

Original Article

CORRELATION OF HAND GRIP STRENGTH WITH ANTHROPOMETRIC VARIABLES AND QUANTIFYING HAND GRIP STRENGTH IN CHILDREN OF AGE 3 - 5.5 YEARS WITH MARTIN VIGORIMETER IN INDIAN POPULATION

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ABSTRACT

Background: Hand grip strength is an important quantitative measure in evaluation of hand which is also considered as a predictor of general health status. Influence of various anthropometric variables on Hand Grip Strength has been studied in adult population. Martin Vigorimeter is a simple instrument which is considered to be appropriate for measuring hand grip strength in the age group 3-5.5 years for which norms have been established in Caucasian population. This study aims to analyse the correlation of hand grip strength with anthropometric variables and to quantify grip strength in children of age 3-5.5 years using Martin Vigorimeter in Indian population.

Methods and Methodology: 211 children from five schools were included in this cross sectional study after getting consent from the principal of the schools. The anthropometric variables height, weight, BMI, hand anthropometric variables were measured. Hand grip strength was measured using Martin Vigorimeter, three trials were measured and best of the three was taken as the standard grip strength on both right and left sides.

Results: Pearson's correlation was used to analyse the relation between hand grip strength and anthropometric variables which showed a positive correlation between BMI and hand grip strength and independent t-test was used to compare hand grip strength of Indian and Caucasian population which showed a significant decrease in hand grip strength in Indian population with a p value <0.05.

Conclusion: The study concludes that anthropometric variables should be considered while quantifying hand grip strength. A significant decrease in hand grip strength in Indian population when compared to Caucasian population demands a need to evaluate the cultural sensitivity of such instruments prior to clinical usage and to interpret clinically.

KEY WORDS: Hand Grip, Strength, Vigorimeter, Anthropometric Variables.

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INTRODUCTION

The human hand is an inexplicable tool which serves us extremely well in multitude of ways. Human hand is capable of complex and precise functions which can be divided into grasping

abilities and manual dexterity. The power grip is grasping of an object against the palm with the isometric motion where as manual dexterity is the ability to make coordinated hand and finger movements to grasp and manipulate objects [1]. Grip strength is the result of

forceful flexion of the finger joints with a maximal voluntary force that the subject is able to exert under normal biokinetic conditions [2].

Hand grip strength is an important component to perform precise and refined fine motor activities. These fine motor skills start developing as the child grows but precise need of these skills increases when the child starts performing activities such as drawing, feeding etc. As the child grows there will be increased demand for performing fine motor activities, which forms an integral part of the child's motor development.

Hand grip strength is influenced by multiple factors such as age, gender and body size [3]. Studies done in adult population on anthropometric variables and hand grip strength showed a positive relation between them such as BMI, hand anthropometric variables [4,5,6]. The relation of the anthropometric variables and hand grip strength below 6 years of age is not explored which demands the need to know their influence on hand grip strength.

Quantification of hand grip strength is important in determining the efficiency of various treatment strategies in rehabilitation of hand and to monitor prognosis. The commonly used instruments for measuring hand grip strength are Jamar dynamometer, Lode dynamometer, Pneumatic squeeze dynamometer, Harpenden dynamometer, Isometric strength testing unit, Rotterdam Intrinsic Hand Myometer (RIHM), Grip track dynamometer [7,8] for which norms are established in adults. Certain limitations were observed while measuring the grip strength with the above mentioned dynamometers such as inappropriate size, weight of the instrument etc., when used in younger population. An ideal instrument which is suitable for measuring the hand grip strength in children of age 3-6 years has not been recognized.

Martin Vigorimeter is a type of dynamometer used to measure the grip strength which could be an appropriate instrument for measuring hand grip strength in children due to its easy construct and handling which enables the children to understand and perform easily. Literature gives norms for the Martin Vigorimeter from the age group of 3 which have been quantified in Caucasian populations, [9]

which may not be appropriate to apply clinically in Indian population due to cultural and ethnic variations.

This study aims to find out the relationship of anthropometric variables with hand grip strength and quantify hand grip strength using Martin Vigorimeter in children of 3- 5.5 years in Indian population. The results of the study will help the physical therapist to evaluate and quantify hand grip strength in children with abnormal pathological or structural impairments of the upper extremities by which one can be guided in the rehabilitation and monitor the prognosis.

MATERIALS AND METHODS

This cross sectional study involves children from age 3-5.5 years as subjects to find the correlation between anthropometric variables with hand grip strength and to quantify hand grip strength in the same population. This study has been approved by the Ethics committee for Student's proposals (CSP/13/OCT/31/162) Sri Ramachandra University, Tamil Nadu, India.

The subjects were recruited from schools in Chennai. Five schools were approached to conduct the study and permission was obtained from the principal of the school. 211 children of both genders in the age group from 3-5.5 years were included in this study and children with Neurological impairments, Musculoskeletal impairments of upper limb and Congenital deformities were excluded from the study.

INSTRUMENTATION:

MARTIN VIGORIMETER: The Martin Vigorimeter is a device developed in the late 1970s, used to assess the spherical grip strength of children. It consists of a set of three rubber bulbs of different sizes (diameters of 4 cm, 5 cm, and 6 cms) and a dial that records the strength of spherical grasp. The smallest bulb was used as it was found to be effective for the younger children. The air pressure within the bulb is recorded in kilo pounds per square centimeter on a manometer via a rubber connection (1 kp/cm² = 98.1 kPa). The dial on the manometer has an arrow that rotates and stops at the highest point of pressure exerted and then maintains the readings to allow for accurate recording.

ANTHROPOMETRIC MEASUREMENTS: The height is measured by the stadiometer or the height rode, weight is measured by the weighing machine. [Weight (kg)/ Height (m²)] was used to calculate Body Mass index. Hand breadth is measured from the radial side of metacarpal (index finger) to ulnar side of metacarpal (small finger). Hand span is measured from the tip of the thumb to the tip of the small finger with the hand opened as wide as possible. Hand length is measured from the tip of the middle finger to the distal wrist crease.

PROCEDURE: The children of 3-5.5 years age who met with inclusion criteria were taken as the sample for the study. The dominance of hand is found by using Edinburgh Handedness Inventory. The anthropometric measurements were measured and hand grip strength is measured by Martin Vigorimeter. The child is made to sit on a child size chair that allowed their feet to be flat on the floor. The upper extremity to be tested is positioned so that shoulder is adducted and neutrally rotated; elbow is flexed at 90 degrees, forearm in neutral and wrist in 30 degrees of extension, maintained by the elbow and wrist on the table. The Vigorimeter bulb is placed in the palm of the child and the fingers are wrapped around the bulb thumb opposed to the middle or the ring finger and asked to press the bulb as much as possible. Three trails were taken for each hand with rest period between each trail by performing alternately on left and right hands to prevent fatigue and the measurements were taken, best of the three was taken as the grip strength value.

The children were grouped into 5 groups with age as reference as follows Group I (3- 3.5 years), Group II (3.6 -4 years), Group III (4- 4.5 years), Group IV (4.6 -5 years), Group V (5- 5.5 years)

Martin Vigorimeter



Grip strength of right hand using martin vigorimeter:



STATISTICAL ANALYSIS AND RESULTS:

Pearson's correlation was used to analyse and establish the correlation between hand grip strength and anthropometric variables, Independent t-test was used to find the significant difference between Caucasian and Indian populations.

The mean grip strength of male population is greater than the grip strength of female population which says that boys are having greater grip strength even in the younger age groups which is shown in the Table 1.

Table 2 shows the mean, standard deviation, r value and p value of BMI and grip strength in all the five groups. The right and left hand grip strength have a significant positive correlation with BMI in all the age groups except left hand grip strength in group I which is shown in Graphs 1&2, but the hand anthropometric variables did not show a positive correlation in all the age groups.

The grip strength of the Indian population is less when compared to the Caucasian population with the significant difference between them with the p value (<0.05) which is shown in the Tables 3&4.

Table 1: Comparison of grip strength in males and females.

GRIP STRENGTH	Sex	N	MEAN	STD. DEVIATION	t value	p value
RIGHT	GIRLS	101	27.37	5.93	-2.32	0.021
	BOYS	110	29.36	6.49		
LEFT	GIRLS	101	25.47	6.11	-2.52	0.012
	BOYS	110	27.67	6.56		

Table 2: Correlation of BMI with right and left hand grip strength.

Group	BMI		N	MEAN	SD	r value	p value
	Grip strength						
Group I	BMI		40	15.37	1.37		
	Grip strength	Right		22.05	3.37	0.353	0.026
		Left		20.2	3.56	0.154	0.343
Group II	BMI		48	15.61	10.91		
	Grip strength	Right		25.71	3.75	0.678	0
		Left		24.13	4.45	0.611	0
Group III	BMI		42	16.42	2.45		
	Grip strength	Right		28.95	5.11	0.789	0
		Left		27.1	5.53	0.761	0
Group IV	BMI		41	17.2	2.68		
	Grip strength	Right		29.76	5.4	0.88	0
		Left		28.05	5.16	0.707	0
Group V	BMI		40	20.01	2.3		
	Grip strength	Right		36.05	3.88	0.568	0
		Left		34.05	4.21	0.509	0.001

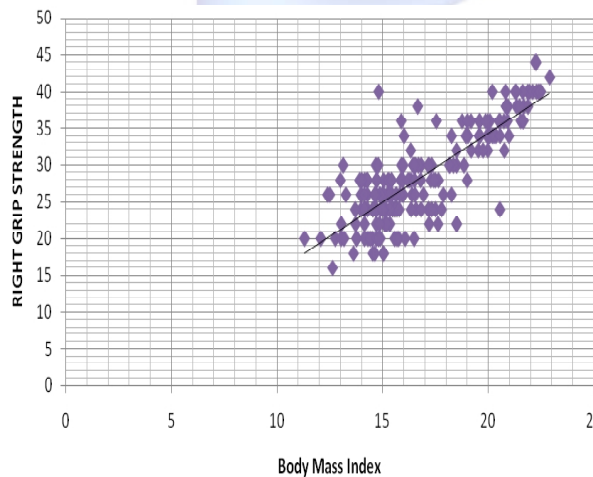
Table 3: Correlation between right handgrip strength of caucasian and indian population.

GROUP		CAUCASIAN POPULATION	INDIAN POPULATION	p VALUE
		GROUP I	M	
	SD	6	3.37	
GROUP II	M	28	25.71	0
	SD	5	3.75	
GROUP III	M	32	28.95	0
	SD	7	5.11	
GROUP IV	M	35	29.76	0
	SD	7	5.4	
GROUP V	M	42	36.05	0
	SD	9	3.88	

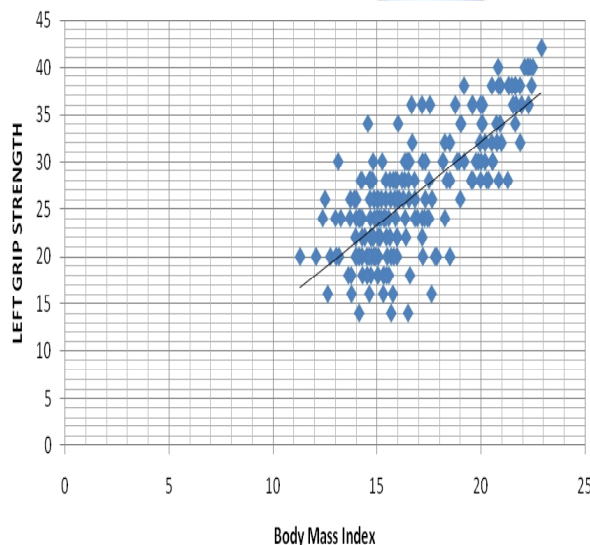
Table 4: Comparison between left handgrip strength of caucasian and indian population.

GROUP		CAUCASIAN POPULATION	INDIAN POPULATION	p VALUE
		GROUP I	M	
	SD	5	3.56	
GROUP II	M	27	24.13	0
	SD	5	4.45	
GROUP III	M	31	27.1	0
	SD	7	5.53	
GROUP IV	M	34	28.05	0
	SD	6	5.16	
GROUP V	M	40	34.05	0
	SD	10	4.21	

Graph 1: Correlation of BMI with right hand grip strength.



Graph 2: Correlation of BMI with left hand grip strength.



DISCUSSION

Quantification of hand grip strength plays a vital role in framing goals in hand rehabilitation and to monitor prognosis. The increased hand grip strength in male children when compared to female children of the same age group suggests that even in the younger age group gender difference in hand grip strength is evident which is in contrast with the result done by Lisa Link et al 1995 which did not show any gender difference.

Correlation between BMI and hand grip strength showed a positive correlation in all the age groups with a significant p value of <0.05 except for left hand grip strength in Group I. This positive correlation shows that hand grip strength increases as the BMI increases. This interpretation correlates with the study done by S Koley et al., 2007 which concludes that there is a strong association between height, weight and BMI with right and left hand grip strength.

Hand anthropometry did not show positive correlation with hand grip strength with all the groups. Right hand breadth showed positive correlation in Groups II -V but left hand breadth correlated to left hand grip strength only in Group II. Right hand length showed positive correlation with right hand grip strength in Groups I -IV but left hand length correlated only in Group II and Group III. Right and left hand span showed positive correlation with grip strength in all Groups except Group IV. The entire correlations of specific hand anthropometry with hand grip strength showed a varied presentation in contrast with the study done by Mohamed Sherif Sirajudeen et al (2012) in adults with the similar parameters which showed a positive correlation with specific hand anthropometric variables (hand breadth, hand length, hand span, forearm width). The reason for this varied presentation in this age group could be due to the difference in the rate of growth of the child with respect to the hand anthropometry in the age group studied.

The analysis of mean grip strength in all the 5 Groups shows significant statistical difference ($p < 0.05$) with that of the Caucasian population. The difference in the mean grip strength from Group I -V between Caucasian and Indian population are 0.95, 2.29, 3.05, 5.24, 5.95 on right hand and 2.80, 2.87, 3.90, 5.95, 5.95 on left hand. The difference in the mean grip strength in the two populations increases as the age increases which could be due to greater experience of children in the Caucasian population to different toys which demands a lot of throwing, squeezing and grasping activities at an early age. The results of this study go in concordance with study done by Rajani P Mullerpatan et al., (2013) in the age group of 18-30 years which concludes that the decreased grip strength in Indian population might be due to short stature, lower BMI when compared with similar age groups in other continents. Though the construct of Martin Vigorimeter was simple and suitable for children, some children found it difficult to comprehend the instructions, probably due to lack of exposure to such items which also could have an influence on the grip strength.

A study done by P. Deurenberg et al., (2002) to analyse the relationship between BMI and

BF% (body fat percentage) in Asians and Caucasian population concludes that Asian population have a higher body fat percentage at a lower BMI when compared to Caucasian population and body fat percentage was higher for similar BMI values in Asian population. The increased fat percentage and decreased BMI compared to Caucasian population could be the reason for decrease in grip strength as the BMI and grip strength has a positive correlation.

The mean grip strength of right and left side is 28.41 and 26.62. The dominant hand grip is stronger than non dominant which coincides with the results of the study done by Mohamed Sherif Sirajudeen et al., in adult population. A study done by I. C. McManus et al., 1988 to find the development of handedness concluded that though degree of handedness increases over the range of 3-7 years handedness is more or less fixed by the age of three. This is supported by the scores on Edinburgh handedness inventory which showed strong handedness from the age of three and increased hand grip strength on the dominant hand than non dominant in all age groups in this study states that dominance is strongly established by 3 years of age.

Correlation between birth weight and grip strength did not show any association in this study which is in contrast with a study done by JG Barr et al 2010. This study states that greater grip strength in childhood is associated with the larger overall size and muscle mass at birth. Lack of correlation in this study could be due to limited number of subjects with known history of birth weight.

Though Martin Vigorimeter is a standardized measure to assess hand grip strength in the age group of 3- 5.5 years, environmental, cultural and Ethnic variation limit the usage of this instrument with established norms for Caucasian population. Evaluation of cultural sensitivity of such measures should be done prior to clinically using and framing goals based on the results.

CONCLUSION

The results of the study conclude that there is an influence of Body Mass Index on Grip strength in the age group of 3 -5.5 years which conveys that BMI should be considered while

quantifying grip strength in clinical practice.

The decrease in grip strength in Indian population when compared to their counterparts in Caucasian population makes it necessary to evaluate the cultural sensitivity for a specific region or ethnic group especially when the instrument is being used to quantify, diagnose and plan the treatment of a child.

Conflicts of interest: None

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