

BIOMECHANICS TRENDS IN GRIP AND PINCH STRENGTH IN TWO AGE GROUPS OF CHINESE

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Hands are one of the most complex and useful systems of the human body with grip and pinch strength being the most important biomechanics factor to assess the hand functions. Many diseases including malfunction of nervous systems and osteoarthritis may lead to weakness or abnormality of hand grip and pinch strength. The measurement of grip and pinch strength could be used to assess the degree of injury degree, treatment effect and recovery, thus making it necessary to build a biomechanics normative database of grip and pinch strength for use by researchers (such as doctors and sport researchers) from different fields (i.e. professional injury assessment, ergonomics and product design). The database is expected to provide detailed features of grip and pinch strength of the Chinese people.

KEY WORDS: hand function, data, grip distance, pinch posture

INTRODUCTION: The strength of hand has been extensively investigated as it is regarded as the reliable and effective evaluation parameter for surgical treatment, sport research, occupational injury. Virgil Mathiowetz and his colleagues built a normative database of hand grip and pinch strength based on a study of 638 subjects ranging from 20 to 94 (Mathiowetz et al., 1985).

The Chinese government has established The Provisions of The Work of National Physical Fitness Surveillance (12th February, 2001) since 2001. There will be a physique survey in each province every five years and one of the test items is grip strength, indicating the importance of it as key index.

The current research is a preliminary study for the National Human Ergonomics Parameter Test Project, intended to explore the biomechanics features in different postures and states. The data were collected from five grip distances and three pinch postures of the subjects, consisting of Chinese adult.

METHODS: Participants: 140 subjects participated in this study (72 women and 68 men) with age ranging between 18 and 66 and body weight between 42 and 98 kg. The subjects are all physically active, without any pain or limitation in cubitus, the upper arm, wrist muscle or osteoarticular. They were divided into two groups: the adult group is 18-40 years (sample size, n=98, 54 men and 44 women) and the elderly group is 40-66 years (n=42, 14 men and 28 women). All of the subjects were right-hand dominant.

Instruments: BTE-EvalTech hand functions assessment system (BTE, Hanove, Germany), operating at a sample frequency of 100Hz.

Experimental Protocol: In the experiment, the subjects are required to adopt a specific posture recommended by American Society of Hand Therapists (AHST), the test standard as follows(Fig. 1 Spring from the manufacturer's instructions): (1) Both feet flat on the floor; (2) upper arm next to body; (3) elbow flexed at 90°; (4) forearm neutral (thumb up); (5) Hand and forearm in slight shoulder internal rotation (toward the center front of the torso);(6) forearm should not be resting on any surface while measurement.

Every grip distance(1.5/2/2.5/3/3.5 Inch) and pinch (Key/Palmar/Tip) posture were tested in each time. Every time three sets of data were collected. Test-time is 3s. After every test, the participants needed to rest for 15s. After three tests, the participants had a rest for 3-5min.

When subjects listened to the command, he/she should try his/her best to sustain 3s. The computer screen was used to monitor and fed back the whole test procedure. The figures displayed on the monitor are the average about 3 tests and its coefficient of variation (CV). If CV was greater than 15, this means that the operation of the subject is unqualified and must be tested again, to reduce subjective factors of subjects.



Fig.1: Posture and type of grip and pinch strength test

Data Analysis: We used EvalTech Software (BTE, Hanove, Germany) to collect all the strength data (LBS in each time instant) , and recorded the maximum value of each group.

Statistical Analysis: All data were then coded and analyzed using SPSS (SPSS 13.0 for Windows, September 1, 2004). Paired sample t-tests, independent sample t-tests and ANVOA were conducted for the statistical significance test.

RESULTS: Table 1 and Table 2 are experiment results, which they present the mean (SD) of maximum value.

Table 1 Test result of five kinds of grip distance (LBS)

	Men				Women			
	Group A		Group B		Group A		Group B	
	R	L	R	L	R	L	R	L
Grip Distance 1(1.5 Inch)	60.2 (13.3)** [¶]	56.0 (11.6) [¶]	39.8 (9.9)** [¶]	36.4 (8.3) [¶]	55.9 (12.2)**	48.5 (10.6)	34.1 (7.4) [¶]	33.3 (7.0)
Grip Distance 2(2.0 Inch)	73.3 (14.4)** [¶]	68.5 (14.6) [¶]	65.7 (15.1) [¶]	61.4 (12.4) [¶]	44.5 (11.6)**	41.5 (9.3)	41.4 (8.7)	41.9 (7.5)
Grip Distance 3(2.5 Inch)	69.6 (14.5)** [¶]	64.2 (13.8) [¶]	58.7 (15.6) [¶]	55.8 (15.6) [¶]	40.7 (11.0)**	37.8 (9.3)	36.8 (8.1)	37.3 (7.7)
Grip Distance 4(3.0 Inch)	62.3 (13.2)** [¶]	59.4 (14.9) [¶]	55.1 (15.1) [¶]	50.5 (15.0) [¶]	35.1 (9.8)**	32.4 (8.9)	33.7 (7.2)	34.3 (8.1)
Grip Distance 5(3.5 Inch)	51.7 (11.8)** [¶]	48.2 (12.1) [¶]	46.0 (11.6) [¶]	43.6 (11.8) [¶]	29.2 (8.0)**	26.7 (7.5)	28.9 (6.1)	28.3 (6.6)
p	0.000**	0.000**	0.009**	0.010*	0.000**	0.000**	0.000**	0.000**
L/R	0.935		0.933		0.913		1	
Latest result of physique survey of Chinese (2010)	92.7-93.7	/	70-92.3	/	53.8-56.1	/	44.1-55.5	/
Mathiowetz et al.(1985)	119.7-121	104.5-112.9	91.1-116.8	76.8-112.8	70.4-74.1	61-68	49.6-70.4	41-62.3

*p<0.05, **p<0.01 between right and left hand. [¶]p<0.01 between group A and group B. [¶]p<0.01 between men and women.

Table 2 Test result of three kinds of pinch strength posture (LBS)

		Men				Women			
		Group A		Group B		Group A		Group B	
		R	L	R	L	R	L	R	L
Present study	Key type	19.8 (3.8)** [¶]	18.8 (3.8) [¶]	19.6 (5.3)** [¶]	17.6 (4.6) [¶]	12.4 (2.7)*	11.8 (2.7)	13.0 (2.7)	12.7 (2.7)
	Palmar type	16.1 (3.1)** [¶]	15.4 (3.4) [¶]	15 (3.7) [¶]	14.1 (2.6) [¶]	11.6 (2.2)**	10.7 (2.2)	11.3 (2.5)*	10.4 (2.6)
	Tip type	14.2(3.3) ** [¶]	12.9 (2.8) [¶]	13.7 (4.2)** [¶]	12.2 (3.9) [¶]	10 (2.2)**	8.8 (2.2)	10.5 (2.0)**	9.6 (2.0)
	p	0.000**	0.000**	0.002**	0.003**	0.000**	0.000**	0.000**	0.001**
Mathiowetz et al.(1985)	Key type	26- 26.7	24.8- 26.2	23.2- 26.7	22- 24.8	16.6- 18.7	16.2- 17.8	15- 17.6	14.3- 16.6
	Palmar type	24.7- 26.6	25.1- 25.9	21.4- 24.5	21.2- 24.8	17.2- 19.3	16.3- 18.1	14.2- 17.9	13.7- 17.5
	Tip type	17.6- 18.3	17.0- 17.7	15.8- 18.7	15- 17.8	11.1- 12	10.5- 11.9	10.1- 13.2	9.9- 12.1

*p<0.05, **p<0.01 between right and left hand. [¶]p<0.01 between group A and group B. [¶]p<0.01 between men and women.

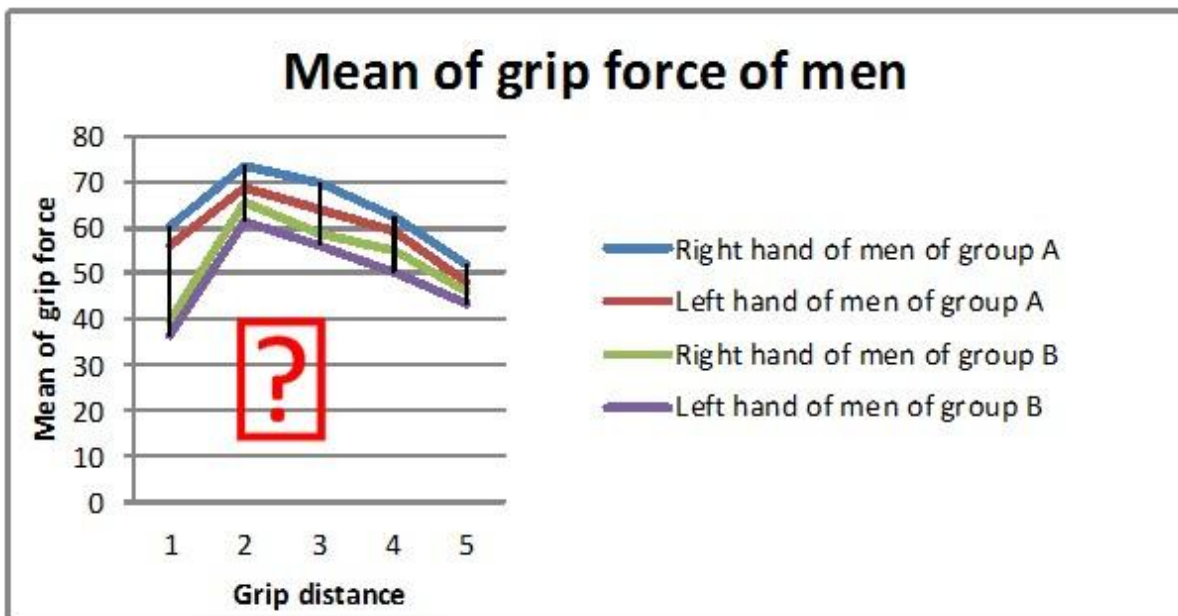


Figure 2: Mean of grip force of men

DISCUSSION: Table 1 shows that obvious differences exist between different grip distances. On the grip distance 2, the grip strength is at the maximum. According to Hatem WP et al. (1999), 72% of the subjects' maximum grip strength was on Grip Distance 2(2 Inch) while 28% of them fell on Grip Distance 3(2.5 Inch). Chong CK et al. (1994) concluded that the grip strength of the right hands was greater than that of the left ones for the right-handed, and there is a 10% principle, which means the grip force of the left hand is about 90% of right hand. Our findings are consistent with the 10% principle except women of group B. In addition, the value of the grip strength of the Chinese subjects is less than that of the American by Mathiowetz et al. (1985), and the value of physique survey of Chinese is greater than our test results. Grip distance is the main factor to impact grip strength, which will show reverse "V" change(see Figure 2) when grip distance change from 1.5 to 3.5 inch, and the maximum is on the about 2 inch.

Table 2 presents that pinch strength of right and left hands from women of different age group is about 66%-79% of men, close to the statistics range (64%-78%) of Imrhan SN (1989). Age and gender are both influential factors for the three kinds of pinch strength, but no obvious difference can be found between right and left hands. Meanwhile there is distinct difference between right and left hands of men. The same as grip strength, pinch strength of Chinese is less than American by Mathiowetz et al. (1985).

CONCLUSION: Age is not an important factor affecting the hand strength, as long as proper exercise and participated in physical exercise, hand strength can be well maintained.

Gender is another important factor affecting hand strength. There is an obvious difference between men and women, and grip strength of women is about 62% of men, and pinch strength is about 72%.

Posture exerts a great influence on grip and pinch strength of men. Among three kinds of postures, the test results showed the value of strength in a descending in Key type, Palmar type and Tip type. So, we need consider posture in practice and training to avoid injury.

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