



## Original Research

# Association of ethnicity, Fitzpatrick skin type, and hirsutism: A retrospective cross-sectional study of women with polycystic ovarian syndrome <sup>☆,☆☆</sup>



L. Afifi, MS <sup>a</sup>, L. Saeed, BA <sup>a</sup>, L.A. Pasch, PsyD <sup>b</sup>, H.G. Huddleston, MD <sup>c</sup>, M.I. Cedars, MD <sup>c</sup>, L.T. Zane, MD, MAS <sup>d</sup>, K. Shinkai, MD, PhD <sup>a,\*</sup>

<sup>a</sup> Department of Dermatology, University of California, San Francisco, CA

<sup>b</sup> Department of Psychiatry, University of California, San Francisco, CA

<sup>c</sup> Department of Obstetrics, Gynecology, and Reproductive Sciences, University of California, San Francisco, CA

<sup>d</sup> Anacor Pharmaceuticals, Palo Alto, CA

## ARTICLE INFO

## Article history:

Received 12 November 2016

Received in revised form 25 January 2017

Accepted 26 January 2017

## Keywords:

PCOS

hirsutism

ethnicity

Fitzpatrick skin type

hyperandrogenism

modified Ferriman–Gallwey

## ABSTRACT

**Background:** The complex interplay between ethnicity, Fitzpatrick skin type (FST), and hirsutism in patients with polycystic ovarian syndrome (PCOS) is poorly understood.

**Objective:** In this cross-sectional, retrospective analysis, we examined the prevalence, severity, and distribution of hirsutism with clinician-rated site-specific and total modified Ferriman–Gallwey (mFG) visual scoring in a diverse cohort of American patients with PCOS.

**Methods:** Independent analyses were conducted on the basis of patient-reported FST ratings and ethnicity. **Results:** In this PCOS cohort, a correlation was found between hirsutism and ethnicity and the highest prevalence of hirsutism and total mFG scores was observed in Hispanic, Middle Eastern, African American, and South Asian patients. A positive correlation between hirsutism and FST was also observed with an increasing prevalence of hirsutism in the group of patients with higher FSTs. Significant trends in the anatomic distribution of hirsutism were observed between ethnic groups as well. A higher facial mFG score was found in African American patients but higher mFG scores in the truncal and extremity regions were observed in Middle Eastern patients. Truncal hirsutism was also associated with higher FSTs.

**Conclusions:** Ethnicity and FST may be important variables in both the quantitative and qualitative presentations of hirsutism in women with PCOS and should be considered in the diagnostic evaluation of any patient who is suspected of having the condition. Previously published studies that examined ethnicity, FST, and hirsutism in homogeneous cohorts limited comparison and generalizability but the strength of this study lies in its detailed analysis within a single large and diverse PCOS cohort. Validated studies are needed to determine whether clinical criteria for hirsutism should be adjusted for ethnicity and FST in the PCOS population and particularly within diverse cohorts and patients of mixed ancestry.

© 2017 Women's Dermatologic Society. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Polycystic ovarian syndrome (PCOS) affects approximately 2% to 7% of women in the general population (Schmidt and Shinkai, 2015). The pathogenesis of PCOS is not well understood but current evidence indicates a multifactorial etiology that involves gonadotropic

dysregulation, genetic predisposition, and environmental factors (Norman et al., 2007). The presentation of PCOS is heterogeneous and typical features include chronic anovulation, biochemical or clinical signs of hyperandrogenism, polycystic ovaries, and metabolic derangement (Kosus et al., 2012). Ninety-two percent of women with PCOS exhibit cutaneous manifestations including signs that are associated with hyperandrogenism, which implicates an important role for dermatologists in the recognition and diagnosis of women who are suspected of having PCOS (Azziz et al., 2004; Carmina et al., 2006; Schmidt et al., 2016; Schmidt and Shinkai, 2015). A study of women who presented with PCOS features for the first time found that 25% of the study population was referred by

<sup>☆</sup> Conflicts of interest: Dr. Cedars reported being an investigator for and a recipient of grants from Ferring and Nova Therapeutics. Dr. Zane reported being an employee and stockholder of Anacor Pharmaceuticals.

<sup>☆☆</sup> Funding sources: None.

\* Corresponding Author.

E-mail address: [Kanade.shinkai@ucsf.edu](mailto:Kanade.shinkai@ucsf.edu) (K. Shinkai).

dermatology clinics (Sivayoganathan et al., 2011). A timely, accurate diagnosis of PCOS is paramount because it may lead to a number of long-term complications such as type 2 diabetes, obesity, hypertension, infertility, macrovascular disease, thrombosis, and cancer (Ehrmann, 2005). However, an accurate diagnosis of PCOS is challenging due to the number of heterogeneous phenotypes in this condition including the observed ethnic variations in the presentation of PCOS (Zhao and Qiao, 2013).

Hirsutism is defined as excessive terminal hair growth in an androgen-sensitive skin distribution in women and is a reliable cutaneous marker for hyperandrogenism, the most common cause of which is PCOS. The primary modality to evaluate and quantify hirsutism is the modified Ferriman-Gallwey (mFG) visual four-point scale, which scores hair growth in nine androgen-dependent body areas (Ferriman and Gallwey, 1961). The scale rates hirsutism on a scale from 0 to 36 and clinical hirsutism is typically defined as a total mFG score of 8 or greater. The development of the mFG scoring system was based on the evaluation of primarily Caucasian (Northern European) women, making application of the instrument controversial in the assessment of hirsutism in other ethnicities (Asuncion et al., 2000; Cheewadhanaraks et al., 2004; DeUgarte et al., 2006; Ferriman and Gallwey, 1961; Kim et al., 2011; Moran et al., 2010; Sagsoz et al., 2004; Tellez and Frenkel, 1995; Wong et al., 2014; Zhao et al., 2007). The Androgen Excess-PCOS (AE-PCOS) Society has proposed the need for ethnic-specific mFG cutoff scores to define hirsutism in women with PCOS (Escobar-Morreale et al., 2012; Fauser et al., 2012). How ethnic variation impacts hirsutism in the PCOS population requires further investigation because current evidence stems from limited studies that examined homogeneous cohorts and compared only two or three ethnicities or variable classifications of ethnic groups.

The Fitzpatrick skin type (FST) scale categorizes patients on the basis of skin color and response to sun exposure and has been used in the evaluation of photoaging, skin cancer risk assessment, and laser hair treatment (Fitzpatrick, 1988; Roberts, 2009; Sachdeva, 2009). Few studies have investigated an association between skin type and hirsutism and the generalizability of existing evidence is limited by mixed methodologies in non-PCOS cohorts (Döner and Ekmekçi, 2013; Javorsky et al., 2014). The aim of the current study is to characterize the relationship between ethnicity, FST, and the pattern and severity of hirsutism among an ethnically diverse cohort of American patients with PCOS.

## Methods

Approval by the University of California, San Francisco (UCSF) Committee for Human Research was granted to perform this retrospective cross-sectional study. Participants were recruited consecutively from May 18, 2006 to October 25, 2012 from the UCSF multidisciplinary PCOS clinic. Any patient who was able to provide written consent was eligible to participate in the study. A diagnosis of PCOS was made by joint consultation between a dermatologist and reproductive endocrinologist using the 2003 Rotterdam criteria that require two of three signs or symptoms of the following: oligoovulation and/or anovulation, clinical or biochemical signs of hyperandrogenism, or presence of 12 or more antral follicles per ovary and/or ovarian volume greater than 10 mL by ultrasound (Rotterdam ESHRE/ASRM, 2004). Patients were asked to discontinue any hormonal medication at least 1 month prior to the clinic visit and refrain from any hair removal for at least 1 week before the clinic visit.

### Ethnicity and Fitzpatrick skin type scoring

Self-reported ethnicity and FST information was collected with a demographic questionnaire. Ethnic groups were categorized in nine subgroups: Middle Eastern, Ashkenazi Jew, other Caucasian,

East/Southeast Asian, South Asian, Hispanic, African American, Native American, and mixed/other. Skin type was determined on the basis of self-reported Fitzpatrick skin type including Type I (always burns, never tans), Type II (usually burns, tans minimally), Type III (sometimes mild burn, tans uniformly), Type IV (burns minimally, always tans well), Type V (very rarely burns, tans very easily), and Type VI (never burns, never tans). For the analysis, FSTs were classified into three skin type groups: FSTs I and II (Group 1), FSTs III and IV (Group 2), and FSTs V and VI (Group 3).

### Clinician rating of hirsutism

The evaluation of hirsutism was conducted with the mFG visual scoring method that assesses androgen dependent hair growth in nine body areas: upper lip, chin, chest, upper and lower back, upper and lower abdomen, thighs, and upper arms. A dermatologist rated and recorded each site using the mFG visual scoring method on a scale of 0 (absence of hair) to 4 (extensive terminal hair growth). Site-specific, regional (facial, truncal, and extremity), and total mFG scores were reported. Hirsutism was defined by a total mFG score of 8 or higher.

### Statistical analysis

All analyses were performed with SAS software (SAS Institute, Cary, NC). Kruskal-Wallis and  $\chi^2$  tests were used to compare demographics and mFG scores between the PCOS diagnosis status, and ethnic and FST groups.

## Results

A total of 341 women met the study inclusion criteria and 276 patients met the Rotterdam criteria for PCOS. There was no difference in the ethnic backgrounds between women who were diagnosed with PCOS and those who failed to meet the diagnostic criteria or in the deferred diagnosis group ( $p = .250$ ). Additional baseline characteristics are listed in Table 1. There were significant differences in the total mFG scores ( $p < .001$ ) and rates of clinical hirsutism ( $p = .013$ ) and women who were diagnosed with PCOS had greater severity and prevalence of hirsutism (Table 2).

A comparison between ethnic groups found a significant correlation between self-reported ethnicity and total mFG scores ( $p = .009$ ) and prevalence of clinical hirsutism ( $p = .002$ ). Patients of

**Table 1**  
Mean age, BMI and ethnicity in PCOS vs. non-PCOS groups

	PCOS Diagnosis			p-value
	No (does not meet diagnostic criteria) (N = 48)	Yes (meets diagnostic criteria for PCOS) (N = 276)	Diagnosis Deferred (N = 17)	
Age (Mean $\pm$ SD)	32.8 $\pm$ 9.63	28.1 $\pm$ 6.02	27 $\pm$ 6.38	<b>.008<sup>1</sup></b>
BMI (Mean $\pm$ SD)	28.9 $\pm$ 8.37	30.3 $\pm$ 8.18	29.3 $\pm$ 8.61	.42 <sup>1</sup>
<b>Ethnicity</b>				
African American	1 (2.2%)	16 (5.9%)	1 (5.9%)	.25 <sup>2</sup>
Native American	0 (0.0%)	4 (1.5%)	0 (0.0%)	
South Asian	2 (4.1%)	8 (2.9%)	0 (0.0%)	
East/Southeast Asian	2 (4.1%)	37 (13.4%)	3 (17.6%)	
Caucasian	34 (73.9%)	123 (45.4%)	10 (58.8%)	
Ashkenazi Jewish	0 (0.0%)	17 (6.3%)	0 (0.0%)	
Middle Eastern	1 (2.2%)	10 (3.7%)	0 (0.0%)	
Hispanic	2 (4.3%)	30 (11.1%)	1 (5.9%)	
Mixed/Other	4 (8.7%)	27 (10.0%)	2 (11.8%)	

BMI, body mass index; PCOS, polycystic ovarian syndrome.

<sup>1</sup> On the basis of the Kruskal-Wallis test.

<sup>2</sup> On the basis of the  $\chi^2$  test.

**Table 2**  
mFG scores in PCOS vs. non-PCOS groups

	PCOS Diagnosis			p-value
	No (does not meet diagnostic criteria) (N = 45)	Yes (meets diagnostic criteria for PCOS) (N = 242)	Diagnosis Deferred (N = 12)	
<b>mFG (mean +/-SD)</b>				
Upper lip	0.978 ± 0.965	1.08 ± 0.993	1 ± 0.953	.81 <sup>1</sup>
Chin	0.889 ± 0.982	1.34 ± 1.3	0.833 ± 1.27	.055 <sup>1</sup>
Chest	0.133 ± 0.405	0.417 ± 0.782	0.0833 ± 0.289	.017 <sup>1</sup>
Upper abdomen	0.267 ± 0.495	0.653 ± 0.885	0.167 ± 0.389	.005 <sup>1</sup>
Lower abdomen	0.956 ± 1.19	1.66 ± 1.15	0.75 ± 1.22	<.001 <sup>1</sup>
Upper arm	0.267 ± 0.688	0.419 ± 0.843	0.25 ± 0.452	.43 <sup>1</sup>
Thigh	1.33 ± 1.15	1.66 ± 1.08	0.917 ± 0.669	.012 <sup>1</sup>
Upper back	0.2 ± 0.505	0.504 ± 0.79	0.333 ± 0.651	.027 <sup>1</sup>
Lower back	0.6 ± 1.03	0.888 ± 1.05	0.25 ± 0.622	.009 <sup>1</sup>
<b>mFG (total)</b>	5.62 ± 5.12	8.5 ± 6.27	4.58 ± 4.23	<.001 <sup>1</sup>
<b>mFG anatomic region</b>				
Facial*	1.87 ± 1.66	2.4 ± 2.02	1.83 ± 2.12	.19 <sup>1</sup>
Trunk**	2.16 ± 2.82	4.08 ± 3.6	1.58 ± 2.43	<.001 <sup>1</sup>
Extremity***	1.6 ± 1.51	2.05 ± 1.55	1.17 ± 0.577	.016 <sup>1</sup>
<b>Clinical hirsutism</b>				
No (mFG total <8)	31 (68.9%)	126 (51.4%)	10 (83.3%)	.013 <sup>2</sup>
Yes (mFG total ≥/8)	14 (31.1%)	119 (48.6%)	2 (16.7%)	

BMI, body mass index; mFG, modified Ferriman-Gallwey; PCOS, polycystic ovarian syndrome.

<sup>1</sup> On the basis of the Kruskal-Wallis test.

<sup>2</sup> On the basis of the  $\chi^2$  test.

\* Facial mFG score: Summation of upper lip and chin mFG scores.

\*\* Truncal mFG score: Summation of chest, upper and lower back, and upper and lower abdomen mFG scores.

\*\*\* Extremity mFG score: Summation of thigh and upper arm mFG scores.

Hispanic, Middle Eastern, South Asian, African American, and mixed ethnicity had the highest total mFG scores and prevalence of clinical hirsutism while those of Caucasian, Ashkenazi Jewish, East/Southeast Asian, and Native American ethnicity had lower severity and prevalence rates of hirsutism. Site-specific comparisons found significant ethnic differences in facial ( $p = .031$ ), truncal ( $p < .001$ ), and extremity ( $p = .017$ ) mFG scores. Patients of Hispanic, mixed, and African American ethnicity had higher facial mFG scores, particularly in the chin area for African American patients ( $p = .015$ ). Middle Eastern and Hispanic women had higher truncal and extremity mFG scores. The full details on mFG scores by ethnicity are outlined in Table 3.

Age and obesity are known to affect the cutaneous presentation of PCOS. No age difference was detected between the ethnic groups; however, a significant ethnic difference in body mass index (BMI) was found ( $p < .001$ ). Patients of Hispanic, Middle Eastern, and Native American ethnicity had the highest BMI scores while South Asian women had a much lower BMI score. Among the FST groups, a significant difference in total mFG score ( $p = .021$ ) and prevalence of hirsutism ( $p = .012$ ) was found. Patients in Group 3 (skin Types V and VI) had the highest mFG scores and prevalence of hirsutism, followed by Group 2 (skin Types III and IV), and Group 1 (skin Types I and II). The majority of this variation in hirsutism among skin types is due to differences in truncal mFG scores ( $p = .008$ ). Detailed mFG scores and skin type results are found in Table 4.

## Discussion

This analysis of a diverse cohort of American patients with PCOS revealed significant differences in prevalence, pattern, and severity of hirsutism between ethnic and FST subgroups. An increased prevalence of hirsutism and higher total mFG scores were found in patients of Hispanic, Middle Eastern, South Asian, African American, and mixed ethnicity. A lower prevalence in hirsutism and total mFG scores were found in Caucasian, Asian, Ashkenazi Jewish, and Native American women with PCOS.

The results of this study are consistent with some but not all published studies that investigated ethnic variations in the prevalence and severity of hirsutism in women with PCOS. A comparison with

existing literature was limited by differences in methodology, which precluded generalizability. Some studies focused on a single homogeneous ethnic cohort but many of the available studies focused on a comparison of hirsutism in limited subsets of ethnic groups rather than examining hirsutism across multiple ethnicities within a single PCOS cohort (Carmina et al., 1992; Glintborg et al., 2010; Guo et al., 2012; Kim et al., 2014; Legro et al., 2006; Welt et al., 2006; Wijayarathne et al., 2002a; Wong et al., 2014).

Studies that identify ethnic differences in hirsutism in patients with PCOS have largely relied on a limited comparison of two or three ethnic subgroups. Several cross-sectional studies have found significantly higher mFG scores among migrant South Asian and Middle Eastern women with PCOS who live in Europe compared with their Caucasian European counterparts (Glintborg et al., 2010; Mani et al., 2015; Wijayarathne et al., 2002b). Important differences may lie in the distinction of Asian subgroups because comparisons between European Caucasian and Chinese cohorts of patients with PCOS who live in their native countries found a lower prevalence of hirsutism and mFG scores in the East Asian group (Guo et al., 2012). Similarly, a multi-center cross-sectional study of women with PCOS found lower mFG scores in an East Asian (Japanese) cohort compared with Italian and Hispanic American cohorts with all patients living in their native countries (Carmina et al., 1992).

In contrast, multiple studies of American women with PCOS did not find ethnic differences in hirsutism prevalence and severity (Knochenhauer et al., 1998; Ladson et al., 2011; Legro et al., 2006; Welt et al., 2006). A study of a diverse cohort in Boston reported equal prevalence of hirsutism and mFG scores between Caucasian, African American, Hispanic, and Asian patients with PCOS (Welt et al., 2006). In the Pregnancy in Polycystic Ovarian Syndrome study, similar rates of hirsutism prevalence and severity were also reported among patients who were categorized by race in African American, Asian, Caucasian, and American Indian/Native American groups and in Latino versus non-Latino ethnic subgroups (Legro et al., 2006). In contrast to previous studies that identified differences in hirsutism between distinct Caucasian and East Asian cohorts of patients with PCOS who all lived in their native countries, a focused study that examined Caucasian (primarily of European ancestry) and East Asian

**Table 3**  
Relationship between ethnicity and hirsutism in women with PCOS

	Ethnicity									p-value
	Caucasian Ethnic Subgroups			Asian Ethnic Subgroups		Additional Ethnic Groups				
	Middle Eastern (N = 9)	Ashkenazi Jewish (N = 16)	Caucasian (other) (N = 110)	East/Southeast Asian (N = 37)	South Asian (N = 5)	Hispanic (N = 29)	African American (N = 15)	Native American (N = 2)	Mixed/Other (N = 20)	
Age (Mean ± SD)	28.4 ± 7.55 (n = 10)	28 ± 5.4 (n = 17)	28.2 ± 6.05 (n = 123)	27.1 ± 5.44 (n = 37)	23 ± 6.27 (n = 4)	28.9 ± 6.43 (n = 30)	30.9 ± 6.76 (n = 16)	23 ± 6.27 (n = 4)	28.3 ± 5.28 (n = 26)	.11 <sup>1</sup>
BMI (Mean ± SD (N))	35.8 ± 10.4 (n = 10)	29.1 ± 8.1 (n = 17)	29 ± 7.69 (n = 123)	29.7 ± 8.44 (n = 35)	23 ± 3.84 (n = 7)	34.2 ± 8.88 (n = 30)	31.4 ± 6.6 (n = 16)	38.8 ± 4.83 (n = 4)	32 ± 7.85 (n = 26)	<.001 <sup>1</sup>
<b>mFG score (mean +/-SD)</b>										
Upper lip	0.778 ± 1.09	0.875 ± 0.719	0.945 ± 0.947	1.36 ± 1.11	1 ± 0.707	1.31 ± 1.11	1.07 ± 0.704	0.5 ± 0.707	1.53 ± 1.17	.19 <sup>1</sup>
Chin	1.44 ± 1.42	0.938 ± 1.12	1.2 ± 1.3	1.12 ± 1.17	1.2 ± 0.837	1.97 ± 1.43	2.13 ± 1.06	0.5 ± 0.707	1.68 ± 1.29	.015 <sup>1</sup>
Chest	1.22 ± 1.2	0.375 ± 0.619	0.367 ± 0.835	0.333 ± 0.645	0.6 ± 0.548	0.571 ± 0.836	0.333 ± 0.617	0.0 ± 0.0	0.421 ± 0.607	.081 <sup>1</sup>
Upper abdomen	1.22 ± 0.972	0.563 ± 0.814	0.491 ± 0.854	0.576 ± 0.751	1 ± 0.0	1.17 ± 1.1	0.667 ± 0.724	0.5 ± 0.707	0.684 ± 0.885	.004 <sup>1</sup>
Lower abdomen	1.56 ± 1.01	1.5 ± 0.966	1.55 ± 1.2	1.36 ± 1.06	1.8 ± 0.447	2.31 ± 1.23	1.47 ± 0.915	1 ± 0.0	2.16 ± 1.21	.050 <sup>1</sup>
Upper arm	0.667 ± 1	0.0667 ± 0.258	0.3 ± 0.736	0.485 ± 0.972	0.8 ± 0.837	1.03 ± 1.21	0.467 ± 0.743	0.5 ± 0.707	0.158 ± 0.375	<.001 <sup>1</sup>
Thigh	2.44 ± 0.882	1.88 ± 0.885	1.6 ± 1.09	1.18 ± 1.07	1.4 ± 1.14	2.07 ± 1.05	1.73 ± 0.704	1 ± 1.41	1.68 ± 1.25	.014 <sup>1</sup>
Upper back	1.33 ± 1.12	0.5 ± 0.73	0.291 ± 0.611	0.515 ± 0.87	0.8 ± 0.447	0.966 ± 0.944	0.8 ± 0.775	0.0 ± 0.0	0.421 ± 0.838	<.001 <sup>1</sup>
Lower back	1.67 ± 1.22	0.688 ± 0.793	0.673 ± 0.94	0.97 ± 1.13	1 ± 0.707	1.69 ± 1.14	0.733 ± 0.799	0.0 ± 0.0	0.842 ± 1.17	<.001 <sup>1</sup>
Total (Mean ± SD (N))	12.3 ± 8.57	7.38 ± 5.28	7.42 ± 5.7	7.91 ± 6.39	9.6 ± 1.52	12.6 ± 7.52	9.4 ± 4.4	4 ± 4.24	9.1 ± 6.62	.009 <sup>1</sup>
<b>Regional mFG scores (mean +/-SD)</b>										
Facial*	2.22 ± 2.39	1.81 ± 1.64	2.15 ± 2	2.48 ± 2.15	2.2 ± 1.3	3.28 ± 2.07	3.2 ± 1.42	1 ± 1.41	3.05 ± 2.06	.031 <sup>1</sup>
Trunk**	7 ± 4.97	3.63 ± 2.96	3.37 ± 3.31	3.76 ± 3.51	5.2 ± 0.447	6.69 ± 4.12	4 ± 2.67	1.5 ± 0.707	4.3 ± 3.7	<.001 <sup>1</sup>
Extremity***	3.11 ± 1.76	1.94 ± 0.998	1.9 ± 1.4	1.67 ± 1.76	2.2 ± 1.64	3.03 ± 1.92	2.2 ± 1.15	1.5 ± 2.12	1.75 ± 1.41	.017 <sup>1</sup>
<b>Clinical hirsutism</b>										
No (mFG total <8)	3 (33.3%)	10 (62.5%)	66 (60.0%)	19 (57.6%)	0 (0.0%)	8 (26.7%)	4 (26.7%)	2 (100.0%)	9 (45.0%)	.002 <sup>1</sup>
Yes (mFG total ≥8)	6 (66.7%)	6 (37.5%)	44 (40.0%)	14 (42.4%)	5 (100.0%)	22 (73.3%)	11 (73.3%)	0 (0.0%)	11 (55.0%)	

BMI, body mass index; mFG, modified Ferriman-Gallwey; PCOS, polycystic ovarian syndrome.

Notes: The South Asian subgroup includes individuals who reported ancestry of Afghanistan, Bangladesh, Nepal, India, Pakistan, and Sri Lanka. The East Asian subgroup includes individuals who reported ancestry of China, Japan, North Korea, South Korea, and Taiwan. The Southeast Asian subgroup includes individuals who reported ancestry of Indonesia, Singapore, Philippines, Thailand, Vietnam, Cambodia, and Laos. The Middle Eastern subgroup includes individuals who reported ancestry of Turkey, Cyprus, Syria, Lebanon, Iraq, Iran, Israel, Jordan, Egypt, Sudan, Libya, and other.

<sup>1</sup> On the basis of the Kruskal-Wallis test.

<sup>2</sup> On the basis of the  $\chi^2$  test.

\* Facial mFG score: Summation of upper lip and chin mFG scores.

\*\* Truncal mFG score: Summation of chest, upper and lower back, and upper and lower abdomen mFG scores.

\*\*\* Extremity mFG score: Summation of thigh and upper arm mFG scores.

**Table 4**  
Relationship between Fitzpatrick skin type and hirsutism in women with PCOS

	Fitzpatrick skin type						p-Value
	Group 1 (N = 61)		Group 2 (N = 128)		Group 3 (N = 33)		
	Skin Type I (n = 14)	Skin Type II (n = 47)	Skin Type III (n = 61)	Skin Type IV (n = 67)	Skin Type V (n = 23)	Skin Type VI (n = 10)	
Age (Mean ± SD)	28.3 ± 5.7		28.1 ± 6.14		26.7 ± 6.69		.370 <sup>1</sup>
BMI (Mean ± SD (N))	31.5 ± 8.99 (n = 61)		29.4 ± 8.03 (n = 126)		31.2 ± 6.89 (n = 33)		.180 <sup>1</sup>
<b>mFG score (mean +/-SD)</b>							
Upper lip	1.11 ± 1.07		1.02 ± 0.992		1.33 ± 0.957		.170 <sup>1</sup>
Chin	1.49 ± 1.39		1.3 ± 1.29		1.61 ± 1.22		.320 <sup>1</sup>
Chest	0.361 ± 0.876		0.406 ± 0.736		0.636 ± 0.822		.056 <sup>1</sup>
Upper abdomen	0.541 ± 0.923		0.641 ± 0.858		0.97 ± 0.883		.015 <sup>1</sup>
Lower abdomen	1.56 ± 1.15		1.69 ± 1.18		1.73 ± 1.1		.620 <sup>1</sup>
Upper arm	0.41 ± 0.883		0.32 ± 0.742		0.848 ± 1.09		.004 <sup>1</sup>
Thigh	1.61 ± 1.1		1.66 ± 1.09		1.73 ± 1.01		.780 <sup>1</sup>
Upper back	0.393 ± 0.737		0.484 ± 0.784		0.97 ± 0.918		.001 <sup>1</sup>
Lower back	0.721 ± 0.951		0.938 ± 1.11		1.36 ± 1.06		.008 <sup>1</sup>
Total (Mean ± SD (N))	8.2 ± 6.45		8.46 ± 6.34		11.2 ± 6.13		.021 <sup>1</sup>
<b>Regional mFG scores (mean +/-SD)</b>							
Facial*	2.61 ± 2.26		2.32 ± 1.96		2.94 ± 1.92		.220 <sup>1</sup>
Trunk**	3.57 ± 3.58		4.16 ± 3.62		5.67 ± 3.71		.008 <sup>1</sup>
Extremity***	2.02 ± 1.59		1.98 ± 1.54		2.58 ± 1.66		.120 <sup>1</sup>
<b>Clinical hirsutism</b>							
No (mFG total <8)	36 (59.0%)		65 (50.8%)		9 (27.3%)		.012 <sup>2</sup>
Yes (mFG total ≥8)	25 (41.0%)		63 (49.2%)		24 (72.7%)		

BMI, body mass index; mFG, modified Ferriman-Gallwey; PCOS, polycystic ovarian syndrome.

<sup>1</sup> On the basis of the Kruskal-Wallis test.

<sup>2</sup> On the basis of the  $\chi^2$  test.

\* Facial mFG score: Summation of upper lip and chin mFG scores.

\*\* Truncal mFG score: Summation of chest, upper and lower back, and upper and lower abdomen mFG scores.

\*\*\* Extremity mFG score: Summation of thigh and upper arm mFG scores.

subgroups within a cohort of American patients with PCOS (same cohort used in this study) found no difference in prevalence and severity of hirsutism between the two groups (Wang et al., 2013).

An important consideration for the disparate findings among studies lies in the differences in methodology. Studies have utilized subgroups on the basis of race, ethnicity, or a combination of the two, which makes comparisons between studies challenging. Broad racial grouping, for example of Caucasian and Asian subjects, may have masked important differences between ethnic subgroups that were revealed in the present study, which utilized more granular categories on the basis of ethnicity such as Middle Eastern, Hispanic, South Asian, and East/Southeast Asian. Discrepancies in the criteria used to diagnose PCOS may also contribute to discordant findings. The use of the Rotterdam diagnostic criteria may identify a more phenotypically heterogeneous PCOS cohort because the criteria have been shown to classify more women with PCOS than the previous consensus criteria by the National Institutes of Health (NIH; Broekmans et al., 2006). A study using the more stringent NIH criteria may systematically exclude women from specific ethnicities that typically present with lower rates of hirsutism.

In this study, patients with PCOS demonstrated high truncal and extremity mFG scores; however, our data also suggested distinct patterns in the presentation of hirsutism between different ethnic subgroups. Higher facial mFG scores were observed in African American patients and particularly in the chin area in contrast with higher truncal and extremity mFG scores in the Middle Eastern subgroup. Prior studies have also suggested increased truncal and extremity mFG scores in Middle Eastern women with and without PCOS (Döner and Ekmekci, 2013; Glinborg et al., 2010; Hassa et al., 2005). Distinct patterns in hirsutism were not seen in other groups such as Hispanic patients who demonstrated higher mFG scores in all areas. The prevalence and severity of hirsutism when compared between Caucasian and East Asian patients with PCOS in a previous study in this cohort did not differ; however, a decrease in upper truncal hirsutism in East Asian women was observed (Wang et al.,

2013). Interestingly, East Asian women in this study demonstrated a trend for higher upper lip mFG scores, which is consistent with prior studies of East Asian women (Cheewadhanaraks et al., 2004; Wong et al., 2014). Whether weighting of site-specific mFG scores on the basis of ethnicity is warranted requires validation.

In this study, there was a positive correlation between hirsutism and higher FST. Patients with FSTs V and VI had greater total mFG scores and a higher prevalence of clinical hirsutism than those with other skin types. Increased prevalence of truncal hirsutism was also noted in higher FSTs. Few studies have investigated the relationship between skin type and hirsutism, none in patients with PCOS, and among the few studies the methodologies differ. A cross-sectional Turkish study of 1034 premenopausal women (excluding women with a complaint of hirsutism) found that women with higher FSTs (FSTs IV and V) had higher total mFG scores compared with the groups of patients with lower FSTs (Döner and Ekmekci, 2013). Additionally, a multi-center cross-sectional study of 2895 women who were recruited from Los Angeles, Rome, London, and Akita (Japan) reported that upper lip mFG score was influenced by ethnicity but not skin color as assessed by a chromometer (Javorsky et al., 2014). In the present study, upper lip mFG scores were also not associated with higher FST.

The current study provides important evidence for the correlation of ethnicity and FST on the presentation of hirsutism in patients with PCOS and offers additional support for a reconsideration of the current clinical criteria to diagnose hirsutism on the basis of these factors (Escobar-Morreale et al., 2012; Fauser et al., 2012). Although the original study by Ferriman and Gallwey (1961) defined hirsutism as a total score of 8 or higher, the proposal to adjust mFG criteria on the basis of ethnicity has already been implemented through the utilization of distinct mFG criteria by different research groups (Cheewadhanaraks et al., 2004; Guo et al., 2012; Ichikawa et al., 1988; Kim et al., 2014; Li et al., 2013; Welt et al., 2006; Zhang et al., 2013; Zhao et al., 2011; Zhao et al., 2010). Studies within the general population (not necessarily patients with PCOS) have provided

validation for this practice and suggest distinct ethnic-specific mFG diagnostic criteria for clinical hirsutism on the basis of the 95th percentile of the ethnic population (Asuncion et al., 2000; Cheewadhanaraks et al., 2004; DeUgarte et al., 2006; Kim et al., 2011; Moran et al., 2010; Tellez and Frenkel, 1995; Zhao et al., 2007). On the basis of these studies, lower diagnostic cutoff points for East Asian women (mFG >2 to >5) and higher cutoff points for Middle Eastern (mFG >8 to >10), Mediterranean (mFG >7 to >10), and Mexican (>11) women have been recommended (Api et al., 2009; Asuncion et al., 2000; Cheewadhanaraks et al., 2004; Kim et al., 2011; Moran et al., 2010; Noorbala and Kefae, 2010; Sagsoz et al., 2004; Zhao et al., 2007). Given the complex interplay of ethnicity and FST on the presentation of hirsutism, additional studies are needed to validate mFG criteria for each ethnic subgroup and especially to assess individuals of mixed ethnic backgrounds.

## Limitations

One of the limitations of this study is the small sample size. Additionally, self-reported ethnicity and FST data are subject to reporting bias and misinterpretation of the classifications. The relationship between ethnicity and skin type is complex and a subanalysis of FST and ethnicity in this study found a significant positive correlation between ethnicity and skin type ( $p < .001$ , data not shown) although a wide range of skin types can be found in patients of certain ethnicities.

Hirsutism is more prevalent in obese individuals with PCOS; however, this relationship may differ between ethnic groups and further limits the interpretation of the study findings (Glintborg et al., 2010; Mani et al., 2015; Schmidt et al., 2016; Yuan et al., 2016). Middle Eastern and Hispanic patients had the highest BMI, followed by African American patients. These groups also had some of the highest mFG scores and prevalence of clinical hirsutism. Whether these ethnicities have genetic or environmental risk factors predisposing to both weight gain and hirsutism or whether there is a direct effect of obesity on the manifestation of hirsutism is not known.

## Conclusions

Ethnicity and FST have an important impact on the presentation of hirsutism in patients with PCOS. Because of the distinct patterns of hirsutism presentation in patients with PCOS, understanding a patient's ethnic background and skin type in addition to a comprehensive skin exam is recommended for accurate patient assessment. Larger cohort studies are required to validate whether clinical qualitative (distribution) and quantitative criteria (mFG) for hirsutism should be adjusted for ethnicity and FST in the PCOS population.

## Acknowledgements

The authors would like to acknowledge I. Elaine Allen, PhD and Chengshi Jin, PhD of the UCSF CTSI for their statistical assistance under CTSI grant #UL1 TR000004. Kanade Shinkai, MD, PhD was supported by a Dermatology Foundation Medical Dermatology Career Development Award (2010–2013).

## References

Api M, Badoglu B, Akca A, Api O, Gorgen H, Cetin A. Interobserver variability of modified Ferriman-Gallwey hirsutism score in a Turkish population. *Arch Gynecol Obstet* 2009;279:473–9.

Asuncion M, Calvo RM, San Millan JL, Sancho J, Avilla S, Escobar-Morreale HF. A prospective study of the prevalence of the polycystic ovary syndrome in unselected Caucasian women from Spain. *J Clin Endocrinol Metab* 2000;85:2434–8.

Azziz R, Sanchez LA, Knochenhauer ES, Moran C, Lazenby J, Stephens KC, et al. Androgen excess in women: Experience with over 1000 consecutive patients. *J Clin Endocrinol Metab* 2004;89:453–62.

Broekmans FJ, Knauff EA, Valkenburg O, Laven JS, Eijkemans MJ, Fauser BC. PCOS according to the Rotterdam consensus criteria: Change in prevalence among WHO-II anovulation and association with metabolic factors. *BJOG* 2006;113:1210–7.

Carmina E, Koyama T, Chang L, Stanczyk FZ, Lobo RA. Does ethnicity influence the prevalence of adrenal hyperandrogenism and insulin resistance in polycystic ovary syndrome? *Am J Obstet Gynecol* 1992;167:1807–12.

Carmina E, Rosato F, Janni A, Rizzo M, Longo RA. Extensive clinical experience: Relative prevalence of different androgen excess disorders in 950 women referred because of clinical hyperandrogenism. *J Clin Endocrinol Metab* 2006;91:2–6.

Cheewadhanaraks S, Peeyananjarassri K, Choksuchat C. Clinical diagnosis of hirsutism in Thai women. *J Med Assoc Thai* 2004;87:459–63.

DeUgarte CM, Woods KS, Bartolucci AA, Azziz R. Degree of facial and body terminal hair growth in unselected black and white women: Toward a populational definition of hirsutism. *J Clin Endocrinol Metab* 2006;91:1345–50.

Döner N, Ekmekçi TR. Criticising modified ferriman-gallwey scoring system in the evaluation of hirsutism in 1034 Turkish women. *Turkiye Klinikleri J Med Sci* 2013;33:314–20.

Ehrmann DA. Polycystic ovary syndrome. *N Engl J Med* 2005;352:1223–30.

Escobar-Morreale HF, Carmina E, Dewailly D, Gambineri A, Kelestimur F, Moghetti P, et al. Epidemiology, diagnosis and management of hirsutism: A consensus statement by the Androgen Excess and Polycystic Ovary Syndrome Society. *Hum Reprod Update* 2012;18:146–70.

Fauser BC, Tarlatzis BC, Rebar RW, Legro RS, Balen AH, Lobo R, et al. Consensus on women's health aspects of polycystic ovary syndrome (PCOS): The Amsterdam ESHRE/ASRM-Sponsored 3rd PCOS Consensus Workshop Group. *Fertil Steril* 2012;97:28–38.

Ferriman D, Gallwey JD. Clinical assessment of body hair growth in women. *J Clin Endocrinol Metab* 1961;21:1440–7.

Fitzpatrick TB. The validity and practicality of sun-reactive skin types I through VI. *Arch Dermatol* 1988;124:869–71.

Glintborg D, Mumm H, Hougaard D, Ravn P, Andersen M. Ethnic differences in Rotterdam criteria and metabolic risk factors in a multiethnic group of women with PCOS studied in Denmark. *Clin Endocrinol (Oxf)* 2010;73:732–8.

Guo M, Chen ZJ, Eijkemans MJ, Goverde AJ, Fauser BC, Macklon NS. Comparison of the phenotype of Chinese versus Dutch Caucasian women presenting with polycystic ovary syndrome and oligo/amenorrhoea. *Hum Reprod* 2012;27:1481–8.

Hassa H, Tanir HM, Yildirim A, Senses T, Eskalen M, Mutlu FS. The hirsutism scoring system should be population specific. *Fertil Steril* 2005;84:778–80.

Ichikawa Y, Asai M, Masahashi T, Wu MC, Ohsawa M, Narita O, et al. Clinical assessment of body hair growth in Japanese women. The relationship between a grade of hirsutism and the menstrual status. *Nihon Sanka Fujinka Gakkai Zasshi* 1988;40:1719–24.

Javorsky E, Perkins AC, Hillebrand G, Miyamoto K, Boer Kimball A. Race, rather than skin pigmentation, predicts facial hair growth in women. *J Clin Aesthet Dermatol* 2014;7:24–6.

Kim JJ, Chae SJ, Choi YM, Hwang SS, Hwang KR, Kim SM, et al. Assessment of hirsutism among Korean women: Results of a randomly selected sample of women seeking pre-employment physical check-up. *Hum Reprod* 2011;26:214–20.

Kim JJ, Hwang KR, Choi YM, Moon SY, Chae SJ, Park CW, et al. Complete phenotypic and metabolic profiles of a large consecutive cohort of untreated Korean women with polycystic ovary syndrome. *Fertil Steril* 2014;101:1424–30.

Knochenhauer ES, Key TJ, Kahsar-Miller M, Waggoner W, Boots LR, Azziz R. Prevalence of the polycystic ovary syndrome in unselected black and white women of the southeastern United States: A prospective study. *J Clin Endocrinol Metab* 1998;83:3078–82.

Kosus N, Kosus A, Kamalak Z, Hizli D, Turhan NO. Impact of adrenal versus ovarian androgen ratio on signs and symptoms of polycystic ovarian syndrome. *Gynecol Endocrinol* 2012;28:611–4.

Ladson G, Dodson WC, Sweet SD, Archibong AE, Kunselman AR, Demers LM, et al. Racial influence on the polycystic ovary syndrome phenotype: A black and white case-control study. *Fertil Steril* 2011;96:224–9.

Legro RS, Myers ER, Barnhart HX, Carson SA, Diamond MP, Carr BR, et al. The Pregnancy in Polycystic Ovary Syndrome study: Baseline characteristics of the randomized cohort including racial effects. *Fertil Steril* 2006;86:914–33.

Li R, Zhang Q, Yang D, Li S, Lu S, Wu X, et al. Prevalence of polycystic ovary syndrome in women in China: A large community-based study. *Hum Reprod* 2013;28:2562–9.

Mani H, Davies MJ, Bodicoat DH, Levy MJ, Gary IJ, Howlett TA, et al. Clinical characteristics of polycystic ovary syndrome: Investigating differences in White and South Asian women. *Clin Endocrinol (Oxf)* 2015;83:542–9.

Moran C, Tena G, Moran S, Ruiz P, Reyna R, Duque X. Prevalence of polycystic ovary syndrome and related disorders in Mexican women. *Gynecol Obstet Invest* 2010;69:274–80.

Noorbala M, Kefae P. The prevalence of hirsutism in adolescent girls in Yazd, Central Iran. *Iran Red Crescent Med J* 2010;12:111–7.

Norman RJ, Dewailly D, Legro RS, Hickey TE. Polycystic ovary syndrome. *Lancet* 2007;370:685–97.

Roberts WE. Skin type classification systems old and new. *Dermatol Clin* 2009;27:529–33.

Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. *Fertil Steril* 2004;81:19–25.

Sachdeva S, Fitzpatrick skin typing: Applications in dermatology. *Indian J Dermatol Venereol Leprol* 2009;75:93–6.

Sagsoz N, Kamaci M, Orbak Z. Body hair scores and total hair diameters in healthy women in the Kirikkale Region of Turkey. *Yonsei Med J* 2004;45:483–91.

Schmidt TH, Shinkai K. Evidence-based approach to cutaneous hyperandrogenism in women. *J Am Acad Dermatol* 2015;73:672–90.

- Schmidt TH, Khanijow K, Cedars MI, Huddlestone H, Pasch L, Wang ET, et al. Cutaneous findings and systemic associations in women with polycystic ovary syndrome. *JAMA Dermatol* 2016;152:391–8.
- Sivayoganathan D, Maruthini D, Glanville JM, Balen AH. Full investigation of patients with polycystic ovary syndrome (PCOS) presenting to four different clinical specialties reveals significant differences and undiagnosed morbidity. *Hum Fertil (Camb)* 2011;14:261–5.
- Tellez R, Frenkel J. Clinical evaluation of body hair in healthy women. *Rev Med Chil* 1995;123:1349–54.
- Wang ET, Kao CN, Shinkai K, Pasch L, Cedars MI, Huddlestone HG. Phenotypic comparison of Caucasian and Asian women with polycystic ovary syndrome: A cross-sectional study. *Fertil Steril* 2013;100:214–8.
- Welt CK, Arason G, Gudmundsson JA, Adams J, Palsdottir H, Gudlaugsdottir G, et al. Defining constant versus variable phenotypic features of women with polycystic ovary syndrome using different ethnic groups and populations. *J Clin Endocrinol Metab* 2006;91:4361–8.
- Wijayaratne CN, Balen AH, Barth JH, Belchetz PE. Clinical manifestations and insulin resistance (IR) in polycystic ovary syndrome (PCOS) among South Asians and Caucasians: Is there a difference? *Clin Endocrinol (Oxf)* 2002a;57:343–50.
- Wijayaratne CN, Balen AH, Belchetz PE. Polycystic ovary syndrome and its relevance to women from south Asia. *Ceylon Med J* 2002b;47:22–6.
- Wong M, Zhao X, Hong Y, Yang D. Semiquantitative assessment of hirsutism in 850 PCOS patients and 2,988 controls in China. *Endokrynol Pol* 2014;65:365–70.
- Yuan C, Liu X, Mao Y, Diao F, Cui Y, Liu J. Polycystic ovary syndrome patients with high BMI tend to have functional disorders of androgen excess: A prospective study. *J Biomed Res* 2016;30:197–202.
- Zhang HY, Guo CX, Zhu FF, Qu PP, Lin WJ, Xiong J. Clinical characteristics, metabolic features, and phenotype of Chinese women with polycystic ovary syndrome: A large-scale case-control study. *Arch Gynecol Obstet* 2013;287:525–31.
- Zhao Y, Qiao J. Ethnic differences in the phenotypic expression of polycystic ovary syndrome. *Steroids* 2013;78:755–60.
- Zhao JL, Chen ZJ, Shi YH, Geng L, Ma ZX, Li Y, et al. Investigation of body hair assessment of Chinese women in Shandong region and its preliminary application in polycystic ovary syndrome patients. *Zhonghua Fu Chan Ke Za Zhi* 2007;42:590–4.
- Zhao X, Zhong J, Mo Y, Chen X, Chen Y, Yang D. Association of biochemical hyperandrogenism with type 2 diabetes and obesity in Chinese women with polycystic ovary syndrome. *Int J Gynaecol Obstet* 2010;108:148–51.
- Zhao X, Ni R, Li L, Mo Y, Huang J, Huang M, et al. Defining hirsutism in Chinese women: A cross-sectional study. *Fertil Steril* 2011;96:792–6.