INTRODUCTION

Hirsutism is defined as excessive growth of terminal hair in androgen-dependent areas of the body in women.[1] It is a common endocrine disorder responsible for a lot of anxiety and stress among young women and can be a threat to feminine identity. The severity of hirsutism and its acceptance depend on racial, cultural, and social factors. Hirsutism is broadly divided into androgen-and non-androgen induced. Polycystic ovarian syndrome (PCOS) is the most common cause of hyperandrogenic hirsutism, and idiopathic hirsutism is the most common cause of non-androgen-induced hirsutism. Both idiopathic hirsutism and PCOS account for 95% of hirsutism.[1] The spectrum of hirsutism varies from mild to severe. To quantify hirsutism, Ferriman and Gallwey introduced a scoring system in...
Aswini and Jayapalan: mFG in hirsutism and metabolic syndrome

1961 incorporating eleven androgen dependent sites.[1] This was later modified incorporating only nine sites and this modified Ferryman–Gallwey (mFG) scoring system is considered the standard scoring system that defines hirsutism quantitatively.[1‑3] The prevalence of hirsutism depends on the method used to determine its presence, the population under study and the score that is used as the cutoff. Although conventionally, mFG score ≥8 is considered hirsutism, studies conducted in different races have shown that this cutoff value may not be applicable in many cases.[8‑10] In clinical practice, it has often been suggested that real hirsutism is simply that, which the woman in question thinks is excessive.[1] We were interested in knowing the mFG score of our patients who consider themselves as hirsute. Metabolic syndrome is a constellation of interrelated risk factors of metabolic origin that promote the development of the atherosclerotic cardiovascular disease.[11‑13] This is characterized by hyper‑insulinemia, low glucose tolerance, dyslipidemia, hypertension, and obesity. Although the pathophysiology of metabolic syndrome is a subject of continuing controversy a causal relationship with insulin resistance has been suggested.[12] The association of PCOS, the most common cause of hirsutism and metabolic syndrome has been reported.[14,15] Hirsutism is often observed in patients with metabolic syndrome alone. Whether the metabolic syndrome diagnosed in hirsutism is due to the underlying PCOS or whether metabolic syndrome can occur as an independent association has not been reported from our part of the country. Hence, in addition to the mFG score, we also studied the association of metabolic syndrome and hirsutism.

METHODS

One hundred female patients with male pattern distribution of terminal hair who attended the Department of Dermatology and Venereology, of a tertiary care center in South India were subjected to the study after getting informed written consent. Nonconsenting patients and those patients without male pattern hair growth in the androgen sensitive areas were excluded from the study. Hospital-based, cross-sectional, descriptive type of the study design was used. The sample size was calculated using the formula “pq (Zα)²/ d²”, where p represents the proportion of women with hirsutism and q the proportion without hirsutism. With p as 10.5%,[16] Zα of 1.96 with the significance level of P < 0.05 and precision as 6, the sample size was calculated to be 100 (10.5 × 89.5 × [1.96]² × 6 × 6). Structured questionnaire was used to collect the data under the broad domains of sociodemographic characteristics (age, marital status, menstrual irregularities, family history, infertility, body weight, height, body mass index (BMI), waist circumference, and blood pressure), disease characteristics (mFG score, PCOS, metabolic syndrome, acne, acanthosis nigricans, cushingoid features, and virilization) and investigations (high-density lipoprotein [HDL] level, triglyceride [TG] level, fasting blood sugar (FBS), thyroid function tests, and abdominal ultrasound). Grading of hirsutism was done based on mFG scoring system.[13‑15] The conventional definition of hirsutism based on mFG score ≥8 was used for studying the association with metabolic syndrome and other diseases. The presence of metabolic syndrome was assessed using the American Heart Association/National Heart, Lung, and Blood Institute criteria.[11] PCOS was diagnosed using the Gynaecology department. Data were entered into MS Exel. Mean was used for describing continuous variables and proportion for categorical variables. For univariate analysis, patients were categorized into two groups—those with hirsutism (mFG ≥8) and those without hirsutism (mFG < 8). The association of variables such as acne, acanthosis nigricans, menstrual irregularities, infertility, family history of hirsutism, BMI, waist circumference, blood pressure, FBS, HDL, TG levels, and metabolic syndrome with hirsutism were studied. Student’s t‑test was used for testing the difference in mean in two groups, and Chi‑square statistic was used for testing the difference in proportion in two groups. Logistic regression analysis was performed with those variables that were statistically significant in univariate analysis. The study was approved and conducted according to the institutional review board guidelines.

RESULTS

The age ranged from 17 to 77 years (mean 35.2 ± 13 years), with majority (29%) belonging to the age group of 31–40 years. Eighty percent of the patients were married. Majority (96%) had hirsutism for more than a year. The family history of hirsutism was present in 27%. Forty‑three percent had menstrual irregularities. Nearly 26.3% of married women gave a history of infertility.

The mFG score ranged from 2 to 10 with a mean score of 5.5 ± 2.1. The most common score was 6 (20%) followed by 4 (17%), 8 (16%), 5 (12%), 3 (10%), 2 (9%), and 3 (9%), and 10 (1%). Majority (77%) had score < 8. Only 23% had score ≥8. All the 23 had mild hirsutism. The face was the most common site of involvement followed by the chest.

Table 1 shows the number- and percentage-wise distribution of each variable within the groups—mFG
Table 1: Univariate analysis

| Variables                        | mFG score | Total, n (%) | P      | OR with 95% CI |
|----------------------------------|-----------|--------------|--------|---------------|
|                                  | ≥8, n (%) | <8, n (%)    |        |               |
| Family history                   |           |              |        |               |
| Present                          | 5 (21.7)  | 22 (28.6)    | 27     | 0.601         | 0.694 (0.19-2.32) |
| Absent                           | 18 (78.3) | 55 (71.4)    | 73     |               | 5.56 (1.4-25.7)   |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| Waist circumference (cm)         |           |              |        |               |
| ≥88                              | 20 (87)   | 42 (54.5)    | 62     | 0.006*        | 5.56 (1.4-25.7)   |
| <88                              | 3 (13)    | 35 (45.5)    | 38     |               | 1.7 (0.57-5.05)   |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| Acne                             |           |              |        |               |
| Present                          | 9 (39.1)  | 21 (27.3)    | 30     | 0.276         | 1.7 (0.57-5.05)   |
| Absent                           | 14 (60.9) | 56 (72.7)    | 70     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| Acanthosis nigricans             |           |              |        |               |
| Present                          | 14 (60.9) | 26 (33.8)    | 40     | 0.02*         | 3.05 (1.06-8.9)   |
| Absent                           | 9 (39.1)  | 51 (66.2)    | 60     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| Menstrual cycle                  |           |              |        |               |
| Regular                          | 6 (31.6)  | 33 (52.4)    | 39     | 0.112         | 0.42 (0.12-1.38)  |
| Irregular                        | 13 (68.4) | 30 (47.6)    | 43     |               | 100               |
| Total                            | 19 (100)  | 63 (100)     | 82     |               | 100               |
| Infertility                      |           |              |        |               |
| Present                          | 3 (14.3)  | 18 (30.5)    | 21     | 0.147         | 0.38 (0.07-1.6)   |
| Absent                           | 18 (85.7) | 41 (69.5)    | 59     |               | 100               |
| Total                            | 21 (100)  | 59 (100)     | 80     |               | 100               |
| BMI                              |           |              |        |               |
| Obese                            | 19 (82.6) | 37 (48.1)    | 56     | 0.004*        | 5.1 (1.6-16.4)    |
| Nonobese                         | 4 (17.4)  | 40 (51.9)    | 44     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| SBP ≥140 or DBP ≥85              |           |              |        |               |
| Present                          | 10 (43.5) | 33 (42.9)    | 43     | 0.958         | 1.02 (0.36-2.89)  |
| Absent                           | 13 (56.5) | 44 (57.1)    | 57     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| FBS ≥100                         |           |              |        |               |
| Present                          | 10 (43.5) | 24 (31.2)    | 34     | 0.274         | 1.69 (0.58-4.89)  |
| Absent                           | 13 (56.5) | 53 (68.8)    | 66     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| HDL <50                          |           |              |        |               |
| Present                          | 16 (69.6) | 39 (50.6)    | 55     | 0.110         | 2.23 (0.75-6.79)  |
| Absent                           | 7 (30.4)  | 38 (49.4)    | 45     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| TG ≥150                          |           |              |        |               |
| Present                          | 13 (56.5) | 20 (26)      | 33     | 0.006*        | 3.70 (1.27-10.95) |
| Absent                           | 10 (43.5) | 57 (74)      | 67     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |
| Metabolic syndrome               |           |              |        |               |
| Present                          | 15 (65.2) | 29 (37.7)    | 44     | 0.019*        | 3.10 (1.06-9.23)  |
| Absent                           | 8 (34.8)  | 48 (62.3)    | 56     |               | 100               |
| Total                            | 23 (100)  | 77 (100)     | 100    |               | 100               |

Contd...
Table 1: Contd...

| Variables | mFG score | Total, n (%) | P | OR with 95% CI |
|-----------|-----------|--------------|---|---------------|
|           | ≥8, n (%) | <8, n (%)    |    |               |
| PCOS      |           |              |    |               |
| Present   | 12 (52.2) | 15 (59.4)    | 27 | 0.002*        |
| Absent    | 11 (47.8) | 62 (80.6)    | 73 |               |
| Total     | 23 (100)  | 77 (100)     | 100|               |

*Significant P value. OR – Odds ratio; CI – Confidence interval; TG – Triglycerides; FBS – fasting blood sugar; SBP – Systolic blood pressure; DBP – Diastolic blood pressure; PCOS – Polycystic ovarian disease; HDL – High-density lipoprotein; BMI – Body mass index; mFG – Modified Ferriman–Gallwey

score ≥8 and <8 and the P value of the difference in proportion. Metabolic syndrome was present in 44%. 65.2% (15/23) patients with score ≥8 had metabolic syndrome whereas only 37.7% (29/77) of patients with score <8 had hirsutism (P = 0.019). The components of metabolic syndrome like waist circumference ≥88 cm was observed in 62%, HDL cholesterol <50 mg/dl in 55%, hypertension in 43%, diabetes in 34%, and elevated TG ≥150 in 33%. Among the patients with mFG score ≥8, 87% (20/23) had waist circumference ≥88 cm and in patients with score <8, there were only 54.5% (42/77) patients with waist circumference ≥88 cm (P = 0.006). TGs ≥150 was seen in 56.5% (13/23) with mFG ≥ 8 and 26% (20/77) with mFG score <8 (P = 0.006). The proportion of other components in the mFG score ≥8 and <8, respectively, were: HDL cholesterol <50 mg/dl (69.6%, 50.6%; P = 0.11), hypertension (43.5%, 42.9%; P = 0.96), and diabetes (43.5%, 31.2%; P = 0.27).

Fifty-six percent were preobese/obese. 82.6% (19/23) in mFG ≥8 group and 48.1% (37/77) in mFG <8 group were preobese/obese (P = 0.004). PCOS was present in 27%. 52.2% (12/23) in mFG ≥8 group and 19.4% (15/77) in mFG <8 group had PCOS (P = 0.002). Acanthosis nigricans was present in 40%. 60.9% (14/23) in mFG ≥8 group and 33.8% (26/77) in mFG <8 group (P = 0.02). Acne was seen in 30% and thyroid disorders in 19%. Table 1 shows the percentages of these disorders in the two groups.

In the univariate analysis [Table 1] when the variables such as acne, acanthosis nigricans, menstrual history, infertility, family history of hirsutism, BMI, waist circumference, blood pressure, FBS, HDL, TG, and metabolic syndrome were cross-tabulated with mFG score, family history of hirsutism, acne, irregular cycles, infertility, hypertension, diabetes, HDL cholesterol <50 mg/dl, thyroid disorders did not achieve statistical significance. The statistically significant variables were PCOS (P = 0.002), BMI (P = 0.004), waist circumference ≥88 cm (P = 0.006), hypertriglyceridemia ≥150 mg/dl (P = 0.006), metabolic syndrome (P = 0.019), and acanthosis nigricans (P = 0.02).

From the statistically and clinically significant variables in the univariate analysis, logistic regression analysis was performed. Two logistic regression models were studied. In the first model acanthosis nigricans, PCOS and metabolic syndrome were chosen [Table 2]. The significant variables in the first model were PCOS (P = 0.003) and metabolic syndrome (P = 0.018). In the second model, all the variables significant in univariate analysis were incorporated [Table 3] and the significant variables were PCOS (P = 0.004), TGs ≥150 mg/dl (P = 0.024) and BMI (P = 0.033).

**DISCUSSION**

Hirsutism although not a life-threatening disorder can negatively influence the psychological well-being. The acceptance of hirsutism depends on racial, cultural, and social factors. The modified Ferriman and Gallwey scoring system has become the standard scoring system, and the most important aspect is the selection of the cut-off value of the score to define hirsutism. Currently, many clinicians and researchers use mFG score of ≥8 as hirsutism. This score of ≥8 was put forward by Hatch et al., although Ferriman and Gallwey themselves have used different cutoffs in different studies. As ethnicity and race can affect the terminal hair growth, the ideal cutoff value should be the 95th percentile value of the score of unselected women of reproductive age. A specific statistical cutoff value may not reflect the subjective nature of hirsutism. We studied the mFG score of one hundred patients who considered themselves as having hirsutism, attending the Department of Dermatology and Venereology of a tertiary care center in South Kerala. The association of metabolic syndrome and other diseases were studied after categorizing patients into two groups; mFG score ≥8 and <8.

The mean age (35.12) and the most common age range (31–40) was higher in our patients compared to other reports. The duration of hirsutism (>1 year) was both in agreement and disagreement with other studies. The family history of hirsutism was present in 23% of
The prevalence of acanthosis nigricans (60.9%), acne (39.1%), and PCOS (52.2%) in those with MFG score ≥8 was almost similar to other studies with minimal variations. None of our patients had ovarian tumors.

To study the association of hirsutism with metabolic syndrome and other clinical parameters, the conventional definition of MFG score ≥8 was used to define hirsutism. The study population were, thus, categorized into two, those with hirsutism (MFG score ≥8) and without hirsutism (MFG score <8). Mean age of those with MFG score <8 was 35.5 and those with MFG score ≥8 was 34.3. There was no statistically significant difference (P = 0.68) in the mean age of two groups ensuring comparability of the two groups. After univariate analysis, PCOS, BMI, waist circumference ≥88 cm, serum TGs level ≥150 mg/dl, metabolic syndrome, and acanthosis nigricans were found to have a significant association with MFG ≥8 with P = 0.002, 0.004, 0.006, 0.019, and 0.02, respectively. The findings of univariate analysis were comparable to previous reports. In those patients with metabolic syndrome the chance that the patient will have MFG score ≥8 was 3.1 times when compared to those without metabolic syndrome. Among the components of metabolic syndrome, the significant components were waist circumference ≥88 cm and serum TGs more than 150 mg/dl. The patients with waist circumference ≥88 cm had 5.6 times chance for developing MFG score ≥8 when compared to those with waist circumference <88 cm.

The mFG score ranged from 2 to 10 and was <8 in 77% and was consistent with the study by Noorbala and Kefaie and Sharma et al.,[16,19,21] however, it ranged from 10 to 34 in the study by Chhabra et al. and Ahmad et al.[18,20] The mean score was 12.4 and 13.5 in Delhi and Kashmir, respectively.[16,19] The low score in our study may be due to our inclusion criteria definition of hirsutism as terminal hair in at least one androgen dependent site rather than the definition of mFG score ≥8 used by others.

The majority of patients belonged to the preobese/obese category similar to that observed by Apridonidze et al.[22] Metabolic syndrome was present in 44% of our patients. Studies also report the prevalence of metabolic syndrome in 43% and 46% in patients with PCOS. Sixty-five percentage of patients with MFG score ≥8 had metabolic syndrome. As in other studies the most common metabolic syndrome component and the second most common component was waist circumference ≥88 cm and HDL cholesterol <50 mg/dl, respectively, although these studies were in PCOS. The lowest prevalent component in our study was serum TG ≥150 mg/dl whereas in other studies, it was FBS.[13,22]

Table 2: Logistic regression analysis: Model 1

| Variables | B    | SE   | Wald | P     | Exp(B) | 95% CI          |
|-----------|------|------|------|-------|--------|-----------------|
| Step 1    |      |      |      |       |        |                 |
| PCOS      | 1.506| 0.507| 8.825| 0.003 | 4.509  | 1.669-12.18     |
| Constant  | -1.283| 0.844| 2.328| 0.127 | 0.277  |                 |
| Step 2    |      |      |      |       |        |                 |
| Metabolic syndrome | 1.260| 0.533| 5.594| 0.018 | 3.524  | 1.242-10.018    |
| PCOS      | 1.674| 0.536| 9.110| 0.003 | 5.039  | 1.763-14.404    |
| Constant  | -3.396| 1.268| 6.928| 0.008 | 0.036  |                 |

Table 3: Logistic regression analysis: Model 2

| Variables | B    | SE   | Wald | P     | Exp(B) | 95% CI          |
|-----------|------|------|------|-------|--------|-----------------|
| Step 1    |      |      |      |       |        |                 |
| PCOS      | 1.506| 0.507| 8.825| 0.003 | 4.509  | 1.669-12.18     |
| Constant  | -1.283| 0.844| 2.328| 0.127 | 0.277  |                 |
| Step 2    |      |      |      |       |        |                 |
| PCOS      | 1.674| 0.536| 9.110| 0.003 | 5.039  | 1.763-14.404    |
| TG        | 1.477| 0.539| 7.509| 0.006 | 4.379  | 1.523-12.590    |
| Constant  | -3.893| 1.358| 8.232| 0.004 | 0.02   |                 |
| Step 3    |      |      |      |       |        |                 |
| PCOS      | 1.638| 0.567| 8.354| 0.004 | 5.146  | 1.694-15.639    |
| BMI       | 1.371| 0.643| 4.550| 0.033 | 3.938  | 1.188-13.877    |
| TG        | 1.263| 0.558| 5.136| 0.024 | 3.536  | 1.842-10.566    |
| Constant  | -5.305| 1.610| 10.856| 0.001 | 0.005  |                 |

SE = Standard error; Exp(B) = Odds ratio; CI = Confidence interval; PCOS = Polycystic ovary syndrome; BMI = Body mass index; TG = Triglycerides

most of these variables were inter-related. PCOS is a known cause of hirsutism, and there are reports of association of metabolic syndrome and PCOS.\cite{15,22} In our study, metabolic syndrome was seen in 44.4% (12/27) with PCOS, and 43.8% (32/43) without PCOS and this difference in proportion was not statistically significant. As metabolic syndrome was almost equally present in those with and without PCOS, metabolic syndrome can be considered an independent risk factor for hirsutism. The proportion of metabolic syndrome in PCOS was higher than reported by Ehrmann et al. and same as that reported by Apridonidze et al. and Glueck et al.\cite{15,22,23} Acanthosis nigricans can occur in PCOS and metabolic syndrome. Increased BMI can occur in metabolic syndrome, and increased waist circumference can occur in those with increased BMI. Waist circumference ≥88 and elevated TG level ≥150 mg/dl are components of metabolic syndrome. These variables, since they can occur together can act as confounding variables. Logistic regression analysis was performed with the significant variables in univariate analysis. Two models were analyzed. In the first model, the variables incorporated were acanthosis nigricans, metabolic syndrome, and PCOS and in the second model BMI, acanthosis nigricans, PCOS, and instead of metabolic syndrome, the significant components of metabolic syndrome like waist circumference and elevated TG level were incorporated. In the first model, there was a statistically significant association of hirsutism with PCOS and metabolic syndrome. The patients with PCOS and those with metabolic syndrome have 5 and 3.5 times increased the chance of developing hirsutism. Acanthosis nigricans, though significant in univariate analysis, lost its significance in the logistic regression model. Acanthosis nigricans can occur in both metabolic syndrome and PCOS, and when analyzed individually it became significant, and when analyzed together it lost its significance. In the second model, instead of metabolic syndrome, the significant components of metabolic syndrome like waist circumference and elevated TG were incorporated along with PCOS, acanthosis nigricans and BMI. The patients with PCOS had 3.9 times and increased BMI had 3.1 times chance for developing hirsutism. Waist circumference though highly significant in univariate analysis lost its significance in logistic regression analysis as waist circumference ≥88 cm was seen in 91% with increased BMI. BMI can be a proxy measure for waist circumference ≥88 cm. Acanthosis nigricans lost its significance as it can occur in PCOS and increased BMI.

The sample size was adequate to study the mFG score, but when the patients were categorized into two groups within this sample, the sample size became inadequate. There is also the issue of generalizability of the study findings as the study setting was a tertiary care center. The androgen levels were not estimated in the study. Although in a study on hirsutism not estimating, the androgen levels is itself a limitation, it was not done, as the idea was to study the mFG score and association of metabolic syndrome.

The low mean mFG score in clinic attendees implies even lower score in unselected general population. This signifies the need for conducting population studies among females in the reproductive age group to determine a cutoff for mFG score to define hirsutism in our population.

**CONCLUSION**

Hirsutism still remains a major psychosocial problem among females. Hirsutism in any form remains disturbing to social sensibilities and conventions. Even though PCOS was the most significant association with hirsutism, metabolic syndrome and or its components also had a significant association with hirsutism. Logistic regression modeling has shown that in spite of the association of metabolic syndrome with PCOS, metabolic syndrome has become an independent risk factor. PCOS and metabolic syndrome have common clinical features and share the same pathogenesis. Insulin resistance and compensatory hyperinsulinemia is the key pathogenic event in both the conditions. The prevalence of 37.7% metabolic syndrome in those with mFG score <8 indicates that metabolic syndrome starts early even before hirsutism manifest and as metabolic syndrome progress the score increases. Hence terminal hair in an androgen dependent site can be considered as a surrogate marker for metabolic syndrome. So when patient complaints of terminal hair in androgen-dependent areas, the patient needs to be evaluated for metabolic syndrome in spite of the low mFG score. Metabolic syndrome is a condition that is preventable to a greater extent with lifestyle modification. As metabolic syndrome is associated with increased risk of cardiovascular disorders, early identification of metabolic syndrome is of prime importance. Prevention of the development of metabolic syndrome will be able to prevent hirsutism also. The successful treatment of hirsutism should incorporate lifestyle modification for sustained clinical response.

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**Conflicts of interest**

There are no conflicts of interest.
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