Evaluation of Axillae Skin Thickness by High-Frequency Ultrasound

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BACKGROUND High-frequency ultrasound has been utilized in dermatology to visualize superficial cutaneous structures. Axillae are often target of treatments for hair removal, for spot clearing, and for skin conditions such as hyperhidrosis, bromhidrosis, and hidradenitis. Detailed knowledge of armpit thickness can help improve existing therapies and increase their effectiveness.

OBJECTIVE To describe the mean skin thickness of axillae, by further investigating possible correlations with variations in age, sex, and body mass index (BMI).

MATERIALS AND METHODS Axillae were divided into 5 quadrants, 1 central and 4 peripherals. Skin has been assessed by ultrasonography, measuring the distance from epidermis surface to dermal depth, in millimeters, for each of the regions.

RESULTS Thirty healthy patients participated, most of them were female ($n = 22$; 73%), mean age 50 years (26–70 years). Most patients have maximum thickness in the center of axillae (87%). Average skin thickness in the central region was 3.1 ± 0.4 mm. There was significant difference between axillary thickness in central and peripheral regions ($p < .05$). On the periphery, the mean thickness was smaller (1.8 mm) without significant variation between the squares. There was no significant variation of skin thickness by sex, age, and BMI.

CONCLUSION This study shows a difference between thickness of axillae in the central region and in its periphery.

High-frequency ultrasound (US) has been increasingly utilized in dermatology to visualize superficial cutaneous structures since 1979, the first description.[1,2] Olsen and colleagues,[3] in 1995, mapped with US, 22 anatomical sites, evaluating skin thickness in different body regions and showing variations between them. Wortsman and colleagues reported clinical utility of high-frequency US in skin lesions. They described thickness of epidermis and dermis of healthy individuals, obtained by US of skin of frontal region, temples, forearm, and dorsal thoracic and lumbar region.[4] In axillae, only 1 study evaluated thickness of skin in 8 healthy individuals, comparing them with patients with axillary hidradenitis.[5]

Axillae are often target of treatments for hair removal and for skin conditions such as hyperhidrosis, bromhidrosis, and hidradenitis.[5–7] So, detailed knowledge of axillary skin thickness is fundamental, to improve existing therapies. This study aims to describe the mean skin thickness of axillae, by further investigating possible correlations with variations in age, sex, and body mass index (BMI).

Materials and Methods

Healthy adults were recruited from the Dermatology outpatient clinics and employees of the Hospital do Servidor Público Municipal of São Paulo (HSPM). They were evaluated in a single visit, and all provided written informed consent.

The presence of any disease in axillae or restriction to elevation and abduction of arms were exclusion factors for participating in the study that was approved by HSPM ethics committee (CAAE: 172646619.5.0000.5442).

1A standardized form was used to collect the following data: age, sex, weight, height, and skin thickness (epidermis and dermis) in millimeters of the 2 armpits, which were divided into 5 quadrants: 1 central and 4 peripherals.

Skin has been assessed by US, measuring distance from epidermal surface to dermal depth, in millimeters, for each of the 5 regions. Ten measurements were obtained for each individual with LOGIQ E (R7) US device (GE Medical systems, China) and a transducer with a frequency of 22 MHz.

Ultrasound examination was performed with the patient in supine position, with a pillow under the head

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This study was approved by HSPM ethics committee (CAAE: 172646619.5.0000.5442), on August 16, 2019.

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TABLE 1. Descriptive Statistics by Variable							
Variable	***n***	**Mean**	**SD**	**Min**	**Median**	**Max**	**IC (95%)**
Sex							
Women	22	2.1	0.4	1.4	2.1	2.8	1.9–2.3
Men	8	2.1	0.5	1.2	2.2	2.9	1.6–2.5
IMC							
Overweight and adequate weight	17	2.1	0.5	1.2	2.1	2.9	1.8–2.3
Obese	13	2.1	0.4	1.4	2.2	2.7	1.8–2.3
Age							
20–39 yrs	7	1.8	0.4	1.2	1.8	2.2	1.4–2.1
40–59 yrs	15	2.2	0.4	1.4	2.3	2.8	2.0–2.4
60+ yrs	8	2.1	0.5	1.4	2.2	2.9	1.7–2.5

IC, confidence interval; IMC/BMI, body mass index.

and arms raised behind it. The armpits were divided into a central region and 4 peripheral quadrants. Ultrasound gel was applied, and thickness in millimeters was measured from surface of epidermis to depth of the dermis in each region.

Statistical Analysis

Descriptive analysis of maximum and minimum thickness by armpit region was performed using frequencies and percentages. Mean thickness of the 10 regions evaluated was compared between age, sex, and BMI groups using Student *t*-test or variance analysis (ANOVA) models. Nonparametric tests could be used if there were violations of data normality.

The mean thickness of the sides per quadrant and for the central region was calculated. These were compared to each other by an ANOVA model followed by the less significant difference or Tukey multiple comparisons tests. Friedman nonparametric test could be used if there were major violations of data normality.

The confidence level of the comparative analyzes was 95%.

Results

Thirty patients participated in the study, most of them were female (n = 22; 73%). The mean age of patients was 50 years, ranging from 26 to 70 years. Forty-three percent of the sample was obese (BMI ≥ 30), 30% overweight (25 ≤ BMI < 30), and 27% adequate weight.

Patients were stratified into the following age groups: 20 to 39 years (n = 7, 23%), 40 to 59 years (n = 15, 50%), and 60+ (n = 8, 27%).

There was no significant variation of average skin thickness by sex (p = .961), age (p = .116), and BMI (p = .918).

Most patients have the maximum thickness in the center of axillae (87%). Average skin thickness in the central region was 3.1 ± 0.4 mm, with significant difference between the axillary thickness in the central and peripheral regions ($p < .05$). On the periphery, the mean thickness was smaller, averaging 1.8 mm in the 4 peripheral squares, without significant variation between them (Tables 1 and 2, Figure 1).

Discussion

This study evaluated, using high frequency US, the thickness of the axillary skin and compared the difference between the central and peripheral regions, investigating a possible relationship between the thickness of the axillary skin and sex, age, and BMI.

In the authors' study, the average thickness of skin (epidermis and dermis) of armpits did not show significant variation between sexes and no correlation between axillary skin thickness and BMI. Differently, Van Mulder and

TABLE 2. Descriptive Statistics of Average Thickness by Region						
Region	**Mean**	**SD**	**Min**	**Median**	**Max**	**IC (95%)**
Outer upper quadrant	1.8	0.5	1.1	1.7	3.2	1.6–2
Internal upper quadrant	1.8	0.5	1.2	1.8	2.9	1.6–2
Outer lower quadrant	1.8	0.4	1.3	1.8	2.8	1.7–1.9
Inner lower quadrant	1.8	0.4	1.1	1.9	2.7	1.7–2
Central region	3.1	1.0	1.1	3.1	5.3	2.7–3.5

IC, confidence interval.

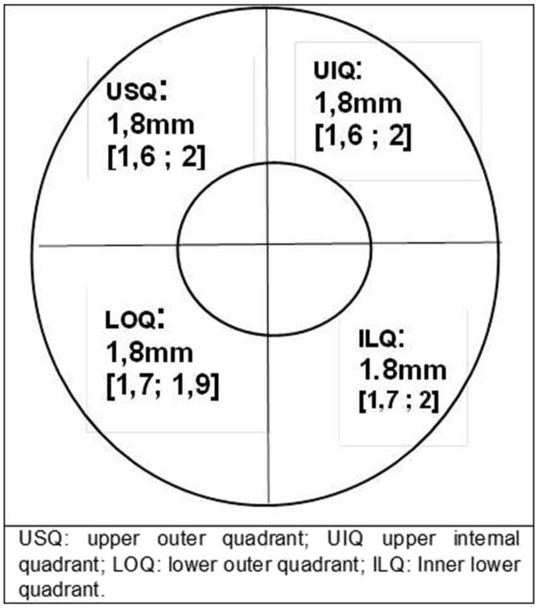

Figure 1. Illustrative diagram of thickness averages.

colleagues[1] associated an increase in BMI with forearm skin thickness and observed a greater value of men forearm skin. This same finding had already been reported in forearm skin by Escoffier and colleagues.[8]

Casabona and colleagues, studying the depth of the superficial fascia on the medial side of arms, also correlated an increase in distance from skin surface to superficial muscular fascia with an increase in BMI. They observed that depth of fascia was greater in women in all BMI groups.[9] The present study, however, only measured thickness of axillary epidermis and dermis, not evaluating the thickness of the subcutaneous tissue.

In the authors' protocol, there was no variation in mean thickness of armpits with increasing age, as Escoffier and colleagues[8] also reported. They found that forearm skin thickness remains relatively constant until the 70 years, decreasing after this age.

Regarding armpit regions, the authors found that mean skin thickness was smaller on the periphery, averaging 1.8 mm in 4 peripheral squares, without significant variation between them. This finding is similar to described by Wortsman and colleagues (mean 1.4 ± 0.3 mm), who evaluated only thickness of anterior border of right axilla of 7 healthy individuals.[5] The authors did not find the value of central skin thickness in literature.

The average thickness obtained in this study can help to optimize therapies for axillary diseases.

Naouri and colleagues evaluated the results of rejuvenating laser therapy by comparing skin thickness using US before and after the procedure. Standardized parameters were used across the face, and it was observed that thinner areas were better treated than thicker regions. The authors suggested that the standardization of parameters could have limited the depth of laser penetration in thicker regions.[10]

Nestor and Park, evaluating the microfocused US for treatment of axillary hyperhidrosis ($n = 9$), treated entire armpit with 2 sessions, with 4.5 mm and 3.0 mm tips, repeated after 30 days. Two patients did not respond to treatment. Most patients reported some discomfort during treatment, which was greater when treating the 4.5 mm depth.[6] Maybe these results could have been better if 3 mm and 1.5 mm tips had been used, in order to reach the desired structures in center and on periphery of armpits. In addition, discomfort during the procedure could also be mitigated using smaller tips.

Some limitations of this study were the predominance of women, the average high age of the patients, and the fact of depth of superficial fascia has not been assessed, since the authors have not evaluated the thickness of subcutaneous tissue. Another limitation is that although this is the largest study done to date, it is still relatively a small study in a single location. Additional studies are needed to confirm these findings in other geographical regions.

Detailed knowledge about axillary cutaneous thickness may help in improving existing therapeutics for this area and increasing their efficacy.

Knowing this difference of axillary skin thickness in central and periphery could help to optimize technologies, adjusting the parameters according to region and achieving desired structures throughout armpit, in order to have a more effective and cheaper treatment.

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