

ORIGINAL RESEARCH

Anthropometric Evaluation of Hand In Typically Developing Children

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ABSTRACT

Introductio: The advanced technology used in toys development encourages increased hand use. The repetitive demand of hand use if not of proper size could lead to a growing number of cumulative hand injuries. Thus it is important to know hand size- maximum hand span (MHS), maximum grip diameter (MGD) and palm length(PL), hand length(HL), hand length/height ratio (HL/HT) and digit index (DI) in typically developing children of both (right, left hand) in order to decide appropriate toys for the child.

Methods: It is a cross sectional study where typically developing children both the gender (boys, girls) between the age group 3 – 9 yrs were recruited from day care centre and schools of Udupi, Karnataka. Maximum hand span was measured with hand stretched on the standard ruler, maximum grip diameter by holding a graduated cone until the middle finger and thumb only touch and the diameter was measured with vernier caliper, palm length from distal flexion crease of wrist to proximal flexion crease of middle finger by inch tape and digit length.

Results: Mean & standard deviation was calculated for each age group. Maximum hand span and maximum grip diameter increases in girls in 6 yr old age group and in boys increases by 8 yr old. Palm length and digit length increases with age (boys> girls) in 8 yr old age group.

Conclusion: There is a linear relationship between age & anthropometric measures of hand.

Keywords: Hand anthropometry, Hand span, Children

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INTRODUCTION

Anthropometrics refers to the measurement of human individual for the purpose of understanding human variation related to arms, hand, legs and foot.^{1,2} Specific anthropometry includes hand dimensions like hand length, hand breadth, palm length, hand span, digit length and grip diameter which is important in the design of various facilities like-hand tools (hammer, spanner, screwdriver), handles of luggage, door and sports equipments in sports like pool, cricket, tennis, badminton, bicycle handle, to handle a hand gun.³ The advanced technology in toy development now relies on and encourages increased hand use.¹ Size of sports equipment available in the market is according to anthropometrics of international population. Improper toy size, sports equipment size and repetitive hand activity can lead to cumulative hand injuries.¹ Proper hand size is required so as to reduce the number of cumulative trauma disorders. Thus knowing hand size could lead to a suitable match of toys, hand tools and training in sports appropriate for the child.

Bear et al. performed a study on hand grip strength and hand size (palm length) among 81 preschoolers using standard conditions for grip strength, pinch strength and hand size. Hand size is the length of third metacarpal bone (palm length) and hand strength were found to increase with each age. The 5 yr olds have strongest grip and pinch ability and larger hands than the 3yr olds and 4 yr olds.^{4,5} Digit length of every digit is measured from the tip to the base of the finger.^{6,7} Hand length is defined as the distance from the tip of the middle finger to the midline of the distal wrist crease when the forearm and hand are supinated on a table. Hand length which is a combined length of the palm as well as the digit length is also one of the important factor affecting grip strength.^{7,8}

Hand length/ height ratio calculated and digit index was derived with 3rd digit length*100 divided by hand length. Koley et al. showed association of grip strength with five anthropometric traits like height, weight, body mass index, hand breadth and hand length on

100 women as laborers and 100 sedentary women in the age group 18-40 years. Significant differences in height, weight, BMI, hand length, hand breadth in right dominant and left dominant female laborers between the age group 18-40 years was found.⁹ In another study in 2008, he compared seven anthropometric measures-hand width, hand length, 3rd digit length, shape index, digit index, palmar length/width ratio and hand length/ height ratio and grip strength for a population of different sport groups-basketball, handball and volleyball players. Significant difference was found among hand ball players.⁷ Hand span increases as the hand size and grip strength increases with age. Hand anthropometry-hand size is also a deciding factor for handle span of power tools. Large handed subjects used a handle span of 6 cm to produce maximum grip strength whereas medium and small handed subjects used a handle span of 5cm.¹⁰

Anthropometrics data in children in following countries is established- Semproli .S⁶ China - Linghua ran et al,¹¹ U.S.A -Huh C, Bolch WE,¹² Italy- Jordan - Yunis AA mohammad¹³ and Thai – Bunterngrchit. Thus there is inadequate data received from India about anthropometric parameters in children age 3-9 yr old. Therefore aim of the study was to measure Anthropometric evaluation in typically developing children with normal receptive and language ability which included maximum hand span (MHS), maximum grip diameter (MGD), digit length(DL), palm length(PL), hand length(HL), hand length/height ratio (HL/HT) and digit index (DI).

MATERIAL AND METHODS

This study was reviewed by the Institutional review board of Manipal College of Allied Health Sceinces. In this cross sectional study we used typically developing children with receptive language abilities to understand instructions in both the gender between the age group 3-9 yrs from day care centre in Manipal, Karnataka. Samples were recruited with convenience sampling with sample size 160, divided in to 6 groups based on age (3-3.12, 4-4.12, 5-5.12, 6-6.12, 7-7.12, 8-8.12). Subjects with any neuromuscular disorder or orthopaedic dysfunction that affects skeletal growth were excluded from the study. Subjects were selected based on inclusion and exclusion criteria. Informed consent from parents / teachers and assent from child was taken. Height was documented for each child and the following measurements will

be taken on both the hand. Three trials were measured and average of the three of each parameter was calculated.

PROCEDURE:

1. **Maximum Hand Span:** Measure the linear distance between thumb and little finger with stretched hand placed on ruler.
2. **Maximum Grip Diameter:** Measured by sliding hand down a graduated cone until the thumb and middle fingers only touch. And the space between the thumb and index finger measured with vernier calliper.



Figure- 1: Maximum Hand span



Figure-2: a) grip diameter b) diameter measured with vernier calliper



Figure- 3: Digit length; Figure- 4: palm length

3. **Digit Length:** Measure from the proximal flexion crease at the base of every digit to the tip of that digit.

4. **Palm Length:** Measure from distal flexion crease at wrist and proximal flexion crease of middle finger.
5. **Hand length/height:** Hand length- palm length +digit length of 3rdmetacarpal. Height was measured further was calculated.
6. **Digit index:** 3rdDigit length*100/hand length.

STATISTICAL ANALYSIS

DESCRIPTIVE ANALYSIS: The software used for statistical analysis was SPSS-16. The parameters (MHS, MGD, PL, DL,HL,DI,HL/HT RATIO) were summarized using descriptive statistics.(Mean and Standard deviation). Paired t test was calculated between right and left hand for both the genders boys and girls.

RESULTS

Hand anthropometrics of 160 children was evaluated in which right dominant. Children was 150- right dominant and left dominant 10 children. P value was not significant for any of the parameters.Thus average of the two (rt,lt) hand was taken and mean & standard deviation was calculated.

Maximum hand span- no significant difference from 3-5 yr old age group between boys and

girls.From 6-7 yr old girls >boys. 8 yr old boys >girls. Maximum grip diameter-no significant difference from 3-4 yr old age group, 5 yr old-girls >boys,6 yr old –no difference and 7-8 yr old boys > girls. Palm length- 3-7 yr old age group no significant difference. But 8 yr old age boys >girls. Thumb length no significant difference between 3-7 yr old age group. But in 8 yr old boys>girls. Index finger length- only difference in 6 yr old where girls> boys. And 8 yr old where boys> girls.Middle finger length- no significant difference from 3-4 age group but 5,7 age group girls> boys and 8 yr old boys> girls.Ring finger length-in 4 yr old- girls> boys, 8 yr old –boys> girls and others no significant difference. Little finger length- 6 yr old-girls> boys, 8yr old- boys> girls. And others no significant difference.

SAMPLE SIZE(N)	BOYS	GIRLS
3-3.12	18	16
4-4.12	20	25
5-5.12	19	11
6-6.12	8	10
7-7.12	9	10
8-8.12	10	4

Table 1- Demographic of children

Sample size-160; Right dominant-150 Left dominant-10

age	P VALUE	MHS	MGD	PL	THUMB	IF	MF	RF	LF
3-3.12	boys	0.053	0.29	0.36	0.86	0.16	0.73	0.49	0.18
	girls	0.33	0.81	0.48	0.29	0.38	0.25	0.78	0.46
4-4.12	boys	0.08	0.35	0.83	0.19	0.05	0.73	0.43	0.57
	girls	0.56	0.95	0.48	0.22	0.48	0.93	0.18	0.08
5-5.12	boys	0.69	0.07	0.88	0.23	0.25	0.18	0.05	0.06
	girls	0.53	0.11	0.09	0.93	0.43	0.05	0.05	0.60
6-6.12	boys	0.77	0.05	0.94	0.90	0.27	0.84	0.84	0.80
	girls	0.14	0.37	0.13	0.65	0.07	0.46	0.75	0.94
7-7.12	boys	0.74	0.54	0.05	0.10	0.53	0.80	0.88	0.95
	girls	0.50	0.20	0.34	0.24	0.82	0.38	0.85	0.76
8-8.12	boys	0.77	0.21	0.50	0.75	0.08	0.50	0.85	0.46
	girls	0.92	0.18	0.22	0.64	0.36	0.39	0.60	0.22

Table 2-Paired t test was done between R & L hand readings for all parameters of both the gender (boys, girls)

DISCUSSION

The study was to evaluate anthropometric data in

typically developing children. To our knowledge, there is no study which looked into

the data of anthropometry in India especially in the growing children. 160 normal children in the age Group of 3-9 years were recruited for the study. The subjects were divided in the 6 class intervals (3-3.12, 4-4.12, 5-5.12, 6-6.12, 7-7.12 and 8-8.12).

Dominance is one of the factors affecting anthropometry. We followed the 10% rule where it is always right hand preferred. As the number of subjects for right hand dominance are 150 and left hand dominance are 10, so we ignored the issue of dominance due to small amount of sample size.⁴

Most of the parameters showed no significant difference in 3- 6 yr age group and then the variations in 7-9 yr old. In this study, Maximum hand span and maximum grip diameter increases in girls in 6 yr old age group and in boys increases by 8 yr old. It has been proved pubertal age growth period- for girls-6-13 age group and boys- 8-15 age group. This shows that with increase in age there is increase in hand anthropometrics. Palm length increases with age (in 8 yr old with boys>girls). Bear et al. performed a study on hand grip strength and hand size (palm length) among preschoolers. The 5 yr olds have strongest grip and pinch ability and larger hands than the 3yr olds and 4 yr olds.⁵ Digit length increases with age. This is agreed in our study.

The different toys and its relation to age has been established. Most common toys used are rattles, squeezetoy, blocks, mobile phone, beads, puzzles, ball, musical instrument, crayons and shapes. For all these toys grip is important and it varies with each age group. Thus the grip size has to be standardized and the toys has to be suggested according to each age group and grip size.

For any design anthropometric measurements of right hand is considered. Various hand tools important in daily tasks, toys, sports equipments are designed with these anthropometric measures. So it's important that these parameters are measured with Indian population especially in the age where maturity develops (children). Anthropometric Measures reduces the risk of disorders and is an important part in the hand rehabilitation. Thus incorporating these

parameters would help an efficient tool to be established.

Limitation of the study-It cannot be generalized as it is performed in a small population in a small area. It has to be performed in a mass group of children

CONCLUSION

There is linear co-relation between the age and hand anthropometrics between the age group 3-9 yrs. Through this survey we have analyzed the anthropometric data in children in the age group 3-9 year old. And we understand the importance of anthropometric data to be included in hand evaluation.

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