



# Assessment of Hand strengths and Hand functions in children aged 6-12 years: A cross-sectional study

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## Abstract

**Introduction:** Work activities as well as play and leisure activities require both grip strength and manual dexterity. Moreover, 60% of school activities require fine motor and manual dexterity skills. Assessment of hand function considers an essential part in clinical practice. When it comes to the grip and pinch strengths of children, much less research has been performed in general. Therefore, there is no clear answer as to how hand preference affects grip and pinch strengths in children and adolescents. **Objectives:** To assess hand functions using Sollerman Hand Function Test and to assess hand grip and pinch strength using Jamar Handheld Dynamometer among children aged 6- 12 years. **Purpose of the Study:** To develop normative values of hand grip and pinch strengths and hand function for 6-12 year-old children. **Methods:** Grip and pinch strengths and Hand function was measured in school children using Jamar hand-held dynamometer and Sollerman Hand Function test respectively. **Results:** The grip strength and pinch strength increased of both right and the left hand. Except in the age group 10- 12 years where there is a decrease in the grip and pinch strengths of both boys and girls. **Conclusions:** There is gradual gains in hand grip strength with age in favour of the older children across both genders. Boys had significantly greater hand grip strength for both hands than did girls across all age groups. **Keywords:** Hand function; Hand Grip strength; Hand Pinch strength; children.

## Introduction

An objective score is produced by pinch and grip strength while assessing hand function. Grip strength assessment aids in determining the degree of disability, therapeutic efficacy, and motor development stage. Normative data on grip and pinch strength for kids and teenagers worldwide are, however, hard to come by.(1)

Obtaining normative data for grip strength in adults has been the focus of numerous investigations, since comparing to normative data is crucial for making statements about particular patient groups or treatments. On the other hand, normative data for youngsters are much harder to come by.(2)

The Hand Grip Strength measurement is commonly used by professionals interested in hand strength and function in healthy populations and also in patients with various pathological conditions.(3)

Adults typically estimate that preferred hand is 10% stronger than the non-preferred hand. It's unclear if this also holds true for kids and teenagers. After a review of the literature, no studies were found that looked at whether or not hand preference influences grip strength throughout childhood and adolescence, or whether there are variations in this influence between boys and girls or between young children who have different hand preferences. Thus, we think that the question of how hand choice influences grip strength in kids and teenagers remains unanswered. (4)

Considering it is hypothesized that grip and pinch strength may differ at specific crucial growth milestones, a composite score for the whole paediatric age range may not be useful to clinicians in assessing rehabilitation outcomes. As a result, Hepping AM et al. produced reference values for pinch and grip strength in healthy Indian adolescents and young children who were divided into age-specific groups.(1)

The most efficient way to communicate and carry out the complex activities involved in daily living is with the help of hands (e.g., eating, grooming, and bathing). Grip strength and manual dexterity are necessary for both work and pleasure activities. Additionally, 60% of educational tasks call upon manual dexterity and fine motor

skills. Thus, for children with a variety of illnesses, including trauma, congenital, and neurologic disorders, the evaluation of hand function is a crucial component of physical and occupational therapy. In order to assess the integrity of upper limb functions, evaluate the effectiveness of rehabilitation, and compare scores from typical and atypical children based on age, gender, race/ethnicity, and body measures and other factors, normal data on hand grip strength and manual dexterity are crucial. (5)

The objectives of this study are to establish normative data for hand functions using Sollerman hand function test and to investigate the impact of gender and age on hand strength and hand functions in children aged 6-12 years.

## **Need of study**

Age, gender, and body size are examples of anthropometric, demographic, and dietary characteristics that affect hand grip strength. Numerous studies have documented correlations between age, gender, body mass index (BMI), and dominance and handgrip and pinch strength.

Children's motor skill development can be monitored for delays or anomalies by having their hand strength and function evaluated. It enables doctors and researchers to monitor development and make sure kids are hitting developmental milestones that are acceptable for their age.

Early detection of any impairments in hand strength or function can assist focus therapies and interventions to meet the unique needs of young patients. It has been demonstrated that early intervention is beneficial in enhancing motor abilities and general functionality.

Rehabilitation may be necessary for children with specific medical disorders or traumas in order to restore hand strength and function. It is possible to customize rehabilitation programs for children and ensure the best possible recovery and functional outcomes by studying and comprehending the evaluation measures.

Standardized assessment techniques and norms can be developed through research on hand functions and strength in children aged 6-12 years. These can serve as benchmarks for comparing a kid's performance to that of their peers and offer a thorough assessment of the motor abilities of the child.

Hand functionality and hand strength are necessary for daily tasks including writing, picking up objects, and taking care of oneself. Healthcare providers can make well-informed judgments about treatment plans, modifications, and accommodations for children with particular motor deficits by measuring and evaluating these abilities.

In addition to examining the effects of age, gender, hand dominance, and anthropometric variables on grip and pinch strength, the study of hand strength and function assessment in children aged 6 to 12 years offers important insights into motor development, supports early detection of motor impairments, directs intervention strategies, and improves clinical decision-making for improved functional outcomes in children.

## **Methodology**

This is a cross sectional study that was carried out in 40 primary and high school children for one month. They were decided using purposive sampling. After obtaining permission from the Institutional Ethical committee, written and informed consent was obtained from the parents and the school authorities. The children were divided according to the classes and their samples were collected.

### **1. Sollerman Hand Function Test:**

The test consists of 20 subtests, each comprising a task considered to be an activity of daily living, the performance of which could be easily scored. Each subtest is scored by the examiner on a scale from 4 to 0 points. When testing hand function, the subject is seated in front of the box, which is placed on a table. The test is done with one hand at the time with the exception of subtests 11, 14, and 15 which require both hands. As the upper time limit for each subtest is one minute, the test can usually be completed within 20 minutes(6). Each child was explained the tests and was asked to do a trial test.

### **2. Hand-held Dynamometer:**

Grip and pinch strengths of both dominant and non- dominant hands were taken using the hand held Jamar dynamometer. The procedure was same as described by Mathiowetz *et al.* and as per the recommendations by the American Society of Hand Therapists (ASHT). For measuring grip strength, ASHT recommended a sitting position with the arms close to the torso without rotation, the elbow flexed at 90 degrees, the forearm in neutral position and the wrist slightly extended (0–15 degrees)(7,8) Pinch strength was also measured using the method

proposed by Mathiowetz *et al.* Three types of pinch strengths were assessed. The tip-pinch strength, the lateral pinch strength and the 3-fingered pinch strength. Three trials were taken and the best value among them was noted for statistical evaluation.

After recording the values of hand function and grip and pinch strength, data was documented and analysed further.

## Results

**Table 1:** Demographic characteristics of participants

Age	Boys (n)	Girls (n)
6-7	8	6
8-9	6	4
10-12	8	8

Table no 1 shows the distribution of boys and girls according to various age groups. The no of boys and girls is 8 and 6 respectively, in the age group 6-7 years. It is reduced by 2 in the age group 8- 9 i.e. males (n= 6) and females (n= 4). There is equal distribution of boys and girls in the ages 10- 12, (n = 8).

**Table 2:** Age wise distribution of hand function and hand strength

Age	Hand function (Mean± SD)	Hand strength (Mean± SD)							
		Right hand				Left hand			
	Sollerman hand function (dominant )	Grip strength (kg)	Tip pinch strength (kg)	Lateral pinch strength (kg)	3-fingered pinch strength (kg)	Grip strength (kg)	Tip pinch strength (kg)	Lateral pinch strength (kg)	3-fingered pinch strength (kg)
6-7	74.1 ±3.41	9 ± 2.57	3.1±0.62	2.8 ±0.62	2.6±0.69	8.7±3.4	3.1±0.67	2.6±0.56	2.4±0.75
8-9	76.3 ±3.36	9.2 ±1.03	3.5 ±0.70	3.3 ±1.45	2.9 ±0.73	8.8 ±2.70	3.5 ±0.92	3.1 ±1.63	3 ±1.36
10- 12	78.3±2.27	10.1±2.73	3.5±0.94	3.2±1.03	2.6±1.12	8.9±3.12	3.3±0.14	3±1.09	2.7±1.09

Values of Sollerman Hand function test of the dominant hand increases with age. It is 74.1 for children between 6- 7. It increases to 76.3 in the age group 8- 9 years. And among 10- 12 years it is 78.3. Similarly, the grip strength and all types of pinch strengths increased of both right and the left hand. Except in the age group 10- 12 years where there is a decrease in the grip and pinch strengths of both boys and girls. Though the grip strength of left hand showed increment from 8.8 to 8.9 in the ages 10- 12 years.

## Discussion

In order to detect any potential developmental delays or anomalies, the goal of this study is to produce normative data for hand functions in children aged 6 to 12 by using the Sollerman hand Function Test. Sollerman Hand Function Test was originally developed in 1995 to assess the hand function of tetraplegic patients. It was later used in many other studies for assessing patients of various other neurological problems. this is the first study in

our knowledge that is using the Sollerman Hand Function Test to check the development of hand function in children.

Both genders exhibit a steady increase in hand functions with increasing age. This conclusion is consistent with a study conducted in 2014 by Mohammed Taher Ahmed Omar et al., which gave the normative values of hand grip strength for Saudi Arabian children aged 6 to 12 and compared the findings with previously published Western data. (9). Ours is the first study that assessed the hand functions of children with the Sollerman Hand Function test. Observing the values, we find that there is a direct relationship between age and the hand function. That is, as the age increases, hand function also improves.

The grip strength disparities between boys and girls vary with age, according to Joris JW Ploegmakers et al. (2013), who also found a substantial difference and gradual gains in hand grip strength with age in favour of the older children across both genders (2). Given that we discover variations in the grip and pinch strengths of boys and girls across different age groups, it seems consistent with our findings.

Boys had significantly greater hand grip strength for both hands than did girls across all age groups. At all ages, boys were noticeably stronger than girls. Mohammed T.A. Omar verified it in 2017. According to him, guys always have stronger grips than girls, and the difference does not seem to be consistent across all age groups. The start of puberty and biological maturity (e.g., muscle mass, total body mass, and height) are partially responsible for the gender disparities and acceleration of hand grips around the age of 10 to 12 years. These factors have a significant impact on strength measures, particularly for males.(5)

Wessam Ali Saied Alkholly et al in 2017 stated that hand grip strength which is strong in primary grades due to higher physical performance and pre-pubertal factors and weak in preparatory and secondary grades due to hormonal changes in both genders. (10)

The Sollerman Hand Function Test is designed to assess hand function in individuals. While the test itself is standardized, the difficulty or ease of the test can vary depending on the specific tasks and the child's individual abilities(6). Here are some examples of both easy and difficult tasks within the Sollerman Hand Function Test:

Easy Tasks:

1. Grasping and holding a large, lightweight object such as a wooden block. (test no 5).
2. Turning a doorknob. (test no 17).
3. Opening a jar. (test no 9).
4. Simple fine motor tasks like picking up small objects (e.g., coins). (test no 2).
5. Fastening and unfastening zippers. (test no 3).

Difficult Tasks:

1. Lifting heavy objects like iron. (test no 6).
2. Tightening the screws with the screwdriver. (test no 7).
3. Fastening and unfastening small buttons. (test no 10).

It's important to note that the difficulty of these tasks can vary not only with the specific task itself but also with the child's age, developmental stage, and individual abilities. What may be easy for one child in the 6-12 age range may be challenging for another, so the Sollerman Hand Function Test is often used to assess a range of tasks that gradually progress in difficulty to gain a comprehensive understanding of a child's hand function capabilities.

## **Conclusion**

The present study provides reference values for Hand function among healthy Indian children using Sollerman Hand Function Test aged 6- 12 years. A linear rise in hand function and grip strength is noted from 6 to 12 years. Pinch strength increased from 6 -9 years but was either stagnant or decreased in the age group 10- 12 years. Boys demonstrated greater grip and pinch strength compared to girls in all age groups of both hands.

## **Limitations**

The major limitation of this study is small sample size. Due to small sample size, accurate values of hand function could not be assessed.

Developmental differences between a 6-year-old and a 12-year-old affects grip strength and hand function differently.

Cultural and geographical factors such as urban and rural population can significantly impact a child's hand grip strength and hand function. These factors may not be adequately addressed in the study and can limit the applicability of the findings to diverse populations.

**Conflict of interests:** There are no conflicts of interests.

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