

Hand grip and pinch strength: Effects of workload, hand dominance, age, and Body Mass Index

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ABSTRACT

Objective: Grip and pinch strength are considered important factors which reflect proper hand function, muscle function, general weakness, nutritional status, physical activities and muscle disability. Some of the factors affecting grip and pinch strength are hand dominance, posture, elbow joint angle, height, age and gender. Present study was designed to see the effects of Workload, Hand Dominance, Age, and Body Mass Index on grip and pinch strength among university students.

Methodology: This study was conducted among 82 male student, with means and standard deviation of 24.25 (3.76) years and 24.75(2.44) kg/m² for age and BMI, respectively. Grip and pinch strength for each participant were measured in time of rest and during light, moderate and heavy workload. Hand held dynamometer was used for measuring grip strength and pinch gauge to measure pinch strength. All Data analyses were performed using the statistical software package; SPSS-18 and analyzed with use of Pearson Correlation Statistical tests and paired sample t-test.

Results: Pearson Correlation test showed that grip and pinch strength for the dominance hand was significantly higher than non-dominant hand for all workloads ($p < 0.05$). Study results showed that there is no significant correlation between age with grip and pinch strength ($p > 0.05$) but BMI considered as an effective parameter on grip and pinch strength for dominant and non-dominant hand in moderate and heavy activities ($p < 0.05$).

Conclusion: these findings, unlike to age, workload and BMI are important factors on grip and pinch strength. This suggests that there is a need for more research to precisely evaluate the effects of these factors on grip and pinch strength.

KEY WORDS: Workload, Grip strength, Pinch strength, BMI.

doi: [http://dx.doi.org/10.12669/pjms.291\(Suppl\).3535](http://dx.doi.org/10.12669/pjms.291(Suppl).3535)

How to cite this:

Habibi E, Kazemi M, Dehghan H, Mahaki B, Hassanzadeh A. Hand grip and pinch strength: Effects of workload, hand dominance, age, and Body Mass Index. *Pak J Med Sci* 2013;29(1)Suppl:363-367. doi: [http://dx.doi.org/10.12669/pjms.291\(Suppl\).3535](http://dx.doi.org/10.12669/pjms.291(Suppl).3535)

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INTRODUCTION

Many daily tasks and sport activities need high level of forearm and hand muscles strength. These muscles contribute to grip strength which is necessary for performing tasks in many sports events such as wrestling, tennis; in addition to accomplish daily activities such as turning door handle and etc.¹⁻⁴ It is assumed that grip strength can be predictive for whole body strength. For example, Smith et al in a study established the direct correlation between grip strength and whole body strength among elderly women.³ Fry also found a direct relationship between grip strength and muscle function.²

Grip and pinch strength is one of the most important factors related to proper hand function.^{5,6} Many recent studies have been performed in order to evaluate grip and pinch strength and provide standard values among people of different age groups.^{7,8} Some of these research studies looked at the effects of various parameters on grip and pinch strength⁹, therefore some of them could provide models for estimating grip and pinch strength.¹⁰⁻¹³

There are various factors that may effect on grip and pinch strength, like hand dominance (being right or left handed, posture and arm joint angle, height, body weight, age, fingers length, ...). According to some research results, where arm joint bend less, bigger grip strength is obtained.¹⁴ Until now there has been many studies on evaluation of the effect of hand dominance on grip and pinch strength among various groups of people.^{4,15} Much research has been done for evaluation of relations between muscle strength and BMI. Some of these studies have shown a significant and positive relation between these two factors and some found opposite relationship between them, whereas some studies did not report any relation between muscle strength and BMI.¹⁴⁻¹⁷

The tests for evaluation of hand grip strength are simple, safe and reliable and they do not require expensive and complicated instruments.¹⁸ Therefore hand held dynamometer which is a simple and easy measuring muscle strength tool is applicable.¹⁹

Hand grip strength is related to variables such as muscle function and low activity among older people. It can also be related to general weakness, nutritional status, physical activities, muscle disability, Activities of daily living dependency, decrease of cognitive measures and all-caused mortality issues.²⁰⁻²⁶ Physical activities are parameters which can affect muscle function and consequently grip strength rate. Among the related studies, we can point to Bautmans research which analyzed the effect of various parameters, such as fatigue, physical activities and etc on grip and pinch strength rate.²⁷

Until now, there have been only a few studies concerning grip and pinch strength in our country. Present study aimed to establish the relationship between workload, hand dominance, BMI and age variables with grip and pinch strength among university students.

METHODOLOGY

Eight two male participant students which were all in a good healthy physical condition were tested. Tape measure and calibrated digital scale were used

to measure height and body weight, respectively. At the end, BMI was measured with obtained weight and height results for individual.

Hydraulic hand dynamometer device (Model 5001SH) was used to measure grip strength. The pinch strength was measured with hydraulic pinch gauge (Model 5005 SH). Grip and pinch strength were presented in kilograms of force units.

For measuring grip and pinch strength in this study, ASHT (American Society of Hand Therapists) recommendations were applied. Participant seated in a chair with their plantar were laid flat on the ground. Shoulders were in a neutral position and arm was placed in 90° elbow flexion. The shoulders, elbow and wrist were in a neutral position at the time of measuring grip and pinch strength. Pinch gauge was held by researcher for measuring pinch strength in order to create the highest force.^{28,29} All subjects were tested in a similar posture at time of grip and pinch strength measurements. The dominant hand was considered the hand which used more often by individual, In other words, the hand that person could write with it was considered as dominant hand.^{19,30}

After measuring grip and pinch strength of dominant and non-dominant hands in rest position, 3 workloads; light (with speed of 3 km/h), moderate (speed of 4.8 km/h) and heavy (speed of 6 km/h) for people on treadmill were applied. After each activity, a 15 minutes rest was given in order to return the physical and physiological status of participants to normal. After each rest period, the next step of activity was started.

To determine the duration of each activity, first a pre-test on 20 subjects in the study was performed and the duration of each workload (activity) by averaging the duration of the activity was obtained. Duration of activity for light, moderate and heavy were considered 26, 15 and 10 minutes, respectively.

Grip and pinch strength of dominant and non-dominant hands for each individual were obtained after each Workload and compared to grip and pinch strength at rest time. The data were analyzed with Pearson Correlation Coefficient statistical test for comparing grip and pinch strength for dominant and non-dominant hand for workloads, and paired t-test were used for assessing the correlation between workload and grip and pinch strength.

RESULTS

The research was done on 82 male university students, age range 20-34 years with a height range of 165-194 cm, and mean and standard deviation of

Table-I: Explanatory parameters and t-test results for comparing grip strength (kg) for dominant hand and non-dominant hand for all workloads.

Workload	Dominant hand				Non-dominant hand			
	mean	SD	max	min	mean	SD	max	min
Rest situation	44.78	7.54	61.00	32.00	42.90	7.15	57.00	30.00
light activity	42.97	7.71	60.00	30.00	41.21	7.22	56.00	23.00
moderate activity	42.46	7.15	57.00	29.00	41.45	6.57	55.00	28.00
heavy activity	40.90	7.16	57.00	27.00	38.58	6.46	53.00	26.00

Table-II: Explanatory parameters and t-test results for comparing pinch strength (kg) for dominant hand and non-dominant hand for all workloads.

Workload	Dominant hand				Non-dominant hand			
	mean	SD	max	min	mean	SD	max	min
Rest situation	23.70	5.05	38.00	15.00	22.23	4.76	35.00	15.00
light activity	23.38	4.98	33.00	13.00	21.26	4.74	34.00	14.00
moderate activity	22.12	4.88	33.00	14.00	20.89	4.59	31.00	14.00
heavy activity	20.89	5.25	32.00	11.00	19.29	5.35	31.00	10.00

24/25(3/76) years and 24/75(2/44) kg/m² for age and BMI, respectively.

Finding of this study for comparing grip strength for dominant hand and non-dominant hand for all workloads showed the highest grip strength among participants was at time of rest, light workload. In other words with increasing workload, the grip strength decreased (Table-I). Table-II shows the comparison of pinch strength for dominant hand and non-dominant hand for all workloads.

As shown in Tables I and II, grip and pinch strength in all situations; rest, light, moderate and heavy activities, for dominant and non-dominant hands showed significant difference ($p < 0.05$). In other words, grip and pinch strength values were higher for dominant hand compared to non-dominant hand in all workloads.

Paired t-test showed that grip and pinch strength for dominant and non-dominant hands showed significant differences in rest time compare to time of light, Moderate and heavy workloads activities and also for light activities compared to heavy activities and for moderate activities compared to heavy activities ($p < 0.05$), but grip and pinch strength values did not show significant differences for light activities compared to moderate activities,

Table-III: Relation of BMI with grip strength of dominant and non-dominant hands for all workloads.

Workload	Dominant hand		Non-dominant hand	
	P-value	SD	P-value	SD
Rest situation	0.015	0.268	0.013	0.272
light activity	0.01	0.282	0.037	0.231
moderate activity	0.016	0.266	0.009	0.288
heavy activity	0.112	0.117	0.009	0.287

($p > 0.05$).

Paired t-test was used for assessing BMI and grip and pinch strength of dominant and non-dominant hands for all workloads. The summary of results is shown in Tables III and IV.

As shown in Tables III and IV, there is a significant relation between BMI with grip and pinch strength of dominant and non-dominant hands. The only exception was grip strength of dominant hand in heavy workloads, which in this activity no relationship was found between grip strength for dominant hand with BMI ($p > 0.05$).

DISCUSSION

Grip and pinch strength are most important factors associated with proper function of hand.^{5,6} Recently, there have been several studies for evaluation of grip and pinch strength. Some of these studies have evaluated the effect of various parameters on grip and pinch strength rate.⁹

In this study, we evaluated the effect of some of the different parameters on grip and pinch strength. One of these parameters was evaluation of workloads on grip and pinch strength of dominant and non-dominant hands. The research shows that there was a significant relationship between

Table-IV: Relation of BMI with pinch strength of dominant and non-dominant hands for all workloads.

Workload	Dominant hand		Non-dominant hand	
	P-value	SD	P-value	SD
Rest situation	0.007	0.354	0.013	0.328
light activity	0.01	0.343	0.015	0.324
moderate activity	0.011	0.336	0.023	0.303
heavy activity	0.012	0.333	0.024	0.302

grip and pinch strength for dominant and non-dominant hands in rest situation compared to light, Moderate and heavy activities and also for light activities compared to heavy activities and for moderate activities compared to heavy activities. In other words, highest grip and pinch strength were obtained in rest time and lowest rate was associated with heavy workloads for dominant and non-dominant hands. One of the reasons for this issue has been related to activity rate and energy consumption rate for difference workloads. In moderate workloads and heavy workloads, people are forced to consume higher amount of energy and higher force is needed to perform activities compared to rest time. This issue causes decrease in muscle strength and results in lower grip and pinch strength. Analysis of data showed that this rate for heavy activities was lower compared to moderate and light activities.

It also showed significant difference between grip and pinch strength in dominant hand compared to non-dominant hand while our data showed grip and pinch strength for dominant hand in all workloads was higher compared to non-dominant hand. Possibly, one of the reasons is people usually use the dominant hand more often to perform daily tasks and this repeated use causes strengthening of dominant hand muscles and consequently increased grip and pinch strength of dominant hand compared to non-dominant hand. Many studies have showed that there is a significant difference between grip and pinch strength of dominant hand and non-dominant hand.³¹ Studies have also showed grip and pinch strength for dominant hand was higher than non-dominant hand.^{14,32} Kadir in a research has shown that in left handed people, grip and pinch strength of this dominant hand is almost 10% higher than non-dominant hand but in other people grip and pinch strength was equal for both hands.¹⁴

Other studied parameters in this research were relationship between BMI and age with grip and pinch strength. The results of present research did not show significant relationship between age with grip and pinch strength, but there was a significant relation between BMI with grip and pinch strength for dominant and non-dominant in moderate and heavy activities. Hence, it can be concluded that BMI has higher effect in moderate and heavy activities on grip and pinch strength compared to rest and light activities. Many studies have been done to evaluate the relationship between muscle strength and BMI. Some of these studies have

shown a direct and positive relation between these two parameters.¹⁵⁻¹⁷ However, another study found inverse relationship between muscle strength and BMI¹⁵, Apovian's research which studied similar issue, did not report any relationship between grip strength and BMI.¹⁴ Klum et al has reported a positive relation between BMI With rip and pinch strength but they found an inverse relation between age With grip and pinch strength.⁸ Yasuo also found a significant relation between maximum grip strength in dominant hand and common anthropometric variables in all studied age groups.

CONCLUSION

Workload is known as an effective factor on grip and pinch strength. In moderate and heavy workloads, people had lower grip and pinch strength compared to rest and light activities. Research findings also show that grip and pinch strength for dominant hand was higher than non-dominant hand which may be the result of using dominant hand frequently and continuously compare to non-dominant hand performing daily tasks, which result in strengthening the dominant hand muscles which consequently increase muscle strength (grip and pinch strength). Considering that the research was done on male students, similar research among female population will be helpful and beneficial to support our findings.

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