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*Conference abstract*

# Ultrasound Assessment of Subcutaneous Adipose Tissue in Cyclists of Different Categories

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**Abstract:** Body composition has a large impact on cycling performance. Successful cyclists aim to maintain body adipose tissue as low as possible. This study seeks to investigate the subcutaneous adipose tissue (SAT) thickness and body fat percentage (BF%) in cyclists of different categories. Thirteen junior cyclists, eighteen U23 cyclists and nineteen professional cyclists underwent B-mode ultrasound assessment of subcutaneous adipose tissue at seven ISAK anatomical sites. Professional riders showed the smallest sum of SAT thickness, ISAK, and BF%, in comparison of the junior and U23 ($p < 0.001$). The current study provides information of SAT thickness and BF% assessment through ultrasound B-mode in different categories of cyclists.

**Keywords:** Body Composition, Ultrasound, Body Fat, Junior, U23, Professional

## 1. Introduction

Road cycling is a demanding sport in terms of energy expenditure and mental focus (Sanchez-Munoz et al 2023). From the youngest riders to professionals, training load exposes them to several physiological stimulus that could impact body composition (Giorgi et al 2018).

To improve cycling performance, emphasis is placed on physical traits, such as body fat (Sanchez-Munoz et al 2023). The most popular technique for body fat assessment is the skinfold thickness measurement of subcutaneous adipose tissue (SAT) using skinfold calipers. However, its use may be prone to tester bias and poor inter-tester reliability (Meyer et al, 2013). Moreover, accuracy is limited due to skin and SAT are measured together in a compressed state, without considering the compressibility and viscous-elastic behavior at the measurement sites.

Recently, the application of B-mode (brightness mode) ultrasound has emerged as an accurate and efficient method to measure SAT in field settings (O'Neill et al, 2016; Müller et al, 2013; Sullivan et al 2023). Moreover, in comparison to skinfold assessment using calipers, ultrasound has the potential to reduce inter- and intra-operator variability in the measurement of SAT thickness (Müller et al, 2013).

The aim of this study was to determine SAT and body fat percentage across cyclists from junior, U23 and professional categories.

## 2. Materials and Methods

### *2.1. Subjects*

Fifty male road cyclists classified at Tier 4 (Elite/International level) according to the participant classification framework proposed by McKay et al., (2021). Participants were divided into three categories, according to the *Union Cycliste Internationale* (UCI) rules: junior (n = 14, age: 16.6 ± 0.5 years), U23 (n = 20, age: 19.9 ± 1.8 years), and professional (n = 12, age: 26.0 ± 3.7 years). All cyclists were assessed at the end of the pre-season period, at least 3 months after their last competition. Participants were free of musculoskeletal injuries or diseases. They volunteered to participate in the study after being informed of the study procedures, providing written informed consent.

*2.2. Methodology*

Anthropometric and ultrasound assessments were made by a single operator. Anthropometric variables include height, body mass, seven ultrasound skinfolds ISAK sites (biceps, triceps, supraspinal, abdominal, thigh, and medial calf), five girths (wrist, upper arm, waist, hip, thigh, and calf). Body mass was measured to the nearest 0.1 kg using a calibrated digital scale (GIMA, Gessate MI, Italy). Standing height was measured to the nearest 0.5 cm using a manual stadiometer (GIMA, Gessate MI, Italy). Body circumference was measured to the nearest 0.1 cm using a flexible tape (GIMA, Gessate MI, Italy).

All ultrasound measures were performed on the right side of the body using Vscan Air CL B-Mode ultrasound system (GE HealthCare) with a linear array transducer (3-12 MHz) under the general musculoskeletal setting option. Approximately 3-5 mm layer of ultrasound transmission gel (GIMA, Gessate MI, Italy) was applied between the probe and the skin. Caution was taken to minimize any pressure of the transducer on the skin. A single ultrasound image was taken at each measurement site, with the probe perpendicular to the skin and centered over inked site marking. All ultrasound images were saved and analyzed later using electronics calipers associated with the Vscan Air device.

Body surface area (BSA) expressed in square meters, was calculated according to the formula described by Du Bois and Du Bois (1916). Body mass index (BMI) was calculated as weight (kg) / [height (m)$^2$]. Percentage of body fat mass (BF%) was calculated, as in (O'Neill et al., (2016)

BF% = [0.476 x (the sum of subcutaneous adipose tissue deep (mm) at triceps, biceps, supraspinal, and thigh) + 1.846].

*2.3. Statistical Analysis*

After verifying that variables were normally distributed, data were analyzed using one-way analysis of variance (ANOVA) with Bonferroni post hoc comparison to determine differences between groups (Junior, U23, Professional). Statistical analyses were performed using JASP 0.16.3 (JASP, Amsterdam, Netherlands). Statistical significance was set at $p < 0.05$.

## 3. Results

**Table 1.** Anthropometrics measures.

| Variable | JUNIOR (n = 14) | | UNDER 23 (n = 20) | | PROFESSIONAL (n = 12) | |
|---|---|---|---|---|---|---|
| | X ± SD | Range | X ± SD | Range | X ± SD | Range |
| Age (years) | 16.6 ± 0.5$^{\alpha,\beta}$ | 16.0 – 17.0 | 19.9 ± 1.8$^{\alpha}$ | 17.0 – 23.0 | 26.0 ± 2.7 | 23.0 – 31.0 |
| Body mass (kg) | 62.2 ± 5.2$^{\alpha}$ | 56.0 – 72.5 | 64.5 ± 4.6 | 54.6 – 74.9 | 67.4 ± 4.6 | 61.4 – 77.7 |
| Height (cm) | 174.4 ± 5.5 | 165.0 – 185.0 | 176.7 ± 5.6 | 169.0 – 187.0 | 176.1 ± 5.0 | 170.0 – 184.0 |
| Upper arm girth (cm) | 25.8 ± 2.0$^{\alpha\beta}$ | 23.0 – 29.0 | 27.0 ± 1.3 | 24.5 – 29.0 | 27.3 ± 1.3 | 23.5 – 29.0 |
| Wrist girth (cm) | 16.3 ± 0.6$^{\beta}$ | 15.5 – 17.2 | 16.1 ± 0.7 | 15.0 – 18.5 | 16.7 ± 0.7 | 16.0 – 18.0 |
| Waist girth (cm) | 72.6 ± 4.3$^{\alpha}$ | 66.0 – 80.0 | 74.0 ± 2.1 | 70.0 – 77.5 | 75.8 ± 3.2 | 71.5 – 82.0 |
| Hip girth (cm) | 90.0 ± 3.1 | 84.5 – 95.0 | 90.3 ± 2.9 | 84.0 – 95.0 | 91.3 ± 3.2 | 87.0 – 97.0 |
| Thigh girth (cm) | 53.7 ± 3.4 | 48.0 – 59.0 | 53.9 ± 2.5 | 48.5 – 59.5 | 55.2 ± 2.3 | 52.0 – 61.0 |
| Calf girth (cm) | 35.2 ± 2.2 | 32.0 – 39.0 | 34.8 ± 1.2 | 32.5 – 37.0 | 35.9 ± 2.1 | 33.00 – 39.00 |
| Body surface area (cm$^2$) | 1.8 ± 0.1 | 1.6 – 2.0 | 1.8 ± 0.9 | 1.7 – 2.0 | 1.8 ± 0.8 | 1.7 – 2.0 |
| BMI (kg*m$^2$) | 20.5 ± 1.3$^{\alpha}$ | 18.6 – 22.8 | 20.7 ± 1.0 | 18.0 – 22.1 | 21.8 ± 1.2 | 19.8 – 23.5 |

Data presented as mean (X) ± standard deviation (SD). $^{\alpha}$ denotes significant difference from Professional; $^{\beta}$ denotes significant difference from Under 23.

**Table 2.** Ultrasound SAT thickness and body fat percentage.

| Variable | JUNIOR (n=14) | | UNDER 23 (n=20) | | PROFESSIONAL (n=12) | |
|---|---|---|---|---|---|---|
| | **X ± SD** | **Range** | **X ± SD** | **Range** | **X ± SD** | **Range** |
| Triceps site (mm) | 2.0 ± 0.7 | 0.3 – 2.9 | 2.5 ± 1.2 | 0.6 – 4.8 | 1.6 ± 0.9 | 0.7 – 3.8 |
| Biceps site (mm) | 1.0 ± 0.4 | 0.4 - 1.6 | 1.9 ± 0.6 | 0.5 – 2.9 | 0.7 ± 0.3 | 0.3 – 1.3 |
| Subscapular site (mm) | 0.8 ± 0.3 | 0.3 – 1.5 | 1.0. ± 0.7 | 0.3 – 2.8 | 1.1 ± 0.9 | 0.3 – 3.0 |
| Supraspinal site (mm) | 1.2 ± 0.4 | 0.4 – 1.8 | 1.5 ± 0.6 | 0.4 – 2.6 | 1.1 ± 0.4 | 0.6 – 1.8 |
| Abdominal site (mm) | 1.7 ± 0.7 | 1.0 – 4.2 | 1.5 ± 0.7 | 0.4 – 3.0 | 1.5 ± 0.8 | 0.4 – 3.3 |
| Thigh site (mm) | 2.3 ± 1.1$^{\alpha}$ | 1.1 – 4.6 | 2.0 ± 0.9 | 0.5 – 4.1 | 1.4 ± 0.7 | 0.6 – 2.4 |
| Calf site (mm) | 1.7 ± 0.9$^{\alpha}$ | 0.7 – 4.1 | 1.3 ± 0.6 | 0.6 – 2.9 | 1.0 ± 0.3 | 0.5 – 1.6 |
| Upper body sum (mm) | 6.6 ± 2.0 | 2.4 – 10.9 | 7.6 ± 2.9 | 3.3 – 12.7 | 5.9 ± 2.4 | 3.9 – 12.6 |
| Lower body sum (mm) | 4.1 ± 1.9$^{\alpha}$ | 1.8 – 8.5 | 3.3 ± 1.2 | 1.2 – 7.0 | 2.4 ± 0.8 | 1.2 – 3.7 |
| SUM 7 sites (mm) | 10.6 ± 3.3 | 4.2 – 17.0 | 10.9 ± 3.8 | 5.3 – 18.4 | 8.3 ± 2.7 | 5.4 – 15.2 |
| Body fat (%) | 5.1 ± 0.8 | 3.7 – 6.6 | 5.2 ± 0.9 | 3.9 – 6.9 | 4.6 ± 0.6 | 4.0 – 6.2 |

Data presented as mean (X) ± standard deviation (SD). $^{\alpha}$ denotes significant difference from Professional; $^{\beta}$ denotes significant difference from Under 23.

Thigh SAT thickness was significantly lower in Professional (1.4 ± 0.7 mm) than in Junior (2.3 ± 1.1 mm, $p$ = 0.027). Calf SAT thickness was significantly lower in Professional (1.0 ± 0.3 mm) than in Junior (1.7 ± 0.9 mm $p$ = 0.033). Lower body sum of SAT thickness in Professional (2.4 ± 0.8 mm) was significantly lower than in Junior (4.1 ± 1.9 mm, $p$ = 0.011) categories. Full disclosure of the results can be found in Table 1 and Table 2.

## 4. Discussion

To the best of our knowledge, the present study reports, for the first time, SAT thickness and BF% through ultrasound assessment of male road cyclists from different UCI categories. The comparison of SAT thickness among the three categories revealed that professional riders had particularly lower body SAT thickness than the Junior.

Despite recent interest in ultrasound as a method to assess body composition, there is no consensus on a globally accepted protocol. In this study, SAT has been assessed through 7 sites from ISAK assessment because of its widespread use in sports medicine, despite the potential anatomical limitations in capturing clear ultrasound images (Sullivan et al 2023).

Body composition has a large impact on health and performance, particularly in endurance sports, where many athletes aim to reduce weight and maintain an extremely low adipose tissue to gain a competitive advantage (Sanchez-Munoz et al, 2023).

A potential explanation for a large variance in adipose tissue could be training volume, it was shown that increased fatty acid oxidation occurred during submaximal and prolonged exercise (Purdom et al, 2018).

Lipolytic activity is associated with an increase of blood flow in the adipose tissue and, thus, to the oxygenation of the adipocyte, suggesting that lipolysis and blood flow are generally higher on SAT adjacent to contracting muscles (Paoli et al, 2021). Cycling mainly involves lower limb muscles, professional riders sustain higher training volumes than the other categories. Therefore, a reduction on SAT in the legs could be potentially explained by an increased lipolysis in the lower limbs, due to training volume. Moreover, as cyclists progress in their careers, they receive more attention, being monitored by various professional figures who help them to manage their body composition.

## 5. Practical Applications

Our study provides novel information of SAT thickness and BF% assessment through ultrasound B-mode in different categories of cyclists. This information could be used to establish a new framework in relation to the anthropometric characteristics in junior, U23 and professional cyclists, using high accuracy and interobserver reliability in field settings.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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