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Demographic, clinical, and lifestyle factors associated with polycystic ovary syndrome among women attending health centers in Mashhad, Iran (2017–2023): a cross-sectional study

Elnaz Ghasemi[1], Neda Atashgahi[1], Robab Latifnejad Roudsari[2], Sanaz Solati Sadati [3], Ehsan Mosa Farkhani[4*]

1. Department of Epidemiology, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran
2. Evidence-Based Care Research Center, Department of Midwifery, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran
3. Department of Acupuncture, School of Persian and Complementary Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
4. Department of Epidemiology, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran

*** *Corresponding author:*** Ehsan Mosa Farkhani, Department of Epidemiology, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran. E-mail: farkhanie@mums.ac.ir

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Abstract

Background: Polycystic ovary syndrome (PCOS) is the most common endocrinopathy of reproductive-age women, affecting roughly 10% worldwide. The demographic, clinical, and lifestyle factors associated with PCOS in the Iranian population remain incompletely characterized, particularly at the population level.

Objectives: We aimed to characterize the demographic, clinical, and lifestyle factors associated with PCOS in a large Iranian population-based sample.

Methods: We conducted a cross-sectional, registry-based study using routinely collected data from 12,391 wom aged 15–50 years (3,098 with PCOS and 9,293 without) who attended primary-care centers affiliated with Mashh University of Medical Sciences between March 2017 and June 2023. Records were extracted from the Sina Electroı Health Record system. An ICD-10-CM code of E28.2 defined cases. Associations between candidate factors and PC were examined using χ^2 tests and multivariable logistic regression, reporting adjusted odds ratios (AOR) with 9 confidence intervals (CI).

Results: PCOS was most frequent among women aged 31–40 years (53.2% of cases; AOR 1.99, 95% CI 1.54–2.59 versus <20 years). Obesity was independently associated with PCOS (AOR 1.45, 95% CI 1.26–1.66), and 57.0% of cases were overweight or obese. Regular fast-food consumption raised the odds of PCOS both monthly (AOR 1.56, 95% CI 1.27–1.92) and weekly (AOR 1.41, 95% CI 1.25–1.59). Hypertension (AOR 1.72, 95% CI 1.38–2.15) and anemia (AOR 1.40, 95% CI 1.22–1.60) were also independently associated with PCOS. A history of abortion showed a dose-response pattern, with AORs rising from 1.35 (one abortion) to 1.63 (three or more).

Conclusion: In this large registry-based sample, PCOS was independently associated with several modifiable factors, obesity, frequent fast-food intake, and reproductive history—alongside coexisting hypertension and anemia. These findings support integrated preventive strategies centered on weight management, dietary modification, and comprehensive reproductive-health care. Because of the cross-sectional design, associations should not be interpreted as causal. Future research should employ longitudinal designs to clarify the causal pathways underlying these associations.

Keywords: polycystic ovary syndrome; obesity; lifestyle; reproductive health

1. Background

Obesity is a significant global public health challenge, currently affecting approximately 16% of the global population, with its prevalence continuing to rise at an alarming rate (1). It is closely associated with various chronic metabolic disorders (2), including type 2 diabetes (3), cardiovascular diseases (4), metabolic dysfunction– associated steatotic liver disease (MASLD) and several types of cancer (5). One of the major complications of obesity is metabolic syndrome (MetS), which is primarily driven by insulin resistance (6). The key diagnostic criteria for MetS include central obesity, elevated plasma glucose, hypertension

(HTN), hypertriglyceridemia, and reduced levels of high-density lipoprotein-cholesterol (HDL-C) (7). Increased visceral adiposity and insulin resistance are also closely associated with fat accumulation in the liver, resulting in hepatic steatosis and subsequent MASLD (8).

The new term MASLD highlights the underlying metabolic dysfunction associated with hepatic fat accumulation. These metabolic abnormalities, which constitute the core pathophysiological features of MetS, play a crucial role in the development and progression of MASLD (9). Notably, MASLD and MetS share a bidirectional relationship, each exacerbating the other (10). Under such circumstances, uncontrolled inflammation and oxidative stress can accelerate the progression of hepatic steatosis to more severe stages, including steatohepatitis, fibrosis, cirrhosis, and eventually hepatocellular carcinoma (11).

Management of MetS and MASLD typically focuses on underlying causes such as obesity and insulin resistance, with lifestyle interventions like dietary changes, increased physical activity, and weight loss being first-line treatments (12). In recent years, pharmacological therapies, particularly glucagon-like peptide-1 receptor agonists (GLP-1 RAs) such as semaglutide, have emerged as promising options for obesity management and have demonstrated beneficial effects on metabolic dysfunction and hepatic outcomes (13, 14). However, issues related to long-term affordability, accessibility, tolerability, and applicability across different patient populations remain important considerations (15). In cases of severe obesity with comorbidities, bariatric surgery is increasingly utilized due to its capacity for substantial and sustained weight loss and improvement of obesity-related conditions (16).

Bariatric surgery has also been shown to reduce hepatic steatosis, fibrosis, and inflammation (17), while positively impacting all components of MetS (18). However, studies have reported potential drawbacks following surgery, including transient liver dysfunction and reductions in HDL-C levels (19). Moreover, patients with these metabolic conditions may be at increased risk of surgical complications (20). Therefore, optimizing metabolic status before surgery is crucial to improve surgical outcomes.

Curcumin, a polyphenolic compound derived from turmeric, has demonstrated various pharmacological effects relevant to human health (21, 22). Among these activities are potent antioxidant, anti-inflammatory, and immunomodulatory properties (23). Evidence suggests that curcumin supplementation benefits individuals with MetS by improving insulin sensitivity (24, 25), inhibiting lipogenesis (26, 27), reducing blood pressure (21, 28), significantly affecting anthropometric indices (29, 30), and modulating enzymes involved in lipoprotein metabolism, which leads to lower triglycerides (TGs) and higher HDL-C levels (31, 32). Additionally, curcumin appears to play a pivotal role in reducing hepatic fat accumulation by enhancing insulin sensitivity and regulating pathways associated with lipid metabolism and liver fibrosis (33). Curcumin also suppresses pro-inflammatory cytokines such as TNF-α, IL-6, and IL-1β (34).

These properties position curcumin as a potential adjunctive therapy for managing MetS and MASLD, while mitigating inflammation associated with these disorders. Despite recent advances in the management of patients undergoing bariatric surgery, identifying strategies to prevent adverse surgical outcomes and minimize complications remains a priority. Curcumin supplementation may contribute to better surgical outcomes by reducing inflammation, improving liver function, and enhancing control over various aspects of MetS. However, its low oral bioavailability due to poor absorption and rapid metabolism may

limit its efficacy (35). Piperine, by inhibiting curcumin metabolism, enhances its stability and absorption (36).

To date, no clinical trial has specifically evaluated the effects of curcumin-piperine supplementation in bariatric surgery candidates with concurrent MetS and MASLD.

Therefore, evidence regarding the potential role of this intervention in modulating metabolic and hepatic outcomes in this high-risk population remains limited. Accordingly, this study aims to evaluate the potential effects of curcumin-piperine supplementation on the components of metabolic syndrome, as well as the severity of hepatic steatosis and fibrosis, in bariatric surgery candidates, both immediately after the intervention and six months post-surgery.

2. Methods and Materials

2.1. Study design and setting

This cross-sectional study was based on secondary analysis of routinely collected records covering 1 March 2017 to 20 June 2023 from primary-care facilities affiliated with Mashhad University of Medical Sciences, north-eastern Iran. Data were extracted from the Sina Electronic Health Record (Sina-EHR) system. This comprehensive platform captures health information obtained through structured face-to-face interviews conducted by trained health workers (17).

2.2. Study population

The study included 12,391 women aged 15–50 years who attended affiliated health centers during the study period. Of these, 3,098 had a recorded diagnosis of PCOS (cases), and 9,293 did not (controls). Because the analysis used all eligible records in the registry, no formal sample-size calculation was required; the achieved sample provided more than 99% power to detect an odds ratio of 1.3 at a two-sided α of 0.05.

2.3. Case definition

Cases were identified using the ICD-10-CM code E28.2 (polycystic ovarian syndrome) recorded in the Sina-EHR system. While the diagnosis was based on ICD-10 coding, these codes represent clinical assessments made by healthcare providers during routine visits. Diagnoses were made by treating clinicians in accordance with standard clinical criteria and documented in the medical record. The specific diagnostic criteria applied at the individual level (e.g., Rotterdam, NIH, or Androgen Excess and PCOS Society criteria) could not be verified from the electronic record, as the underlying hormonal, ultrasonographic, and clinical findings were not separately captured. Women without this diagnostic code during the study period served as controls.

2.4. Variables

Demographic and anthropometric variables comprised age (<20, 21–30, 31–40, >40 years), education (illiterate, elementary, diploma, academic), employment status (housewife, employed, student, self-employed, worker), residence (village, suburban, city, metropolitan), marital status (single, married), nationality (Iranian, non-Iranian), and body mass index (BMI). BMI was classified as underweight (<18.5 kg/m²), normal weight (18.5–25.0 kg/m²), overweight (25.1–30.0 kg/m²), or obese (>30.0 kg/m²).

Lifestyle variables comprised self-reported physical-activity readiness (screened with the Physical Activity Readiness Questionnaire, PAR-Q, categorized as PAR-Q negative versus positive) (18). This pre-exercise safety-screening instrument identifies women who may need medical clearance before increasing physical activity, rather than directly measuring habitual activity level or physical fitness. Other lifestyle variables were included. Smoking (self-reported tobacco use in the previous 12 months), fast-food consumption (never, monthly, weekly), predominant cooking-oil type (liquid, mixed,

solid), and self-reported substance use. Reproductive-health variables comprised number of childbirths (0, 1, 2, 3, ≥4), number of abortions (0, 1, 2, ≥3), and history of child death (yes/no).

Coexisting medical conditions were ascertained from recorded ICD-10 codes and laboratory values: diabetes mellitus (E10, E11), hypertension (I10, I15), and anemia (defined as hemoglobin <12 g/dL in accordance with World Health Organization thresholds for non-pregnant women).

2.5. Statistical analysis

Analyses were performed in Stata 16 (StataCorp, College Station, TX). Categorical variables were summarised as counts and percentages and compared between cases and controls using the χ^2 test. Bivariate logistic regression estimated unadjusted associations between each candidate factor and PCOS. Variables with $P < 0.25$ in bivariate analysis were entered into a multivariable logistic regression model, from which adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were derived. This purposeful-selection strategy, which uses a more liberal threshold than the conventional $P < 0.05$, is intended to reduce the risk of excluding variables that confound the exposure–outcome association despite a weak marginal effect: we nonetheless recognize that contemporary guidance favors selecting adjustment variables primarily on clinical relevance and an a priori causal framework, a point we return to in the Strengths and limitations section. Model calibration was assessed with the Hosmer–Lemeshow goodness-of-fit test, and multicollinearity was evaluated using variance inflation factors. A two-sided $P < 0.05$ was considered statistically significant.

3. Results

A total of 12,391 women were analyzed (3,098 cases and 9,293 controls). The demographic, clinical, and lifestyle characteristics of the two groups are presented in Table 1.

PCOS was most common among women aged 31–40 years, who comprised 53.2% of cases; this group had the highest odds of PCOS relative to women aged <20 years (AOR 1.99, 95% CI 1.54–2.59). Most cases had completed diploma (52.5%) or elementary (35.0%) education. Compared with illiterate women, elementary education was associated with modestly higher odds of PCOS (AOR 1.27, 95% CI 1.02–1.57), whereas academic education was associated with lower odds (AOR 0.62, 95% CI 0.48–0.80) (Tables 1 and 2).

Table 1. Demographic, clinical, and lifestyle characteristics of women with and without polycystic ovary syndrome, Mashhad Health centers, 2017–2023.

Variable	Cases (n=3,098)	%	Controls (n=9,293)	%	P-value
Age (years)					
<20	178	5.75	1,248	13.43	<0.001
21–30	751	24.24	1,526	16.42	
31–40	1,649	53.23	2,833	30.49	
>40	520	16.79	3,686	39.66	
Body mass index (kg/m²)					
<18.5	118	3.84	656	7.11	<0.001
18.5–25.0	1,202	39.15	3,872	42.00	
25.1–30.0	979	31.89	2,913	31.59	
>30.0	771	25.11	1,779	19.30	
Education level					
Illiterate	181	5.84	692	7.45	<0.001
Elementary	1,084	34.99	2,511	27.02	
Diploma	1,627	52.52	4,134	44.49	
Academic	206	6.65	1,956	21.05	

Employment status					
Housewife	2,439	78.73	3,136	33.75	<0.001
Employed	37	1.19	616	6.63	
Student	325	10.49	1,128	12.14	
Self-employed	269	8.68	3,202	34.46	
Worker	28	0.90	1,211	13.03	
Place of residence					
Village	1,880	60.68	2,370	25.50	<0.001
City	543	17.53	1,838	19.78	
Suburban	403	13.01	2,290	24.64	
Metropolitan	272	8.78	2,795	30.08	
Marital status					
Single	386	12.46	2,563	27.58	<0.001
Married	2,712	87.54	6,730	72.42	
Nationality					
Iranian	3,028	97.74	8,709	93.72	<0.001
Non-Iranian	70	2.26	584	6.28	
Smoking (last 12 months)					
No	2,843	91.77	8,574	92.26	0.37
Yes	255	8.23	719	7.74	
Physical-activity readiness (PAR-Q negative)					
No	1,799	58.16	5,957	64.10	<0.001
Yes	1,294	41.84	3,336	35.90	
Fast-food consumption					
Never	942	30.41	4,092	44.03	<0.001
Monthly	249	8.04	639	6.88	
Weekly	1,907	61.56	4,562	49.09	
Cooking-oil type					
Liquid oil	1,547	49.94	4,266	45.91	<0.001
Mixed oil	1,261	40.70	4,349	46.80	
Solid oil	290	9.36	678	7.30	
Diabetes mellitus					
No	2,974	96.00	9,004	96.89	0.017
Yes	124	4.00	289	3.11	
Hypertension					
No	2,869	92.61	8,844	95.17	<0.001
Yes	229	7.39	449	4.83	
Anaemia					
No	2,330	75.21	8,504	91.51	<0.001
Yes	768	24.79	789	8.49	
Number of childbirths					
0	782	25.24	5,780	62.20	<0.001
1	648	20.92	765	8.23	
2	852	27.50	1,362	14.66	
3	504	16.27	796	8.57	
≥4	312	10.07	590	6.35	
Number of abortions					
0	2,302	74.31	8,410	90.50	<0.001
1	569	18.37	628	6.76	
2	158	5.10	194	2.09	
≥3	69	2.23	61	0.66	
History of child death					
No	3,047	98.35	9,260	99.64	<0.001
Yes	51	1.65	33	0.36	

P-values from χ^2 tests. Percentages are column percentages within cases and within controls.

Overall, 57.0% of cases were overweight (31.9%) or obese (25.1%). Obesity was independently associated with PCOS (AOR 1.45, 95% CI 1.26–1.66). Among coexisting conditions, hypertension (AOR 1.72, 95% CI 1.38–2.15) and anemia (AOR 1.40, 95% CI 1.22–1.60) were independently associated with PCOS (Table 2).

Regarding lifestyle, regular fast-food consumption was associated with higher odds of PCOS, both monthly (AOR 1.56, 95% CI 1.27–1.92) and weekly (AOR 1.41, 95% CI 1.25–1.59), relative to women who never consumed fast food. Most cases were housewives (78.7%); all other employment categories were associated with lower odds of PCOS (Table 2).

For reproductive history, relative to women with one childbirth, both nulliparous women and those with multiple childbirths showed lower odds of PCOS (AORs 0.45–0.62). A history of abortion showed a dose-response association, with AORs rising from 1.35 (one abortion) to 1.63 (three or more). Geographically, women living in suburban (AOR 0.19, 95% CI 0.16–0.22), metropolitan (AOR 0.15, 95% CI 0.13–0.18), and city areas (AOR 0.45, 95% CI 0.39–0.51) all had lower odds of PCOS than village residents (Table 2).

Table 2. Unadjusted and adjusted odds ratios for factors associated with polycystic ovary syndrome, Mashhad health centers, 2017–2023.

Variable	Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
Age (years)				
<20	Ref.		Ref.	
21–30	3.45 (2.88–4.12)	<0.001	1.66 (1.31–2.09)	<0.001
31–40	4.08 (3.44–4.82)	<0.001	1.99 (1.54–2.59)	<0.001
>40	0.98 (0.82–1.18)	0.90	0.47 (0.35–0.63)	<0.001
Body mass index (kg/m²)				
18.5–25.0	Ref.		Ref.	
<18.5	0.57 (0.47–0.71)	<0.001	0.85 (0.66–1.10)	0.24
25.1–30.0	1.08 (0.98–1.19)	0.11	1.10 (0.97–1.25)	0.11
>30.0	1.39 (1.25–1.55)	<0.001	1.45 (1.26–1.66)	<0.001
Education level				
Illiterate	Ref.		Ref.	
Elementary	1.65 (1.38–1.97)	<0.001	1.27 (1.02–1.57)	0.03
Diploma	1.50 (1.26–1.78)	<0.001	1.04 (0.84–1.28)	0.68
Academic	0.40 (0.32–0.50)	<0.001	0.62 (0.48–0.80)	<0.001
Employment status				
Housewife	Ref.		Ref.	
Employed	0.07 (0.05–0.10)	<0.001	0.19 (0.13–0.27)	<0.001
Student	0.37 (0.32–0.42)	<0.001	0.71 (0.58–0.86)	0.001
Self-employed	0.10 (0.09–0.12)	<0.001	0.28 (0.24–0.33)	<0.001
Worker	0.03 (0.02–0.04)	<0.001	0.03 (0.02–0.04)	<0.001
Place of residence				
Village	Ref.		Ref.	
Suburban	0.22 (0.19–0.25)	<0.001	0.19 (0.16–0.22)	<0.001
City	0.37 (0.33–0.41)	<0.001	0.45 (0.39–0.51)	<0.001
Metropolitan	0.12 (0.10–0.14)	<0.001	0.15 (0.13–0.18)	<0.001
Marital status				
Single	Ref.		Ref.	
Married	2.67 (2.38–3.00)	<0.001	0.64 (0.54–0.77)	<0.001
Smoking				
No	Ref.		Ref.	
Yes	1.06 (0.92–1.24)	0.37	—	—

Physical-activity readiness (PAR-Q negative)				
No	Ref.		Ref.	
Yes	1.28 (1.18–1.39)	<0.001	1.07 (0.94–1.21)	0.27
Diabetes mellitus				
No	Ref.		Ref.	
Yes	1.29 (1.04–1.60)	0.017	—	—
Hypertension				
No	Ref.		Ref.	
Yes	1.57 (1.33–1.85)	<0.001	1.72 (1.38–2.15)	<0.001
Fast-food consumption				
Never	Ref.		Ref.	
Monthly	1.69 (1.43–1.99)	<0.001	1.56 (1.27–1.92)	<0.001
Weekly	1.81 (1.66–1.98)	<0.001	1.41 (1.25–1.59)	<0.001
Cooking-oil type				
Liquid oil	Ref.		Ref.	
Solid oil	1.17 (1.01–1.36)	0.030	1.05 (0.87–1.28)	0.55
Mixed oil	0.79 (0.73–0.87)	<0.001	1.03 (0.85–1.24)	0.75
Anaemia				
No	Ref.		Ref.	
Yes	3.55 (3.18–3.96)	<0.001	1.40 (1.22–1.60)	<0.001
Number of childbirths				
1	Ref.		Ref.	
0	0.15 (0.14–0.18)	<0.001	0.45 (0.37–0.54)	<0.001
2	0.73 (0.64–0.84)	<0.001	0.62 (0.53–0.73)	<0.001
3	0.74 (0.64–0.87)	<0.001	0.61 (0.50–0.74)	<0.001
≥4	0.62 (0.52–0.74)	<0.001	0.49 (0.39–0.62)	<0.001
Number of abortions				
0	Ref.		Ref.	
1	3.31 (2.92–3.74)	<0.001	1.35 (1.16–1.58)	<0.001
2	2.97 (2.39–3.68)	<0.001	1.32 (1.02–1.72)	0.031
≥3	4.13 (2.91–5.84)	<0.001	1.63 (1.08–2.45)	0.019
History of child death				
No	Ref.		Ref.	
Yes	4.69 (3.02–7.29)	<0.001	1.70 (1.02–2.84)	0.039

OR, odds ratio; CI, confidence interval; Ref., reference category. Adjusted odds ratios derived from a multivariable logistic regression model including all variables with $P < 0.25$ in bivariate analysis; smoking did not meet this threshold ($P = 0.37$) and was not retained. Diabetes mellitus was also not retained in the adjusted model; the authors are reviewing this against the bivariate result. Em dash (—) indicates variable not entered in the adjusted model.

4. Discussion

In this large registry-based study of women attending health centers in Mashhad, PCOS was independently associated with obesity, frequent fast-food consumption, reproductive history, and coexisting hypertension and anemia. These findings are consistent with the international literature and add a population-level perspective from Iran, where large-scale data on PCOS remain scarce (19–21), complementing findings from other Iranian cohorts (30). The concentration of cases in the 31–40-year age band highlights the mid-reproductive years as a period of peak symptomatic presentation and diagnosis, in keeping with prior work (22). The strong association with obesity reinforces the central role of adiposity in the pathophysiology of PCOS: excess weight aggravates insulin resistance, a key driver of hyperandrogenism, and is linked to adverse reproductive outcomes, including subfertility and reduced treatment success (23, 24). Insulin resistance operates across adipose, hepatic, muscular, and ovarian tissue in PCOS. It offers a unifying mechanistic explanation for the clustering of metabolic

and reproductive features observed in this cohort (25).

Hypertension and anemia emerged as coexisting conditions independently associated with PCOS. Hypertension frequently accompanies insulin resistance and metabolic syndrome in PCOS. It contributes to elevated long-term cardiovascular risk, particularly among women with chronic hyperandrogenaemia (21). Anemia may reflect the abnormal uterine bleeding and menstrual irregularity that are characteristic of the syndrome, underscoring the value of integrated care that addresses both metabolic and reproductive health (14). A systematic review and meta-analysis conducted for the 2023 international PCOS guideline confirmed a significantly elevated risk of clinical cardiovascular events in women with PCOS. Recent commentary has specifically called for earlier, systematic cardiometabolic screening in this population (26, 27). The association between frequent fast-food consumption and PCOS is consistent with a growing body of evidence implicating diet in disease expression. Diets rich in saturated fat and refined carbohydrate worsen insulin resistance and low-grade inflammation, amplifying the metabolic burden of PCOS (19). Conversely, dietary modification and modest weight loss can improve metabolic profiles and symptom severity, positioning nutrition as a practical target for prevention and management (21, 23). A recent narrative review similarly found that high-glycaemic-load, Western-style dietary patterns are consistently associated with a higher risk of PCOS. In contrast, fiber-rich diets and adequate vitamin D appear protective (28).

The reproductive-health findings warrant careful interpretation. The apparently lower odds of PCOS among nulliparous and grand-multiparous women, together with a dose-response association for prior abortion, most plausibly reflect the complex interplay between fertility, healthcare contact, and the timing of diagnosis rather than a direct causal effect. Ascertainment is likely to differ by reproductive history, since women who seek fertility care are more likely to undergo the investigations that lead to a PCOS diagnosis. The lower odds observed among urban and suburban residents relative to village residents may similarly reflect differences in healthcare access, diagnostic intensity, dietary patterns, and health-seeking behavior rather than a true protective effect of urban living.

Several factors showed a significant unadjusted association with PCOS that did not persist after adjustment, and these null findings merit comment. Physical-activity readiness (PAR-Q positive versus negative) was associated with PCOS in bivariate analysis but not after adjustment (AOR 1.07, 95% CI 0.94–1.21). As the PAR-Q is a screening instrument for exercise-related health risk rather than a direct measure of habitual activity level or physical fitness, its crude association more plausibly reflected confounding by obesity, hypertension, and other comorbidities than a true behavioral effect; this is consistent with evidence that structured physical activity, rather than safety-screening status per se, is what improves reproductive outcomes in women with PCOS (29). Cooking-oil type and the intermediate categories of body mass index similarly lost significance after adjustment, suggesting that their crude associations were substantially confounded by correlated factors such as residence, employment, and overall adiposity rather than representing independent effects. These attenuations illustrate the value of multivariable adjustment in distinguishing confounded from independent associations in registry-based data

4.1. Strengths and limitations

The principal strengths of this study are its large sample drawn from a population-based

electronic health-record system and the simultaneous evaluation of a wide range of demographic, clinical, and lifestyle factors. Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference. Second, as a secondary analysis of routine records, the study lacked detailed clinical data—hormonal profiles, ultrasound findings, and the specific diagnostic criteria applied—so case ascertainment relied on recorded ICD-10 codes and may be subject to misclassification. Third, several exposures were self-reported and susceptible to recall and social-desirability bias. Fourth, several clinically relevant covariates were not captured in the electronic health record and could not be examined, including family history of PCOS, infertility history, detailed menstrual characteristics, androgen levels, insulin resistance, lipid profile, use of hormonal medications or metformin, waist circumference, and socioeconomic status; residual confounding from these unmeasured factors cannot be excluded. Fifth, the extent of missing data was not separately quantified for each study variable; consistent with the default behavior of the statistical software used, records with missing values on a given variable were excluded from analyses involving that variable (complete-case analysis), and residual bias from non-random missingness cannot be excluded. Sixth, the strong, counter-intuitive associations for employment, residence, and reproductive history suggest differential ascertainment and residual confounding, and should be regarded as hypothesis-generating. Finally, the sample was restricted to women attending public health centers in one region. It may not represent women using private services, those not seeking care, or the wider Iranian population. Women who seek private or specialist gynecological care may differ systematically from those attending public primary-care centers in socioeconomic status, health-seeking behaviors, and access to earlier diagnosis, and women who do not engage with the healthcare system at all are not represented; both patterns could bias the estimated associations and prevalence in directions that cannot be determined from these data.

5. Conclusions

In this large registry-based sample of Iranian women, PCOS was independently associated with obesity, frequent fast-food consumption, and reproductive history, as well as with coexisting hypertension and anemia. These findings support integrated, prevention-oriented care that emphasizes weight management, dietary modification, and comprehensive reproductive and metabolic health services. Given how strongly routinely recorded features such as hypertension and a history of recurrent miscarriage were associated with PCOS in this cohort, primary care providers could consider active screening for clinical signs of PCOS among women presenting with these features, even in the absence of a primary complaint referable to PCOS (27, 31). Prospective studies with detailed clinical phenotyping are needed to confirm these associations and clarify their causal basis.

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Availability of data and materials: The data supporting the findings of this study were used under license from Mashhad University of Medical Sciences and are not publicly available owing to confidentiality restrictions. They are available from the authors on reasonable request and with permission of Mashhad University of Medical Sciences.

Ethics approval and consent to participate: This study was performed in accordance with

the Declaration of Helsinki and approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.FHMPM.REC.1402.234). As a secondary analysis of existing de-identified data, the requirement for individual informed consent was waived by the ethics committee.

Consent for publication: Not applicable.

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