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## ORIGINAL RESEARCH

# ADDUCTOR POLICIS MUSCLE: A NEW ANTHROPOMETRIC PARAMETER

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**PURPOSE:** To measure the thickness of adductor pollicis muscle in healthy adults. This measurement will be used as a nutritional anthropometric parameter in further studies.

**SUBJECTS AND METHOD:** Four hundred and twenty-one healthy adults were studied, 209 men and 212 women, with ages ranging from 18 to 87 years, living in Rio de Janeiro.

The adductor pollicis muscle was also studied in the human anatomy lab as well as in normal healthy volunteers using CAT scans and nuclear magnetic resonance imaging to ensure that only the adductor pollicis was included in measurement of muscle thickness with a Lange caliper.

To standardize the measurement, the methodology was detailed, with subjects sitting with the dominant hand dangling over the homolateral thigh and the elbow bent at approximately a 90° angle. The Lange caliper was applied at a pressure of 10 g/mm$^2$, pinching the adductor pollicis muscle at the vertex of an imaginary angle between the thumb and the index finger. The average of 3 consecutive measurements was considered to be the muscle thickness.

**RESULTS:** This study provides the first estimates of adductor pollicis thickness in normal healthy subjects as an anthropometric parameter. The normal values in the dominant hand for men were 12.5 ± 2.8 mm (mean ± SD), median 12 mm, and for women were 10.5 ± 2.3 mm, median 10 mm.

KEY WORDS: **Adductor pollicis. Muscle atrophy. Malnutrition. Nutritional assessment. Anthropometry.**

Technological evolution has enabled the development of several sophisticated devices for the analysis of body composition, but the high costs of such equipment limit their utilization in clinical practice[1]. Thus, anthropometric and laboratory parameters, primarily circumferences and muscle areas, are still routinely used as measurements in nutritional assessment at the bedside[2].

Since there is no report in the literature of the thickness of the adductor pollicis muscle (APM) as an anthropometric parameter, but only references on dynamometry[3], electric stimulation of the ulnar nerve[4], and acoustic myography of the thumb adductor[5], we standardized the measurement of thickness of APM, correlating it with age, sex, frame size, and race.

## SUBJECTS

The assessment involved 421 healthy adults, randomly selected among professors, graduate and undergraduate students, physicians, employees, and companions of outpatients of our university hospital and employees and companions of outpatients of the National Cancer Institute (INCa) during a period of 8 months.

Subjects were distributed into the following age groups: 18 to 25 years, 26 to 45 years, 46 to 65 years, and greater than 65 years.

The project was approved by the Ethics and Research Committee of our institution.

## METHOD

Subjects underwent nutritional assessment using the parameters of the

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Classical Anthropometry and Subjective Global Assessment.

Classical anthropometry comprised height, actual, usual and ideal weight, body mass index (BMI), arm muscle circumference (AMC), total arm circumference (TAC), arm muscle area (AMA), triceps (TSF) and biceps (BSF) skin fold, arm fat area (AFA), and calf circumference (CC). Such measures were taken according to methods classically described by several authors[6-11].

Subjective global assessment was performed using the standard questionnaire described by Baker[12], classifying the subjects as eutrophic or mildly, moderately, or severely malnourished.

### Measurement of Thickness of Adductor Pollicis Muscle (APM)

The technique of measurement of APM thickness was studied in detail through images obtained by CAT scans and magnetic resonance imaging and in anatomical specimens of the Department of Anatomy of Medical School, with the muscle gently pinched by the Lange caliper in the selected location to ensure that no other muscles were involved in the measurement.

It is worth mentioning that measuring the adductor muscle with a plastic adipometer was reason for disagreement among 4 examiners, who observed that the use of the Lange caliper is mandatory.

Through these methods, we concluded that the point we selected is virtually deprived of fat tissue and that it would be possible to take repetitive measurements of the total thickness of the muscle. Consequently, the following method was developed: With the subject sitting with the hand lying on the knee and with the elbow in angle of approximately 90° degrees over the homolateral lower limb, the Lange caliper was used with a continuous pressure of 10 g/mm$^2$ to pinch the adductor muscle in the vertex of an imaginary triangle formed by the extension of thumb and index finger. The average of 3 measurements was considered to be the mean thickness of the adductor muscle.

**Figure 1 -** How to measure adductor pollicis muscle thickness.

The APM index (iAPM) was also assessed, which is defined as the relationship between the APM measured in millimeters and the height in square meters, computed using the same formula used for the calculation of BMI.

### Statistical Analysis

The Student's *t* test was used to verify significant differences in anthropometric measurements between genders and also between whites and non-whites. One-way analysis of variance (ANOVA) was used to compare the anthropometric measurements in the 3 levels of frame size. Tukey's test for multiple comparisons was applied to identify which body frame size levels differed from one another and analogically in the 4 age groups. The level of significance was set at 5%. Statistical analysis was processed by statistical software SAS® system.

## RESULTS

### Nutritional State of Subjects

The results in table 1 show that all assessed subjects were well nourished.

### Measuring of thickness of APM and iAPM

The average thickness of APM for both genders was 11.50 ± 2.76 mm (mean ± SD) and average iMAP was 4.20 ± 1.01 (Table 1).

### Assessment of APM and iAPM according to gender

Males had an average APM of 12.49 ± 2.85 mm and females an average of 10.53 ± 2.29 mm. The iAPM did not present variation in the values among genders.

**Table 1 -** General descriptive analysis of anthropometric measurements.

| Variable | n | Mean | SE | SD | Median |
|---|---|---|---|---|---|
| Age | 421 | 44.86 | 0.95 | 19.41 | 46 |
| Height | 421 | 1.66 | 0.00 | 0.10 | 1.65 |
| Usual weight | 421 | 67.81 | 0.59 | 12.19 | 67 |
| Actual weight | 421 | 67.85 | 0.59 | 12.15 | 67 |
| Wrist | 421 | 15.88 | 0.08 | 1.59 | 16 |
| Ideal Weight | 416 | 66.74 | 0.34 | 6.88 | 67 |
| Body Mass Index | 421 | 24.65 | 0.18 | 3.64 | 24.3 |
| Triceps Skin Fold | 421 | 15.52 | 0.38 | 7.77 | 15 |
| Biceps Skin Fold | 421 | 9.82 | 0.27 | 5.56 | 8.5 |
| Total Arm Circumference | 421 | 28.17 | 0.17 | 3.54 | 28 |
| Arm Muscle Circumference | 421 | 23.29 | 0.17 | 3.46 | 22.86 |
| Arm Muscle Area | 421 | 44.15 | 0.66 | 13.57 | 41.61 |
| Arm Fat Area | 421 | 20.00 | 0.53 | 10.77 | 17.36 |
| Calf Circumference | 421 | 35.40 | 0.18 | 3.65 | 36 |
| Adductor Pollicis Muscle | 421 | 11.50 | 0.13 | 2.76 | 11.0 |
| Adductor Pollicis Muscle Index | 421 | 4.20 | 0.05 | 1.01 | 4.1 |

**Assessment of APM and iAPM according to race**

There was no significant variation for means of APM and iAPM among the races.

**Assessment of APM and iAPM according to frame size**

Mean thickness of APM and iAPM is progressively higher in subjects with small, medium, and large frame sizes (Table 2).

**Assessment of APM and iAPM according to age group and gender**

Table 3 shows the results of APM and iAPM according to the age group, while tables 4 and 5 show muscle variations according to gender per age group.

## DISCUSSION

Man is the only animal able to perform thumb opposition, and this movement exists in all routine activities developed. Thus, the trophic state of the thumb adductor muscle can reflect an individual's labor activity. APM, as for every skeletal peripheral muscle, is also consumed during catabolism and atrophied by inactivity[13]. The loss of contractile function has already been studied by dynamometry[3] and has been related to a higher prevalence of postoperative complications. Thus, not only is the reduction of muscle mass a

**Table 2 -** Descriptive analysis of adductor pollicis muscle according to frame size.

| Variable | Frame Size | n | Mean | SE | SD | Median | Min | Max | *P* value | Significant differences |
|---|---|---|---|---|---|---|---|---|---|---|
| Adductor Pollicis Muscle | | | | | | | | | | |
| | 0 | 165 | 10.49 | 0.18 | 2.31 | 10 | 5 | 16 | **0.0001** | **0 ≠ 1 0 ≠ 2** |
| | 1 | 179 | 11.95 | 0.20 | 2.67 | 12 | 6 | 21 | | **1 ≠ 2** |
| | 2 | 76 | 12.66 | 0.36 | 3.13 | 13 | 6 | 22 | | |
| Adductor Pollicis Muscle Index | | | | | | | | | | |
| | 0 | 165 | 3.69 | 0.06 | 0.79 | 3.67 | 1.73 | 5.71 | **0.0001** | **0 ≠ 1 0 ≠ 2** |
| | 1 | 179 | 4.40 | 0.07 | 0.95 | 4.41 | 2.4 | 7.26 | | **1 ≠ 2** |
| | 2 | 76 | 4.87 | 0.12 | 1.07 | 4.89 | 2.13 | 7.79 | | |

**Table 3** - Descriptive analysis of adductor pollicis muscle and adductor pollicis muscle index according to age group.

| Variable | Age Group | n | Mean | SE | SD | Median | Min | Max | P value | Significant differences |
|---|---|---|---|---|---|---|---|---|---|---|
| Adductor Pollicis Muscle | | | | | | | | | | |
| | <= 25 | 106 | 10.69 | 0.25 | 2.57 | 10.5 | 6 | 21 | **0.0001** | **1 ≠ 2** |
| | 26-45 | 104 | 11.84 | 0.28 | 2.87 | 11.5 | 5 | 22 | | **1 ≠ 3** |
| | 46-65 | 108 | 12.46 | 0.25 | 2.57 | 12 | 7 | 20 | | **3 ≠ 4** |
| | > 65 | 103 | 10.99 | 0.26 | 2.68 | 11 | 5 | 18 | | |
| Adductor Pollicis Muscle Index | | | | | | | | | | |
| | <= 25 | 106 | 3.72 | 0.08 | 0.81 | 3.63 | 2.2 | 6.86 | **0.0001** | **1 ≠ 2 1 ≠ 3** |
| | 26-45 | 104 | 4.26 | 0.11 | 1.11 | 3.92 | 1.95 | 7.79 | | **1 ≠ 4** |
| | 46-65 | 108 | 4.61 | 0.09 | 0.95 | 4.52 | 2.83 | 7.12 | | **2 ≠ 3** |
| | > 65 | 103 | 4.23 | 0.10 | 0.97 | 4.41 | 1.73 | 6.02 | | **3 ≠ 4** |

**Table 4** - Descriptive analysis of adductor pollicis muscle according to age for males.

| Variable | Age Group | n | Mean | SE | SD | Median | Min. | Max. | P value | Significant differences |
|---|---|---|---|---|---|---|---|---|---|---|
| Adductor Pollicis Muscle | | | | | | | | | | |
| | <= 25 | 51 | 11.94 | 0.36 | 2.58 | 12 | 7 | 21 | **0.007** | **1 ≠ 3 3 ≠ 4** |
| | 26-45 | 52 | 12.82 | 0.42 | 3.00 | 12.25 | 8 | 22 | | |
| | 46-65 | 54 | 13.41 | 0.35 | 2.58 | 13 | 8 | 20 | | |
| | > 65 | 52 | 11.73 | 0.41 | 2.95 | 12 | 5 | 18 | | |
| Adductor Pollicis Muscle Index | | | | | | | | | | |
| | <= 25 | 51 | 3.85 | 0.12 | 0.83 | 3.76 | 2.34 | 6.86 | **0.001** | **1 ≠ 3** |
| | 26-45 | 52 | 4.27 | 0.16 | 1.16 | 3.92 | 2.36 | 7.79 | | |
| | 46-65 | 54 | 4.62 | 0.13 | 0.99 | 4.41 | 2.83 | 7.12 | | |
| | > 65 | 52 | 4.21 | 0.14 | 1.01 | 4.3 | 1.73 | 6.02 | | |

**Table 5** - Descriptive analysis of adductor pollicis muscle and adductor pollicis muscle index.

| Variable | Age Group | n | Mean | SE | SD | Median | Min. | Max | P value | Significant differences |
|---|---|---|---|---|---|---|---|---|---|---|
| Adductor Pollicis Muscle | | | | | | | | | | |
| | <= 25 | 55 | 9.54 | 0.27 | 1.97 | 10 | 6 | 15 | **0.0001** | **1 ≠ 2 1 ≠ 3** |
| | 26-45 | 52 | 10.86 | 0.33 | 2.37 | 10 | 5 | 16 | | **3 ≠ 4** |
| | 46-65 | 54 | 11.52 | 0.30 | 2.20 | 12 | 7 | 18 | | |
| | > 65 | 51 | 10.24 | 0.30 | 2.16 | 10 | 5 | 13 | | |
| Adductor Pollicis Muscle Index | | | | | | | | | | |
| | <= 25 | 55 | 3.60 | 0.11 | 0.78 | 3.47 | 2.2 | 6.09 | **0.0001** | **1 ≠ 2 1 ≠ 3** |
| | 26-45 | 52 | 4.25 | 0.15 | 1.07 | 3.975 | 1.95 | 6.25 | | **1 ≠ 4** |
| | 46-65 | 54 | 4.59 | 0.13 | 0.93 | 4.545 | 2.88 | 7.08 | | |
| | > 65 | 51 | 4.25 | 0.13 | 0.94 | 4.44 | 2.11 | 5.86 | | |

prognostic parameter for complications in postoperative patients[14] but the loss of muscle function is also a predictor of mortality in healthy subjects[15].

Malnutrition causes decrease of contraction strength, relaxation rate, and increase of muscle fatigue of the adductor muscle of the thumb. Several functional and morphological alterations[13] have been demonstrated in healthy adults related to temperature, neuromuscular blocking[16], intensity of generated force, age[17], gender[18], race, perfusion pressure[19], and nutritional state. However, in daily clinical practice, the routine utilization of electromyography or electric stimulation of the ulnar nerve is difficult, not only due to its high cost, but also because of the need for experience with the procedure.

Because the APM is flat and located between 2 bone structures, it is the only muscle allowing an adequate assessment of its thickness, since it presents a well-defined anatomic reference, and importantly, measurements are reproducible by other investigators.

The assessment of classical anthropometric parameters reflects the degree of malnutrition[20], but the alterations in such parameters appear only after a variable period of malnutrition. Functional alterations occur before anatomical alterations appear. Thus, all somatic modifications, although important for the diagnosis of chronic malnutrition, are not able to assess such condition in its acute stage[21].

Likewise, the reduction of APM shows the loss of working life as a consequence to various clinical and surgical conditions, with intensity and duration varying according to the underlying morbid condition.

Considering only the APM and iAPM value for males and analyzing their variations among the different frame sizes, there was a progressive increase of the APM values with significant differences among small, medium, and large frame sizes. iMAP measurements produced the same results for males, with increasing values according to frame size.

Table 6 below shows normal values for APM using only 2 indexes, the Z score and the percentage of median. The selection of these 2 indicators was based on their easy application in the clinical practice and their adequate capacity to assess extremes in the population[22] (Table 6).

The APM value in the various age groups was always significantly higher in males, although the iMAP did not vary between genders in the various age groups. Thus, we would emphasize the importance of further characterization of the sex-related APM values.

The values expressed in Table 6 use the same criteria used by Janssen[23] to classify sarcopenia according to muscle mass assessed by bioimpedance. Subjects were considered to have a normal APM thickness if their value was greater than 1 standard deviation above the sex-specific mean, class I values were considered present in subjects whose APM was within 1 to 2 standard deviations of normal values, and class II with values of APM thickness below 2 standard deviations of normal mean value.

Percentages of the mean were similarly referred to in the description by

**Table 6 -** Adults standards for adductor pollicis muscle thickness.

| Classification Type: | | | Standard Deviation (SD) | | | Percentages of Median | | |
|---|---|---|---|---|---|---|---|---|
| Sex | Mean | Median | Normal > 1 SD | Class I Between 1 and 2 SD | Class II < 2SD | Light >90% | Moderate 60-90% | Severe <60% |
| Male | 12.5 | 12 | > 9.5 | 7 – 9.5 | < 7 | > 11 | 11 – 7 | < 7 |
| Female | 10.5 | 10 | >8 | 8 – 6 | < 6 | > 9 | 9 - 6 | < 6 |

Jellife[9] regarding the TSF, in which light muscle loss was considered to be when the values are above 90% of the mean, moderate between 60% and 90%, and severe when the values are below 60% of the mean.

Although the variation of the mean APM was significant in males and females, the median values remained virtually unaltered in the different age groups, making the utilization of values corresponding to each age group unnecessary.

In our case study, AMP progressively increased with age up to 65 years and then it showed a clear decline (decrease in thickness). As to iMAP, the highest value of thickness is also found in the 46-65 year age group, suggesting greater activity in such age group. These results demonstrate that after 65 years of age, in the absence of systemic diseases, neuropathies, or disuse, sarcopenia does not seem to contribute to the reduction of the adductor muscle mass with consequent functional disability. However, the APM mass in individuals over 65 years of age is sustained[23,24]. As to the point selected for measuring the thickness, Kaufman[25] studied the isometric forces and electric activity generated by voluntary contraction in 7 muscles present in the thumb area. He demonstrated that the highest production of strength is obtained during flexion. APM was measured in extension (angle >70%), preserving at maximum the anatomic architecture of adductor muscle.

## CONCLUSIONS

1. The thickness of the adductor pollicis muscle was standardized in 421 healthy adult subjects, with results varying according to gender, age, and frame size. The mean for males was 12.5 mm and for females was 10.5 mm.

This parameter will be assessed in future works as a predictor of complications in clinical and surgical patients.

## RESUMO

LAMEU EB e col. - Músculo adutor do polegar: um novo parâmetro antropométrico. **Rev. Hosp. Clín. Fac. Med. S. Paulo 59**(2):57-62, 2004.

**OBJETIVO:** Padronizar a medida da espessura do músculo adutor do polegar em adultos saudáveis, para futuras avaliações como parâmetro antropométrico.

**INDIVÍDUOS E MÉTODOS:** Foram estudados 421 adultos saudáveis, oriundos de vários municípios do Rio de Janeiro, de ambos os sexos e nas faixas etárias compreendidas entre 18 a 25 anos, 26 a 45 anos, 46 a 65 anos e mais de 65 anos. Após a confirmação pelos estudos radiológicos e anatômicos, concluindo que com a técnica empregada, nenhum outro músculo além do adutor do polegar foi incluído na medição, foi elaborado o seguinte método: Com o indivíduo sentado, mão dominante repousando sobre o joelho homolateral, cotovelo em ângulo de aproximadamente noventa graus sobre o membro inferior, foi utilizado o paquímetro de Lange exercendo uma pressão contínua de 10g/mm$^2$ para pinçar o músculo adutor no vértice de um ângulo imaginário formado pela extensão do polegar e o dedo indicador. A média de três aferições foi considerada como a medida da espessura do músculo adutor.

**RESULTADOS:** A média obtida para a espessura do músculo adutor do polegar, na mão dominante, no sexo masculino foi de 12,5 ± 2,8 mm, com uma mediana de 12 mm e no sexo feminino foi de 10,5 ± 2,3 mm, com uma mediana de 10 mm.

UNITERMOS: **Músculo adutor do polegar. Atrofia muscular. Desnutrição. Avaliação nutricional. Antropometria.**

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