in 11 years), dominant right handgrip strength (in 12 - 14 years) and highly significant differences ($p<.001$) were observed for height (in 11 years) and % body fat (in 11-14 years) between boy and girl students.

Tables 2-5 show the Pearson's correlation coefficients, p- values and R^2 values between dominant right handgrip strength and height, weight and % body fat of 11-14 year old boys and girls. In age groups11, 12 and 13 years, significant correlations ($p<.05$) were noted between dominant right handgrip strength and height and weight both in boys and girls. In age group 14 years, significant correlations ($p<.05$) were found with dominant right handgrip strength and height ($p<.02$) in girl students only. R^2 value showed significant correlations ($p< .006 - .000$) in boys in age group 11, 13 years and in girls ($p< 036 - .001$) in all the age groups.

Table 1. Descriptive statistics of some anthropometric variables and dominant right handgrip strength in boys and girls

Age(years)	**11**		**12**		**13**		**14**	
Sex	**Boys (n = 35) Mean (S.D)**	**Girls (n =35)**	**Boys (n = 35) Mean (S.D)**	**Girls (n = 35)**	**Boys (n = 35) Mean (S.D)**	**Girls (n = 35)**	**Boys (n = 35) Mean (S.D)**	**Girls (n = 35)**
Height (cm)	132.11 (4.60)**	140.67 (8.40)	141.71 (6.17)	142.60 (8.05)	147.51 (8.47)	146.34 (4.05)	152.83 (5.86)	151.04 (5.44)
Weight (Kg)	25.97 (2.52)*	30.13 (6.38)	31.70 (4.89)	33.70 (9.31)	34.77 (6.98)	34.63 (6.38)	39.63 (7.24)	41.53 (8.98)
%Body Fat	18.83 (3.43)**	26.50 (3.38)	21.52 (3.70)**	27.41 (2.82)	20.74 93.17)**	27.59 (2.98)	22.16 (3.83)**	28.46 (3.90)
Dominant Handgrip strength	13.78 (2.47)	14.79 (4.06)	17.35 (4.43)*	13.95 (3.47)	19.01 (4.99)*	15.28 (4.74)	21.82 (3.34)*	17.83 (3.21)

Table 2. Pearson's correlation coefficients, p- values and R^2 values between dominant right handgrip strength and height, weight and percentage body fat of 11 year old boys and girls.

	Boys(n=35)		**Girls(n=35)**	
	Coefficient/ p-value	**Individual contribution / Significant level**	**Coefficient/ p-value**	**Individual contribution / Significant level**
Height	.519 (.016)	32% (.000)	.801 (.000)	64% (.000)
Weight	.528 (.015)	30% (.000)	.758 (.000)	3% (NS)
% Body fat	-.129 (.311)	18% (.01)	.255 (.170)	-
R^2	.804 (.000)		.668 (.003)	

Table 3. Pearson's correlation coefficients, p- values and R^2 values between dominant right handgrip strength and height, weight and percentage body fat of 12 year old boys and girls.

	Boys(n=35)		**Girls(n=35)**	
	Coefficient/ p-value	**Individual contribution / Significant level**	**Coefficient/ p-value**	**Individual contribution / Significant level**
Height	.568 (.014)	32% (.000)	.795 (.000)	63% (.000)
Weight	.544 (.018)	4% (.05)	.250 (.040)	2% (NS)
% Body fat	.011 (.485)	8% (.05)	-.294 (.135)	6% (.05)
R^2	.444 (.081)		.711 (.001)	

Table 4. Pearson's correlation coefficients, p- values and R^2 values between dominant right handgrip strength and height, weight and percentage body fat of 13 year old boys and girls.

	Boys(n=35)		**Girls(n=35)**	
	Coefficient/ p-value	**Individual contribution / Significant level**	**Coefficient/ p-value**	**Individual contribution / Significant level**
Height	.682 (.003)	46% (.000)	.618 (.005)	38% (.000)
Weight	.774 (.000)	15% (.001)	.572 (.010)	2% (NS)
% Body fat	.314 (.128)	5% (.05)	.091 (.369)	8%(.05)
R^2	.661 (.006)	.006	.485 (.041)	

Table 5. Pearson's correlation coefficients, p- values and R^2 values between dominant right handgrip strength and height, weight and percentage body fat of 14 year old boys and girls.

	Boys(n=35)		**Girls(n=35)**	
	Coefficient/ p-value	**Individual contribution / Significant level**	**Coefficient/ p-value**	**Individual contribution / Significant level**
Height	.277 (.150)	-	.517 (.020)	27%(.001)
Weight	.274 (.154)	-	-.336 (.102)	19% (.001)
% Body fat	.220 (.207)	-	-.009 (.486)	4% (NS)
R^2	.091 (.756)		.497 (.036)	

DISCUSSION

It is reported that contractile properties of human skeletal muscles become mature early in infancy.[37] Age is one of the important factors of handgrip strength.[32] It was also reported that considerable increase of grip strength was noted in post-adolescent period, especially in females.[38] Neimpoog *et al*[39] estimated the grip strength during puberty in Thai populations. In the present study an attempt was made to investigate the age-wise contribution of some anthropometric variables as factors that effect on handgrip strength. The results showed that the dominant right handgrip strength continued to be increased both in boys and girls from age group 11 years up to 14 years. This increase in the strength can be attributed to the hormonal changes taking place after entering the pubertal period. In boys, growth hormone and testosterone have more effects on performance levels than girls.[40,41] In boys, the rate of annual increment for handgrip strength was found to be 3.57 kg from age 11 to 12 years, 1.66 kg from age 12 to 13 years and 2.81 kg between age 13 to 14 years and in girls, 0.84 kg decrease between 11 to 12 years, then increase at 1.33 kg between 12 to 13 years and 2.55 kg between 13 to 14 years. Both in boys and girls, handgrip strength had significant correlations with height and weight from age group 11 to 13 years. In boys, the independent parameter height contributed significantly 32% in age 11 and 12 years, 46% in age 13 years to the dependent parameter dominant right handgrip strength. In girls, height contributed significantly 64%

in age 11, 63% in age 12 years, 38% in 13 years and 27% in age 14 years. Weight contributed significantly 30% in age 11 years, and 15% in age 13 years in boys and in girls, 19% in age 14 years only. Percent body fat contributed significantly 18% (negatively correlated) in age 11 years, 8% in age 12 years and 5% in age 13 years in boys and 6% in age 12 years and 8% in age 13 years in girls. So the individual contributions of the independent variables to the dependent variable were the novel part of the study. The limitation of the study was that, only pubertal periods were considered for the study, more age groups covering vast sample size might be considered in the future study.

CONCLUSION

In the present study, considerable increase in handgrip strength was noted in both the sexes in their puberty. Height and weight showed significant contribution to the handgrip strength in almost all the age groups. The findings of the present study may be used as a reference value in hand rehabilitation as well as to set the treatment strategies to regain the grip strength during rehabilitation.

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