



Normative Data of Grip and Pinch Strengths in Healthy Adults of Iranian Population

*Mostafa MOHAMMADIAN¹, Alireza CHOOBINEH², Aliakbar HAGHDOOST³,
Naser HASHEMINEJAD⁴

1. Student Research Committee, Kerman University of Medical Sciences, Kerman, Iran

2. Dept. of Occupational Health Engineering, Shiraz University of Medical Sciences, Shiraz, Iran

3. Research Centre for Modeling in Health, Institute for Future Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

4. Dept. of Occupational Health Engineering, Kerman University of Medical Sciences, Kerman, Iran

*Corresponding Author: Email: n_hasheminejad@kmu.ac.ir

(Received 19 Feb 2014; accepted 14 May 2014)

Abstract

Background: Measuring and comparing grip and pinch strengths with their normative data is a valid method to detect intensity of the numerous damages of hand. This research was carried out with the aim of establishing normative data of grip strength and three types of pinch strengths (Tip, Key and Palmar) in healthy Iranian adults.

Methods: In this cross-sectional study, the study population was formed of 1008 people (526 men and 482 women) from healthy Fars race adults of over 20 years old in five cities of Iran. American Society of Hand Therapists (ASHT) recommendations were followed to establish normative data of grip and pinch strengths. Normative data of grip and pinch strengths were developed based on sex, 12 different age groups and dominant and non-dominant hands. Jamar dynamometer and Seahan pinch gauge were used to measure grip and pinch strengths, respectively.

Results: Normative data of grip and pinch strengths were provided. Grip and pinch strengths of men were significantly stronger than women. The maximum grip strength of men was obtained in the group of 20-24 years and among women it was in the age group 35-39 years. Regardless of gender, grip and pinch strengths were declined with aging.

Conclusion: Normative data of grip and pinch strengths were developed for Iranian population.

Keywords: Hand strength, Grip strength, Pinch strength, Normative data

Introduction

Grip and pinch strengths are generally the most important parameters to determine hand function (1). Grip strength not only describes hand normality but is also used as an objective evaluator of upper extremities in treating hand damages (2). Furthermore, it predicts post-surgical complications and losses (3), general inabilities and aging consequences such as disability (4), increase in illness risk (5) and mortality (6). It is also used to determine job qualification of those who suffer from local hand injuries (5). Other uses include evaluation of other inabilities like rheumatoid ar-

thritis, chronic fatigue syndrome, developing disability, muscular dystrophy and heart attack (7). Hand strength can therefore be a predictor of economic consequences of illnesses (8). Measurement of pinch strength is also used for the same purposes.

Measuring grip strength can be done quickly and for this reason it is called quick bedside test (9). Sargent was the first person who used grip strength test as a way of determining strength in 1880 (10). Later in 1971, Klor et al. prepared the first normative data of grip and pinch to be ap-

plied in rehabilitation (11). Preparing normative data of grip strength is a reliable method for diagnosing the impact of damages to either musculo-skeletal or nervous system of hand. This data is usually obtained from healthy people based on factors like age and sex (12, 13). One of the main applications of these data is in physiotherapy to check the recovery progress of patients suffering from upper extremities damages. Trying to rehabilitate patients suffering from hand damages, Iranian physiotherapists consider the opposite hand, i.e. the healthy one, (as suggested by Reikers (14)) as a gauge to evaluate the recovery progress and to bring back the grip strength to the pre-injury level; this method, however, may be misleading because it ignores the strength difference of left and right hand as well as the loss of total body strength during the illness period. Additionally, it is not appropriate in cases where both hands are damaged. For this reason, the normative data of grip strength is used in order to clinically compare patients with healthy people to bring back this strength to the pre-injury and pre-illness levels (15). This data is of importance to ergonomists as a way of optimizing work programs and tool designs (16, 17).

The normative data cannot be generalized to be true for other people living in different social and economic conditions (9). In the same way Ugurlu and Ozdogan emphasized the importance of specific normative data for each population (18). Therefore, considering the widespread use and importance of such data as well as the lack of a database on the normative data of grip strength for Iranian population, the present study was undertaken with the purpose of establishing the normative data of grip and pinch strengths (Tip, Key and Palmar) for adults.

Materials and Methods

Subjects

Fars race is the dominant race in Iran (19); so in order to avoid manipulative effect of race it was considered to represent the entire Iranian population. Based on this, the rate of grip strength and three kinds of pinch strength were measured in

five cities of Iran with the highest number of Fars race adults, i.e. Mashhad, Isfahan, Shiraz, Kerman and Yazd. The study population of each of the aforesaid cities was formed of 96 persons of each sex, divided into 12 age groups; the age interval between the groups was 5 years except for the age group of over 75.

The study used stratified sampling. The samples were selected via simple random sampling method in crowded places like department stores, markets, parks, housing complexes and sidewalks. Inclusion criteria for adults under 60 were: (a) feeling no pain or impairments in upper extremities, (b) having no case of hand surgery, fracture or any other conditions that could affect upper extremities (e.g. arthritis, spinal disk problems, joint pain and so on), and (c) having no recent hospitalization history. Inclusion criteria for adults over 60 were: (a) feeling no severe pain in arms and hands, (b) not being hospitalized for more than 6 months (due to heart attack or any surgical operations), and (c) not being restricted in performing daily activities owing to health disorders. As for the time of experiments, according to a pre-determined plan, spring and summer were chosen because the temperature is most appropriate in these seasons.

Measurement procedure

A notice board containing experiment specifications was prepared and installed to inform subjects of the aim and nature of the study. Furthermore, the purpose, methods and the time span of the experiments were described to them and their approval to participate in the study was received orally for the sake of moral principles. In the first stage, each person was briefly interviewed concerning their qualification to be selected as a subject; a form containing demographic information was then developed; including their race, age (in years), sex, dominant hand (used for writing), city (to make sure they were the natives of the city in which the study was undertaken). Inclusion criteria were also completed by interviewers. In the second stage, examiners measured the different grip strengths. Four occupational hygienists were selected as the examiners and received related

training. Experiments were undertaken according to recommendations of American Society of Hand Therapists (ASHT) (20). As recommended by ASHT, the body postures or positions of the subjects during the strength tests were defined as sitting, arms attached to the torso not rotating, the elbow flexed at 90 degrees, the forearm in neutral position, the wrist in 0-15 degrees of extension and 0-15 degrees of ulnar deviation. Three grip strength measurements (for both hands) were taken in this position with a 1-minute rest between each task (to avoid muscle fatigue) using Jamar Hydraulic Dynamometer (Sammons Preston Rol-yan). The mean of three successive trials of strength measurements was then used for statistical analysis. Moreover, in order to standardize the grip span, the handle of Dynamometer was adjusted to second position for all subjects and the distance between two Dynamometer handles was 4.67 cm. Thereafter, based on the method applied by Mathiowetz et al. (21) and the recommendations of ASHT (20), the subjects were tested for Tip, Key and Palmar pinch two successive times for each hand by Seahan pinch gauge and the maximum strength was recorded as the result of each type of pinch. The instruments for measuring strength were calibrated by the manufacturers and this equipment were particularly purchased for the present study. Meanwhile, the calibrations were checked regularly throughout the study. To compare the average grip strength of Iranian adults with populations of other regions of the world, the studies were selected on the basis of the following criteria: a) healthy people to be

screened so as to establish normative data b) The standard recommendations of ASHT to be followed c) Information to be gathered from random samples d) The instruments utilized to be standard and similar to the present study e) Information not to be provided based on a considerable age interval(at most 10 years).

Statistical analysis

The relationship between dependent and independent variables was analyzed with 95% confidence interval using parametric tests. Accordingly, to investigate the relationship between grip strength and age, Pearson Correlation Test was conducted. In order to examine the influence of sex on grip strength and to evaluate the strength of right and left-handed subjects the Independent-samples *t*-test was applied. Furthermore, to assess the strength difference between dominant and non-dominant hands and also right and left hands, the Paired-samples *t*-test was performed.

Results

Participant characteristics

The study population was formed of 1008 healthy Iranian persons (526 men and 482 women) from 20 to over 75 years of age who participated in the study from May to November 2012. Most of the participants were right-handed and only 6.6 percent of the whole (66 persons) were left-handed. Table 1 presents the demographic characteristics of the subjects.

Table 1: Demographic characteristics of participants

Variables		Men	Women	Total
n (%)		526(52.2)	482(47.8)	1008(100)
Age (yr)	Mean(SD)	49.4(18.1)	48.0(17.0)	48.7(17.6)
	Min-Max	20-107	20-91	20-107
Hand Dominance	Right. n(%)	495(94.1)	447(92.7)	942(93.4)
	Left. n(%)	31(5.9)	35(7.3)	66(6.6)
City	Mashhad. n(%)	107(20.4)	93(19.3)	200(19.9)
	Isfahan. n(%)	96(18.2)	100(20.7)	196(19.4)
	Shiraz. n(%)	117(22.2)	99(20.5)	216(21.5)
	Kerman. n(%)	107(20.4)	94(19.5)	201(19.9)
	Yazd. n(%)	99(18.8)	96(20.0)	195(19.3)

Results related to normative data

Table 2 shows the normative data of grip strength based on sex and different age groups. Normative data of Tip, Key and Palmar pinch strength for men and women is presented in Tables 3 and 4 based on age groups. The maximum grip strength of dominant hand in the men aged 20-24 years and women aged 35-39 years was 54.4 kg and 29.7 kg, respectively. The maximum Tip pinch strength of dominant and non-dominant hand was ob-

served in the men aged 25-29 and women aged 40-44. The maximum Key pinch strength of dominant and non-dominant hand was obtained in the men aged 20-24 and in women aged 20-24 and 40-44. The maximum palmar pinch strength of dominant and non-dominant hand was detected in the men and the women aged 20-24 and 25-29 respectively. The minimum grip and pinch strengths, however, were found in age group of over 75 years of age irrespective of subjects' sex.

Table 2: Normative Data of Grip Strength (in kg force) for all subjects by age and sex (n=1008)

Age ^a	n	Hand ^b	Men (n=526)				Women (n=482)					
			Mean	SD	SEM	Min- Max	n	Hand	Mean	SD	SEM	Min-Max
20-24	55	D	54.4	9.4	1.27	33.7-77.7	44	D	28.5	6.2	0.93	15.3-42.5
		ND	51.9	8.0	1.08	32.3-70.0		ND	26.1	5.9	0.89	13.3-37.5
25-29	43	D	50.9	10.2	1.56	33.3-71.7	42	D	29.6	4.6	0.71	19.0-38.7
		ND	49.9	9.6	1.46	31.3-70.0		ND	26.6	8.4	0.74	17.3-37.3
30-34	37	D	52.6	8.1	1.33	37.7-69.7	42	D	29.4	5.2	0.80	17.0-41.2
		ND	49.4	7.5	1.23	37.3-71.0		ND	26.4	5.0	0.77	14.3-36.0
35-39	40	D	48.9	7.7	1.22	31.7-72.3	42	D	29.7	4.5	0.70	21.0-39.7
		ND	46.5	7.1	1.13	32.7-66.7		ND	27.7	4.1	0.63	18.0-38.0
40-44	39	D	48.2	7.3	1.17	32.7-66.3	42	D	29.4	4.6	0.72	21.0-40.3
		ND	45.9	6.1	0.98	31.1-56.7		ND	26.9	4.7	0.73	18.7-37.7
45-49	43	D	47.2	7.5	1.14	31.7-71.3	43	D	29.1	5.9	0.89	19.2-50.0
		ND	44.8	7.0	1.07	29.3-69.7		ND	27.3	5.5	0.83	16.7-43.7
50-54	51	D	43.7	7.0	0.97	30.2-58.7	44	D	26.5	5.1	0.77	16.3-38.3
		ND	41.4	6.9	0.97	27.5-61.3		ND	24.9	5.3	0.80	13.8-38.7
55-59	41	D	42.2	6.7	1.04	28.0-58.7	39	D	24.9	4.8	0.77	13.3-35.3
		ND	40.2	5.8	0.90	28.7-53.0		ND	23.5	5.0	0.80	12.0-31.7
60-64	46	D	41.4	6.9	1.01	29.7-57.7	40	D	24.6	4.2	0.66	17.0-33.7
		ND	39.4	5.9	0.87	27.3-50.7		ND	23.4	3.8	0.61	17.3-32.8
65-69	39	D	35.9	7.9	1.27	16.0-56.0	37	D	22.0	4.9	0.81	10.7-32.7
		ND	35.9	6.6	1.06	18.3-54.3		ND	20.8	4.4	0.72	10.9-28.3
70-74	46	D	34.0	6.3	0.93	17.7-45.0	34	D	22.4	4.5	0.77	16.5-34.3
		ND	32.3	6.0	0.89	16.7-44.0		ND	20.8	4.7	0.80	11.7-30.3
75<	46	D	30.2	7.8	1.15	14.8-49.3	33	D	17.9	4.6	0.79	8.7-25.3
		ND	28.7	7.2	1.06	14.1-44.3		ND	17.2	4.1	0.71	7.3-26.3
Total	526	D	44.1	10.8	0.47	14.8-77.7	482	D	26.5	6.1	0.28	8.7-50.0
		ND	42.2	9.9	0.43	14.1-71.0		ND	24.6	5.6	0.26	7.3-43.7

^aYears/^bD, Dominant hand; ND, Non-Dominant hand

The effect of demographic factors

All strengths measured in women were significantly lower than those of the men ($P < 0.0001$). Accordingly, the grip strength of dominant and non-dominant hand in the women was 40 percent (17.7 kg) and 41.7 percent (17.6 kg) weaker than that of the men, respectively. Tip, Key and Palmar pinch strength of dominant hand in women were

also determined 34.3 percent (3 kg), 32.5 percent (3.4 kg) and 34.5 percent (3.5 kg) weaker than the men's dominant hand, respectively. Whereas, for the non-dominant hand of the women Tip, Key and Palmar pinch strength were respectively 33.9 percent (2.9 kg), 33.2 percent (3.4 kg) and 35.4 percent (3.6 kg) weaker than those of men.

Table 3: Normative data of pinch strengths (Tip, Key and Palmar) in kg force for men by age (n=526)

Age ^a	Hand ^b	Tip Pinch (kg)				Key Pinch (kg)				Palmar Pinch (kg)			
		Mean	SD	SEM	min-max	Mean	SD	SEM	min-max	Mean	SD	SEM	min-max
20-24	D	9.5	1.7	0.24	6.5-14.3	11.5	1.4	0.19	9.0-14.5	12.9	2.2	0.30	7.1-17.7
	ND	9.4	1.6	0.22	5.5-13.8	10.9	1.4	0.18	7.0-13.3	12.9	2.0	0.27	7.0-18.2
25-29	D	9.6	1.9	0.30	6.5-14.5	11.1	1.6	0.25	7.7-15.5	11.7	2.5	0.39	6.7-21.0
	ND	9.3	1.6	0.25	6.5-14.2	11.1	1.5	0.23	7.5-16.0	11.8	2.3	0.35	6.9-21.0
30-34	D	9.1	2.3	0.38	3.0-17.5	11.1	1.6	0.27	8.0-15.0	11.6	2.7	0.44	6.5-19.9
	ND	9.1	2.0	0.33	6.0-16.5	10.4	1.4	0.23	7.0-13.0	11.4	2.5	0.42	5.8-17.8
35-39	D	9.5	1.9	0.30	5.5-15.1	11.1	1.7	0.27	7.3-15.7	11.2	2.5	0.39	5.9-19.0
	ND	9.0	1.5	0.24	5.6-12.8	10.9	1.9	0.30	5.9-16.2	11.3	2.1	0.33	8.0-20.0
40-44	D	9.2	1.5	0.24	6.2-13.2	11.6	1.8	0.28	8.5-15.5	11.3	2.2	0.36	6.0-16.4
	ND	8.9	1.3	0.20	6.4-12.0	11.0	1.6	0.26	8.1-15.2	11.2	2.1	0.34	8.0-19.2
45-49	D	9.1	1.4	0.22	6.5-14.0	11.1	1.4	0.22	7.9-16.5	10.4	2.4	0.36	5.9-18.0
	ND	8.8	1.1	0.16	6.9-12.5	10.9	1.2	0.18	9.0-14.7	10.1	1.9	0.29	5.2-14.5
50-54	D	8.6	1.6	0.22	5.8-13.4	10.5	1.4	0.20	6.8-14.4	9.9	2.0	0.29	5.3-16.0
	ND	8.1	1.5	0.21	2.2-10.8	10.0	1.7	0.23	5.0-13.8	10.0	2.2	0.31	5.0-17.5
55-59	D	8.6	1.9	0.29	4.2-16.2	10.8	2.0	0.31	5.1-16.8	10.0	3.1	0.49	5.5-22.0
	ND	8.3	1.7	0.27	4.8-13.5	10.1	1.7	0.26	4.7-13.0	9.9	3.0	0.47	4.2-19.0
60-64	D	8.9	2.0	0.30	4.3-14.5	10.6	1.6	0.24	7.2-15.5	9.6	2.5	0.37	5.5-15.7
	ND	8.3	1.8	0.27	4.8-13.5	10.4	2.1	0.32	6.5-17.7	9.4	2.0	0.30	4.0-15.3
65-69	D	8.3	1.7	0.27	5.0-12.7	9.9	1.3	0.21	6.8-12.5	8.4	1.7	0.27	4.2-13.0
	ND	7.7	1.5	0.25	4.9-11.5	9.7	1.4	0.23	5.0-12.1	8.3	1.8	0.29	4.7-13.9
70-74	D	8.1	1.6	0.24	3.5-13.5	9.9	1.2	0.18	7.0-12.5	8.5	1.4	0.21	4.7-12.5
	ND	7.7	1.6	0.23	5.0-12.2	9.5	1.1	0.17	7.2-13.0	8.5	1.6	0.23	6.0-14.0
75<	D	7.3	1.4	0.21	4.1-12.3	8.9	1.3	0.19	6.0-11.9	7.6	1.2	0.18	4.8-10.4
	ND	6.8	1.3	0.19	4.2-10.6	8.5	1.3	0.19	5.8-12.2	7.5	1.2	0.17	5.0-10.3
Total	D	8.8	1.9	0.08	3.0-17.5	10.7	1.7	0.07	5.1-16.8	10.3	2.7	0.12	4.2-22.0
	ND	8.4	1.7	0.07	2.2-16.5	10.3	1.7	0.07	4.7-17.7	10.2	2.6	0.11	4.0-21.0

^aYears/^bD, Dominant hand; ND, Non-Dominant hand**Table 4:** Normative data of pinch strengths (Tip, Key and Palmar) in kg force for women by age (n=482)

Age ^a	Hand ^b	Tip Pinch (kg)				Key Pinch (kg)				Palmar Pinch (kg)			
		Mean	SD	SEM	min-max	Mean	SD	SEM	min-max	Mean	SD	SEM	min-max
20-24	D	5.7	1.8	0.27	1.4-9.6	7.8	1.6	0.25	2.6-14.0	7.2	1.5	0.23	3.6-12.0
	ND	5.5	1.3	0.19	2.9-9.2	7.4	1.5	0.23	4.0-14.0	7.3	1.5	0.22	3.1-11.8
25-29	D	6.1	0.9	0.14	4.2-8.2	7.8	0.8	0.13	5.6-9.7	7.6	1.0	0.15	5.7-10.9
	ND	5.9	1.0	0.15	3.9-8.0	7.4	1.0	0.15	5.1-10.0	7.3	1.2	0.19	3.5-11.5
30-34	D	6.0	0.9	0.14	4.0-9.0	7.8	1.0	0.16	5.7-10.5	7.3	1.1	0.17	4.5-10.4
	ND	5.6	1.0	0.15	3.0-7.5	7.3	0.9	0.14	5.0-9.6	6.8	1.0	0.15	4.0-8.2
35-39	D	6.1	0.8	0.13	4.6-8.5	7.7	0.9	0.14	5.0-10.0	7.2	1.2	0.18	5.1-12.2
	ND	5.9	0.7	0.11	4.0-7.2	7.3	0.8	0.12	5.5-9.4	7.2	1.2	0.19	4.5-12.5
40-44	D	6.2	1.0	0.15	4.8-10.2	7.8	1.0	0.16	6.0-11.5	7.4	1.4	0.21	5.0-13.0
	ND	5.9	0.8	0.12	4.5-8.6	7.4	1.1	0.16	5.4-10.0	7.3	1.3	0.21	5.1-11.2
45-49	D	6.1	1.1	0.17	4.1-9.9	7.6	1.1	0.17	5.1-10.6	7.0	1.3	0.20	3.5-11.7
	ND	5.9	0.8	0.12	4.0-7.7	7.3	1.0	0.15	5.0-10.7	6.9	1.3	0.19	4.2-11.3
50-54	D	5.9	0.9	0.14	4.5-8.2	7.3	0.9	0.14	5.5-9.2	7.0	1.2	0.18	5.5-10.0
	ND	5.6	0.7	0.11	3.5-7.4	7.1	0.9	0.14	4.6-9.6	6.7	1.2	0.18	5.0-11.0
55-59	D	5.8	0.8	0.13	3.8-7.5	7.0	0.8	0.13	4.5-8.6	6.8	1.2	0.19	4.5-10.0
	ND	5.7	0.6	0.10	4.7-6.9	6.9	0.8	0.12	5.4-8.5	6.6	1.0	0.16	4.5-10.0
60-64	D	5.5	0.9	0.15	3.5-9.0	6.6	0.9	0.14	4.5-9.2	6.1	1.1	0.18	2.9-9.0
	ND	5.4	0.8	0.13	3.2-7.5	6.3	0.9	0.14	3.8-8.0	6.1	1.0	0.16	3.5-9.0
65-69	D	5.5	0.9	0.15	4.2-8.5	6.4	0.8	0.13	4.5-9.3	6.0	0.8	0.13	3.6-12.0
	ND	5.4	0.7	0.12	4.0-8.1	6.3	0.7	0.12	5.0-8.0	5.8	0.8	0.13	3.0-6.8
70-74	D	5.4	0.8	0.13	2.7-7.0	6.2	0.9	0.16	4.0-8.0	5.6	0.9	0.15	5.7-10.9
	ND	5.2	0.5	0.10	4.1-6.3	5.8	0.6	0.11	4.5-7.1	5.6	0.8	0.13	3.6-7.3
75<	D	4.7	0.7	0.12	2.5-6.4	5.4	0.8	0.14	3.7-7.8	5.1	1.2	0.20	4.5-10.4
	ND	4.6	0.7	0.12	2.5-6.5	5.2	0.7	0.12	3.8-7.2	4.8	0.9	0.16	2.7-7.5
Total	D	5.8	1.1	0.05	1.4-10.2	7.2	1.2	0.06	2.6-14.0	6.7	1.4	0.06	5.1-12.2
	ND	5.6	0.9	0.04	2.5-9.2	6.9	1.1	0.05	3.8-14.0	6.6	1.3	0.06	2.7-12.5

^aYears/^bD, Dominant hand; ND, Non-Dominant hand

The results of investigating the effect of age on grip and pinch strength of the men and women (Table 5) demonstrated that there was an inverse and significant correlation between age and all measured strengths in dominant and non-dominant hand ($P<0.0001$). The highest and lowest correlation between age and pinch strength were achieved for men in Tip and Palmar and for women in Tip and Key.

There appeared no significant difference between the strength of right and left-handed persons. The grip and pinch strength of dominant hand, irrespective of sex (except for the palmar pinch strength in the men), were stronger than those of non-dominant hand ($P<0.0001$).

A comparison of grip strength in Iranian adults with that of other countries

A comparison of the average grip strength in Iranians with the average of different societies according to age, derived from previous studies, is depicted in Fig 1. As it is evident, there is no considerable difference between the average grip strength in Iranian adults and that of other societies like America, Switzerland, Australia and common database of western countries. Grip strength in Taiwanese population, however, is significantly different in all age groups from other compared regions in a way that the average strength in both sexes is less than other nations.

Table 5: Pearson’s correlation coefficients between the strength evaluations of each hand and age: Women, Up the diameter; Men, Down the diameter

Variables	Age	Pearson’s correlation coefficients [r]							
		D ^a -GS ^b	D-TP	D-KP	D-PP	ND-GS	ND-TP	ND-KP	ND-PP
Age	1	-0.525*	-0.290*	-0.547*	-0.488*	-0.460*	-0.262*	-0.519*	-0.492*
D-GS	-0.685*	1	0.572*	0.665*	0.608*	0.899*	0.533*	0.643*	0.588*
D-TP	-0.331*	0.476*	1	0.722*	0.663*	0.524*	0.719*	0.547*	0.551*
D-KP	-0.400*	0.627*	0.663*	1	0.718*	0.592*	0.591*	0.791*	0.648*
D-PP	-0.564*	0.686*	0.573*	0.633*	1	0.538*	0.581*	0.652*	0.764*
ND-GS	-0.706*	0.925*	0.503*	0.613*	0.656*	1	0.560*	0.619*	0.556*
ND-TP	-0.431*	0.565*	0.800*	0.679*	0.607*	0.608*	1	0.615*	0.633*
ND-KP	-0.388*	0.522*	0.558*	0.774*	0.526*	0.546*	0.672*	1	0.722*
ND-PP	-0.598*	0.621*	0.536*	0.596*	0.850*	0.644*	0.600*	0.516*	1

* P-value < 0.0001/^aD: Dominant hand; ND: Non-Dominant hand. ^b GS: Grip Strength; TP: Tip Pinch; KP: Key Pinch; PP: Palmar Pinch

Discussion

In this study, the normative data of grip strength and three types of pinch strengths known as Tip, Key and Palmar were detected for the adult population of Iran. In the previous studies, various age groups with 10-year (12, 22) or even 14-year intervals (1) were applied to establish normative data. In the present study, nevertheless, normative data of grip strength, as in some other researches (18, 21), was provided for age groups with 5 years of age interval, except for the age group of over 75 years of age, so as to provide the information for each age group of the society with more precision. In this study, grip strengths of dominant and non-dominant hands in the men were respectively 40 and 42 percent stronger than those of women the

ratio of which was also verified by other researchers (1, 21, 23-25). There has been some other studies, however, reporting lower (11) or higher (26) ratios. Iranian adult men were stronger than women even in pinch strengths since pinch strength in the women was 32 to 35 percent weaker than that of men. The ratios determined by Puh are similar to the results of the present study (1). But there have also been some researches detecting more significant differences of pinch strength in the men and women with the men dominance (18, 21, 23). This discrepancy is relevant to the differences in gender-specific muscle fibers (11). In this study, maximum grip strength was acquired in the men of 20-24 years of age. Some previous studies also found maximum grip strength of men in similar age group (12, 17, 21).

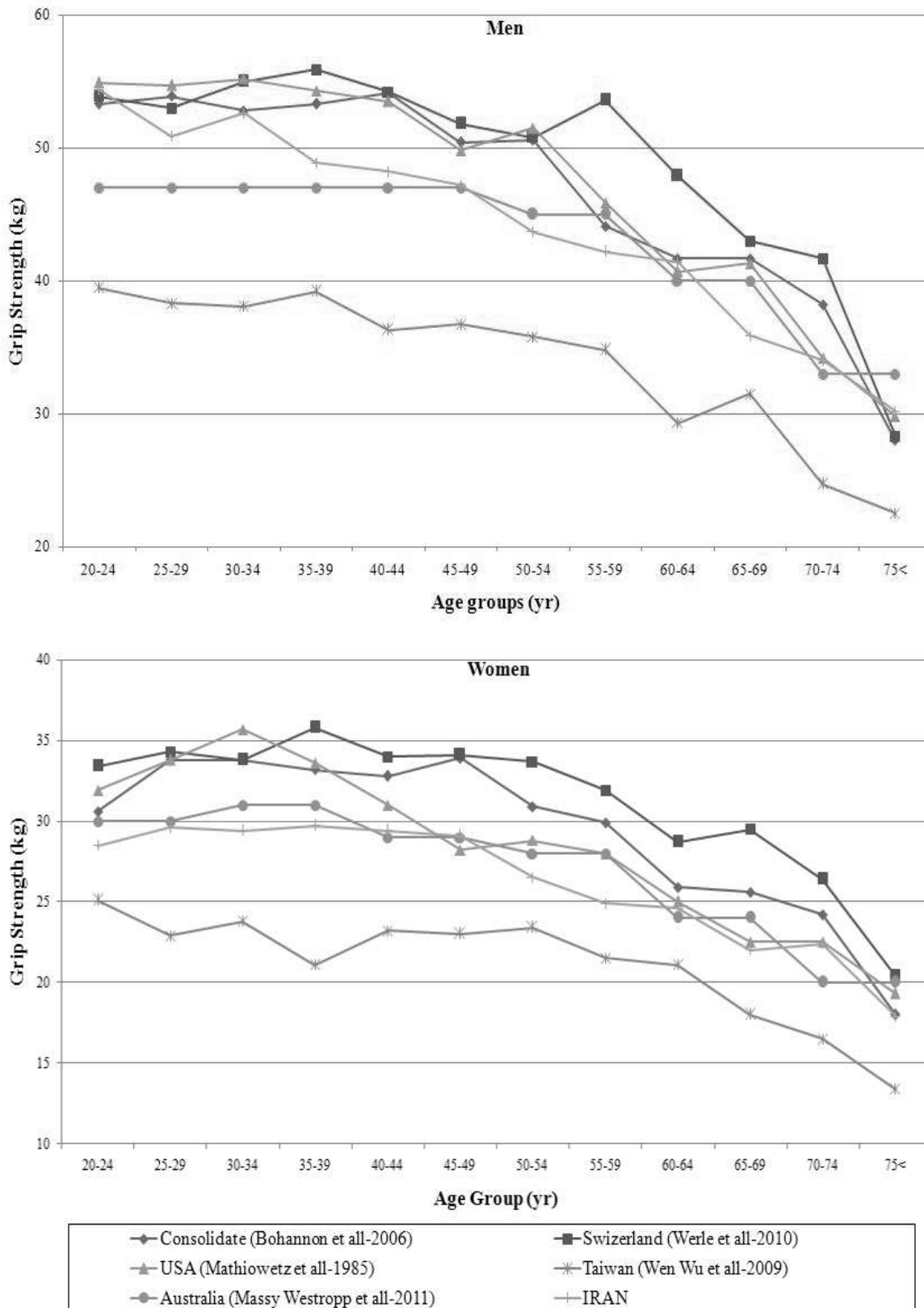


Fig. 1: Comparison regional reports of mean grip strength by sex and age groups

Nonetheless, Werle et al. (15), Angst et al (9) and Gunther et al. (24) reported maximum grip strength in 35-39, 25-29 and 30-49 age groups, respectively. Among women, maximum grip strength was obtained in age group of 35-39 years which was compatible with some previous studies (1, 24). Also some researches existed detecting maximum grip strength of women in age groups younger (12, 17, 21) and older (15) than those of this study. Although most of them reported minimum grip strength, irrespective of sex, in the last age groups i.e. the seventh and eighth decades (2, 10, 15, 17, 21, 27) which were in agreement with the results of the present study. In this research, the mean value of Tip, Key, and Palmar pinch strengths was relatively stable up to the age group of 50-59 and afterwards the steep decline started. Although Mathiowetz et al. agree with the results of this study in this respect (21).

The results of this study indicated that with age increase, grip and pinch strengths would decline in both sexes; in fact there was found a significant inverse linear relationship between these strengths and age (Table 5) which has also been asserted by a number of previous studied (1, 8, 9, 21). In the current study, regardless of sex, the inverse relationship between age and grip strength was stronger than that of pinch strengths and it had a lower *P*-value ($P < 0.0001$) in such a way that the inverse correlation between grip strength and age was calculated as $r = -0.68$ to -0.52 (Table 5). Mathiowetz et al. (21) also had approximately the same correlation coefficient as ours. But Puh (1) and Adedoyin et al. (12) reported weaker correlation coefficients respectively as ($r = -0.37$ to -0.38) and ($r = -0.27$), in such a way that in their study the inverse relationship of age with grip strength in Nigerian women was not significant ($r = -0.02$, $P > 0.05$).

Comparing grip strength of people in different regions can, based on research type, reveal hidden facts including geographical differences, genetic factors, nutritional deficiencies and social and cultural conflicts (28). No significant difference was observed comparing grip strength of Iranian adults (irrespective of sex) with other countries except for Taiwan. Although the average grip

strength of Switzerland, America and common database, up to 55-59 age groups, was stronger than that of Iranian population, the differences were not significant (fig 1) but grip strength of Taiwanese population was significantly different from strength of Iranian population and other compared countries. Kamarul et al. and Xiao et al. reported a significant difference in comparison of grip strength of Malaysian adults and Chinese ones with western dominance, respectively (25, 29). It is probable that the discrepancies in normative data values of grip strength in various regions and populations are to a great extent resulted from the difference between anthropometric factors. Anthropometric factors like height and weight depend on the race type (12). Therefore, the tremendous difference between grip strength of Taiwanese population and that of western and Iranian populations is related to racial differences. The race influence can be so effective that it may undermine the role of other efficient factors such as nutrition, socio-economic situation and geographical region. The importance of race effect was evident in the study carried out by Anjum et al. in which geographical and socio-economic factors of the compared populations were under investigation. The residents of West Yorkshire, England were investigated with a population of British people and a considerable number of Asian people and it was observed that British people had a statistically significant dominance in all grip and pinch (Tip and Key) strengths compared to Asian people (10).

As in the research done by Mathiowetz et al. (21), in this study, while testing Tip pinch strength, some women had difficulty with long fingernails. Lack of sufficient number of healthy persons in elderly age group due to incidence of diseases common in this group or old age conditions, was one of the limitations of the previous studies which was particularly true in the present study among women. Consequently, several elderly were not included in statistical analysis. Another limitation was that the established normative data of grip strength may not be able to be generalized to countries and populations with various races, cultures and socio-economic situations. Moreover,

due to the fact that Iran is made up of diverse ethnic groups and races, normative data resulted from the present study is not recommended for Iran races other than Fars (Turks, Kurds, Lurs, Arabs and etc.). It is therefore recommended that normative data of grip strength would be established specifically for each race in future studies. To establish normative data of grip for Iranian population under 20 years of age is further suggested by this research.

Conclusion

The information obtained from normative data of grip strength can be applied to treatment needs, estimation of individual efficiency in specific occupations and hand tool design. The results of comparing grip strength of different regions showed that the influence of race on grip strength may be more impressive than other factors such as geographical differences, nutritional deficiencies and social and cultural conflicts.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgment

This study was financially supported by the Office of Vice Chancellor for Research at Kerman University of Medical Sciences with the grant number 91/37. The said entity is hereby thanked for all its supports. We would like to thank AA. Alinaghi Langari, AR Mostafavi Nave and HR. Hokmabadi for their assistance in the study as testers. We also thank all Iranian people for their involvement in the research as volunteers. The authors declare that there is no conflict of interests.

References

1. Puh U (2010). Age-related and sex-related differences in hand and pinch grip strength in adults. *Int J Rehabil Res*, 33:4-11.

2. Mitsionis G, Pakos EE, Stafilas KS, Paschos N, Papakostas T, Beris AE (2009). Normative data on hand grip strength in a Greek adult population. *Int Orthop*, 33:713-717.
3. Mahalakshmi VN, Ananthakrishnan N, Kate V, Sahai A, Trakroo M (2004). Handgrip strength and endurance as a predictor of postoperative morbidity in surgical patients: Can it serve as a simple bedside test? *Int Surg*, 89:115-121.
4. Guerra RS, Amaral TF (2009). Comparison of hand dynamometers in elderly people. *J Nutr Health Aging*, 13:907-912.
5. Bohannon RW (2008). Hand-grip dynamometry predicts future outcomes in aging adults. *J Geriatr Phys Ther*, 31:3-10.
6. Ensrud KE, Ewing SK, Taylor BC, Fink HA, Cawthon PM, Stone KL, Hillier TA, Cauley JA, Hochberg MC, Rodondi N (2008). Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. *Arch Int Med*, 168:382-389.
7. Silventoinen K, Magnusson PKE, Tynelius P, Batty GD, Rasmussen F (2009). Association of body size and muscle strength with incidence of coronary heart disease and cerebrovascular diseases: a population-based cohort study of one million Swedish men. *Int J Epidemiol*, 38:110-118.
8. Flipon E, Brazier M, Clavel G, Boumier P, Gayet A, Le Loët X, Fardellone P (2009). Is it possible to identify early predictors of the future cost of chronic arthritis? The VERA project. *Fundam Clin Pharmacol*, 23:105-113.
9. Angst F, Drerup S, Werle S, Herren D, Simmen B, Goldhahn J (2010). Prediction of grip and key pinch strength in 978 healthy subjects. *BMC Musculoskelet Disord*, 11:94-99.
10. Anjum SN, Choudary P, Dimri R, Ankarath S (2012). Comparative evaluation of grip and pinch strength in an Asian and European population. *Hand Ther*, 17:11-14.
11. Kellor M, Frost J, Silberberg N, Iversen I, Cummings R (1971). Hand strength and dexterity. *Am J Occup Ther*, 25:77-83.
12. Adedoyin RA, Ogundapo FA, Mbada CE, Adekanla BA, Johnson OE, Onigbinde TA, Emechete AAI (2009). Reference Values for Handgrip Strength Among Healthy Adults in Nigeria. *Hong Kong Phys J*, 27:21-29.
13. Mathiowetz V, Weber K, Volland G, Kashman N (1984). Reliability and validity of grip and

- pinch strength evaluations. *J Hand Surg*, 9:222-226.
14. Reikers O (1983). Bilateral differences of normal hand strength. *Arch Orthop Trauma Surg*, 101:223-224.
 15. Werle S, Goldhahn J, Drerup S, Simmen BR, Sprott H, Herren DB (2009). Age- and gender-specific normative data of grip and pinch strength in a healthy adult Swiss population. *J Hand Surg Eur Vol*, 34:76-84.
 16. Karwowski W, Marras WS (2003). Occupational Ergonomics: Engineering and Administrative Controls. *Taylor & Francis e-Library*, 3ed. CRC.
 17. Wu SW, Wu SF, Liang HW, Wu ZT, Huang S (2009). Measuring factors affecting grip strength in a Taiwan Chinese population and a comparison with consolidated norms. *Appl Ergon*, 40:811-815.
 18. Ugurlu A, Ozdogan H (2012). Age- and gender-specific normative data of pinch strengths in a healthy Turkish population. *J Hand Surg Eur Vol*, 37:436-446.
 19. Pilsczek FH (2011). Infectious diseases of Afghan immigrants in the United States: review of published reports. *J Ayub Med Coll Abbottabad*, 23:159-62.
 20. Fess EE, Moran CA (1981). Clinical Assessment Recommendations. *Am Soc Hand Ther*.
 21. Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S (1985). Grip and pinch strength: normative data for adults. *Arch Phys Med Rehabil*, 66:69-72.
 22. Massy-Westropp NM, Gill TK, Taylor AW, Bohannon RW, Hill CL (2011). Hand Grip Strength: age and gender stratified normative data in a population-based study. *BMC Res notes*, 4:127-131.
 23. Crosby CA, Wehbe MA (1994). Hand strength: Normative values. *J Hand Surg*, 19:665-670.
 24. Gunther CM, Burger A, Rickert M, Crispin A, Schulz CU (2008). Grip strength in healthy Caucasian adults: reference values. *J Hand Surg*, 33:558-565.
 25. Kamarul T, Ahmad TS, Loh WYC (2006). Normal hand grip strength in the adult Malaysian population. *J Orthop Surg*, 14:172-71.
 26. Nicolay CW, Walker AL (2005). Grip strength and endurance: Influences of anthropometric variation, hand dominance, and gender. *Int J Indus Ergon*, 35:605-618.
 27. Bohannon RW, Peolsson A, Massy-Westropp N, Desrosiers J, Bear-Lehman J (2006). Reference values for adult grip strength measured with a Jamar dynamometer: a descriptive meta-analysis. *Physiotherapy*, 92:11-15.
 28. Jeune B, Skytthe A, Cournil A, Greco V, Gampe J, Berardelli M, Andersen-Ranberg K, Passarino G, DeBenedictis G, Robine JM (2006). Handgrip strength among nonagenarians and centenarians in three European regions. *J Gerontol A Biol Sci Med Sci*, 61:707.
 29. Xiao G, Lei L, Dempsey PG, Lu B, Liang Y (2005). Isometric muscle strength and anthropometric characteristics of a Chinese sample. *Int J Indus Ergon*, 35:674-679.