Original Article

Comparison of strength of shoulder flexors measured through manual muscle testing and hand-held dynamometry in young healthy females

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Objective: To compare the strength of shoulder flexors of both extremities measured through manual muscle testing and hand held dynamometer in different age groups of young healthy females.

Methodology: In this cross-sectional study, 300 young healthy females in the age group of 18-39 years were recruited by non-probability convenient sampling technique. The muscle strength of the shoulder flexors of both upper extremities was measured by hand-held dynamometer and manual muscle testing. The strength was analyzed according to the variation of strength across grade 4 and 5 in different age groups by comparing means.

Results: In dominant side the muscle strength of 194 participants was in grade 4 with quantitative mean to be 9.32.1kgs, (range 4.08-16.10kgs); 106 participants had normal muscle strength with quantitative mean to be 10.24kgs (range 5.22-21.9kgs). In non-dominant side, 206 participants were graded in grade 4, the quantitative mean of strength was 9.1 kilograms (range 3.85-14.29kgs); 94 participants were graded in grade 5 with quantitative mean to be 9.8kgs (range 5.33-18.74kgs).

Conclusion: In young adult females, wide range of strength was seen in grade 4 and 5 with an overlap in strength measured quantitatively through hand-held dynamometer. Dominant side was stronger than non-dominant. In normal population weaker shoulder flexors were found. (Rawal Med J 202;45:483-487).

Keywords: Muscle strength, muscle strength dynamometer, manual muscle testing.

INTRODUCTION

Manual muscle testing and hand-held dynamometry are two most commonly used tools which are used to measure muscle strength.[1] Muscle strength is the ability of a muscle to produce maximal force in a single effort.[2] It varies with respect to population and age depending on muscle mass and neural control to activate muscle fibers.[3] Manual muscle testing has a subjective approach which grade muscle into six different grade. Grade 5 is considered as normal reference measure which is the maximal effort of the muscle against maximum resistance.[4] Hand-held dynamometer provides with objective measure of strength in pounds or kg. It has been in practice for a decade with its quantified approach.[5]

The normal muscle strength varies with characteristics of the population and many normative studies have emphasized the varying character of strength.[6-8] The subjectivity of manual muscle testing in grade 4 and 5 is debated in various studies which questions its reliability.[9] Bohannon conducted a study on knee extensors and grip strength and concluded that in grade 4 and 5 there was overlap in strength across dynamometric measures.[10, 11] A study on spinal cord injury patients concluded that dynamometer is subtler to detect minor strength deficits which is important factor to measure progression or regression in strength across a particular grade.[12] Quantification of strength by dynamometer which provides normative reference value is lacking in Asian population and requires exploration.

Flexion at shoulder joint of upper extremity is an

essential part of functional movement patterns which makes sure functional independence through performance of activities of daily livings. The average shoulder flexion involved to perform functional tasks is 121° ± 6.7°.[13] The normal strength of shoulder flexors is graded in grade 5 by manual muscle testing. This study was aimed at comparing the quantified dynamometric measures with respect to grades of manual muscle testing in shoulder flexors of normal healthy female population.

METHODOLOGY

In this cross sectional study, strength of shoulder flexors of 300 females of different age groups was measured. Non- probability convenient sampling technique was used. After taking the consent of participants and particular heads of the institutes the data was collected from the females of University of South Asia and Association of Fatima Jinnah old graduate's association. The study was approved by ethical research committee of University of Lahore.

The participants were divided into 5 age groups (18-19, 20-24, 25-29, 30-34, 35-39).[14,15] The dominant extremity was defined as the one used for daily activities. Young healthy females in the age group of 18-35 years without any restriction of movement of upper extremity were recruited. Those with musculoskeletal ailment or any neurological or cardiovascular issues were not included.

Hydraulic baseline analog pull push dynamometer was used. The strength of shoulder flexors of both extremities was measured while the subjects were sitting. In case of manual muscle testing, the patient was seated with arm 90 degrees flexed, palm facing inwards. The tester standing on the side of the arm applied maximal to submaximal resistance above elbow while stabilizing the shoulder with other hand. Depending upon effort of the participant the strength was graded as grade 4 (Good), grade 5 (normal).[4]

While using dynamometer two measures were taken and in case two measures were inconsistent a third measurement was also taken. The mean of these readings was used as quantitative strength of shoulder flexors. The position of the participant was, seated with shoulder flexed to 90 degrees, elbow straight, and palm facing inwards. The dynamometer was placed slightly above the elbow of test arm. The therapist standing on the side of the patient to be tested holding dynamometer with one hand and other hand providing stability. The subjects were requested to build their force to maximum in two second period of time. A steady rise in force make it easy for the tester to hold dynamometer against effort of patient. The participants were then asked to continue their effort for another 4 to 5 minutes.[7,8] This time duration has been adequate according to previous researches to measure maximal force.[16]

Statistical Analysis: The SPSS version 25 was used for data analysis. The p-values were calculated by using independent sample t-test while comparing quantitative mean of strength across grade 4 and 5. $p<0.05$ was considered as significant.

RESULTS

The mean age of the participants was 23.114.7 years. Most of the participants were from the age group of 18-19 and 20-24 years (Table 1). In dominant side, the strength of flexors of 194 participants was graded as good, with dynamometric mean to be 9.3 2.1kgs. 106 subjects had normal strength with dynamometric mean to be 10.24kgs and in non-dominant side 206 were graded as grade 4 having dynamometric mean 9.1kgs (Table 2).

Table 1. Age groups.

Age groups	Frequency	Percent
18-19	109	36.3
20-24	124	41.3
25-29	42	14.0
30-34	16	5.3
35-39	9	3.0
Total	300	100.0

Table 2. Strength of dominant shoulder flexors in different age groups.

Age Group	M1	D1						
		Mean (Kgs)	N	SD	Min. (Kgs)	Max. (Kgs)	% of Total N	p-values
18-19	Good	9.00	77	2.04	4.08	16.10	25.7%	
	Normal	10.88	32	2.63	5.22	17.69	10.7%	
	Total	9.54	109	2.38	4.08	17.69	36.3%	0.000
20-24	Good	8.54	68	1.90	4.99	13.88	22.7%	
	Normal	8.75	56	2.17	5.67	16.55	18.7%	
	Total	8.63	124	2.02	4.99	16.55	41.3%	0.567
25-29	Good	10.91	31	1.61	7.26	14.29	10.3%	
	Normal	14.20	11	3.01	9.75	21.88	3.7%	
	Total	11.78	42	2.50	7.26	21.88	14.0%	0.000
30-34	Good	10.86	11	1.87	7.71	12.93	3.7%	
	Normal	12.68	5	1.28	10.88	14.40	1.7%	
	Total	11.43	16	1.87	7.71	14.40	5.3%	0.071
35-39	Good	10.56	7	1.51	8.01	12.70	2.3%	
	Normal	14.06	2	6.09	9.75	18.37	0.7%	
	Total	11.33	9	2.96	8.01	18.37	3.0%	0.003
Total	Good	9.30	194	2.10	4.08	16.10	64.7%	
	Normal	10.24	106	3.05	5.22	21.88	35.3%	
	Total	9.63	300	2.51	4.08	21.88	100.0%	

SD= Standard Deviation, Min.= Minimum, Max.= Maximum. D1= Dynamometric Strength of Dominant Sh. Flexors. M1= Strength of Dominant shoulder flexors measured by manual muscle testing. Good= Grade 4, Normal= Grade 5, p value ≤0.05 = significant difference.

Table 3. Strength of non-dominant shoulder flexors in different age groups.

Age Group	M2	D2						
		Mean (Kgs)	N	SD	Min (Kgs)	Max (Kgs)	% of Total N	p-values
18-19	Good	8.88	83	1.94	3.85	12.59	27.7%	
	Normal	10.70	26	2.80	6.35	16.10	8.7%	
	Total	9.31	109	2.30	3.85	16.10	36.3%	0.003
20-24	Good	8.05	69	1.81	5.22	13.83	23.0%	
	Normal	8.56	55	1.76	5.33	12.70	18.3%	
	Total	8.28	124	1.80	5.22	13.83	41.3%	0.124
25-29	Good	10.74	34	1.70	6.58	14.29	11.3%	
	Normal	12.76	8	2.71	10.43	18.74	2.7%	
	Total	11.13	42	2.05	6.58	18.74	14.0%	0.010
30-34	Good	10.36	12	1.54	7.63	12.47	4.0%	
	Normal	12.19	4	1.70	10.43	14.06	1.3%	
	Total	10.81	16	1.73	7.63	14.06	5.3%	0.064
35-39	Good	10.69	8	1.90	7.94	12.93	2.7%	
	Normal	17.23	1	.	17.23	17.23	0.3%	
	Total	11.41	9	2.81	7.94	17.23	3.0%	0.014
Total	Good	9.07	206	2.08	3.85	14.29	68.7%	
	Normal	9.75	94	2.70	5.33	18.74	31.3%	
	Total	9.28	300	2.31	3.85	18.74	100.0%	

SD= Standard Deviation, Min.= Minimum, Max.= Maximum. D2= Dynamometric Strength of Non-Dominant Shoulder Flexors. 2= Strength of Non-Dominant Shoulder Flexors measured by Manual Muscle Testing.
Good= Grade 4, Normal= Grade 5, p value ≤0.05 = significant difference

The age group of 20-24 years deviated from prescribed trend of increase in strength with age as strength in grade 5 in dominant flexors was 8.752.17kgs, and 8.61.76 kgs in other side. In the preceding age group of 18-19 the normal strength according to grade 5 was 10.92.63kgs in flexors of dominant extremity and was 10.72.8kgs.in other side. The dominant side was stronger as compared to non-dominant (Table 3).

DISCUSSION

The quantitative comparison of strength of shoulder flexors revealed that in normal female Pakistani population the strength of more than 50% of shoulder flexors is less than normal according to the grading criteria of manual muscle testing as grade 4 indicates lesser strength.[4] This finding is a novel finding in the context of healthy population. The cause of weaker shoulder flexors need to be further studied.

Van Harlinger et al and Bohannon in their studies to compile normative data considered the normal population without any health ailment.[14,17,18] The significant strength differences in various age groups (18-19, 25-30, 35-40years) of healthy population in grade 4 and 5 emphasizes the need of standardization of the population selected to measure muscle strength by hand held dynamometer in normal population while compiling normative data.

The quantification through hand held dynamometer varies with age, muscle mass and other characteristics of population. According to a study, strength in shoulder flexors of females varied between 10.33.2kgs to 10.44.7kgs in dominant side and 9.52.2kgs to 8.44.2kgs in age groups varying from 20 -39.[14] This reference study and most of the other studies which measure the muscle strength in normal healthy individual considers absence of gross ailment as a sign of being healthy. It does not address the query that does the normal healthy individuals have normal muscle strength.

The dynamometric quantification showed overlap in strength in grade 4 and 5. The overlap in strength indicates the dispersed range of shoulder flexors in

normal population as has been discussed earlier in studies conducted on knee extensors and grip strength.[10,11] This diverse range indicate morphological and demographic exploration in Asian population.

The deviation of age group of 20-24 from usual increase in strength indicates towards transition from teen age group. Incel et al [19] and Bohannon [20] have summarized various studies that compared grip strength and concluded that dominant side is stronger as compared to non-dominant one. This study also confirms a stronger dominant side as compared to non-dominant one as per quantitative measures which cannot be resolved with clarity on the basis of grades.

In future, a study considering male population should be considered, the study design should be extended to other muscle groups and causes of weaker shoulder flexors in healthy population should be explored.

CONCLUSION

The comparison of shoulder flexors by both tools to measure muscle strength concluded with domination of dynamometric measures regarding detection of small strength differences as indicated by overlap across grade 4 and grade 5. While considering strength deficit as compared to normal, the lack of standardized normative data emphasizes the importance of Manual Muscle Testing as a tool to indicate weakness in muscle strength. This study also revealed stronger dominant side as compared to non-dominant and significant weaker shoulder flexors in healthy females.

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