Reference values of Grip strength by Hand Held Dynamometer in Gujarati Population

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Abstract: Background & Objectives: Grip strength helps to assess strength of hand function, set treatment goals and analyze the effectiveness of treatment. At present in clinical practice normative reference data for grip strength is used but those are either done in different countries/ states or the sample size is less. Thus, the objective of the study is to estimate the reference values for cylindrical grip strength in Gujarati population and to estimate the reference values for pinch grip strength in Gujarati population. Methods: Observational; cross sectional study design was conducted on 342 normal healthy individuals with age group 18-60 years. Measurement of cylindrical grip strength and pinch grip strength were measured with hand held dynamometer and pinch meter respectively. Measurements were done alternately on both hands. Results: For males, reference values are ≥23 Kg. and ≥21 Kg. for right and left cylindrical grip respectively and ≥3.5 Kg. and ≥3 Kg. for right and left pinch grip respectively. For females, reference values are ≥16 Kg. and ≥14 Kg. for right and left cylindrical grip respectively and ≥2.5 Kg. and ≥2 Kg. for right and left pinch grip respectively. Conclusion: Norms for cylindrical and pinch grip strength are established for Gujarati population. Grip strength is found to be higher in males compared to females. Hand dominance also affects grip strength.[Sorani D Natl J Integr Res Med, 2019; 10(1):25-30]

Key Words: Grip Strength, Hand Held Dynamometer, Pinch meter, Reference values

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Introduction: Human hand is capable of performing grasping objects and manual dexterity. Functionally thumb and index finger are of more importance because of its musculature, strength and interaction with other digits. Hand is very important for various types of grips necessary in activities of daily living. Grips are classified into two i.e. power grip and precision grip. Power grip includes cylindrical grip, spherical grip, hook grip and fist grasp[1].

Power grip is for forceful activities. Precision grip includes pulp to pulp pinch grip, tip to tip grip, pulp to side prehension and three fingured pinch. Precision grip are used for activities which require accuracy. Estimated use of pulp to pulp pinch is 20% for activities of daily living[2]. Grip strength is a maximum isometric force that hand can generate using hand held dynamometer[3]. It helps to assess strength of hand function, set treatment goals and analyze the effectiveness of treatment. Grip strength can be considered to determine overall physical strength of individual[4]. Grip strength can be measured by various methods ranging from oxford muscle scale to various types of dynamometers such as hydraulic, mechanical and electronic. It is measured in variety of positions of shoulder, elbow and wrist. Studies have found that Grip strength was significantly different at different positions of the elbow. Grip and pinch strength of healthy Indian adults is less compared with age and gender-matched population from other continents[5].

A study to generate reference values for grip strength in healthy Indian population was done on 600 individuals with age group 21 to 80 years. Grip strength was assessed using Jamar Dynamometer. The results stated higher grip strength in males compared to females. It also noted higher grip strength in dominant side compared to non-dominant side. It concluded inverse relationship between age and grip strength[6].

A study was conducted to know the trends of handgrip strength in 2167 Indian students (1101 male and 1066 female) between the age group 6-25 years and its correlations with demographic characteristics. Handgrip strength was measured by standard technique. They concluded that statistically significant differences ($p<0.003$-0.001) of dominant and non-dominant handgrip strength were found in all the age groups between the male and female students. The dominant handgrip strength was found to have significantly positive correlations ($p<0.05$-0.01) with high and moderate socio-economic status, height and body weight of the subjects[7].

A study by Thaneshwer et al was conducted to analyze available strength data of Indian agricultural workers in terms of difference in pooled Indian data vs. individual state data and to find out difference between male and female data across various states of India. States included were Gujarat, Jammu and Kashmir,

Madhya Pradesh, Maharashtra, Orissa, TamilNadu, Meghalaya and Arunachal Pradesh. Strength variable that were analyzed were hand grip strength, push strength in standing and sitting posture, pull strength in standing and sitting posture, leg and foot strength in sitting posture, torque strength in standing and sitting posture and hand grip torque. They concluded that there are regional variations and gender variations for strength variable under study. It is found that data of grip strength from Gujarat is not available[8].

At present in clinical practice normative reference data for grip strength is used but those are either done in different countries/ states or the sample size is less with different methodological considerations. Thus, it is necessary to estimate the baseline values of grip strength in Gujarati population. The objective of the study is to estimate the reference values for cylindrical grip strength and pinch grip strength in Gujarati population.

Materials and Methods: Observational; cross sectional study design was conducted on 342 normal healthy individuals with age group 18-60 years.Sample size was decided based on the guidelines of CLSI (Clinical and Laboratory Standards Institute) for reference values. Subjects were called for the study through mouth to mouth publicity. Inclusion criteria were male and female subjects between 18-60 years of age and willing to participate. Subjects were excluded if they had any Neurological or neuromuscular disorders, History of injury, disease or pain in upper limb, History of trauma or pain in cervical region.Random sampling was done. Every alternate subject who was willing to participate was enrolled. Then on the basis of inclusion and exclusion criteria final subjects participated in the study. Each subject filled out the Subject Information sheet and signed informed consent form (in vernacular language if needed). Demographic data such as age, gender, weight and height was taken of the subject. Weight was measured on standard weighing scale(OMRON – HN286). Height was measured with stadiometer (Krups). Double Blinding was done in the study. Ethical approval for the study was taken from M P Shah medical college, Institutional Ethical Committee, Jamnagar, Gujarat, India. Materials used were Hand Held Dynamometer (BASELINE®; 12-0241), Pinch Gauge (BASELINE®; 12-0226), Weighing scale, Stadiometer. Reliability of Hand Held Dynamometer was measured before using for the study; inter-rater and intra-rater reliability is found to be high with intra-class coefficient 0.95 (0.88-0.98) and 0.91 (0.79-0.96) respectively.

Procedure: Familiarization with the technique of test performance was done by demonstrating the technique. For measurement of cylindrical grip strength – subject was in sitting position on a chair with arm rest with shoulder adducted and neutral rotation with elbow 90° flexed, forearm in mid-prone position and wrist in neutral position. Subject was asked to hold hand held dynamometer for cylindrical grip where metacarpophalangeal joints and interphalangeal joints were allowed to flex to the amount to form a cylindrical grip with flexion equal to 90°. Subject was then asked to generate maximum force and the measurement on the dial displayed in kilogram was recorded Three recordings were taken with sufficient rest periodof 3 minutes between them. Best of three was used for final analysis[2].For measurement of pinch grip strength -subject was in sitting position on a chair with arm rest with shoulder adducted and neutral rotation with elbow 90° flexed, forearm supinated and wrist in neutral position. Subject was asked to hold pinch meter between pulp of thumb and pulp of index finger and generate maximum force and the measurement on the dial displayed in kilogram was recorded[2].Three recordings were taken with sufficient rest periodof 3 minutesbetween them. Best of three was used for final analysis.Measurements were done alternately on both hands.

Statistical Analysis: Data was entered and analyzed in Medcalc statistical software. Reference ranges for grip strength are calculated using mean, Standard Deviation, median and Interquartile Range. Reference ranges are calculated using Medcalc statistical software.

Results : As shown in table 1, 55% males and 45% females participated in the study. Among them 93% were right dominant and 7% were left dominant.

Table 1: Characteristics of subjects

Gender	N	Age (Mean(SD))	Dominant side (N)	
			Right	Left
Male	187	30.71(12.53)	172	15
Female	155	28.55(12.55)	146	9
Total	342	29.86(12.55)	318	24

N – number of subjects; SD – Standard Deviation

As shown in table 2, males are having higher cylindrical and pinch grip strength compared to females. Right cylindrical and right pinch grip is higher compared to left cylindrical and left pinch grip strength respectively.

As shown in table 3, Right cylindrical and right pinch grip is higher compared to left cylindrical and left pinch grip strength respectively in subjects with right dominancy.

Table 2: Reference range of cylindrical and pinch grip

Grip	Gender	Mean (SD)	25th Percentile	Median (50th Percentile)	75th Percentile	IQR	Lower limit		Reference values
							Value	90% CI	
Right Cylindrical	Male (n=187)	37.79(7.79)	32	38	42	10	23	18-26	≥ 23
	Female (n=155)	21.68(4.08)	19	22	24	5	16	14-16	≥ 16
	Total (n=342)	30.49(10.25)	22	30	40	18	16	16-18	≥ 16
Left Cylindrical	Male (n=187)	35.78(7.66)	32	38	40	8	21	18-24	≥ 21
	Female (n=155)	19.96(4.02)	18	20	22	4	14	12-16	≥ 14
	Total (n=342)	28.61(10.07)	20	26	38	18	14	14-16	≥ 14
Right Pinch	Male (n=187)	5.75(1.37)	5	5.5	7	2	3.5	3-4	≥ 3.5
	Female (n=155)	4.18(1.19)	3	4.5	5	2	2.5	2-2.5	≥ 2.5
	Total (n=342)	5.04(1.51)	4	5	6	2	2.5	2.5-3	≥ 2.5
Left Pinch	Male (n=187)	5.82(1.41)	5	5.5	7	2	3	3-4	≥ 3
	Female (n=155)	3.89(1.16)	3	4	5	2	2	2-2.5	≥ 2
	Total (n=342)	4.95(1.62)	4	5	6	2	2.5	2-2.5	≥ 2.5

n – number of subjects; SD – Standard Deviation; IQR – Interquartile Range; CI – Confidence Interval

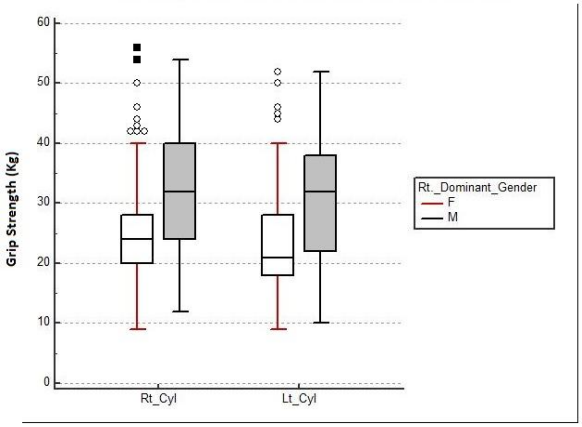
Table 3: Reference range for right dominant subjects

Grip	Gender	Mean (SD)	25th Percentile	Median (50th Percentile)	75th Percentile	IQR	Lower limit		Reference values
							Value	90% CI	
Right cylindrical	Male (n=172)	37.91(7.88)	32	38	42	10	24	18-27	≥ 24
	Female (n=146)	21.54(4.03)	18	21.5	24	6	16	14-16	≥ 16
	Total (n=318)	30.39(10.38)	22	28	40	18	16	16-18	≥ 16
Left cylindrical	Male (n=172)	35.63(7.71)	30	38	40	10	20	18-24	≥ 20
	Female (n=146)	19.83(3.96)	18	20	22	4	14	12-16	≥ 14
	Total (n=318)	28.38(10.07)	20	26	38	18	16	14-16	≥ 16
Right Pinch	Male (n=172)	5.75(1.37)	5	5.5	7	2	3.5	3-4	≥ 3.5
	Female (n=146)	4.20(1.20)	3	4.5	5	2	2.5	2-2.5	≥ 2.5
	Total	5.04(1.50)	4	5	6	2	2.5	2.5-3	≥ 2.5

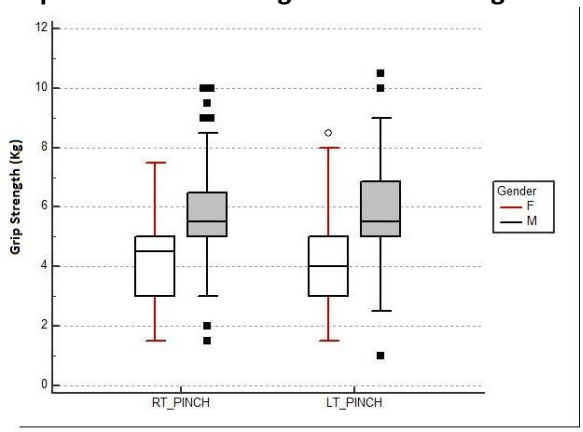
	(n=318)								
Left Pinch	Male (n=172)	5.77(1.40)	5	5.5	7	2	3	3-4	≥ 3
	Female (n=146)	3.87(1.17)	3	4	5	2	2	2-2.5	≥ 2
	Total (n=318)	4.90(1.61)	4	5	6	2	2.5	2-2.5	≥ 2.5

n – number of subjects; SD – Standard Deviation; IQR – Interquartile Range; CI – Confidence Interval

Graph 1: Reference range of cylindrical grip



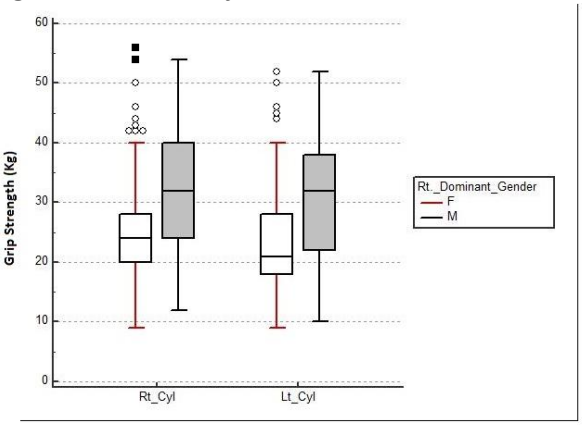
Graph 2: Reference range for Pinch strength



Discussion: The results of the present study shows reference values for the grip strength in Gujarati population varies with gender and dominancy of upper limb. Difference in mean values has been found between both the genders and upper limbs i.e. for males, mean is 37.79 Kg. and 35.78 Kg. for right and left cylindrical grip respectively and 5.75 Kg. and 5.82 Kg. for right and left pinch grip respectively. For females, mean is 21.68 Kg. and 19.96 Kg. for right and left cylindrical grip respectively and 4.18 Kg. and 3.89 Kg. for right and left pinch grip respectively.

Mean grip strength is found to be higher in males compared to females in both cylindrical and pinch grip suggesting presence of gender difference. Gender difference can be attributed to the physiological difference in muscle cross sectional area in both the gender and variation in activities performed by both gender i.e. males performing more physical work compared to females. As it is stated that males have more muscle cross sectional area in comparison to females. Our findings are consistent with previous literature in terms of gender difference.Rajani et al found cylindrical strength in males to be 33.67 (7.2) and females 19.51(3.9) in subjects with age group 18-30 years[5]. M Kaur et al have found cylindrical strength to be 38.95(6.12) and 24.21(3.87) in males and females respectively in age group of 16-30 years[9]. Both the studies have not differentiated between the two upper limbs.We have found higher strength than De et al who found cylindrical strength in males 30.29(7.24) and 28.83(7.18) on right and left upper limb respectively; females had 16.80(4.91) and 15.31(5.10) on right and left upper limb respectively[10].

Graph 3: Reference range of Cylindrical Grip for right dominant subjects



Graph 4: Reference range of Pinch Grip for right dominant subjects

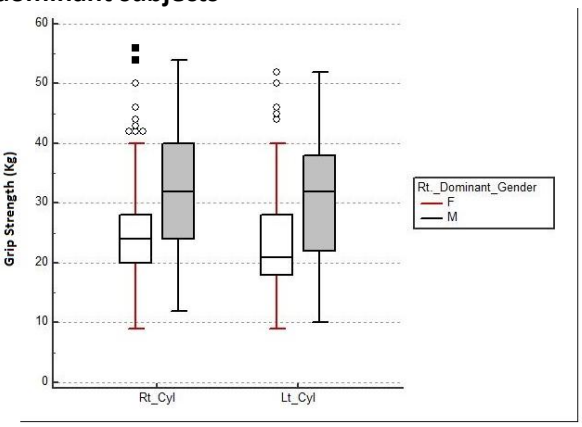


Table 4: Comparison with data of grip strength from various states of India

Grip	Gender	Side	Gujarati (Present study) (18-60 years)	Punjabi [7] (18-25 years)	Bengalee[10](20-60 years)	Dakshina Kannada[11] (20-40 years)
Cylindrical	Male	Right	37.79(7.79)	41.31(6.00)	30.29(7.24)	28.09(7.13)
		Left	35.78(7.66)	41.12(6.88)	28.83(7.18)	29.04(7.27)
	Female	Right	21.68(4.08)	23.82(3.71)	16.80(4.91)	19.89(4.18)
		Left	19.96(4.02)	23.48(3.29)	15.31(5.10)	19.91(4.13)
Pinch	Male	Right	5.75(1.37)	-	-	-
		Left	5.82(1.41)	-	-	-
	Female	Right	4.18(1.19)	-	-	-
		Left	3.89(1.16)	-	-	-

As shown in table 4, difference in grip strengthis observed among the states of India. Possible reason for this can be regional variation within the states of India, nature of subjects enrolled for the study in terms of their lifestyle and age of the subjects.

Our results suggests dominant hand have higher strength than non-dominant hand for both cylindrical grip and pinch grip. This may be as dominant hands are morefunctionally used for all activities of daily living. Our findings are consistent with Koley et al and Prachita et al who found dominant hand is having higher grip strength than non-dominant hand in both males and femalesthough in both the studies gender difference were found with males having more strength in dominant hand and least strength in females on non-dominant side[46.]

Anuppatel et al has found more strength in dominant hands in comparison to non-dominant hands but they have not studied on both the gender. Their result shows more grip strength in comparison to our finding as they measured with elbow in full extension. Elbow extension is thought to show higher grip strength compared to when elbow is kept in different flexion position[12].

Mean pinch grip strength in our study is found to be 5.75 on right side and 5.82 on left side in males whereas 4.18 and 3.89 on right and left side respectively in females. This suggests males having higher pinch grip strength compared to females irrespective of dominancy. Pinch grip which we considered for our study is pad to pad grip.

We have also analyzed results based on dominancy. Our study included more number of right handed dominant subjects compared to left handed dominant subjects. As sampling technique used in our study was random sampling. Our results showed that in right handed dominant subjects cylindrical and pinch grip were stronger on right side than left side.

Available literature shows analyses based on mean and standard deviation but in our study we also considered percentile values and generated reference values. For males, reference values are ≥23 Kg. and ≥21 Kg. for right and left cylindrical grip respectively and ≥3.5 Kg. and ≥3 Kg. for right and left pinch grip respectively. For females, reference values are ≥16 Kg. and ≥14 Kg. for right and left cylindrical grip respectively and ≥2.5 Kg. and ≥2 Kg. for right and left pinch grip respectively. These norms for cylindrical and pinch grip strength can be considered in Gujarati population.

Limitations of our study are factors such as physical activity and occupation were not considered. Stratified sampling based on age group was not done.

Conclusion : Norms for cylindrical and pinch grip strength are established for Gujarati population. Grip strength is found to be higher in males compared to females. Hand dominance also affects grip strength.

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Conflict of interest: None
Funding: None
Cite this Article as: Dinesh M. S, Sheshna R. R Reference values of Grip strength by Hand Held Dynamometer in Gujarati Population Natl J Integr Res Med 2019; Vol.10(1):25-30