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# Passive smoking a significant predictor of Polycystic Ovarian Syndrome: Logistic Regression based Evidence from Karachi, Pakistan

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**Abstract**

**Objective:** To determine the predictors of occurrence of Polycystic Ovarian Syndrome in females of Karachi using Logistic Regression model.

**Methods:** A descriptive cross-sectional study was conducted from (January-June 2022) after the approval of the Institutional Bioethical Committee. Following the pilot study, validated structured questionnaire was disseminated in person and online. Data obtained from 599 individuals was kept confidential and analyzed using SPSS version 23 for descriptive statistics including chi-square based cross tabulations to assess the relationship of predictors with existence and vulnerability to the syndrome. Subsequently, inferential analysis using logistic regression was used to predict the odds of having or being vulnerable to the syndrome.

**Results:** The existence of the syndrome was significantly associated with symptoms ($p<0.01$), level of education ($p<0.05$) , marital status ($p<0.001$), house hold work frequency ($p<0.05$), being tested for diagnosis ($p<0.001$), father/brother smoking ($p<0.001$), source of information ($p<0.05$) and awareness of the syndrome in sex education ($p<0.05$). Regression model revealed that irregularity of menses ($p<0.001$, OR=3.25), hirsutism ($p<0.05$, OR=2.08) and acne ($p<0.05$, OR=1.74) significantly increased the likelihood of suffering from the syndrome. Females subjected to passive smoking were 2.46 times more likely to suffer from the syndrome ($p<0.05$). Thus, exposure to passive smoking increases the vulnerability to having Polycystic Ovarian Syndrome.

**Conclusion:** The identification of variables involved in occurrence of Polycystic Ovarian Syndrome will help to ascertain the etiology of newly diagnosed females. Passive smoking could be regarded as one of the factors in the etiology of Polycystic Ovarian Syndrome.

**Keywords:**
PCOS, life style, passive smoking, irregularity of menses, logistic regression

## Introduction

Polycystic Ovarian Syndrome (A heterogenous complex disorder) occurs when the female hypothalamic pituitary ovarian axis is dysregulated thus bestowing detrimental consequences to the life of 6-20% of women in their reproductive period[1] thus featuring infertility derangements in androgen and estrogen leading to diabetes mellitus, depression[2] , anxiety, dyslipidemia cardiovascular complications and cancer[1]. It is very prevalent in the Subcontinent, having 37.3% incidence in Indian Kashmiri women and an incidence of 20.7% in Pakistani women[3, 4]. The risks of PCOS are still unknown, substantial evidence recommends that this syndrome is an amalgamation of reproductive and metabolic disturbances that can lead to hormonal disruption and ovarian insufficiency[5]. 30% of females affected by polycystic ovarian syndrome

have normal menstrual bleeding. More or less 85%–90% of females affected with PCOS have oligomenorrhea and 30%–40% of females affected with PCOS have amenorrhea. More than 80% of females affected with the syndrome show symptoms of androgen excess[6].

Around 70% of females affected with PCOS showed hirsutism that is a clinical presentation of hyperandrogenism[7]. Acne is also considered as the mark of hyperandrogenemia but prevalence is to a lesser extent in PCOS and less peculiar than hirsutism. Around 15–30% of females affected with the syndrome showed acne[8]. Male and female in first-degree relatives of syndrome affected women are at increased chance of being affected with insulin resistance, obesity and diabetes type II. Although the way it is inherited is still unmapped[9]. Complications like diabetes type II, Gestational Diabetes, insulin resistance are reported.

Previously, it has been documented that there is an association of life style modifications with PCOS[4]. Though substantial efforts are being made to explore the causes of PCOS, but it is still remain obscure [9]. Thus the study is an endeavour to determine the variables involved in predicting the occurrence of PCOS.

## Material and methods

A descriptive cross-sectional study was designed that was approved by the Institutional Bioethical Committee **(**IBCKU-147-2020). It was conducted via online google form and in-person distribution of questionnaire to the general population of Karachi, Pakistan for the duration of six months (Jan 22 to June 22) following convenient sampling. Single and married females from puberty to menopause were included and postmenopausal women, girls below puberty and females not willing to volunteer were excluded from the study. Raosoft sample size calculator [1] was used to estimate the sample size for the survey with 5% margin of error and mentioning population size as 20,000 as the sample size does not change considerably for populations greater than 20,000. Minimal sample size recommended by Raosoft calculator was 377 and 600 responses were obtained from the survey (http://www.raosoft.com/samplesize.html). A validated structured questionnaire was utilized after the informed consent was taken from all the participants. 600 responses were obtained out of which 599 valid responses were included for statistical analysis.

### Statistical Analysis

Data analysis using IBM-SPSS version 23 was employed for descriptive statistics and chi-square based cross tabulations were used to assess the relationship between determining factors and the existence of PCOS. Findings from the survey were used for inferential analysis using logistic regression to predict the odds of having PCOS. Cross tabulations served as the criterion of the sequence of including variables in Logistic regression in terms of most significant to least significant. Hence, following models were predicted on the basis of symptomatology Eq. 1, demographics Eq. 2, lifestyle Eq. 3 and knowledge Eq. 4:

$$\text{Occurrence of PCOS} = \beta_\theta + \beta_1 \text{ Irregularity of menses} + \beta_2 \text{ Hirsutism} + \beta_3 \text{Acne} + \varepsilon \quad \text{Eq (i)}$$

$$\text{Occurrence of PCOS} = \beta_\theta + \beta_1 \text{ Marital status} + \beta_2 \text{ Education} + \varepsilon \quad \text{Eq (ii)}$$

$$\text{Occurrence of PCOS} = \beta_\theta + \beta_1 \text{ Tested yourself for PCOS} +$$

$\beta_2$ Smoking (Father/ Brother/ Husband) + $\beta_3$ House hold work + ε

Eq (iii)

Occurrence of PCOS = $\beta_\theta$ + $\beta_1$ Source of information + $\beta_2$ Awareness of sex education + ε

Eq (iv)

Odds ratio with 95% confidence interval was reported. All p-values less than 0.05 were considered statistically significant.

$\beta_\theta$ = Constant

βi = Odds of having variable in (i)

ε = Deviation in Error Term

## Results

599 participants were classified into PCOS afflicted and probable PCOS cases. Cross tabulations from 599 valid responses revealed that 11.2% females were diagnosed cases of PCOS. It's interesting to note that only 51.56% of PCOS afflicted females exhibited the two criterion symptoms from irregularity of menses, hirsutism and/or acne (Table 1). Whereas, approximately 19.68% of non-PCOS cases reported that they were facing at least 2 of the above stated symptoms of PCOS. Thus, they might be the vulnerable cases of PCOS as per the Rotterdam criteria.

Table 1: shows the frequency of occurrence of PCOS criterion symptoms with respect to diagnosis of PCOS

| | **Facing at least 2 symptoms** | | |
|---|---|---|---|
| **PCOS** | **Yes** | **No** | **Total** |
| Yes | 33 (51.56) | 31 (48.43) | 64 (11.2) |
| No | 112 (22.17) | 393 (77.82) | 505 (88.75) |

Table 2 shows the Chi-square cross-tabulations and binary logistic regression based association and prediction of occurrence of PCOS in relation to its individual symptoms, respectively. The existence of PCOS was significantly associated to irregularity of menses ($p<0.001$), hirsutism ($p<0.01$) and acne ($p<0.01$). Amongst the diagnosed cases of PCOS, 65.7% were suffering from irregularity of menses, 35.9% were experiencing hirsutism and 46.3% had acne. Findings also revealed that the existence of PCOS was significantly associated to demographic variables including level of education ($p<0.05$) and marital status ($p<0.001$).

As per Table 3 shows the existence of PCOS were significantly associated to lifestyle variables including household work frequency ($p<0.05$), testing yourself for diagnosis ($p<0.001$), father/brother smoking (Passive smoking) ($p<0.001$). Similarly, the knowledge variables including source of information ($p<0.05$) and awareness of PCOS in sex education ($p<0.05$) were significantly associated to the existence of PCOS.

Logistic Regression findings revealed that the likelihood of suffering with PCOS significantly increased with the occurrence of the three predictive symptoms; irregularity of menses (OR=3.25; $p<0.001$), hirsutism (OR=2.08; $p<0.01$) and acne (OR=1.74; $p<0.01$). Considering all predictor variables constant, the odds of having PCOS amongst single females was 2.44 ($p<0.001$) and as passive smokers they were 2.46 times more likely to suffer from PCOS ($p<0.001$). Findings suggested that testing for PCOS decreases the likelihood of its occurrence by 38.5% ($p<0.001$). Females who suggested that PCOS awareness should be a part of sex education, thus indicating the quest for knowledge or had acquired information about the syndrome from the doctor

were 47.8% ($p<0.05$) and 40.6% ($p<0.05$), respectively, less likely to suffer with PCOS. On the contrary, findings from Logistic Regression suggested that level of education and household work frequency were not the significant predictors of suffering with PCOS.

## Discussion

The present study revealed the predominance of irregularity of menses (65.7%) amongst PCOS suffering females that has been validated by the findings from UAE[10] and other parts of the world. The next prominent feature amongst PCOS suffering females, acne is concordant with the findings from Poland[11]. Hirsutism, a characteristic feature for 35.9% of PCOS suffering females in present study has also been reported by previous studies from USA[12] and other parts of the world. The increased likelihood of having PCOS with respect to the criterion symptoms has also been reported in other studies[13].

Findings from present study revealed that surveyed females significantly lacked the practice of testing oneself for PCOS (61.7%). 63.67% of diagnosed PCOS had tested themselves for the syndrome. Logistic regression proposes that testing significantly decreases the possibility of being undiagnosed with PCOS by 38.5%. An important aspect in management of PCOS as highlighted by Pramodh[10] was that increased proportions of females remain undiagnosed till the syndrome reaches the optimal level where medicine is the last resort.

Significant majority (49.3%) of PCOS diagnosed were performing household work. Whereas, majority (25.47%) had never exercised. A similar but insignificant trend was observed in vulnerable females. It has been reported that weight loss via exercise can help to combat the problems of infertility and menstrual irregularity in obese PCOS[14]. Lesser tendency to perform physical activity and household work in the Middle East[10, 15]. Integration of exercise in daily routine has been reported advantageous for females suffering with PCOS in terms of clinical presentation[16]. Contrary to the findings from present study, Indian females had a greater tendency to exercise very often[17].

Amongst PCOS sufferers, a significant majority (56.7%) were married in the present study. Young single females have been reported to approach Out Patient Department near their marriage with concerns of acne and skin lesions[18]. Primary concern for married ladies is infertility in India[19]. Yousaf and colleagues (2022)[20] deduced from the findings of a study that PCOS affected women had fewer children and conceived less frequently.

The findings of the present study suggest that passive smoking increases the chance of contracting PCOS by 2.46 times. 49.3% of PCOS diagnosed females reported the presence of smoking father/ brother/ husband. Ovulatory dysfunction in PCOS has been reported to have link with active and passive smoking[21].

The inhaled toxins can disturb follicle synthesis leading to early production of corpus luteum and can also reduce maturation of oocytes lowering primordial follicle reserves[21]. Nicotine, inhaled as an outcome of passive smoking, is the most hazardous carcinogen that decreases estrogen synthesis by reducing the activity of aromatase enzyme invitro and vivo[22].

**Table 2: shows the Cross tabulations between existence of PCOS and symptoms, demographic variables. The variables were included in the Logistic regression model in the ascending order from 1-3. Significant at p <0.05.**

| SYMPTOMS | PCOS | | Total | P value | Exp (B) | 95% C.I. for EXP(B) | |
|---|---|---|---|---|---|---|---|
| | Present | Absent | | | | Lower | Upper |
| **Irregularity of menses[1]** | | | | **0.00** | 3.25 | 1.84 | 5.76 |
| Yes | 44(65.7) | 189(36.3) | 233(39.6) | | | | |
| No | 23(34.3) | 332(63.7) | 355(60.4) | | | | |
| Total | 67(11.4) | 521(88.6) | 588(100) | | | | |
| **Hirsutism[2]** | | | | **0.00** | 2.09 | 1.17 | 3.73 |
| Yes | 23(35.9) | 92(17.8) | 115(19.8) | | | | |
| No | 41(64.1) | 426(82.2) | 467(80.2) | | | | |
| Total | 64(11.0) | 518(89) | 582(100) | | | | |
| **Acne[3]** | | | | **0.01** | 1.74 | 1.01 | 3.00 |
| Yes | 31(46.3) | 156(30.1) | 187(33.09) | | | | |
| No | 36(53.7) | 362(69.9) | 398(68.0) | | | | |
| Total | 67(11.5) | 518(88.5) | 585(100) | | | | |
| **DEMOGRAPHICS** | | | | | | | |
| **Education[2]** | | | | **0.04** | | | |
| No education | 0(0) | 1(0.2) | 1(0.2) | | 0.00 | 0.00 | |
| Primary | 0(0) | 1(0.2) | 1(0.2) | | 0.00 | 0.00 | |
| Secondary | 2(3) | 1(0.2) | 3(0.5) | | 9.65 | 0.85 | 109.33 |
| College | 2(3) | 27(5.1) | 29(4.9) | | 0.71 | 0.16 | 3.09 |
| Higher | 63(94) | 496(94.3) | 559(94.3) | | | | |
| education | 67(11.3) | 526(88.7) | 593(100) | | | | |
| Total | | | | | | | |
| **Marital status[1]** | | | | **0.00** | | | |
| Married | 38(56.7) | 176(33.4) | 214(36) | | 2.44 | 1.44 | 4.12 |
| Single | 29(43.3) | 351(66.6) | 380(64.0) | | | | |
| Total | 67(11.3) | 527(88.7) | 594(100) | | | | |

**Table 3: Cross tabulations between existence of PCOS and life style, knowledge variables. The variables were included in the Logistic regression model in the ascending order from 1-3. Significant at p <0.05.**

| LIFE STYLE | PCOS Present | Absent | Total | P value | Exp (B) | 95% C.I. for EXP(B) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| **House hold work frequency[3]** | | | | **0.04** | | | |
| Daily | 33(49.3) | 187(35.6) | 220(37.1) | | 1.30 | 0.64 | 2.65 |
| Twice a day | 2(3) | 49(9.3) | 51(8.6) | | 0.29 | 0.06 | 1.36 |
| Thrice a day | 0(0) | 10(1.9) | 10(1.7) | | 0.00 | 0.00 | |
| Very often | 18(26.9) | 198(37.6) | 216(36.4) | | 0.60 | 0.27 | 1.30 |
| Never | 14(20.9) | 82(15.6) | 96(16.2) | | | | |
| Total | 67(11.3) | 526(88.7) | 593(100) | | | | |
| **Have you been tested for PCOS[1]** | | | | **0.00** | 0.38 | 0.22 | 0.69 |
| Yes | 42(63.6) | 184(35.1) | 226(38.3) | | | | |
| No | 24(36.4) | 340(64.9) | 364(61.7) | | | | |
| Total | 66(11.2) | 524(88.8) | 590(100) | | | | |
| **Father /brother smoke [2]** | | | | **0.00** | 2.46 | 1.42 | 4.27 |
| Yes | 33(49.3) | 137(26.0) | 170(28.7) | | | | |
| No | 34(50.7) | 389(74.0) | 423(71.3) | | | | |
| Total | 67(11.3) | 526(88.7) | 593(100) | | | | |
| **KNOWLEDGE** | | | | | | | |
| **Source of information[1]** | | | | **0.01** | | | |
| Teacher | 4(6.0) | 60(11.4) | 64(10.8) | | 0.64 | 0.34 | 1.19 |
| Friend | 1(1.5) | 51(9.7) | 52(8.8) | | 1.96 | 0.88 | 4.35 |
| Doctor | 11(16.4) | 40(7.6) | 51(8.6) | | 0.41 | 0.22 | 0.76 |
| Paper | 1(1.5) | 28(5.3) | 29(4.9) | | 0.76 | 0.34 | 1.68 |
| Internet | 12(17.9) | 110(20.9) | 122(20.5) | | 0.56 | 0.31 | 1.01 |
| No source | 13(19.4) | 117(22.2) | 130(21.9) | | 0.75 | 0.32 | 1.75 |
| Multiple sources | 25(37.3) | 119(22.6) | 144(24.2) | | | | |
| Total | 67(11.3) | 527(88.7) | 594(100) | | | | |
| **Awareness of sex education[2]** | | | | **0.04** | 0.48 | 0.25 | 0.92 |
| Yes | 52(77.6) | 454(86.8) | 506(85.8) | | | | |
| No | 15(22.4) | 69(13.2) | 84(14.2) | | | | |
| Total | 67(11.4) | 523(88.6) | 590(100) | | | | |

Lower levels of Estradiol have been reported in females exposed to increased second hand smoking as compared to non-exposed suggesting a dose response relationship between passive smoking and estrogen[23]. Termination of smoking can not only result in a better health of the chief smoker but can also yield third-party benefits by protecting females against PCOS.

Present study revealed that significant majority of females who had PCOS

(77.6%) and who reported the absence of PCOS (86.8%) were of the notion that knowledge of PCOS should be included in education. In Indian, females also endorsed that dissemination of knowledge about PCOS is essential[24]. The significance of knowledge is evident from our study as it unfolds that females who were of the notion that awareness about PCOS should be included in sex education had 47.8% lesser chances of having PCOS.

Multiple sources of information were opted by 37.3% of diagnosed females. 17.9% chose internet as a source of information. Internet was the predominant source of information for adolescent girls in Maharashtra, India[25]. Having information from various sources regarding PCOS significantly decreased the chances of contracting PCOS or being vulnerable to PCOS.

## Conclusion

Our regression model predicts that irregularity of menses, hirsutism and acne increases the chances of having PCOS. Females who have passive smokers in their family had more chances of being affected from PCOS.

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