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Measurement of Adductor Pollicis Muscle Thickness in a Healthy Population in Iran and Its Correlation with other Anthropometric Parameters

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ABSTRACT

Introduction: In clinical settings, anthropometric parameters are used as a measure of nutritional assessment. Assessment of the thickness of the adductor pollicis muscle has been reported as an indicator of muscle compartments of the body. The adductor pollicis is the muscle of the hand with two heads that adducts the thumb in bringing it toward the plane of the palm. The adductor pollicis muscle has a well-defined anatomical position and can be directly measured. We determined thickness values of this new parameter and also its correlation with conventional anthropometric parameters. **Methods:** A total of 432 apparently healthy volunteers who were grouped by sex and age were assessed for the measurements of mid-arm circumference, triceps skin fold, mid-arm muscle circumference, mid-arm area, mid-arm muscle area and adductor pollicis muscle thickness in both hands. **Results:** The average thickness of the adductor pollicis muscle in the dominant and non-dominant hands were 14.55 ± 3.17 and 13.74 ± 3.19 mm in males and 11.24 ± 2.37 and 10.21 ± 2.41 mm in females, and their differences were significant ($P<0.001$). The average thickness of adductor pollicis muscle was progressively higher in subjects with small, medium, and large frame sizes in both genders ($P=0.0001$). The APM thickness had a high correlation with the anthropometric variables in subjects ($P<0.001$). **Conclusion:** Measurement of adductor pollicis muscle thickness is simple, fast, non-invasive and easily reproducible, rendering it a useful anthropometric parameter for evaluating nutritional status of individuals.

Key words: Anthropometry, nutritional assessment, reference values

INTRODUCTION

Body composition is used along with other assessment factors to provide an accurate description of one's overall health. Differences in the skeletal size and the proportion of lean body mass can contribute to body weight variations among individuals of similar height. Indirect methods for measuring body composition include triceps skin fold thickness (TSF), mid-arm muscle circumference (MAMC) and mid-arm circumference (MAC). MAMC is a measure of muscle protein mass to assay nutritional status using inpatient and outpatient settings. Combining MAC with TSF measurements to determine MAMC by formula is time-consuming with 33% calculation error between observers (Grant, 1992).

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Assessment of the thickness of the adductor pollicis muscle (APM) has been reported recently for evaluating the muscle compartments of the body (Lameu *et al.*,2004a). It is a muscle of the hand with two heads that adducts the thumb by bringing it toward the palm. It is a fleshy, flat, triangular, and fan-shaped muscle deep in the thenar compartment beneath the long flexor tendons and the lumbrical muscles at the centre of the palm. It overlies the metacarpal bones and the muscles. Anatomically, the APM is the only muscle in the body that could be directly measured (Gonzalez, Duarte & Budziareck,2010). Furthermore the APM measurement technique is fast, simple and non-invasive. As there are no reference values for the APM in the Iranian population, we conducted this study to determine the thickness of the APM in different age groups and also assayed its correlation with other anthropometric parameters in healthy adults.

METHODS

This cross-sectional study was undertaken among staff of Shahid Beheshti University hospital in Tehran. The study protocol was approved by the University Ethics Committee, and informed consent was obtained from all volunteers. The subjective global assessment (SGA) (Baker *et al.*, 1982) was performed on all the volunteers in order to select only apparently healthy subjects for the study. A total of 432 (284 females and 148 males) were selected. Anthropometric measurements were taken of all the participants by a trained researcher to minimise error of measurements. We categorised age into four groups: 18 to 25 years, 26 to 45 years, 46 to 65 years, and older than 65 years. The study covered a duration of seven months.

Weight of participants was measured while the subjects were minimally clothed with bare feet using digital scales and recorded to the nearest 0.1 kg. Height was measured in a standing position in bare feet using a tape meter while the shoulders were in a normal state. Body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared. Body frame size was measured by a person's wrist circumference in relation to his/her height in centimeters to determine if the body frame is large (<10.1 in female and < 9.6 in male), normal (=10.1-11.0 in female and =9.6-10.4 in male), or small (>11 in female and >10.4 in male). The APM thickness was assessed by caliper (Vogel, Germany) in both hands. It was measured while the subject was seated with the elbow flexed to approximately 90° over the chair handle. The caliper was applied across the adductor pollicis muscle situated in a triangle formed by the extended thumb and the index finger, with a 10 g/mm pressure. The average of three consecutive measurements was considered as a measure of APM thickness for each individual. The APM index (APMi) was calculated as the APM thickness measured in millimeters divided by the height in meters squared. The measurement of triceps skin fold thickness was taken with the person standing upright and arms hanging down loosely. The skin fold was pulled away from the muscle and measured with the calipers, taking a reading four seconds after the calipers had been released. The measuring point was halfway between the olecranon process of the ulna and the acromion process of the scapula. The mid-upper arm circumference was the circumference of the upper arm at that same mid-point, measured with a non-stretchable tape measure. The MAMC was the circumference of the upper-arm muscle at that same mid-point, calculated using the $MAMC = MAC - (\pi \times TSF)$ formula, or by using monogram. The mid-arm area (AA) is an estimation of the area of the upper arm. It is derived from the MAC using the $AA = MAC^2/4\pi$ formula, or by using monogram (Krause *et al.*, 2012; Heymsfield *et al.*, 1982). The AMA is an estimation of the area of the muscle portions of the upper arm, derived from the

MAMC using AMA=MAMC²/4π formula or by using nomogram (Krause *et al.,* 2012; Heymsfield *et al.,*1982).

Statistical analysis

SPSS software version 18 was used to analyse data. A value of P ≤0.05 was considered statistically significant. Wilcoxon signed ranks test was used to compare median of AMA with median of reference values according to age group and gender. Student's *t*-test was used to compare anthropometric measurements between males and females. One-way analysis of variance (ANOVA) was used to compare the anthropometric measurements in the three levels of frame size and among age categories. Correlation among anthropometric parameters was assessed by Pearson's coefficient.

RESULTS

A total of 432 volunteers (284 female and148 male) aged between 18 and 78 years were enrolled in the study. All the subjects were apparently healthy with SGA score of A. The mean ages of males and females were 36.4±14.4 and 38.4±12.8 respectively. Anthropometric data of the subjects are shown in Table 1. The average thickness of APM in the dominant hand was14.55 ± 3.17 mm in males and 11.24 ± 2.37 mm in females and their difference was significant (p<0.001). These values for the non-dominant hand were 13.74 ± 3.19 mm in males and 10.21 ± 2.41 mm in females and their difference was significant (p<0.001).

There was a significant difference in mean thickness of APM between dominant and non-dominant hands in females (11.24±2.37 mm vs. 10.21±2.41mm, p<0.001) and in males (14.55±3.17 mm vs. 13.74±3.19 mm, p<0.001). The average APMi in the dominant hand was 4.75±1.12 mm/m² in males and 4.33±1.08 mm/m² in females and their difference was significant (p<0.001). These values for the non-dominant hand were 4.48 ± 1.11 mm/m² in males and 3.94 ± 1.08 mm/m² in females and their difference was significant (p<0.001). Tables 2 and 3 show that the average thickness of APM and APMi was progressively higher in subjects with small, medium, and large frame sizes in both the male and female.

Tables 4 and 5 show the results of APM and APMi according to the age groups in the genders. It shows that with increasing age, the thickness of APM and APMi increases up to 65 years while it decreases after that. Table 6 shows the correlation between APM thickness and other anthropometric variables. The APM thickness had a high correlation with the

Table 1. General descriptive analysis of anthropometric measurements

Variable(n=432)	*Mean*	*SD*	*median*
Age (year)	37.4	13.4	34
AW[1](Kg)	69.2	12.8	68
BMI[2](Kg/m²)	24.9	4.34	24.9
TSF[3](cm)	17.52	5.71	17
MAC[4](cm)	28.41	4.13	28
MAMC[5](cm)	22.85	3.55	22.8
APM[6](mm)	12.37	3.09	12
APMi[7](mm/m²)	4.47	1.11	4.46
AMA[8](cm²)	42.80	13.1	39
AA[9] (cm²)	65.62	19.14	62

Notes: [1] Actual weight; [2] body mass index; [3]TSF-triceps skin fold; [4]Mid-arm circumference;[5]Mid-arm muscle circumference; [6]Adductor pollicis muscle; [7]Adductor pollicis muscle index; [8] Mid-arm muscle area; [9] Mid-arm area.

Table 2. Descriptive analysis of adductor pollicis muscle by frame size for males

Variable	*Frame Size*	*n*	*mean*	*SD*	*Min*	*Max*	*P value*	*Significant difference*[1]
APM[2] (mm)								
	1[3]	28	12.11	2.3	9	16	0.0001	1#3, 2#3
	2[4]	51	13.25	2.6	9	18		
	3[5]	69	16.49	2.7	11	22		
APMi[6] (mm/m²)								
	1[3]	28	2.78	0.73	2.78	5.28	0.0001	1#2, 1#3, 2#3
	2[4]	51	4.29	0.92	2.87	6.90		
	3[5]	69	5.48	0.91	3.72	8.01		

Notes: [1] Tukey's test; [2]Adductor pollicis muscle; [3] Small frame size; [4] Medium frame size; [5] Large frame size; [6] Adductor pollicis muscle index

Table 3. Descriptive analysis of adductor pollicis muscle by frame size for females

Variable	*Frame size*	*n*	*mean*	*SD*	*Min*	*Max*	*P value*	*Significant difference*[1]
APM[2] (mm)								
	1[3]	28	8.89	2.6	5	12	0.0001	1#2, 1#3, 2#3
	2[4]	130	10.45	1.7	6	16		
	3[5]	126	12.57	2.06	8	17		
APMi[6] (mm/m²)								
	1[3]	28	2.9	0.85	1.56	4.41	0.0001	1#2, 1#3, 2#3
	2[4]	130	3.9	0.74	2.16	5.88		
	3[5]	126	5.02	0.93	3.12	7.61		

Notes: [1] Tukey's test; [2]Adductor pollicis muscle; [3] Small frame size; [4] Medium frame size; [5] Large frame size; [6] Adductor pollicis muscle index.

Table 4. Descriptive analysis of adductor pollicis muscle and adductor pollicis muscle index by age for males.

Variable	*Age group*	*n*	*mean*	*SD*	*Min*	*Max*	*P value*	*Significant difference*[1]
APM[2] (mm)								
	≤25 (1)	39	12.21	2.84	9	22	0.0001	1#2, 3#4, 1#3, 2#4
	26-45 (2)	73	15.52	2.53	11	22		
	46-65 (3)	27	16.19	3.17	9	22		
	>65 (4)	9	11.89	1.84	9	14		
APMi[3] (mm/m²)								
	≤25 (1)	39	3.92	0.90	2.78	6.43	0.0001	1#2, 1#3, 3#4
	26-45 (2)	73	5.01	0.99	3.43	8.01		
	46-65 (3)	27	5.44	1	3.01	7.61		
	>65 (4)	9	4.75	0.84	2.87	5.54		

Notes: [1] Tukey's test; [2]Adductor pollicis muscle; [3]Adductor pollicis muscle index.

Table 5. Descriptive analysis of adductor pollicis muscle and adductor pollicis muscle index by age for females

Variable	*Age group*	*n*	*mean*	*SD*	*Min*	*Max*	*P value*	*Significant difference*[1]
APM[2] (mm)								
	≤25 (1)	48	8.90	1.78	5	12	0.0001	1#2 ,2#3, 1#3, 1#4
	26-45 (2)	151	10.91	1.98	5	16		
	46-65 (3)	82	13.17	1.79	9	17		
	>65 (4)	3	12.33	1.15	11	13		
APMi[3] (mm/m^2)								
	≤25 (1)	48	3.32	0.79	1.56	5.13	0.0001	1#2, 2#3, 1#3, 1#4
	26-45 (2)	151	4.15	0.78	1.87	6.49		
	46-65 (3)	82	5.23	0.92	3.61	7.61		
	>65 (4)	3	5.14	1.70	1.72	5.93		

Notes: [1] Tukey's test; [2]Adductor pollicis muscle; [3]Adductor pollicis muscle index.

Table 6. Correlation between the adductor pollicis muscle and other anthropometric variables

	DAPMT[1]	*NDAPMT*[2]	*P value*
Weight	0.60	0.60	<0.001
BMI[3]	0.46	0.45	<0.001
MAC[4]	0.51	0.52	<0.001
MAMC[5]	0.46	0.46	<0.001
Frame size	0.57	0.56	<0.001
AMA[6]	0.47	0.47	<0.001
AA[7]	0.52	0.51	<0.001

Notes: [1]Dominant adductor pollicis muscle thickness; [2]Non dominant adductor pollicis muscle thickness; [3]Body mass index; [4]Mid-arm circumference; [5] Mid-arm muscle circumference; [6]Arm-muscle area; [7]Mid-arm area.

weight, BMI, MAC, MAMC, AMA, AA and frame size in subjects. Wilcoxon Signed Ranks Test was used to compare median of AMA which measures muscle mass with median of reference values of National Health and Nutrition Examination Survey (NHANES). It shows that median values of AMA (cm^2) has significantly lower values than median of reference values in males in all age groups (19-24.9 y: 43 vs. 59.1, P= 0.0001; 25-34.9 y: 49.5 vs. 62.1, P= 0.0001; 35-44.9 y: 51.3 vs. 64.9, P= 0.0001; 45-54.9 y: 55.2 vs. 62.9, P= 0.02; 55-64.9 y: 54 vs. 61.4, P= 0.02).

DISCUSSION

Measurement of body compartments is part of a routine physical examination. The somatic protein compartment largely represents muscle mass protein. Malnutrition causes a decrease in muscle mass. Also, changes in muscle mass are a good indicator of prognosis in disease states (Bourdel-Marchasson *et al.*, 2001). The APM has a unique anatomical position which makes it accessible to evaluate its thickness (Lameu *et al.,* 2004b). It is the only muscle in the body that could be directly measured. Measurement of the thickness of APM is fast, easy, low cost and non-invasive. A few studies have used this method as a tool for lean body mass assessment to predict morbidity and mortality in critically ill, surgical, hemodialysis and stroke patients (Caporossi *et al.,* 2012 ; de Oliveira *et al.*, 2012; Oliveira & Frangella, 2012; Bragagnolo *et al.*, 2009) but only two studies have measured the thickness of APM in healthy populations to determine its reference value (Gonzalez *et al.*, 2010; Lameu *et al.,* 2004b). Lameu *et al.* studied 421 healthy subjects and Gonzalez *et al.* studied 300 healthy volunteers. Our study was consistent with the results of Gonzalez *et al.*(2010) and Lameu *et al.*(2004b) with higher values for AMP thickness in men versus women. In our study APMi was also higher in men versus women but Lameu *et al.*(2004b) found no difference in this index in both genders. Higher muscle mass in males compared to females may explain why APMi was higher in males in our study although this index is corrected with height.

Our results are similar to the findings of Gonzalez *et al.*(2010) & Lameu *et al.*(2004b) which showed significant differences in APM thickness among age groups. In the study of Gonzalez *et al.* , both male and female subjects aged between 30 and 60 years showed significantly higher values of APM thickness than the other categories. In the study of Lame *et al.*, the thickness of APM increased up to 65 years, then showed a clear decline. Also in our study, the thickness of APM increased with aging and after 65 years showed a decline. This may be due to sarcopenia which decreases thickness of APM after 65 years of age. The mean thickness of the APM was progressively higher in individuals with a small, medium and large frame size which was consistent with the findings of Gonzalez *et al.*(2010) and Lameu *et al.*(2004b)

A difference was found between our study and that of Gonzalez *et al.*(2010). They reported higher values of APM thickness in healthy subjects (26.1 ± 4.4 mm in men, 19.8±3.3 mm in women) than our study (14.55 ± 3.17 mm in men, 11.24 ± 2.37 mm in women). There was also a difference between our study and that of Lameu *et al.*(2004b). They reported lower values (12.49 ± 2.85 mm in men, 10.53 ±2.29 mm in women). As the measuring techniques were the same in these studies, it appears that race may have contributed to these differences. Studies have shown that blacks and Hispanics have a greater bone mineral density and muscle mass than whites (Araujo *et al.,* 2010; Wagner & Heyward, 2000). It has also been demonstrated that African-Americans have larger skeletal mass compared with Asian, Caucasian and Hispanic individuals. In our study the median levels of AMA of Iranian males were lower than the reference values of the NHANES study according to age groups. This inconsistency may be due to the difference in race. Therefore this may be a good reason for the different APM thickness values in our study. In our study the APM thickness had a positive correlation with weight, BMI, AMA, MAC, MAMC, AA and frame size. The highest correlation was with weight and frame size. In the study of Lameu *et al.* (2004b) the APM thickness had a significant positive correlation with MAMC, AMA and calf circumference and in study of Gonzalez *et al.*(2010), this correlation was positive with weight and BMI. Indeed the APM showed a positive correlation with other anthropometric variables that estimate muscle mass.

CONCLUSION

Measurement of the APM thickness is an easy and fast technique to evaluate nutritional status of individuals and it is easily reproducible by other observers since it is the only muscle in the body that could be directly measured and has a well-defined anatomical position.

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Conflict of Interest

There is no conflict of interest.

REFERENCES

Araujo AB, Chiu GR, Kupelian V, Hall SA, Williams RE, Clark RV *et al.* (2010). Lean mass, muscle strength, and physical function in a diverse population of men: a population-based cross-sectional study. *BMC Public Health*. 10: 508.

Baker JP, Detsky AS, Wesson DE, Wolman SL, Stewart S, Whitewell J *et al.*(1982). Nutritional assessment: a comparison of clinical judgement and objective measurements. *N Engl J Med.* 22,306(16): 969-72.

Bourdel-Marchasson I, Joseph PA, Dehail P, Biran M, Faux P, Rainfray M *et al.* (2001). Functional and metabolic early changes in calf muscle occurring during nutritional repletion in malnourished elderly patients. *Am J Clin Nutr* 73(4): 832-8.

Bragagnolo R, Caporossi FS, Dock-Nascimento DB & de Aguilar-Nascimento JE (2009). Adductor pollicis muscle thickness: a fast and reliable method for nutritional assessment in surgical patients. *Rev Col Bras Cir* 36(5): 371-6.

Caporossi FS, Caporossi C, Borges Dock-Nascimento D & de Aguilar-Nascimento JE (2012). Measurement of the thickness of the adductor pollicis muscle as a predictor of outcome in critically ill patients. *Nutr Hosp* 27(2): 490-5.

de Oliveira CM, Kubrusly M, Mota RS, Choukroun G, Neto JB & da Silva CA (2012). Adductor pollicis muscle thickness: a promising anthropometric parameter for patients with chronic renal failure. *J Ren Nutr* 22(3): 307-16.

Gonzalez MC, Duarte RR & Budziareck MB (2010). Adductor pollicis muscle: reference values of its thickness in a healthy population. *Clin Nutr* 29(2): 268-71.

Grant JP (1992). Nutritional assessment by body compartment analysis. In: Handbook of Total Parenteral Nutrition (2nd ed.). W.B. Saunders Co., Philadelphia, USA. p. 15.

Heymsfield SB, McManus C, Smith J, Stevens V & Nixon DW(1982). Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. *Am J Clin Nutr* 36(4): 680-90.

Lameu EB, Gerude MF, Correa RC & Lima KA(2004a). Adductor pollicis muscle: a new anthropometric parameter. *Rev Hosp Clin Fac Med Sao Paulo* 59(2): 57-62.

Lameu EB, Gerude MF, Campos AC & Luiz RR(2004b). The thickness of the adductor pollicis muscle reflects the muscle compartment and may be used as a new anthropometric parameter for nutritional assessment. *Curr Opin Clin Nutr Metab Care* 7(3): 293-301.

Lameu EB, Gerude MF, Correa RC & Lima KA(2004a). Adductor pollicis muscle: a new anthropometric parameter. *Rev Hosp Clin Fac Med Sao Paulo* 59(2): 57-62.

Mahan KL, Escott-Stump S, Raymond J. (2012). Krause's Food and the Nutrition Care Process. 13th ed. Elsevier , Philadelphia.

Oliveira1 DR & Frangella VS(2010). Adductor pollicis muscle and hand grip strength: potential methods of nutritional assessment in outpatients with stroke. *Einstein* 8(4 Pt 1): 467-72.

Wagner DR & Heyward VH(2000). Measures of body composition in blacks and whites: a comparative review. *Am J Clin Nutr* 71(6): 1392-402.