Subcutaneous Adipose Tissue Pattern in Lean and Obese Women with Polycystic Ovary Syndrome

E. TAFEIT,* R. MÖLLER,* S. RACKL,† A. GIULIANI,† W. URDL,† U. FREYTAG,‡ K. CRAILSHEIM,‡ K. SUDI,§ AND R. HOREJSI*,[1]

*Institute of Medical Chemistry and Pregl Laboratory, †Department of Obstetrics and Gynecology, ‡Institute of Zoology, and §Institute of Sport Sciences, Karl-Franzens-University Graz, A-8010 Graz, Austria

The new optical device, Lipometer, permits the noninvasive, quick, safe, and precise measurement of the thickness of subcutaneous adipose tissue (SAT) layers at any given site of the human body. Fifteen anatomically well-defined body sites from neck to calf describe the SAT topography (SAT-Top) like an individual "fingerprint." SAT-Top was examined in 33 women with polycystic ovary syndrome (PCOS), in 87 age-matched healthy controls and in 20 Type-II diabetic women. SAT-Top differences of these three groups were described, and, based on a hierarchical cluster analysis, two distinctly different groups of PCOS women, a lean ($PCOS_L$) and an obese ($PCOS_O$) cluster, were found. For visual comparison of the different types of body fat distribution, the 15-dimensional body fat information was condensed to a two-dimensional factor plot by factor analysis. For comparison of the PCOS like body fat distribution with the "healthy" fat pattern, the (previously published) SAT-Top results of 590 healthy women and men (20-70 years old) and 162 healthy girls and boys (7-11 years old) were added to the factor plot. $PCOS_O$ women showed a SAT-Top pattern very similar to that of women with Type-II diabetes, even though the diabetic women were on average 30 years older. Compared with their healthy controls, SAT-Top of these $PCOS_O$ patients was strongly skewed into the android direction, providing significantly decreased leg SAT development and significantly higher upper body obesity. Compared with healthy women, $PCOS_L$ patients had significantly lower total SAT development (even though height, weight, and body mass index did not deviate significantly), showing a slightly lowered amount of body fat in the upper region and a highly significant leg SAT reduction. This type of fat pattern is the same as found in girls and boys before developing their sex specific body fat distribution. We conclude that women with PCOS develop an android SAT-Top, but compared in more detail, we found two typical types of body fat distribution: the "childlike" SAT pattern in lean PCOS patients, and the "diabetic" body fat distribution in obese PCOS women. Exp Biol Med 228:710–716, 2003

Key words: Lipometer; fat distribution; body composition; PCOS; subcutaneous fat

Polycystic ovary syndrome (PCOS) is a complex disease involving ovulatory dysfunction and hyperandrogenism (1, 2). Functional ovarian hyperandrogenism is closely linked to hyperinsulinemia and to insulin resistance, a symptom that is not obligatory in PCOS women (3, 4).

About 50% of women with PCOS are obese (5–8). Jayagopal *et al.* (9) suggest that insulin resistance is a cardinal feature of overweight patients with PCOS. However, the body fat distribution is a better indicator of metabolic changes than body mass index (BMI) alone (10). Hyperandrogenism is associated with a preferred fat accumulation at the upper body (7, 11, 12). This so-called android fat pattern, which has been described in obese as well as in lean women with PCOS (10, 6, 13, 5), may indicate diminishing fertility (10, 15). Also, women with this android fat pattern are at inherent risk for developing cardiovascular diseases, diabetes mellitus, and endometrial cancer (12, 16–18).

Fat distribution in women with PCOS has been studied with caliper methods, dual energy X-ray absorptiometry (DEXA), and computed tomography (CT) (6, 14). These techniques frequently lack precision and reproducibility (caliper techniques), entail the risk of radiation exposure (computed tomography), and/or are expensive (nuclear magnetic resonance).

The "Lipometer" (European Union patent no. 0516251) is an optical device that measures subcutaneous fat distribution. It permits a noninvasive, quick, precise, and safe measurement of the thickness of subcutaneous adipose tis-

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[1] To whom requests for reprints should be addressed at Institute of Medical Chemistry and Pregl Laboratory, Harrachgasse 21/II, A-8010 Graz, Austria. E-mail: renate.horejsi@kfunigraz.ac.at

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sue (SAT) layers at any given site of the human body. The Lipometer provides detailed information of the distribution of the SAT layer thicknesses. Therefore, the SAT topography (SAT-Top) over the whole body, which is like an individual "fingerprint," can be shown very precisely.

The Lipometer has been used to measure SAT-Top of healthy children and adults and the normal fat pattern of the human population and its development from 7 to 70 years of age (19, 20). These datasets permit comparisons with the SAT-Top of patients with chronic diseases. The deviation from the normal fat pattern seems to be specific for each metabolic disease. For example, Type-II diabetic patients have significantly higher upper trunk obesity and significantly different leg SAT development than healthy controls (21–24). This "diabetic" fat distribution pattern might be similar to that expected in women suffering from PCOS.

The aim of this study was to describe the subcutaneous fat pattern of women with PCOS, to investigate if PCOS patients can be distinguished into two or more significantly different SAT-Top classes, and to compare SAT-Top of women with PCOS with that of Type-II diabetic women, healthy children, and adults of both sexes.

Materials and Methods

PCOS Patients. We recruited 33 Caucasian women with PCOS (mean age of 26.5 years, range 20.1-35.3) who contacted the Division of Reproductive Endocrinology because of undesired infertility (Table I). The diagnosis of PCOS was based on the finding of polycystic ovaries on ultrasound (25), chronic anovulation, and hyperandrogenism. Related disorders were ruled out. SAT-Top was measured on the 3rd, 4th, or 5th day of the cycle.

Healthy Subjects. Eighty-seven healthy young women (mean age of 28.1 years, range 20.3-34.4) with comparable age and height status and regular menstrual cycles were recruited.

Diabetic Patients. Previously, a dataset of 20 women with Type-II diabetes (mean age of 62.4 years, range 48.7-71.3) was applied to study the SAT pattern in diabetics (23) (Table I).

SAT-Top Measurement. The sensor head of the Lipometer contains a set of light-emitting diodes (λ = 660 nm) and a photodetector (26). To measure the thickness of a SAT layer, the sensor head is held perpendicular to the selected body site. The SAT layer is illuminated by different light patterns varying in time. A photodiode measures the corresponding back-scattered light intensities of the light patterns and calculates the thickness of the SAT layer in millimeters. Technical characteristics of the device and a first validation of the results using CT as a standard for comparison have been reported (26).

To describe the complete subcutaneous fat distribution,

Table I. Descriptive Characteristics and SAT-Top Measurements in Healthy Women, PCOS, and Type-2 Diabetic Patients (mean ± SD [minimum – maximum])

	Healthy women	PCOS patients	Type-2 diabetics
n	87	33	20
Age (years)	28.1 ± 4.1 (20.3–34.4)	26.6 ± 4.6 (20.1–35.3)	62.4 ± 6.6 (48.7–71.3)[a]
Height (cm)	165.5 ± 6.6 (130.0–179.5)	165.1 ± 7.3 (149.0–182.0)	160.9 ± 5.4 (150.0–170.0)
Weight (kg)	60.0 ± 9.4 (36.0–95.0)	71.6 ± 17.6 (40.0–110.0)	75.4 ± 13.1 (52.0–97.5)
BMI (kg/m^2)	21.9 ± 2.9 (16.2–32.1)	26.3 ± 6.5 (16.4–37.4)	29.1 ± 4.6 (20.8–36.1)
SAT-Top			
Neck[b]	6.9 ± 3.6 (1.9–18.4)[c]	11.9 ± 7.1 (1.9–24.6)	16.5 ± 5.6 (7.6–26.7)[a]
Triceps	11.7 ± 4.1 (3.1–26.2)	12.5 ± 3.8 (6.5–20.8)	12.8 ± 2.9 (7.3–17.8)
Biceps	5.8 ± 3.5 (1.6–17.7)[c]	8.7 ± 5.4 (1.3–27.1)	10.6 ± 3.2 (4.6–17.1)[a]
Upper back	6.1 ± 3.3 (1.6–18.3)[c]	9.9 ± 5.6 (2.4–21.1)	9.9 ± 3.9 (3.5–20.0
Front chest	8.1 ± 5.1 (1.8–26.1)[c]	13.2 ± 7.3 (2.1–26.2)	14.6 ± 5.7 (4.6–29.9)
Lateral chest	7.9 ± 5.1 (1.6–26.8)[c]	12.5 ± 9.0 (1.0–35.8)	15.9 ± 6.5 (5.2–35.3)
Upper abdomen	9.3 ± 5.5 (2.0–27.4)[c]	12.4 ± 6.1 (2.8–24.8)	13.2 ± 4.9 (5.3–24.3)
Lower abdomen	9.4 ± 4.7 (1.8–25.3)	9.8 ± 4.8 (1.5–22.2)	13.0 ± 3.6 (6.3–21.8)[a]
Lower back	11.3 ± 4.7 (2.8–25.0)	10.9 ± 3.5 (5.3–18.2)	11.5 ± 2.6 (6.5–16.3)
Hip	9.8 ± 6.6 (1.8–31.3)[c]	11.2 ± 4.5 (1.1–24.0)	11.5 ± 4.6 (3.2–20.0)
Front thigh	10.1 ± 3.1 (3.7–20.6)[c]	7.7 ± 2.2 (2.8–12.4)	7.5 ± 2.4 (2.8–11.8)
Lateral thigh	10.3 ± 3.5 (4.0–25.1)[c]	7.8 ± 2.7 (2.3–12.6)	6.9 ± 2.6 (2.3–11.5)
Rear thigh	7.0 ± 2.4 (1.9–17.0)[c]	5.0 ± 1.8 (1.7–9.5)	5.2 ± 2.0 (2.1–9.3)
Inner thigh	11.4 ± 3.8 (3.5–24.8)[c]	9.1 ± 3.0 (2.8–16.4)	9.2 ± 3.7 (2.4–18.2)
Calf	5.5 ± 1.8 (2.1–10.5)[c]	3.9 ± 1.3 (1.5–6.9)	4.1 ± 1.2 (2.4–7.4)
Total SAT	130.6 ± 51.5 (42.9–296.2)	146.8 ± 52.7 (40.1–248.2)	162.3 ± 38.0 (101.2–261.3)
Factor 1[d]	−0.69 ± 1.08 (−2.11–2.45)[c]	0.58 ± 1.6 (−1.80–3.6)	1.17 ± 1.20 (−1.06–4.20)
Factor 2[e]	0.94 ± 0.71 (−0.60–3.30)[c]	0.00 ± 0.61 (−1.40–1.08)	−0.27 ± 0.76 (−1.39–1.08)

[a] Significant difference compared with PCOS women ($P < 0.03$).
[b] SAT thickness of 15 body sites in millimeters.
[c] Significant difference compared with PCOS women ($P < 0.03$).
[d] Corresponds to trunk SAT development.
[e] Corresponds to extremities SAT development.

15 evenly distributed and anatomically well-defined body sites were specified from neck to calf on the right side of the body (26). The measurement cycle takes for about 2 min during which the subject is standing.

Statistical Analysis. Statistical calculations were performed with SPSS for Windows (SPSS Inc., Chicago, IL). The nonparametric Mann-Whitney *U* test for independent samples was applied to test the significance of SAT-Top differences between healthy, PCOS, and diabetic subjects.

For visual comparison of different SAT distributions in the healthy, PCOS, and diabetic groups, a relative SAT-Top plot was constructed. The 15 SAT layer means of the healthy subjects were set to 100% and the SAT-Top means of the other groups were calculated as percentage values, showing the deviation from the "healthy" SAT pattern.

Some previous PCOS studies report on the existence of two different body fat patterns in PCOS women, a "lean" and an "obese" form, categorized by BMI (10, 16, 5). Hierarchical cluster analysis was applied to investigate if the 15 SAT-Top measurements separate our PCOS patients into two (or more) groups.

Lipometer SAT-Top values are often intercorrelated. Applying of factor analysis is useful and enables the reduction of the 15 SAT-Top values to a small number of independent subcutaneous body fat regions, so-called factors. Previously, two factors were extracted from a data set of 590 healthy subjects: Factor 1 corresponded to the trunk SAT-Top development, whereas Factor 2 was related to the SAT-Top of extremities. Results of this factor analysis for 590 healthy men (m_1: 20–30 years old, m_2: 30–40 years old, m_3: 40–50 years old, m_4: 50–60 years old, and m_5: 60–70 years old), and women (w_1: 20–30 years old, ..., w_5: 60–70 years old), divided into five age groups by decades, were depicted in a two dimensional factor value plot (26) whereby the factor values obtained for a subject were applied as the *x* and *y* coordinates of the factor plot. As an example of the "juvenile" and the "diabetic" fat pattern, the SAT-Top results of 162 healthy children (age: 7–11 years old) (20) and 20 Type-II diabetic women (23) were added to the factor plot to permit the comparison of previous data sets with the SAT-Top information of our 33 PCOS and 87 healthy women.

Results

Compared with healthy women, PCOS patients were of similar age and height, whereas weight (+19.3%) and BMI (+20.1%) were significantly higher (P = 0.001 and P = 0.004, respectively, Table I). The overweight PCOS women showed no significantly higher total SAT value (P = 0.074). However, almost all SAT layers of the upper body were significantly thicker in PCOS women, whereas all SAT layers of the legs were significantly lower compared with their healthy control group. These results indicate a strong deviation of the PCOS body fat distribution from the normal female fat pattern.

Body fat distribution of PCOS patients was similar to that of the diabetics despite the significant age difference (of 35.9 years) between these two groups. There were no significant differences in weight, BMI, or total SAT between the two groups. Significant differences were seen at only three of 15 body sites (neck: P = 0.019, biceps: P = 0.031, and lower abdomen), with P = 0.014. These results indicate a high similarity between the SAT-Tops of PCOS and Type-II diabetic patients, with a slight tendency of the Type-II diabetic women to a more pronounced upper body obesity.

The relative SAT-Top plot (Fig. 1) shows these SAT pattern similarities and differences in the three groups. PCOS patients had a stronger pronounced upper body obesity compared with healthy subjects: with the exception of the body site, triceps, all SAT layers of the upper body (1–7) were increased to 130% to 175%, whereas the lower trunk body sites (8–10) did not significantly deviate from the healthy group. All SAT layers of the legs (11–15) were significantly lowered to about 75%. In summary, we detected an android fat pattern in PCOS women with strong upper body obesity and high similarities to the Type-II diabetic SAT distribution.

To clarify whether our PCOS patients can be distinguished into two or more significantly different SAT distribution groups, the 15 Lipometer SAT layer thicknesses of these subjects were subjected to a hierarchical cluster analysis. The dendrogram (Fig. 2) shows a clear classification of our cases into two groups: a "lean" group ($PCOS_L$), containing 15 cases with a BMI value ≤26.0 (mean BMI = 20.7), and an "obese" group ($PCOS_O$), including 18 patients with a BMI ≥ 22.3 (mean BMI = 31.0; Table II). The two groups deviated significantly in weight (+47.7%), BMI (+50.5%), total SAT (+93.2%), and all SAT layer thicknesses of the upper body (1–10) (from +39.8% to +304.3%). There were no significant differences between

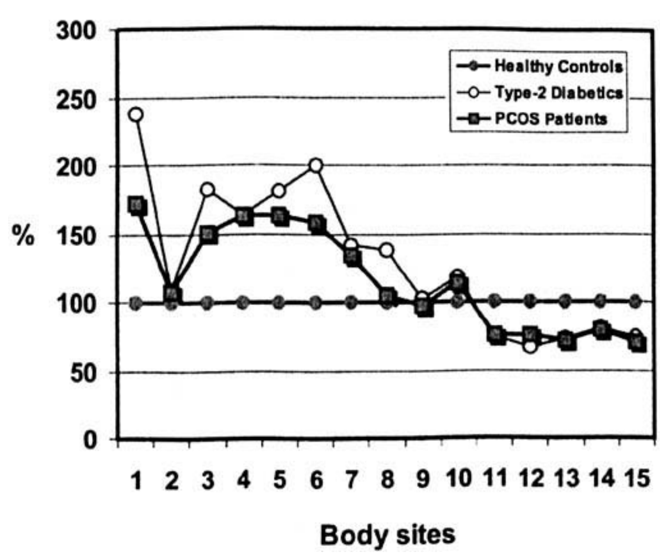

Figure 1. Relative SAT-Top plot of PCOS women, Type-II diabetic patients, and healthy controls (set to 100%), showing the deviation from the "healthy" female fat pattern (in percentage).

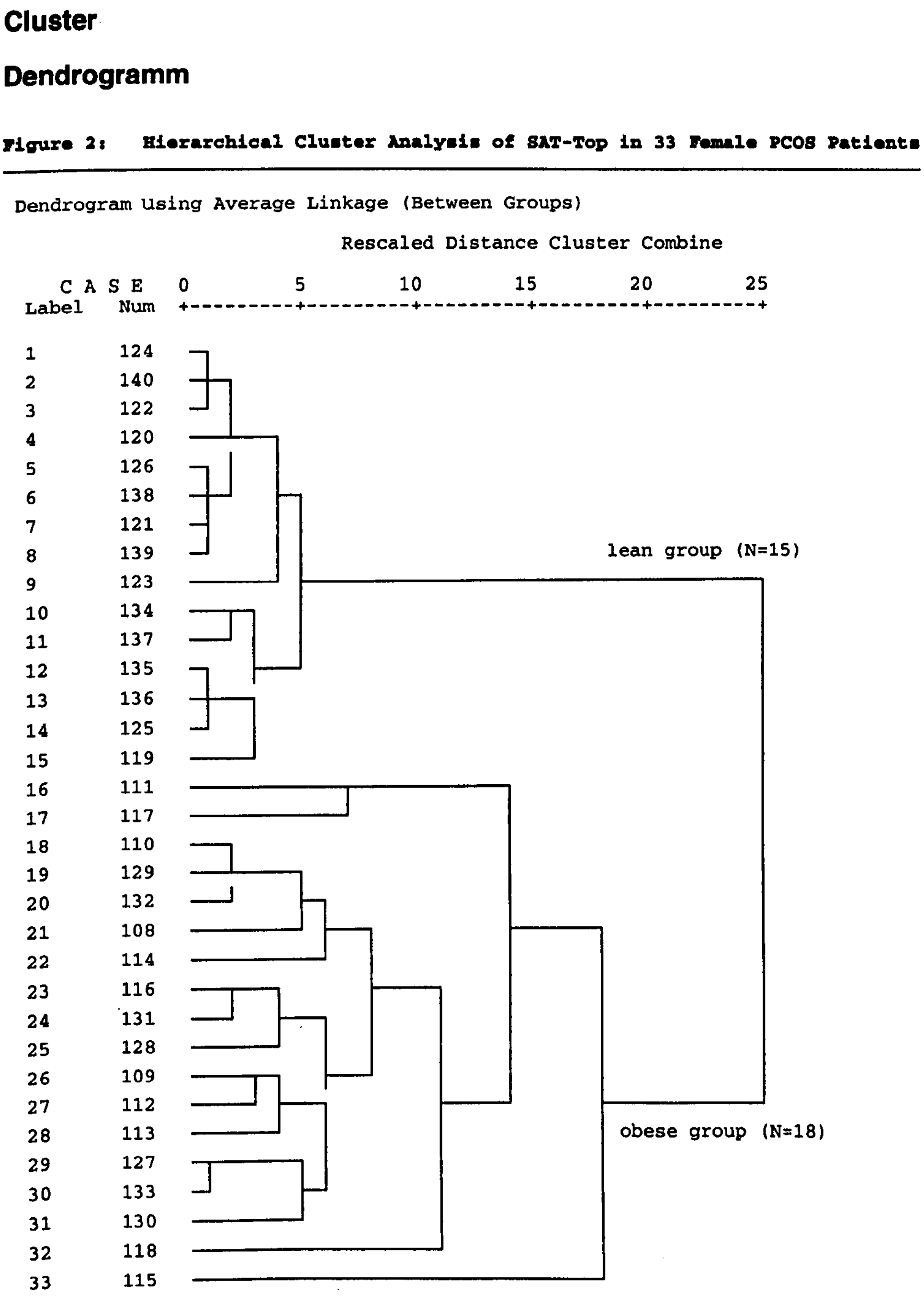

Figure 2. Dendrogram obtained by cluster analysis using the 15 SAT layer thicknesses as input. The 33 PCOS cases are clearly divided into two SAT distribution groups: a "lean" ($n = 15$) and an "obese" ($n = 18$) one.

$PCOS_L$ and $PCOS_O$ for age, height, and all SAT layers of the legs (11–15).

Figure 3 depicts in a relative SAT-Top plot the SAT distribution of the two PCOS groups in relation to healthy and diabetic women. Comparing each PCOS group with Type-II diabetic women shows that only the $PCOS_O$ women showed a SAT-Top pattern very similar to Type-II diabetics. They had even significantly more total SAT ($P = 0.01$) and a more pronounced upper body obesity with significantly increased values at the body sites: upper back ($P < 0.001$), front chest ($P = 0.041$), and upper abdomen ($P = 0.009$). For all other personal parameters and SAT-Top measurements, we found no significant differences between these two groups with the exception of their age.

Compared with healthy women, $PCOS_L$ patients showed significantly lower total SAT development ($P = 0.006$), even though height, weight, and BMI did not differ significantly. The $PCOS_L$ group provided lower SAT layer means at all 15 body sites, whereby we obtained significances in all SAT layers of the legs ($P \leq 0.001$) and just three SAT layers of the upper body (lateral chest, $P = 0.006$; lower abdomen, $P = 0.004$; and lower back, $P = 0.004$). Notably, because of the higher leg SAT reduction in relation to the slightly lowered amount of upper body SAT,

Table II. Descriptive Characteristics and SAT-Top Measurements in Lean and Obese Women with PCOS (mean ± SD [minimum – maximum])

	Lean PCOS	Obese PCOS
n	15	18
Age (years)	25.6 ± 4.1 (20.3–35.0)	27.3 ± 4.9 (20.1–35.3)
Height (cm)	165.8 ± 8.3 (156.0–182.0)	164.5 ± 6.5 (149.0–176)
Weight (kg)	56.8 ± 7.6 (40.0–69.0)	83.9 ± 13.6 (61.5–110.0)[a]
BMI (kg/m^2)	20.7 ± 2.3 (16.4–26.0)	31.0 ± 4.7 (22.3–37.4)[a]
SAT-TOP		
Neck[b]	5.4 ± 2.3 (1.9–8.8)	17.3 ± 4.7 (7.5–24.6)[a]
Triceps	10.3 ± 2.4 (7.2–15.1)	14.4 ± 3.7 (6.5–20.8)[a]
Biceps	4.7 ± 2.2 (1.3–8.8)	12.0 ± 5.0 (6.5–27.1)[a]
Upper back	4.6 ± 2.0 (2.4–9.3)	14.4 ± 3.0 (10.5–21.1)[a]
Front chest	6.8 ± 3.4 (2.1–14.2)	18.5 ± 4.9 (9.6–26.2)[a]
Lateral chest	4.7 ± 2.9 (1.0–12.1)	19.0 ± 6.8 (8.7–35.8)[a]
Upper abdomen	7.0 ± 3.1 (2.8–12.4)	16.9 ± 4.0 (9.6–24.8)[a]
Lower abdomen	5.9 ± 2.4 (1.5–11.6)	13.0 ± 3.7 (6.7–22.2)[a]
Lower back	8.7 ± 2.0 (5.3–11.5)	12.7 ± 3.4 (6.9–18.2)[a]
Hip	8.0 ± 3.2 (1.1–13.0)	13.8 ± 3.7 (7.9–24.0)[a]
Front thigh	7.3 ± 1.8 (2.8–9.7)	8.0 ± 2.4 (4.6–12.4)
Lateral thigh	7.2 ± 2.4 (2.3–10.6)	8.3 ± 2.9 (3.4–12.6)
Rear thigh	4.9 ± 1.8 (1.7–8.2)	5.2 ± 1.9 (2.7–9.5)
Inner thigh	8.1 ± 2.6 (2.8–12.5)	10.0 ± 3.2 (4.8–16.4)
Calf	3.4 ± 1.2 (1.5–5.6)	4.3 ± 1.3 (2.1–6.9)
Total SAT	97.3 ± 26.3 (40.1–130.2)	188.0 ± 26.2 (148.4–248.2)[a]
Factor 1[c]	−0.99 ± 0.56 (−1.80–(−0.07))	1.90 ± 0.73 (0.85–3.60)[a]
Factor 2[d]	0.16 ± 0.50 (−0.77–1.08)	−0.28 ± 0.64 (−1.40–0.68)[a]

[a] Significant difference compared with lean PCOS.
[b] SAT thickness of 15 body sites in millimeters.
[c] Corresponds to trunk SAT development.
[d] Corresponds to extremities SAT development.

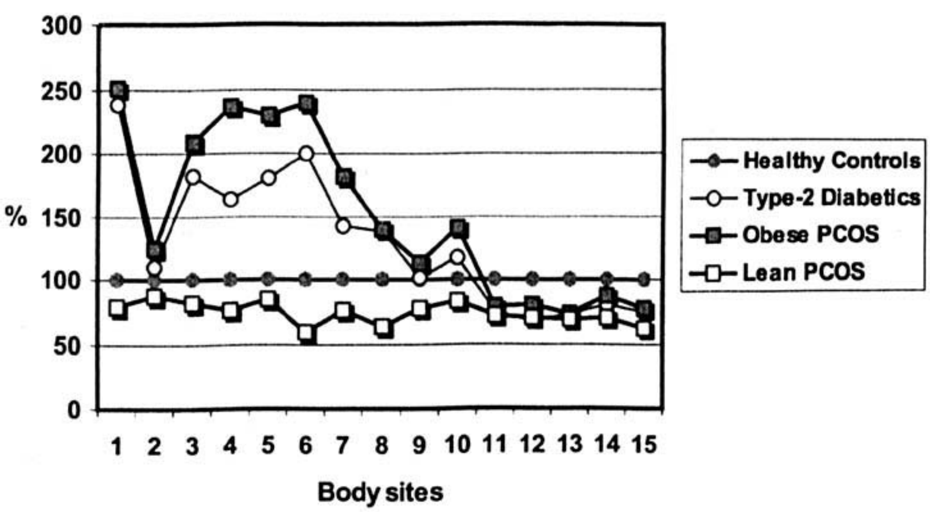

Figure 3. Relative SAT-Top plot of lean and obese PCOS women, Type-II diabetic patients, and healthy controls (set to 100%), showing the deviation from the "healthy" female fat pattern (in percentage).

this indicates an android SAT pattern in PCOS$_L$ women (without upper body obesity) compared with their healthy controls (see Fig. 3).

Factor analysis summarize Factor 1 as a measure of trunk SAT development, whereas Factor 2 corresponds to the SAT development of the extremities. Both factors were significantly different ($P < 0.001$) in healthy and (all) PCOS women (Table I), whereas diabetic compared with PCOS patients showed no significant deviations in these factors ($P = 0.331$ and $P = 0.279$), confirming the results for all 15 body sites.

Both PCOS groups (PCOS$_L$ and PCOS$_O$), the diabetic patients (w_d), and the healthy control group (w_h) were added to a previously published factor plot of 590 healthy men ($m_1,\ldots,m_5$) and women ($w_1,\ldots,w_5$) (19) (Fig. 4), using their trunk SAT development (Factor 1) as *x* coordinate and extremities SAT development (Factor 2) as *y* coordinate. A factor value of 0 implies the average of the SAT-Top development of all 590 healthy adults. A factor value below average indicates for leanness in the corresponding region, whereas a factor value above average indicates a degree of fatness. Furthermore, groups of healthy girls (g) and boys

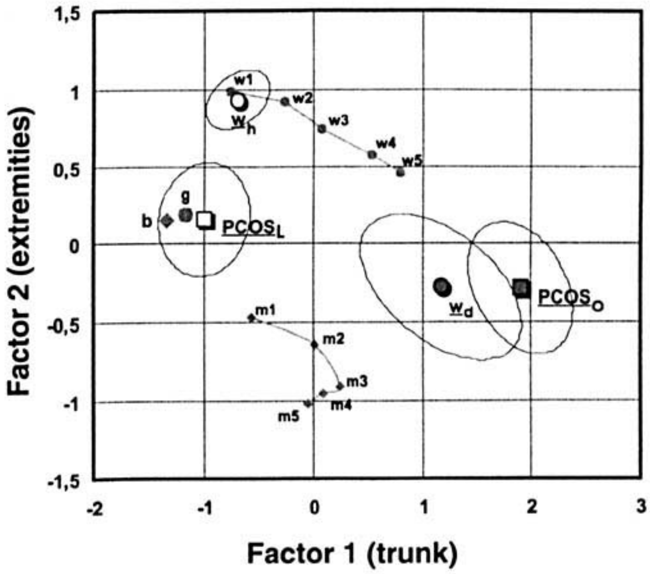

Figure 4. Factor plot showing the trunk SAT development (Factor 1) and extremities SAT development (Factor 2) of "lean" and "obese" PCOS women ($PCOS_L$ and $PCOS_O$) and their healthy controls (w_h). Furthermore, Type-II diabetic patients (w_d), healthy female and male adults of five age groups (w_1, m_1: 20-30 years old,...,w_5, m_5: 60-70 years old), and finally girls and boys (g, b: 7–11 years) were added for comparison. Confidence ellipse (95%) were depicted for the most important groups.

(b) aged 7 to 11 years were added to this factor plot for comparison. By means of these datasets the SAT-Top development over nearly the whole lifespan can be retraced for both sexes (19, 20), and especially, a tendency to the gynoid and the android fat pattern during this age range can be discovered.

$PCOS_O$ women showed a SAT-Top development of the extremities below average (factor 2<0), which usually occurs only in men and Type-II diabetic patients. The high Factor 1 value (mean: 1.9) of the $PCOS_O$ group implies a typical upper body obesity, which is even more pronounced than that of the diabetic women. Consequently, we obtained the strongest android SAT pattern in the obese PCOS group.

$PCOS_L$ patients had a SAT-Top development similar to the body fat distribution of 7- to 11-year-old children. Notably, in this age group, girls and boys show still the same SAT pattern (20) because sex-specific development of the body fat distribution is not yet determined. This is interesting because our lean PCOS patients did not undergo the normal female SAT development toward the healthy control group (w_h), but maintained a child-like fat pattern.

Discussion

Because a gynoid fat pattern is a sign of a potential reproductive success, a sufficient amount of body fat, especially at the lower body regions, is necessary and ensures a regular ovulatory menstrual cycle (12). This gynoid type of fat distribution develops during female puberty and is maintained over the fertile phase of life. From the age of about 30 years on, female SAT-Top slowly changes to an android pattern (19) that is further manifested visibly after menopause. Pathologic conditions can also lead to a change in body fat distribution, which is caused by hormonal disorders and consequently specific for each metabolic disease. Much evidence suggests that differing phenotypes of obesity and fat distribution are associated with differing hormonal environments (27). The typical and strong android fat pattern, which was found in Type-II diabetic women, is consistent with this suggestion (24). The precise description of such a phenotype by a new measurement method was one aim of this study.

As a second aim, we tried to determine whether PCOS women provide only one or several different SAT distribution types. In previous studies, two major groups of "lean" and "obese" PCOS patients were discriminated by their BMI categories (10), according to the WHO suggestion (normal range: BMI between 18.5 and 25.0; overweight: BMI $\geq$ 25.0). On the contrary, our clustering of PCOS women into two groups was performed by means of SAT layer thicknesses, a method including much more specific information. Discriminating our PCOS group by applying the WHO suggestion, two women with a BMI of 26.0 and 25.5 would be added to the obese group, and three cases with a BMI of 22.3, 22.6, and 23.5 were included in the lean cluster. Therefore, 84.8% of our cases were classified according to the BMI model (86.6% of the lean group and 83.3% of the obese group). However, our classification model using SAT layer thicknesses and the objective statistical method of cluster analysis gives reason to be more appropriate. Consequently, 13.4% of the cases would be incorrectly classified by the BMI model. The widely used waist-to-hip ratio describes body scope and silhouette but not the quantitative amount of fat distribution.

Our third aim was the SAT-Top comparison of the two PCOS groups with healthy controls, Type-II diabetic subjects, and healthy children and adults of both sexes and all age groups (from 7 to 70 years). For an exact numeric and visual description of the different SAT distributions, the application of relative SAT-Top plots and the statistical method of factor analysis rendered satisfying results.

$PCOS_L$ provided significantly lowered extremities SAT-Top development compared with healthy subjects (Fig. 4). Their SAT layer thicknesses of the trunk were also lowered, but just tendentious, rendering a body fat distribution type like girls and boys before puberty. Though aged between 20 and 35 years, the lean PCOS patients did not show the typical sexual signs of female fat patterning, but maintained a child-like SAT distribution.

However, obese PCOS women showed a SAT-Top pattern very similar, sometimes even more pronounced, than that of women with Type-II diabetes (Fig. 4) even though the mean age difference between these groups was more than 30 years. Compared with their healthy controls, the SAT-Top of these $PCOS_O$ patients was strongly skewed into the android direction, with a significantly decreased leg SAT development and a significantly increased upper trunk obesity. As the phenotype of body fat distribution is associated with the hormonal status of sexual hormones and insulin, we would suggest that obese PCOS and Type-II diabetic women have not only a similar body fat distribution, but also similarities in their hormone status.

In conclusion, there is a distinct difference in SAT-Top between lean and obese PCOS patients, healthy subjects, and Type-II diabetic women. SAT-Top can attribute PCOS women to an android phenotype. Also, obese patients show a body fat distribution similar to that of Type-II diabetic women after menopause, and lean women have nearly the same fat distribution as children before puberty. The new SAT-Top method with the Lipometer and advanced statistical methods could be used to detect the "PCOS-like" fat pattern that might correspond to an endocrine dysfunction. The quick, safe, precise, and inexpensive Lipometer method could be a useful tool for an early recognition of untypical body fat distributions and may lead to further investigations.

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