

Exploring Hand Grip and Pinch Grip Strength in Students Attending Secondary School: Evidence from Riyadh, Saudi Arabia

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Abstract

Aim: This study aims to is to evaluate the normative data of hand grip strength and (Palmar, key and tip) of pinch strengths in healthy secondary school students in Saudi Arabia according to their age, gender, height and weight.

Methods: In this cross-sectional study was conducted based on 120 (6-18 years) secondary schools' students in Saudi Arabia (45 boys and 75 girls). Pinch gauge and Electronic Digital Hand Dynamometer (GRIPX) were used to measure strengths of hand grip and pinch grip of the participants.

Results: The strength of hand grip and pinch (key, palmar and tip) are increased along with increased age, gender, height, and weight (p value <0.05). There is also significant relationship between hand grip strengths and pinch strengths (p value <0.05).

Conclusion: This study concluded that hand grip and pinch strengths are positively and significantly associated. These strengths are also significantly associated with some demographic factors including age, height and gender while any differences have not been found between girls and boys.

Keywords: hand grip strength, pinch strength, hand dimensions, hand functions

Introduction

1.1 Background

Among human beings, hands are the most functional part of their upper extremities and are also the most differentiated and sophisticated musculoskeletal tool (1). Due to this reason, from the early childhood stage, it is important to produce enough grip force in order to manage everyday tasks independently and to develop skills including typing, playing, drawing, eating, self-care and leisure skills (2,3). In this particular context, the measurement of hand grip strength (HGS) is essential for understanding upper limb function as well as work capacity. In addition to that, the measurement of pinch strengths along with hand grip is also important for determining efficacy of rehabilitation, identifying level of development and accessing the integrity of upper limb functions (7, 8). The results of these measurements also help to predict any disability in musculoskeletal diseases of humans such as bone mineral density, rheumatoid arthritis, as well as the likelihood of falls and fractures in osteoporosis (9, 13). However, tests of both pinch and hand grip strengths are relatively inexpensive, non-invasive and simple and hence, these tests can be considered as an effective screening tool for the measurement of upper body strength (10, 17). Previous studies have shown that HGS is an independent predictor of certain confounding factors including physical activity and socioeconomic factors (14, 15). It has also been found that weak HGS is associated with high fatality rates in people with major illnesses (11, 16). It has also been known from previous evidence that HSG is linked with muscle strength of some other muscle groups such as lower extremities (10,12).

However, there are limited studies on this field that provide important data particularly for secondary school students in Saudi Arabia. On the other hand, the major weaknesses of these existing studies are that various types of testing procedure used, used instruments were not often tested for reliability for the secondary school students. Apart from that, previous studies have not also indicated the amount of time required for using mobile devices which can be considered a supporting variable. Taking these information gaps into consideration, this current study has aimed to evaluate age and sex reference values of HGS and Pinch grip strengths (PGS) among secondary school students in Saudi Arabia. In this study the time spent on the used electronic devices

have also been taken into consideration. The second objective of this study is to determine whether HGS and pinch strength are related to anthropometric characteristics and physical capacity of the individuals.

1.2 Strategy of Research

This study has been conducted based on secondary data gathered from published relevant papers. In this particular context, three online databases including CINAHL, Cochrane Library and PubMed have been used to search for the most relevant papers. A number of relevant keywords, as well as some specific inclusion and exclusion criteria have been used. As per these inclusion criteria, only the relevant articles published between 2000-2021 have been considered for this research. Apart from that only full text articles published in the English language have been used. Moreover, the papers where only different clinical and primary tests such as clinical trials, interventional studies or observational study were conducted, have been included in this present research.

2. Purpose of the Study

The key purpose of this study is to evaluate the normative data of hand grip strength and three types of pinch strengths including Palmar, key and tip in healthy secondary school students in Saudi Arabia.

2.1 Hypothesis

Alternative Hypothesis (H1): Hand grip strength has a significant present relationship with pinch strength of secondary school students and their demographic characteristics.

Null Hypothesis (H0): Hand grip strength has no significant present relationship with pinch strength of secondary school students and their demographic characteristics.

3. Methodology

3.1. Study design and Participants

A cross-sectional study has been conducted in Saudi Arabia with a total of 120 apparently healthy secondary school students. Both male and female students between 6 and 18 years old have been included in this study. These participants have been selected randomly from parks, malls, and shopping centers in different areas of Saudi Arabia.

3.2. Measurement

In the selected studies, the researchers have collected different demographic data of the participants including gender and age. In addition to that, hand dominance of the individuals was determined based on the reported preference for use in daily living activities such as eating, writing, throwing, playing, closing or opening doors and so on.

The HGS of these individuals were measured with the use of a standard adjustable hand dynamometer (GRIPX-EH101). On the other hand, pinch strength of the participants was measured using a Hydraulic Pinch Gauge (BASELINE) considering three trials (Tip, Key and Palmar Pinch) for both non-dominant and dominant hands. The HGS and PGS were tested when the participants were in a sitting position with shoulder neutrally rotated and abducted, the wrist and forearm in neutral position and elbow at 90-degree flexion (5). All these participants were instructed to squeeze the dynamometer's handle as hard as they could and to sustain the effort for a minimum of 5 seconds (1,4,6). In this particular context, the attempts included switching their hands with around 2 minutes of rest in each attempt for reducing fatigue in the participants (4,6). During this training, if any participant failed to hold the correct position, they were paused by the researchers and were being involved in the next trial. In these trials, the HGS of the participants were assessed first followed by the tests of palmar, tip and key pinch.

3.3. Exclusion criteria

Any individual with any cognitive, musculoskeletal and neurological disorders, functional limitations or pain in upper limbs, global delayed milestones and inability to properly understand the specific test procedure were excluded from the research. However, all the included participants as well as their parents signed a consent form before participation to ensure that they were not forced to be involved in the study.

3.4. Sample size

The population of the study consisted of 120 healthy secondary school students in Riyadh, Saudi Arabia, having ages between 6 to 18 years. Among this sample, 45 participants were male and the rest of them (75) were female. However, the majority of these included participants were right-handed.

Ethical Consideration: Research and Ethics Committee of the physical therapy department at applied sciences of Prince Sattam Bin Abdul-Aziz University has approved this study.

3.5. Statistical analysis

The collected quantitative data have been analysed using SPSS (Statistical Package for the Social Sciences) software. An independent t-test and Fisher's exact test have been carried out to calculate baseline differences among both genders for continuous data and categorical data respectively. In addition to that, Spearman's rank correlation analysis has been performed to determine the relationship of HGS and PGS with anthropometric and socio-demographic data. Moreover, multiple linear regression analysis has been performed to show the association between the level of changes in PGS and HGS accounts and changes in anthropometric and socio-demographic variables. In these tests, P value <0.05 has been considered as significant in terms of interpreting the results. A descriptive statistical analysis has been done to indicate the mean value of standard deviation (SD) value of the socio-demographic factors.

4. Results

A total of 120 left- and right-handed participants were recruited for the study and a number of grip strength. The characteristics of the participants were divided into male and female and the ages were divided into two groups; those below 14 years old and those above 14 years old. We then went ahead to compute the means of several variables grouped by age and gender. The table below provides a summary of some of the variables in the study separated by gender.

Table 1: Summary statistics of some key variables in the study

Variable	Gender	Obs	Mean	Std. Dev.	Min	Max
<=14	1	41	9.14	1.03	6	14
	0	65	7.47	1.64	6	14
>14	1	4	15.78	1.02	15	16.7
	0	10	16.21	1.10	15	18
Age	1	45	9.70	3.08	6	16.7
	0	75	9.68	3.47	6	18
Height	1	45	136.56	15.94	113	180
	0	75	135.72	15.15	103	166
Weight	1	45	34.62	16.38	18.8	89
	0	75	35.66	12.99	17.1	69.5
# of hrs using Electronics	1	45	8.44	2.45	4	16
	0	75	9.45	3.41	1	17

The mean age for participants under the age of 14 was 9.14 for males and 7.47 for female while the mean age for male above 14 years was 15.78 and that of females 16.21. The age overall for men was higher than that of females over the entire participants group. The males were slightly taller than the females while the females were heavier than the males. Females spent more hours using electronics compared to the men in the participants.

The first analysis we did was on grip strength for left and right-handed participants divided by age and gender and the results are shown follow below:

Table 2: Hand grip strength left hand compared with age and gender

Age Group	Gender				
		Grip non-dominant		Grip Dominant	
		Mean	SD	Mean	SD
<=14	0	19.24	1.5	21.32	1.69
	1	21.95	3.29	22.07	9
>14	1	22.71	1.22	23.28	0.69
	0	20.04	2.27	23.11	1.84

From the above results, we observe that for left hand participants, the men were stronger than the females in their grip strength on both their dominant and non-dominant hand. The grip in the dominant hand was stronger for both genders with the grip strength being much larger for children with ages larger than 14 years old. This was also done for the participants who were right-handed and the table below summarizes the results:

Table 3: Hand grip strength right hand compared with age and gender

Age Group	Gender				
		Grip non-dominant		Grip Dominant	
		Mean	SD	Mean	SD
<=14	0	12.95	4.39	14.65	5.17
	1	14.95	6.29	15.95	5.48
>14	0	20.04	2.27	23.11	1.84
	1	26.95	10.53	30.54	9.23

Similar results to those above were observed when it came to the differences between the genders across both age groups with the men being much stronger than the females. It was also observed that the grip strength was also much larger for participants that were greater than 14 years old. However, it is important to note that the grip for the right-handed participants who were less than 14 years on both the dominant and non-dominant hand was much less than those of the left-handed participants. This was the same for the female participants who were greater than 1 years old. When we look at the male greater than 14 years old, this is not the case as the grip strength is significantly higher on right-handed participants for both the dominant and non-dominant hands.

We further went ahead and compared the pinch key strength for the participants in a similar fashion to how we did for the grip strength and the results for the left-handed participants is shown below:

Table 4: Pinch key strength left hand compared with age and gender

Age Group	Gender				
		Pinch key non-Dominant		Pinch key Dominant	
		Mean	SD	Mean	SD

<=14	0	13.5	2.77	14.61	1.02
	1	10.13	6.93	10.2	7.02
>14	0	14.78	0.76	13.99	1.62
	1	14.95	3.67	14.45	3.15

The pinch key strength for females less than 14 years was much stronger than that of males for both the dominant and non-dominant hand while the pinch strength for the males was much larger than that of females for the participants that were greater than 14 years old. A similar analysis was conducted for the right-handed participants and the results are shown below:

Table 5: Pinch key strength right hand compared with age and gender

Age Group	Gender				
		Pinch key non-Dominant		Pinch key Dominant	
		Mean	SD	Mean	SD
<=14	0	9.54	2.91	10.47	2.38
	1	10.31	2.95	10.68	2.5
>14	0	14.1	0.89	14.58	0.96
	1	14.75	6.67	15.18	8.15

In this case, the strength was much higher for males than for females across both age groups and we note that left-handed females less than 14 years old have a higher pinch key strength compared to those that are right-handed. We also observe this to be the case when it comes to the non-dominant hand comparison for females across both groups.

We further conducted a correlation analysis between the grip strength, pinch key strength, age and sex and the results are summarized in the table below:

Table 6: Pairwise Correlation between grip strength, pinch key strength, age and sex

	Gripdo~e	Gripno~e	PinchK~e	PinchK~r	Age	Sex
Gripdomina~e	1.0000					
Gripnondom~e	0.9301* 0.0000	1.0000				
PinchKeydo~e	0.6743* 0.0000	0.6756* 0.0000	1.0000			
PinchKeyno~r	0.6588* 0.0000	0.7064* 0.0000	0.8237* 0.0000	1.0000		
Age	0.6526* 0.0000	0.6623* 0.0000	0.6020* 0.0000	0.5971* 0.0000	1.0000	
Sex	0.0972 0.2907	0.1599 0.0810	0.0080 0.9322	0.0745 0.4290	0.0040 0.9656	1.0000

From the above table there exists a statistically positive relationship, at the 5% significance level, between age and both grip and pinch key strength for the non-dominant and dominant hand. This relationship is however not statistically significant when looking at the relationship with the sex of the participants based on the available data.

5. Discussion

This study aimed to evaluate the normative handgrip strength in healthy secondary school students in Saudi Arabia based on their age and gender. Grip and pinch strength are very important features to consider when looking at the functional integrity of the hand. Studies have been conducted to investigate this relationship and have found results quite similar to those of this study. For instance, (21) examined the grip and pinch strength of Japanese high school baseball pitchers and their findings showed that grip strength and palmer pinch strength on the dominant side were much greater than the non-dominant side. Their study however, did not breakdown these differences according to gender. (18) however, conducted this study for both genders and looked at participants who were aged 6-16 years. Their results were similar to those obtained in this study with their research noting that the grip and pinch strengths were statistically different between both genders. Similar results were also obtained by (19) who looked to investigate the influences of gender and hand dominance on the various kinds of pinch strength. Their results showed that the pinch strength of the dominant hand was much greater from the non-dominant hand and that the differences were generally higher in females than in males, a result this study finds as well.

The differences between the strength between male and females have been attributed in various studies to be due to the differences in the type of activities for the different genders with studies like (18) noting that males have more muscular strength when compared to female as a result of their muscle differences which is driven by testosterone in males that then leads to a much larger size of hand. This is well noted in the study where there was a significant jump in the hand grip strength of males greater than 14 years for both the dominant and non-dominant hand and this could be attributed to the fact that at this age is when the boys are getting to puberty and hence they experience significant increase in their testosterone levels that then in turn increases their grip strength.

These studies also conducted further analysis to explore other anthropometric values such as gender, age, height among others and how these may have an influence on the grip strength. Our study shows that there is a significant correlation between age and the grip and pinch strength and this is similar to what was found in the study by (20) who also found that hand grip strength increased with age however, their study did not find a correlation between age and pinch strength. Additionally, their results also found that their hand grip and pinch strength for the dominant hand were much greater than the non-dominant hand in most ages. One key challenge that their study noted that brings variability when trying to compare normative values among similar studies is the variation in the methodology used, the presentation of the data, the difference in the sample size and the geographical differences. They note that this coupled with genetic elements, social norms and nutritional deficits can result in variations between the different studies compared. (18) study is a good example to show the differences based on these factors with their study finding that the hand grip strength for children in Saudi Arabia was much less than those of Western countries, an indication that there are geographical factors at play that contribute to these inter-population variations.

Anthropometric differences were also another reason given for the possible variations in the differences as noted by Omar et al. (2018). The note that it is important to appreciate the association with grip and pinch strength as they could be a representation of the nutritional status of the participants. Unlike our study, most other studies examined the palmar width among other factors and their relationship with age in a bid to understand whether a relationship existed with hand grip strength. Studies like (18) found that palmar width did have a relationship with age and consequently with the hand grip and pinch strength but studies like (20) reported that height and weight were the predictors of handgrip strength. Both studies though, through a regression analysis, found that palmar width was a significant determinant of handgrip strength.

The study had a few limitations however. For instance, most of the other studies that were examined went ahead and conducted a regression analysis to examine the relationship between the grip and pinch strength with other variables to further enhance the analysis of the relationship between the variables and this study did not conduct any regression analysis. Secondly, the sample was localized in terms of its collection in Saudi Arabia and this may not be a true representation of the measurements across the entire kingdom. This therefore, means that a variety of socio-cultural and economic factors were not well representative in the study. This could be improved by using the same consistent procedures across other areas of the country while adopting various sampling techniques to ensure that the resultant sample is completely representative of the entire kingdom. Lastly, the study did

not have further measurements like the size of the arm, the circumference, palmer width among other variables that would have contributed to a much richer analysis of the interdependencies of the various variables to grip and pinch strengths.

6. Conclusion

we can say that there is significant difference in hand grip strength and pinch strength both across age and gender. These differences arise cause of various reasons but generally, males have a much stronger strength than females and the older children have also a much stronger grip. It would benefit other studies in the same area to examine other factors that could affect grip and pinch strength such as handbreadth, thickness, grip diameter among others. It will also offer greater insights if other studies similar to this adopt a regression model to investigate further the relationship between these variables. The findings from this study could be helpful to provide guidance for students especially in the field of sports as has been shown by other studies and through these insights, teams could optimize their composition to achieve the best results.

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