DEVELOPMENTAL MEDICO-LIFE-SCIENCES

Prevalence and Risk Factors of Polycystic Ovary Syndrome Among Adolescent Girls in Urban and Rural Areas of Punjab, Pakistan

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is a leading endocrine disorder during adolescence, conferring reproductive, metabolic, and psychological burdens. Reliable estimates from Pakistan particularly contrasting urban and rural settings remain scarce.

Objective: To estimate the prevalence of PCOS and delineate its principal risk correlates among adolescent girls residing in urban and rural districts of Lahore, Pakistan.

Methods: A cross-sectional survey was undertaken between January and December 2024. Sixty girls aged 13–19 years were recruited by purposive sampling, with equal representation from urban and rural communities. Standardised questionnaires captured sociodemographic and lifestyle variables; physical and anthropometric assessments, transabdominal ultrasonography, and fasting biochemical profiles were obtained. PCOS was defined according to the Rotterdam criteria. Data were analysed with SPSS (version 25.0).

Results: The overall prevalence of PCOS was 26·7%. Urban participants demonstrated a significantly higher prevalence than their rural counterparts (36·7% vs 16·7%; p = 0·04). Urban residency was associated with elevated body-mass index, greater waist circumference, a higher proportion of obesity, sedentary behaviour, and frequent fast-food intake. Menstrual irregularity, acne, and hirsutism were the predominant clinical manifestations. Biochemically, girls with PCOS exhibited raised serum testosterone, fasting insulin, fasting glucose, and HOMA-IR indices (all p < 0·05). A positive familial history of PCOS was more common among urban respondents.

Conclusion: PCOS affects more than one in four adolescent girls in Lahore, with a markedly greater burden in urban communities driven by adiposity, lifestyle patterns, and hereditary predisposition. Early detection, focused health education, and targeted lifestyle modification programmes are essential to mitigate future cardiometabolic and reproductive sequelae.

Keywords: Polycystic, Adolescents, Urban, Rural, Obesity, Insulin

INTRODUCTION

Polycystic ovary syndrome (PCOS) is a common and complex endocrine disorder that is now the most common cause of menstrual irregularities, androgens and infertility in women of reproductive age everywhere [1]. PCOS usually presents clinically with irregular or absent menstrual periods, excessive hair growth, acne, obesity, insulin resistance, and multiple small cysts of th e ovary. PCOS has been accepted as an adult condition for a long time, but it is now increasingly recognized as a condition that starts in adolescence. Because PCOS can lead to long term reproductive, metabolic and psychological complications, including type 2 diabetes, cardiovascular

disease, infertility, depression and anxiety, it is important to identify early in life and manage [2, 3].

Across different countries and ethnic groups, the prevalence of PCOS shows considerable variation, largely due to differences in diagnostic criteria, genetic makeup, environmental exposures, and lifestyle practices. According to international estimates, PCOS affects between 6% and 20% of women and this burden is increasing in South Asian countries, including Pakistan. This upward trend has been attributed to factors including rapid urbanization, changes in the diet characterized by increased consumption of high calorie and processed foods, decreased levels of physical activity and increased incidence of obesity in children and adolescents. Despite a high prevalence of PCOS in Pakistan, most of the research has been done in adult women and very little is known about prevalence and risk factors of PCOS in adolescents, especially in the rural areas where access to healthcare and reproductive health awareness is minimal [4, 5].

Timing of intervention during adolescence is critical because it is a period of time when PCOS can be prevented or delayed through lifestyle modification, counseling, and medical intervention when needed [6]. However, in Pakistan the diagnosis of PCOS is often delayed due to a social stigma, a lack of awareness, no screening programs and no specialized health services in rural areas. The distribution and determinants of PCOS in urban and rural adolescent populations need to be understood in order to address this gap [7, 8].

The current study was designed to estimate the prevalence of PCOS among adolescent girls in selected urban and rural regions of Punjab, Pakistan, and to investigate the key demographic, lifestyle, and clinical factors associated with its occurrence. By providing comparative data from these two distinct settings, this current study aimed to inform public health strategies, enhance early detection efforts, and ultimately improve the reproductive and metabolic health of adolescent girls in the Pakistani context [9, 10].

MATERIALS AND METHODS

This cross-sectional study was carried from January 2024 to December 2024 in Lahore, Punjab, Pakistan. The main aim of the study was to estimate the prevalence of polycystic ovary syndrome (PCOS) and its associated risk factors among adolescent girls residing in the city in both urban and rural areas. The study received the Institutional Review Board (IRB) approval (ERC/08A/01/2024). All of the participants gave written informed consent from the parents and legal guardians or verbal assent from the adolescent girls. All participants were maintained in confidentiality and anonymity and participation was voluntary and the participants could withdraw anytime without any adverse consequences.

The study population included adolescent girls, aged 13–19 years with menarche who were residing in their own area for at least 1 year. However, girls who had been diagnosed with known endocrine disorders including hypothyroidism, hyperprolactinemia, Cushing's syndrome, or congenital adrenal hyperplasia, or were using hormonal medications or oral contraceptive pills at the time of enrollment were excluded. Purposive sampling was used to recruit an equal number of 60 girls from urban and rural localities of Lahore to have adequate representation of both the groups and the final sample size was 60 girls.

Pretested, structured questionnaire administered through face-to-face interviews by trained female researchers in private setting was used to collect data. Sociodemographic data such as age, residence, educational status, family income, and parental education were captured in the questionnaire. Menstrual cycle length, duration of flow, age at menarche and history of oligomenorrhea or amenorrhea were obtained from menstural history. The clinical features of hyperandrogenism were determined by the presence and severity of hirsutism (modified Ferriman and Gallwey score), acne, and androgenic alopecia. Questions on physical activity level, duration of sedentary activities such as television or mobile phone use, dietary patterns, including how often fast food is consumed and sleep habits were used to evaluate lifestyle factors. PCOS, diabetes, obesity and cardiovascular diseases were also recorded in the family history.

A thorough physical examination was performed to record anthropometric measurements, including height, weight, body mass index (BMI), waist circumference, hip circumference, and waist-to-hip ratio, following standard protocols. Blood pressure was measured in a seated position using a calibrated digital sphygmomanometer. Clinical signs of insulin resistance, such as acanthosis nigricans, were noted. Transabdominal pelvic ultrasonography was conducted by an experienced sonographer using a portable ultrasound machine to evaluate ovarian morphology, specifically the presence of polycystic ovaries characterized by the presence of 12 or more small follicles (2–9 mm in diameter) arranged peripherally around a dense stroma.

Fasting morning venous specimens were collected after a 10–12-hour fast to quantify serum total testosterone, fasting insulin, and fasting plasma glucose. Samples were processed immediately in a central, accredited laboratory, where analytes were measured with validated chemiluminescent immunoassays and enzymatic methods. Insulin resistance was estimated using the homeostatic model assessment (HOMA-IR). Polycystic ovary syndrome was diagnosed according to the Rotterdam consensus, which stipulates that at least two of three criteria oligo- or anovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology on ultrasound must be present after exclusion of alternative disorders.

Data were entered into SPSS (version 25·0). Continuous variables including age, body-mass index, and hormone concentrations are presented as means ± standard deviations, and categorical variables including menstrual irregularity, hirsutism, and family history are reported as frequencies and percentages. Urban–rural differences were assessed with independent-sample t tests for continuous data and χ² or Fisher's exact tests for categorical data. Multivariable logistic regression, adjusting for covariates identified in univariable analyses, was employed to identify independent predictors of PCOS. Two-sided p values < 0·05 were considered statistically significant.

RESULTS

This study included a total of 60 adolescent girls aged 13–19 years from urban and rural areas of Lahore, with an equal distribution of 30 girls from each area. The overall prevalence of polycystic ovary syndrome (PCOS), diagnosed according to the Rotterdam criteria, was 26.7% (16 out of 60), with urban girls showing a significantly higher prevalence (36.7%, 11 out of 30) compared to rural girls (16.7%, 5 out of 30; p = 0.04).

Demographic and Socioeconomic Characteristics: The mean age of participants was 16.1 ± 1.7 years, with no statistically significant difference between urban and rural groups. Educational status differed significantly between the groups, with a higher proportion of urban girls enrolled in high school, while rural girls had higher middle school enrollment (p = 0.04).

Family income levels were markedly different between urban and rural participants (p = 0.01), with most rural families earning less than 100,000 PKR per month, whereas urban families were largely in the middle- or higher-income brackets. Parental education also showed a clear urban-rural disparity, with more urban mothers and fathers being graduates compared to their rural counterparts. Family size was larger in rural households (6.4 ± 1.3) compared to urban households (5.2 ± 1.1; p = 0.001). Most families in both groups lived in owned houses, although ownership was slightly higher among rural families.

Table 1: Demographic and Socioeconomic Characteristics of Participants

Characteristic	Urban (n=30)	Rural (n=30)	p-value
Mean age (years)	16.3 ± 1.8	15.9 ± 1.6	0.34
Education level (%)			0.04*
- Middle school	20% (n=6)	43.3% (n=13)	
- High school	80% (n=24)	56.7% (n=17)	
Monthly family income (%)			0.01*
- <100,000 PKR	26.7% (n=8)	66.7% (n=20)	
- 100,000–300,000 PKR	50% (n=15)	30% (n=9)	
- >300,000 PKR	23.3% (n=7)	3.3% (n=1)	
Mother's education (%)			0.02*
- Primary	10% (n=3)	36.7% (n=11)	
- Secondary	46.7% (n=14)	50% (n=15)	
- Graduate	43.3% (n=13)	13.3% (n=4)	
Father's education (%)			0.01*
- Secondary	30% (n=9)	60% (n=18)	
- Graduate	70% (n=21)	40% (n=12)	
Family size (mean)	5.2 ± 1.1	6.4 ± 1.3	0.001*
Housing status (%)			0.05*
- Owned house	86.7% (n=26)	96.7% (n=29)	
- Rented house	13.3% (n=4)	3.3% (n=1)	

Statistically significant (p < 0.05)

Table 2: Lifestyle and Anthropometric Characteristics

Characteristic	Urban (n=30)	Rural (n=30)	p-value
BMI (kg/m²)	24.8 ± 3.1	22.1 ± 2.7	0.01*
Obesity (%)	40% (n=12)	16.7% (n=5)	0.03*
Waist circumference (cm)	82.4 ± 7.3	76.2 ± 6.9	0.01*
Sedentary lifestyle (%)	60% (n=18)	33.3% (n=10)	0.02*
Fast-food ≥3x/week (%)	50% (n=15)	23.3% (n=7)	0.03*
Physical activity >150 min/week (%)	30% (n=9)	53.3% (n=16)	0.04*

Table 3: Prevalence and Clinical Features of PCOS

Feature	Urban PCOS (n=11)	Rural PCOS (n=5)	p-value
Oligomenorrhea (%)	63.6% (n=7)	60% (n=3)	0.86
Amenorrhea (%)	18.2% (n=2)	20% (n=1)	0.90
Hirsutism (%)	54.5% (n=6)	40% (n=2)	0.56
Acne (%)	72.7% (n=8)	60% (n=3)	0.60
Acanthosis nigricans (%)	36.4% (n=4)	20% (n=1)	0.50
Family history of PCOS (%)	45.5% (n=5)	20% (n=1)	0.20

Table 4: Biochemical Parameters in PCOS and Non-PCOS Groups

Parameter	PCOS (n=16)	Non-PCOS (n=44)	p-value
Serum testosterone (ng/dL)	78.5 ± 12.3	42.1 ± 9.8	<0.001*
Fasting insulin (µIU/mL)	20.3 ± 4.6	12.5 ± 3.1	<0.001*
Fasting glucose (mg/dL)	94.7 ± 6.1	88.3 ± 5.4	0.01*
HOMA-IR	3.9 ± 1.2	2.1 ± 0.7	<0.001*

Lifestyle and Anthropometric Characteristics: Urban girls had significantly higher body mass index (BMI) and waist circumference compared to rural girls. Obesity (BMI ≥25 kg/m²) was more prevalent among urban participants (40%) versus rural participants (16.7%; p = 0.03). Sedentary lifestyle, defined as less than 150 minutes of moderate physical activity per week, was significantly more common in urban girls (60%) than in rural girls (33.3%; p = 0.02). Fast-food consumption (≥3 times per week) was reported more frequently by urban participants (50%) compared to rural participants (23.3%; p = 0.03), while rural girls engaged more in physical activity.

Prevalence and Clinical Features of PCOS: PCOS was diagnosed in 26.7% of the overall study population, with a higher prevalence in urban girls. Menstrual irregularities were the most common presenting feature in both groups, followed by acne, hirsutism, and acanthosis nigricans. Positive family history of PCOS was reported more often by urban girls (45.5%) compared to rural girls (20%), though this difference was not statistically significant.

Biochemical Profile: Biochemical parameters demonstrated significantly elevated serum testosterone levels, fasting insulin, fasting glucose, and HOMA-IR scores in PCOS participants compared to non-PCOS participants, indicating the presence of metabolic disturbances and insulin resistance.

The study found a concerningly high prevalence of PCOS among adolescent girls in Lahore, with urban girls almost twice as likely to be affected as rural girls. Socioeconomic differences, particularly higher family income and parental education in urban areas, were paradoxically linked with higher obesity rates, greater sedentary behavior, and more frequent fast-food consumption.

The clinical manifestations were dominated by menstrual irregularities and hyperandrogenic signs, including hirsutism and acne. Regardless of their place of residence, PCOS girls had clear evidence of insulin resistance, as they had significantly high testosterone, fasting insulin levels and higher HOMA-IR scores than their non-PCOS peers. In addition, urban girls had higher rates of obesity and metabolic disturbances, which indicate that environmental and lifestyle factors heighten the genetic risk of PCOS in these populations.

DISCUSSION

The prevalence and risk factors of polycystic ovary syndrome (PCOS) in urban and rural adolescent girls of Lahore, Pakistan was studied in this study. In this cohort, PCOS was overall prevalent in 26.7%, and was significantly higher in the urban (36.7%) than the rural (16.7%). This is consistent with other global and regional reports stating that PCOS is a rising public health problem among adolescents, and particularly in South Asia where urbanization and lifestyle changes are transforming health profiles [11, 12].

Several interrelated factors such as higher rates of obesity, sedentary behaviour, and fast-food consumption are responsible for the high prevalence of PCOS in urban girls. In parallel, BMI, waist circumference, and rates of obesity were significantly greater for urban participants in this study than for rural girls, which is consistent with the well-described association between obesity and the pathophysiology of PCOS. While obesity does not appear to worsen hyperandrogenism in PCOS, it does exacerbate insulin resistance to increase the clinical severity of PCOS. In addition, the prevalence of urban girls with higher frequency of sedentary lifestyle and poor dietary patterns increase their metabolic risk [13].

The most common clinical features were menstrual disturbances especially oligomenorrhea which preceded acne, hirsutism and acanthosis nigricans and were more common in PCOS cases in both urban and rural settings [14]. This pattern emphasizes the need to screen adolescent girls with menstrual irregularities for this reason, as early detection can lead to timely intervention and prevent long term complications. Surprisingly, rural girls with PCOS were not metabolically benign, and even in lower resource settings, PCOS manifests a significant health burden [15].More cases in urban areas reported a positive family history of PCOS, which suggests the influence of complex interaction between genetic predisposition and environmental factors.

The urban environment appears to magnify the expression of genetic risk through modifiable factors such as diet and activity levels, emphasizing the need for culturally tailored prevention strategies [16].

The study's strengths include its focus on a vulnerable adolescent population, use of the Rotterdam diagnostic criteria, and the inclusion of both urban and rural groups, which allowed meaningful comparison [17]. However, there are limitations. The small sample size, purposive sampling method, and single-city setting limit the generalizability of the findings. Furthermore, the use of transabdominal rather than transvaginal ultrasound may have underestimated ovarian morphology, and self-reported lifestyle data are subject to recall bias [18].

Future research should include larger, multicentre studies using representative sampling to capture the true burden of PCOS in Pakistan. In addition, longitudinal

studies are needed to understand the natural history of adolescent PCOS and to evaluate the effectiveness of early lifestyle and pharmacological interventions [19].

CONCLUSION

This study demonstrates a high prevalence of polycystic ovary syndrome among adolescent girls in Lahore, Pakistan, with urban girls disproportionately affected. Obesity, sedentary lifestyle, poor dietary habits, and positive family history emerged as important contributors to the development of PCOS. Early identification, particularly among girls presenting with menstrual irregularities, is critical to prevent long-term metabolic and reproductive complications. Public health strategies focusing on obesity prevention, lifestyle modification, and adolescent health education are urgently needed, particularly in urban areas where the burden appears highest. Addressing PCOS at the adolescent stage offers a unique opportunity to improve women's health trajectories and reduce the future burden of diabetes, cardiovascular disease, and infertility in Pakistan.

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