https://doi.org/10.33472/AFJBS.6 9.2024.3974-3986

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

IMPACT OF COVID-19 PANDEMIC ON THE ONSET OF POLYCYSTIC OVARIAN DISEASE AND SYDROME IN YOUNGWOMEN: A CROSS-SECTIONAL STUDY

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Volume 6, Issue 9, 2024

Received: 09 March 2024

Accepted: 10 April 2024

Published: 20 May 2024
doi:10.33472/AFJBS.6.9.2024.3974-3986

ABSTRACT

This study investigates the link between COVID-19, polycystic ovarian disease (PCOD), and polycystic ovary syndrome (PCOS) in young Indian women. 420 women from 26 Indian states participated in a survey. 15.4% were diagnosed with PCOD/PCOS, and those diagnosed had a higher average BMI than those undiagnosed. The study aimed to assess the pandemic's impact on the onset of PCOD/PCOS. Statistical analysis showed a possible link, but limitations like sample size and self-reported data make it difficult to confirm a causal relationship. However, the study suggests that factors like stress, changes in diet and exercise, and genetics may play a role. A quiz for undiagnosed participants highlighted how the pandemic may have influenced lifestyles that can contribute to PCOD/PCOS. The study emphasizes the importance of early diagnosis and treatment of PCOD/PCOS and that healthcare providers should be aware of how the pandemic may affect young women's reproductive health.

Keywords: public health, endocrinology, female reproductive health, lifestyle

1. INTRODUCTION

Reproductive health, particularly for women, is a complex and multifaceted issue that encompasses physical, mental, and social well-being [1]. However, this is often influenced by social and cultural factors, and women's reproductive rights are crucial in ensuring their autonomy and well-being [2]. The 2019 pandemic had various repercussions, especially affecting

women's mental, physical, and reproductive health. Coronavirus disease, which is commonly known as COVID-19, is a contagious disease first discovered in Wuhan, China [3]. The virus responsible for the outbreak of this disease, SARS-CoV-2, is known to infect various organs and organ systems because of its penetrating receptor enzyme, ACE2, i.e., angiotensin-converting enzyme 2 [4]. The disease is known to cause multisystem complications, and its cell entry depends on the high expression of ACE2 [5]. The presence of ACE2 has also been reported in mammalian ovarian granulosa cells in several studies, providing substantial background to the relationship between COVID-19 and the female reproductive system [5].

The COVID-19 pandemic has had a significant impact on women's reproductive health, with a high percentage reporting changes in their menstrual cycle, worsened premenstrual symptoms, and new menstrual issues [6; 7]. This is likely due to increased stress, poor diet, and changes in exercise and work patterns [7]. In low and middle-income countries, cultural taboos, poor education, and a lack of menstrual hygiene products have further exacerbated these issues [8]. Polycystic ovarian disease (PCOD) and Polycystic ovary syndrome (PCOS) are the two most common hormonal disorders in women of reproductive age [9]. These are diagnosed by hyperandrogenism, ovarian disorder, and polycystic ovaries, although there are significant variations between individuals [10]. These affect 4–8% of reproductive aged women and are characterized by ovarian dysfunction and androgen excess [11]. It is a leading cause of infertility due to anovulation, and early diagnosis and treatment are crucial [12]. PCOS is a heterogeneous disorder with a genetic component and is associated with various health complications, including menstrual dysfunction, infertility, hirsutism, acne, obesity, and metabolic syndrome [13]. This multi-factorial syndrome initially appears in puberty, and individuals with this disease may be exposed to the risk of several diseases, including obesity, metabolic syndrome, insulin resistance, type II diabetes, infertility, cancer, cardiovascular disease, and mental disorders, affecting several dimensions of the quality of life [14]. Research has shown a high prevalence of polycystic ovaries in young women, with one study estimating it at 68% [15]. This is significant as polycystic ovaries are often associated with polycystic ovary syndrome (PCOS), a condition that can have various clinical and biochemical symptoms [16]. The prevalence of polycystic ovarian syndrome (PCOS) in India varies, with studies reporting rates of 3.7% in North Indian women, 6.8% in Haryana, and 9.13% in Indian adolescents [17; 18; 19]. A more recent study found a higher prevalence of 8.1% in urban India, with obesity, insulin resistance, and hypertension being significant risk factors [20]. Recent studies have suggested a potential link between PCOS

and COVID-19 [21]. It is also crucial to continue studying the relationship between the female reproductive system and COVID-19 to better understand and address the possible complex issues. The research has two objectives. The first step was to assess the prevalence of PCOS/PCOD and its clinical presentation in a group of young Indian women living in Chandigarh University dormitories from various states. The second objective was to evaluate the relationship between COVID-19 and the onset.

2. METHODS

2.1. Ethical Approval

This study was approved by Chandigarh University Institutional Review Board. Participation was voluntary and anonymous. Consent was taken before the participation.

2.2. Survey Development

All the questions in the survey were study related and validated by gynecologists. The survey was distributed online both within and outside the university. The questionnaire was to be completed by Indian young women with or without a diagnosis. No personal information was collected.

The general demographic was collected from all respondents. The survey consisted of the following sections:

- Demographic section consisting of domicile state, age, weight, height, and region
- Disorder diagnosis and history
- COVID-19 vaccination doses
- Symptomatic quiz for the participants without the diagnosis

2.3. Recruitment

In this cross-sectional survey, the students at Chandigarh University were asked to participate in the survey. Non-probability sampling was used. The participation requirements included being a young woman between a certain age range and having a potential risk of PCOS or PCOD. The required sample size was obtained using a convenience sampling strategy. Overall, 420 individuals participated in this online survey. Self-reported demographic data (age, height, weight, and domicile state) was collected from each participant.

2.4. Statistical Analysis

The statistical analysis was done using Python (v 3.9). Statistical significance was set at $P \leq 0.05$. Correlations between categorical variables were analyzed using $\chi 2$ analysis. Additionally, descriptive analysis, including frequency statistics, was performed to elucidate trends or associations between variables and PCOD/PCOS diagnosis.

3. RESULTS

3.1. Participation and Demographics

Participation recorded was 420 respondents coming from 26 states of India with a mean age of 20 years. A majority of the participants came from North India i.e. 76.4%, as shown in Figure 1. Punjab is the state with the highest number of respondents i.e. 112. The regions with almost

equal participants were the West (6.6%), East (6.4%), and North-East (6.1%) regions. The states with the least participation were Assam (1), Tamil Nadu (1), Telangana (1), and Tripura (1), and regions being South (2.6%) and Central (1.6%). Out of 420, 65 were already diagnosed with disease and 355 did not know their diagnosis and attempted a symptomatic quiz. The majority of diagnosed responses were from the north region i.e. 66%.

The average weight and height recorded for diagnosed responses were 60.4 kg and 1.6m, corresponding to a mean BMI of 23.57. Whereas for undiagnosed responses average BMI is 21.2, which shows that participants with polycystic ovaries have higher BMI. For diagnosed responses, 12% were recorded as underweight, 50% normal, 30.7% overweight, and 6.5% obese. For undiagnosed responses, 25.9% were underweight, 58% normal, 13.2% overweight, and 2.8% obese as shown in Figure 2.

3.2. Association of PCOD/PCOS with COVID-19 Pandemic

3.2.1. Prevalence and timing of PCOS/PCOD

This study investigated the prevalence of polycystic ovarian syndrome/disorder (PCOS/PCOD) diagnoses among 420 participants. A total of 65 participants 15.48% reported a medical diagnosis of PCOS/PCOD. Diagnoses were further categorized based on the timing relative to the COVID-19 pandemic. 35 participants reported diagnoses prior to the pandemic, while 30 diagnoses were reported afterward as shown in the Figure 3.

3.2.2. Statistical Analysis

A chi-square test revealed a significant association between diagnostic status (PCOS/PCOD) and the timing of diagnosis (before/after COVID-19) ($\chi 2 = 6.924$, $p = 0.008517$). This finding suggests that the pandemic may be linked to an increase in reported PCOS/PCOD diagnoses. Further analysis using Fisher's Exact Test demonstrated that the odds of being diagnosed with PCOS/PCOD after the pandemic were approximately 2.04 times higher than being diagnosed before (Odds Ratio = 2.04, $p = 0.0135$). McNemar's test, specifically designed for paired data, also yielded a significant difference in diagnoses between the pre-pandemic and post-pandemic periods ($\chi 2 = 5.83$, $p = 0.0156$). Finally, the Cochran-Mantel-Haenszel Test corroborated these findings, further strengthening the evidence for an association between the timing of diagnosis and PCOS/PCOD occurrence.

Symptomatic Quiz

All the undiagnosed responses (355) attempted the symptomatic quiz. The symptomatic quiz consisted of 8 questions addressing various symptoms essential for the diagnosis. As shown in Table 1, the first question asks about the genetic aspect of the diagnosis, as having a family member diagnosed with polycystic ovarian syndrome may increase the risk of developing the condition (26, 27, 28, 29). 12.7% of the undiagnosed responses had at least one woman in their family who has PCOD or PCOS. The second and third address the regularity and heaviness of

menses. Heavy and irregular menstrual periods are common clinical features of the disease (30, 31, 32). Almost 15% of the responses encountered irregular periods, and 23.1% had an abnormal flow of bleeding. A strong association between obesity and the occurrence of the disorder is a known fact (33,34,35, 36), therefore the fourth question asks about body weight. 16.3% selected the option underweight, and 27.9% acknowledged that they had gained weight. Another important symptom is hyperandrogenism, which causes skin and hair problems like acne, hirsutism, seborrhea, androgenetic alopecia, acanthosis nigricans, and acrochordon (37-43). In light of this fifth and sixth questions ask about the abnormalities encountered by the participants, where 29.3% had skin problems and 36.7% had hair problems. This endocrine disorder is influenced by many factors out of which lifestyle plays a very important role (44, 45). Unhealthy lifestyle choices like poor diet, obesity, and inactivity can cause the onset of polycystic ovarian disorder or syndrome (46-52). The last two questions addressed this issue by asking about their fast-food consumption in a week, and if they work out regularly. Out of 355, 12.7% consume fast food every day, and 34.4% do not work out.

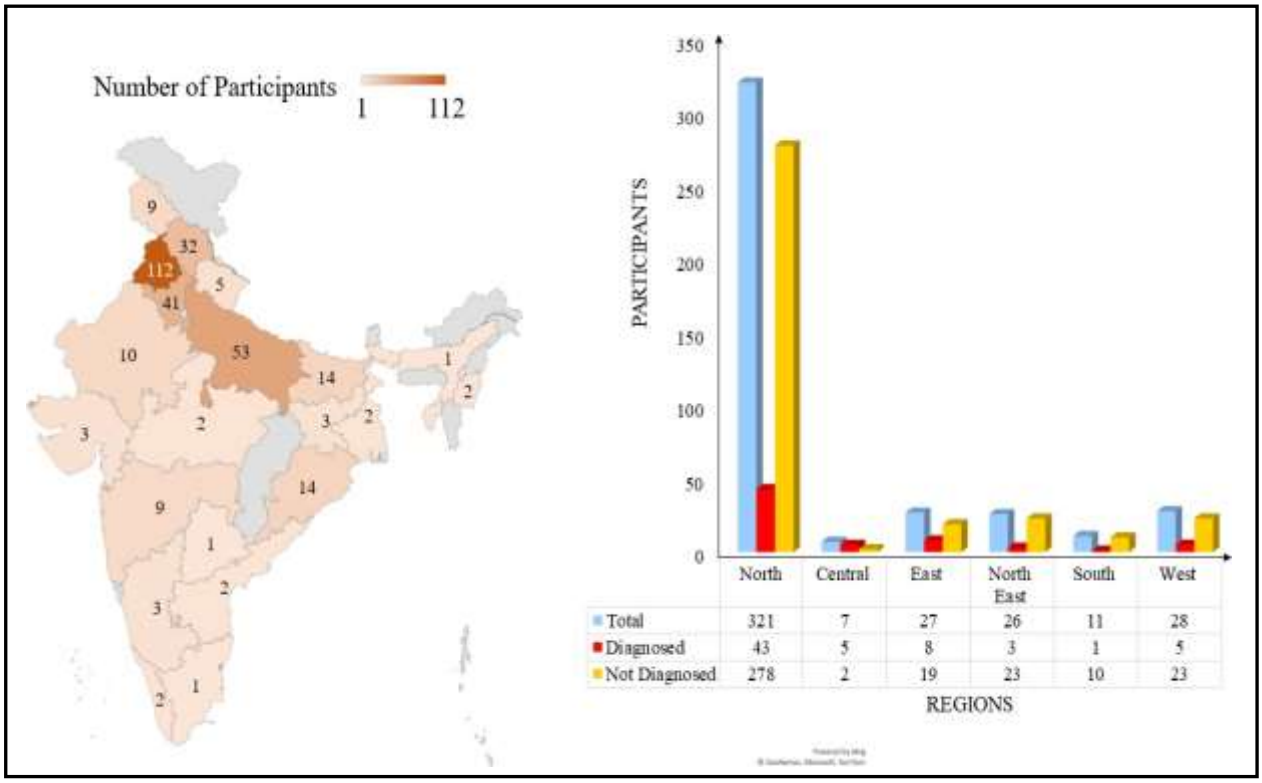

Fig 1*: Map chart depicting the distribution of participation around the country with a bar graph showing regional distribution.*

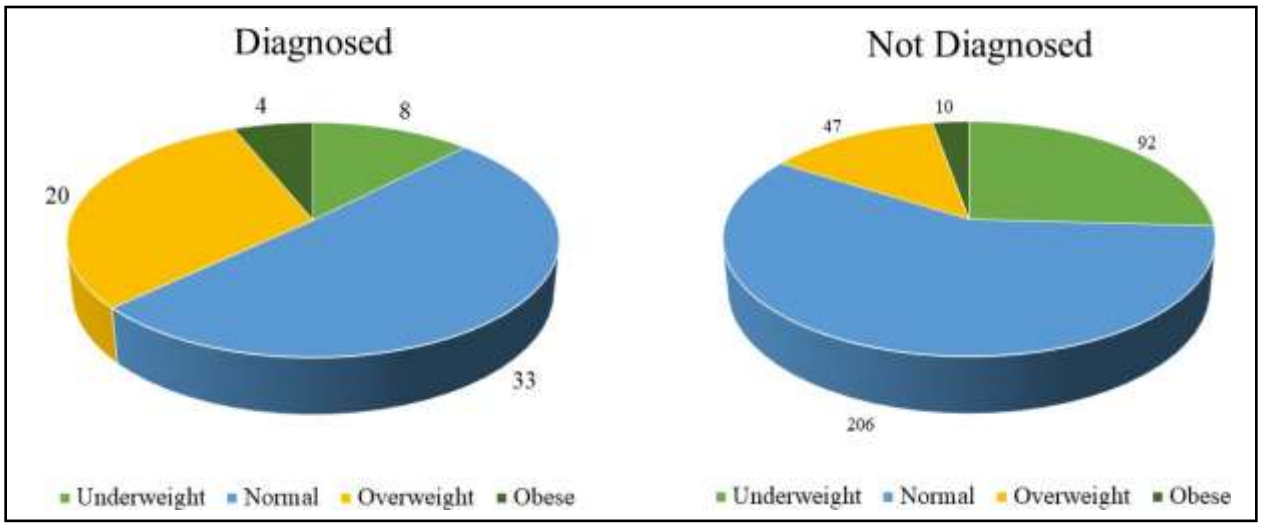

***Fig 2**: Distribution of BMI ranges for diagnosed and undiagnosed responses.*

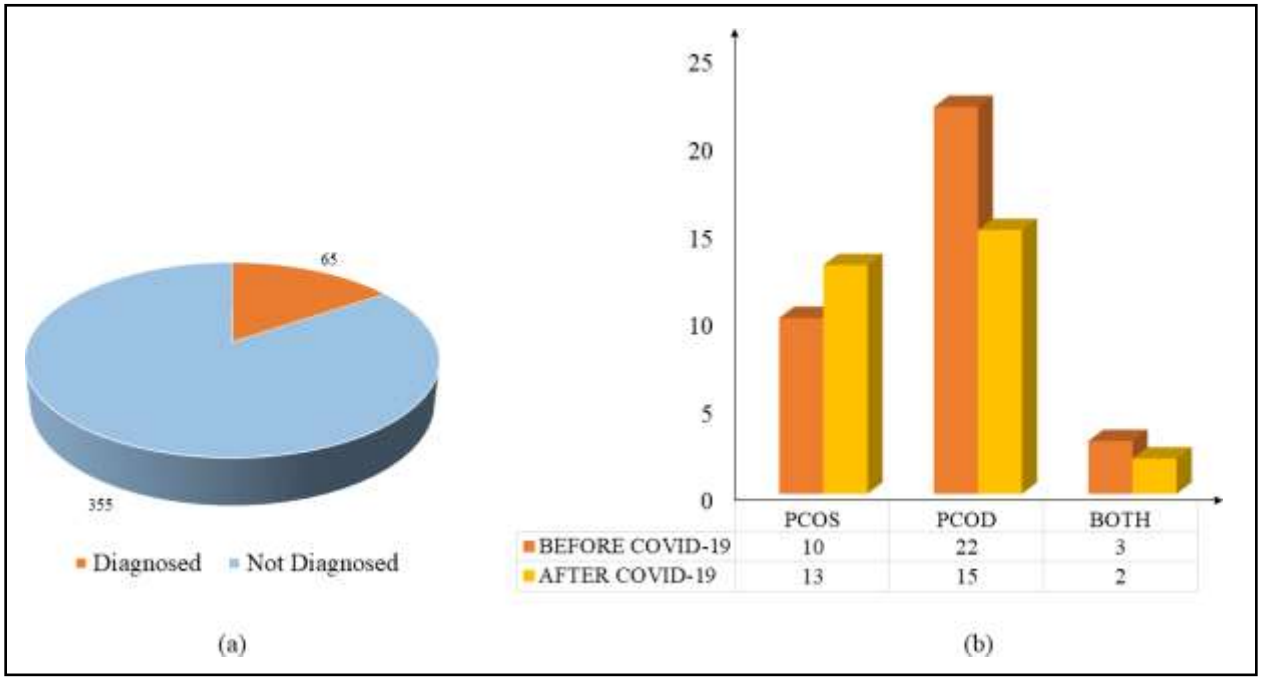

***Fig 3**: (a) Diagnosed and Undiagnosed responses; (b) Time and type of diagnosis of the participants having the disorder*

Table 1: *Participant distribution of symptomatic quiz attempted by 355 undiagnosed responses consisting of 8 questions.*

Sr. No.	QUESTIONS	Participant Distribution (355)	%age
1	**Has any woman in your family ever been diagnosed with PCOS/PCOD?**		
(a)	No; but I do know of a family member who is significantly overweight and has high blood pressure.	39	11.0 %
(b)	No; no one in my family has been diagnosed with PCOS/PCOD (at least that I know about).	271	76.3 %
(c)	Yes, I have at least one person—mother, sister, grandmother, or aunt—who has PCOS/PCOD.	45	12.7 %
2	**How often do you get your period?**		
(a)	I get my period every 20 days or less.	21	5.9%
(b)	I get my period every 35 days or longer.	36	10.1 %
(c)	I go months without a period.	17	4.8%
(d)	My periods are regular (every 21 to 34 days).	281	79.2 %
3	**How heavy is your bleeding during your period?**		
(a)	My bleeding is light.	43	12.1 %
(b)	My bleeding is normal; I change my pad or tampon every 3-4 hours	230	64.8 %
(c)	My bleeding is very heavy during my period.	23	6.5%
(d)	I notice clots of blood during my period.	19	5.4%
(e)	Both C and D	40	11.3 %
4	**Are you struggling to maintain your body weight?**		
(a)	I am underweight.	58	16.3 %
(b)	No, my weight is in the healthy range.	198	55.8 %
(c)	Yes, I have gained weight, especially in the midsection (around my abdomen).	99	27.9 %
5	**Do you have skin problems?**		
(a)	No. Generally, I have a good complexion (I may get a few pimples around the time of my period).	251	70.7 %
(b)	Yes. I have dark patches in the creases of my neck, armpits, groin, or	23	6.5%

	other places.		
(c)	Yes. I struggle with bad acne that won't go away no matter what I do.	67	18.9 %
(d)	Both B and C.	14	3.9%
6	**Have you experienced changes in the way your hair grows?**		
(a)	No, my hair is the same as it has always been.	225	63.4 %
(b)	Yes, I have dark hair growth on my face, chest, and back.	12	3.4%
(c)	Yes, I've noticed that my hair is thinning, and balding near my temples and/or the crown of my head.	100	28.2 %
(d)	Both B and C.	18	5.1%
7	**How frequently do you work out or meditate?**		
(a)	Everyday	39	11.0 %
(b)	never	122	34.4 %
(c)	Once in a while	144	40.6 %
(d)	Only on weekends	30	8.5%
(e)	Three days in a week	20	5.6%
8	**How often do you consume fast food on a weekly basis?**		
(a)	1-2 times	109	30.7 %
(b)	3-4 times	100	28.2 %
(c)	5-6 times	54	15.2 %
(d)	7 times	45	12.7 %
(e)	NA	47	13.2 %

4. DISCUSSION

The participation and demographic data collected from the survey at Chandigarh University provide valuable insights into the distribution of PCOD/PCOS among young women in India. The statistically significant correlations and descriptive analysis shed light on the association between various factors and the prevalence of PCOD/PCOS in this population. The geographical distribution of participation indicates a higher concentration of respondents from North India, particularly Punjab, as compared to other regions. Moreover, the average weight, height, and BMI of participants with diagnosed and undiagnosed conditions reveal important trends. The higher average BMI among diagnosed participants highlights the association between obesity

and PCOD/PCOS, further emphasizing the need for lifestyle interventions and weight management strategies in the prevention and management of these disorders.

The association between the onset of PCOD/PCOS and the COVID-19 pandemic is a particularly intriguing aspect of the study. The statistical analysis, including chi-square tests, Fisher's Exact Test, McNemar's test, and the Cochran-Mantel-Haenszel Test, unequivocally demonstrates a significant association between the timing of diagnosis and the occurrence of diagnoses in relation to the pandemic. This finding not only underscores the potential impact of external factors, such as the pandemic, on the diagnosis and prevalence of PCOD/PCOS but also encourages the need for further research to explore the underlying mechanisms and factors contributing to this association.

The symptomatic quiz administered to undiagnosed participants provides valuable insights into the prevalence of key symptoms associated with PCOD/PCOS. The first question asks about the genetic aspect of the diagnosis, as having a family member diagnosed with polycystic ovarian syndrome may increase the risk of developing the condition [22; 23]. The second and third address the regularity and heaviness of menses. Heavy and irregular menstrual periods are common clinical features of the disease [24]. A strong association between obesity and the occurrence of the disorder is a known fact [25], therefore the fourth question was asked. Another important symptom is hyperandrogenism, which causes skin and hair problems like acne, hirsutism, seborrhea, androgenetic alopecia, acanthosis nigricans, and acrochordon [26]. In the light of which fifth and sixth questions ask about the abnormalities encountered by the participants. This endocrine disorder is influenced by many factors out of which lifestyle plays a very important role [27]. Unhealthy lifestyle choices like poor diet, obesity, and inactivity can cause the onset of polycystic ovarian disorder or syndrome [28]. The high proportion of participants reporting family history, irregular menstrual periods, abnormal bleeding, weight fluctuations, skin problems, and sedentary lifestyle choices represents the multifactorial nature of the disorders and emphasizes the importance of comprehensive assessment and targeted interventions.

The study had various merits, such as investigating the consequences of the 2019 pandemic on female reproductive health. The inclusion of 26 states of India ensures geographical diversity. The symptomatic quiz also aids in spreading knowledge about the various symptoms of the disorder. However, reliance on non-probability sampling which results in selection bias is a limitation of the study. Additionally, the relationship between the COVID-19 pandemic and the onset of PCOS or PCOD cannot be justified only with the help of a cross-sectional study, providing a snapshot of data at a specific time period. Future longitudinal studies should be conducted to address the effects of the pandemic. Overall, the survey data and statistical analysis depict the importance of prompt PCOS and PCOD diagnosis and treatment, particularly in the context of a major global health issue. Healthcare professionals need to be aware of the potential effects of the pandemic on the early onset of PCOS and PCOD in young women in order to develop more effective preventive, early diagnosis, and treatment strategies.

5. CONCLUSION

In conclusion, this study delves into the connection between the COVID-19 pandemic, polycystic ovarian disease (PCOD), and polycystic ovary syndrome (PCOS) among young Indian women. The participation of 420 respondents from 26 states provided a diverse geographical representation, with a majority hailing from North India. Notably, 15.4% of the participants were already diagnosed with the disorder, displaying a higher mean BMI compared to undiagnosed individuals, suggesting a link between obesity and PCOD/PCOS.

The study aimed to explore the potential impact of the pandemic on the onset of these endocrine disorders. While statistical analysis indicates a significant association, as combined results from chi-square, p-values, odds ratio, McNemar's test, and the Cochran-Mantel- Haenszel Test provide robust evidence for a positive association between the COVID-19 pandemic and the reported onset of PCOS/PCOD in this study population.

The symptomatic quiz administered to undiagnosed participants highlighted the lifestyle changes during the pandemic, underscoring the importance of early diagnosis and treatment for PCOS and PCOD. It emphasizes that factors like genetics, stress, diet, and lifestyle changes during the pandemic may contribute to the development of these disorders. The study also acknowledges limitations such as a small sample size, non-probability sampling, and reliance on self-reported data. Additionally, the relationship between the COVID-19 pandemic and the onset of PCOS or PCOD cannot be justified only with the help of a cross-sectional study, providing a snapshot of data at a specific time period. Future longitudinal studies should be conducted to address the effects of the pandemic.

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