Risk of polycystic ovary syndrome: a population-based analysis of sociodemographic factors, healthcare access, health behaviors, and health status

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Abstract

Background Polycystic ovarian syndrome (PCOS) is the most prevalent endocrine concern among women of reproductive age. In Saudi Arabia, there is a lack of evidence to identify who is at higher risk of PCOS and what the potential risk factors are. Thus, this study aimed to investigate the associations of PCOS risk with demographic and socioeconomic characteristics, access to healthcare, health behaviors, and health status.

Methods This cross-sectional study was conducted among women in all different regions of Saudi Arabia to assess PCOS risk and related factors. Ethical approval was obtained, and data collectors distributed anonymous, self-administered questionnaires through social media platforms, with informed consent from participants. Sociodemographic characteristics, health behaviors, and perceived stress were measured, with stress assessed using the Arabic version of Cohen's Perceived Stress Scale. Data management and analyses included statistical description, bivariate analysis, and multinomial logistic regression analyses using SPSS, with significance set at $p < 0.05$.

Results The majority were younger than 30 years old, single, educated, urban residents, employed or students, and non-smokers. Most participants reported no chronic illnesses, with an average stress level of 19.71 ($\pm$ 6.68). Concerning the risk of PCOS, 41.3% were at low risk, 33.3% were at suspected risk, 2.9% were at high risk, and 22.5% were diagnosed with PCOS. Factors associated with PCOS risk included age, region of residence, income, weight status, smoking status, presence of chronic conditions, medication and herbal remedy use, and perceived stress. Adjusted findings indicated that younger age, lower income, and higher stress levels were linked to an increased risk of PCOS, while chronic conditions were significantly associated with PCOS diagnosis rates.

Conclusion The study suggested the need for tailored interventions addressing lifestyle, stress, and comorbid disease management to reduce the risk of PCOS and improve women's health outcomes.

Keywords Polycystic ovary syndrome (PCOS), Risk factors, Sociodemographic factors, Health behaviors, Women's health, Stress, Saudi Arabia

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Introduction

Polycystic ovarian syndrome (PCOS) is considered a common women's health issue, which is characterized by endocrinal abnormalities and accompanied by many metabolic disorders [1, 2]. It was first described comprehensively by Stein and Leventhal in 1935 [3]. It is affecting approximately one out of ten women in reproductive ages [4]. While the global prevalence of PCOS is well-documented, its incidence in Saudi Arabia has been less clear. A recent cross-sectional study conducted in the Western region of Saudi Arabia estimated the incidence of PCOS to be about 31.8% [5].

Empirical studies have shown the profound impact of PCOS on women's health [6–9]. Research indicated that even during the fetal period, the disease can cause hyperandrogenism and insulin resistance, leading to numerous health issues, such as menstrual irregularities, infertility, and metabolic complications [6]. A meta-analysis showed that women with PCOS were at greater risk of developing metabolic syndromes, including hyperglycemia, insulin resistance, hypertension, central obesity, and dyslipidemia [7]. Additionally, women with PCOS were more likely to experience gestational diabetes, preeclampsia, preterm delivery, and miscarriages during pregnancy [8, 9]. Despite these negative impacts on women's health, a substantial percentage of PCOS cases remained unrecognized [10]. A retrospective study in southern Australia estimated that 68% of the PCOS cases were undiagnosed [11], and this failure to identify the disease could lead to poor management and severe complications, such as glucose intolerance, hyperlipidemia, type 2 diabetes, insulin resistance, and cardiovascular diseases [11–13].

Previous literature showed that some risk factors, such as obesity, family history of diabetes, family history of infertility, depression, and lack of physical exercise, could be associated with an elevated risk of PCOS [14–16].

Considering each country's unique social and cultural characteristics, studies exploring the risk factors of PCOS among women in Saudi Arabia are scarce. This may result in an incomplete understanding of the condition and hinder the development of tailored prevention and treatment strategies. To optimize public health outcomes, this study investigated the potential influence of demographic and socioeconomic factors, access to healthcare, health behaviors, and health status on PCOS risk in Saudi Arabia.

Method

Study design

A cross-sectional population-based study was conducted among the 13 administrative regions of Saudi Arabia using a convenient sampling technique.

Procedures

Ethical approval was obtained from the institutional review board (IRB) (IRB log No. 23–0975) by the Declaration of Helsinki. To ensure a representative sample encompassing the entire Saudi Arabian population, trained data collectors distributed the questionnaire via several social media platforms, such as WhatsApp, Telegram, and X platform. After reviewing the study's objectives, participants voluntarily agreed to participate and provided informed consent to complete the anonymous, self-administered questionnaire. Inclusion criteria for this study included adult women aged 18 years and older living in Saudi Arabia who provided informed consent. Women who aged 50 years and older served as a reference group in the statistical analyses. This broader age range facilitates a comprehensive examination of PCOS and its implications across different age groups. Our study excluded participants aged under 18 years old. Also, exclusion criteria included women who did not complete the questionnaire, withdrew consent, or provided unreliable responses during data analysis. This approach ensured a focused and reliable assessment of the risk factors associated with PCOS.

Measures

The independent variables were demographic and socioeconomic factors, access to health care, health behaviors, health status and medication use, and perceived stress. The demographic and socioeconomic factors were age, sex, marital status, education, region of residence, family income, and nationality. Access to health care was measured through participants' medical insurance status, categorized as follows: those with medical insurance, non-insured individuals who use public hospitals and clinics, and those who use private hospitals and clinics (out-of-pocket). This classification allows us to evaluate how different insurance statuses impact access to healthcare services among the study population. Health behaviors were assessed by asking about lifestyle choices impacting health, including smoking, diet, and physical activity. Health status and medication use were evaluated using various factors, including weight status, presence of chronic physical and psychological illnesses, and using medications and herbal remedies. For weight status, participants' body mass index (BMI) was calculated using their reported weight in kilograms and height in centimeters, following the standard BMI formula. Based on the calculated BMI, participants were categorized as underweight (BMI < 18.5), normal weight (BMI 18.5 to 24.9), overweight (BMI 25 to 29.9), and obese (BMI ≥ 30). The presence of chronic illnesses was determined by self-reported diagnosis. Additionally, women were asked whether they use medications or herbal remedies. If yes, they had to mention the name of the medication or

herbal remedies used. Perceived stress was assessed using Cohen's Perceived Stress Scale (PSS), which measures how individuals perceive their life as stressful [17–19]. This scale could be further used to screen for individuals at risk of psychological health issues [18–20]. We utilized the Arabic version of the PSS (10 items), which has shown acceptable internal consistency (Cronbach's alpha coefficient=0.67) and strong validity [21]. Each item scored on a 5-point Likert-type scale ranging from 0 to 4, with a maximum score of 40 (the highest stress level) [21].

The primary outcome of interest was the risk of PCOS. Women were categorized into four groups: low risk, suspected risk, high risk, and women diagnosed with PCOS (self-reported diagnosis). For those who were not previously diagnosed with PCOS, the risk of PCOS was evaluated using Haq's Scale for Clinical Evaluation of PCOS [22]. The scale's items aligned with the Rotterdam criteria to facilitate self-reporting PCOS symptoms. Although this tool cannot be used for definite diagnosis as it does not include Polycystic Ovaries ultrasound, it allows researchers to publicly capture a comprehensive view of PCOS symptoms through screening for women who were not diagnosed with PCOS. Items were translated to Arabic using back-forward translation. Before the survey was distributed, its content validity, face validity, and reliability were tested using a pilot sample.

Women were categorized based on their scale scores and any prior PCOS diagnosis into four groups: low risk (scores less than four), suspected risk (scores ranged from 4 to 8), high risk (scores greater than eight), and those diagnosed with PCOS.

The English language version of the whole survey is provided in supplementary file A.

Statistical analysis

Means with standard deviations (SDs) were reported for continuous variables, and frequencies with percentages were reported for categorical data. The reliability of Haq's Scale for Clinical Evaluation of PCOS was tested using Cronbach's alpha. The unadjusted associations of women's characteristics with the risk of PCOS were analyzed using chi-square test and Fisher's exact test. Bivariate associations between perceived stress and sample characteristics were examined using an independent t-test and one-way analysis of variance (ANOVA). The adjusted associations of independent variables with the risk of PCOS were tested using multinomial logistic regression. P values<0.05 were considered to indicate statistical significance. The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS).

Results

Sample size

The response rate to the distributed survey was 95.9%. A total of 1,144 women were invited to participate in the study. Only 4% of the women (n=47) declined to participate. Among the women who expressed initial interest, eligibility was further assessed based on age criteria, and 29 participants were excluded because they were under 18 years old. The final sample comprised 1,068 women who met the study's eligibility criteria. Figure 1 depicts the flowchart outlining the participant recruitment process.

Characteristics

The sample characteristics, including sociodemographic factors, health behavior, access to health care, and health status, were presented in Table 1. A total of 1068 women were enrolled in this study, 91.9% of whom were Saudi citizens. More than half of the participants were less than 30 years old (57.2%), single (50.2%), had a bachelor's degree (72.4%), lived in an urban area (92.8%), had enough income or enough income with savings (81%), and were either employed or students (69.5%). For access to health care, 33.5% had medical insurance, 33.9% of women were non-insured but used public hospitals or clinics, and 32.6% were non-insured and used private hospitals or clinics (out-of-pocket expenditures). For health behaviors, 93.4% were nonsmokers, 78.1% did not follow a healthy diet, and 43.4% did not exercise. For weight status (based on BMI), 40% of participants had normal weight, 29.2% were overweight, 21.9% were obese, and most women had no chronic physical or psychological illnesses (75.1% and 88.4%, respectively). Most women did not use medications or herbal remedies (76.7% and 84.8%, respectively).

Figure 2 displays women's most commonly reported chronic conditions, classified into physical and psychological categories. The prevalence of anxiety and depression among adult females was approximately 19% and 13%, respectively, making them the most common mental health problems in the studied population. Further psychological disorders that were identified included eating disorders (3%) and obsessive-compulsive disorder (5%). For physical conditions, cardiovascular conditions accounted for 34% of the reported conditions, while endocrine and hormonal conditions constituted 16%. Moreover, 16% reported bone pain, 13% had headaches or migraines, 8% reported sleep disorders, and only 4% had skin conditions.

Medications and herbal remedies use

Figure 3 shows the most used medications reported by participants and provides insights into their underlying health profiles. The most frequently used medications
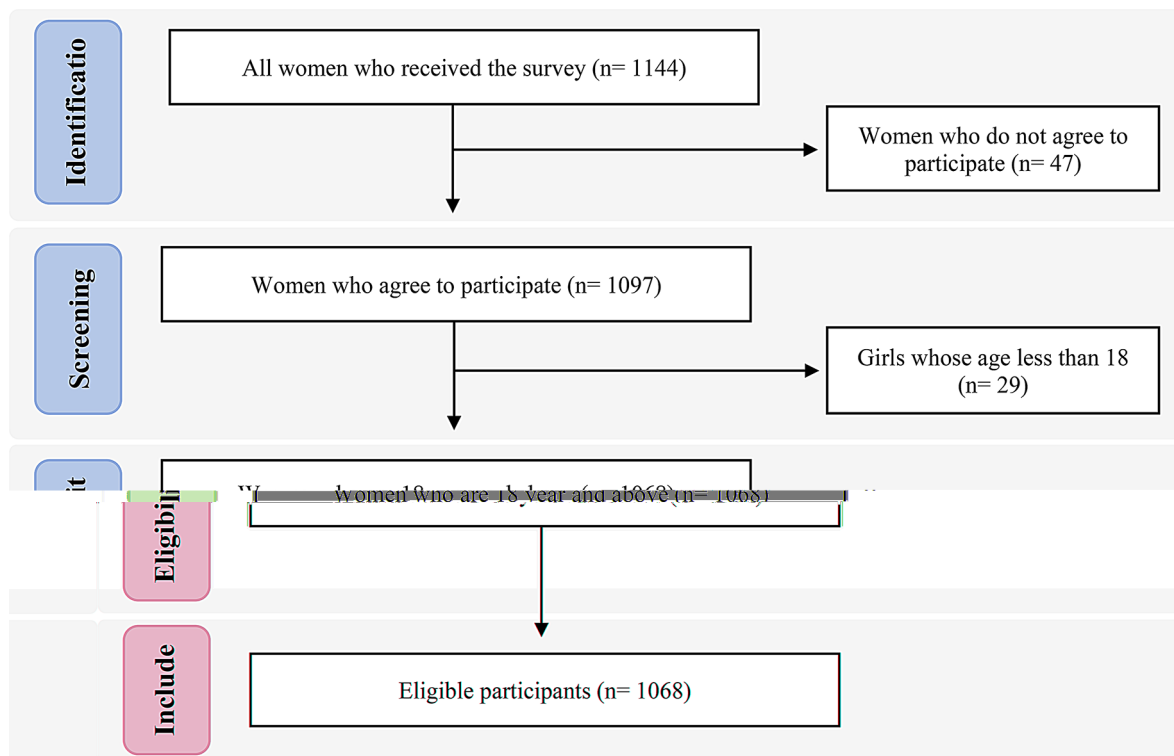
Fig. 1 Flowchart of the study sample

were multivitamin supplements, antihypertensive/cardiac medications, oral antidiabetic medications, or metformin. Additionally, a small proportion reported the use of antidepressants, hypothyroidism, and iron supplements. To gain further insight into the self-reported health practices of women at risk of PCOS, an analysis of the most used herbal remedies within the study sample was conducted (Fig. 4). A significant percentage of women preferred herbal remedies over conventional medicines (*n*=212), highlighting the preference for herbal remedies within the study population. Several herbs emerged as particularly prevalent among participants. These included cumin, anise, chamomile, ginger, marjoram, and purslane. Other herbal remedies were cinnamon, fennel, Indian kudzu, and senna leaves. Furthermore, a wide range of herbal remedies, including coffee husk, peppermint, rosemary, moringa, fenugreek, palm dates, matcha, thyme, lavender, turmeric, sumac, chia seeds, flaxseeds, cloves, frankincense, safflower, olive oil, cardamom, hibiscus, wild blackberry leaves, black seeds, and sesame oil, were reported to a lesser extent.

Unadjusted association between PCOS risk and sample characteristics

The reliability of Haq's Scale for Clinical Evaluation of PCOS was acceptable (Cronbach's alpha=0.716). The bivariate associations of PCOS risk with sample characteristics (sociodemographic factors, health behaviors,

access to health care, and health status) are shown in Table 2. Overall, 41.3% were at low risk of PCOS, 33.3% were at suspected risk of PCOS, 2.9% were at high risk of PCOS, and 22.5% were diagnosed with PCOS. Factors that were significantly associated with PCOS risk included age, marital status, occupation, region of residence, income status, weight status, smoking status, presence of physical and physiological conditions, medication use, use of herbal remedies, and perceived stress.

Perceived stress and sample characteristics

Table 3 demonstrates perceived stress and its association with the sample characteristics. The average perceived stress of women was 19.71 (±6.68). The variables significantly associated with perceived stress were age, marital status, educational level, occupation, income status, nationality, smoking status, diet, physical activity, and the presence of any physical or psychological illness. For age groups, the highest perceived stress score was found for girls younger than 23 years (21.28±6.27), followed by women aged 23 to 30 years (20.85±6.98). Single females had the highest average score for perceived stress (21.18±6.61) compared to married (18.03±6.33) and divorced/widowed women (19.55±6.96). Additionally, the average scores of perceived stress for women who had a bachelor's degree (19.9±6.77), were unemployed and looking for a job (20.05±6.65), had a low income (22.57±6.13), were non-Saudi (21.47±6.58), were

Table 1 Sociodemographic factors, health behaviors, access to health care, and health status of the included women (*N* = 1068)

Characteristics		Frequency	%
Demographic and socioeconomic factors			
Age (years)			
	From 18 to less than 23	336	31.5
	From 23 to less than 30	274	25.7
	From 30 to less than 40	163	15.3
	From 40 to less than 50	164	15.4
	> 50	131	12.3
Marital status			
	Single	536	50.2
	Married	461	43.2
	Divorced/widowed	71	6.6
Educational level			
	Less than or equals to high school	230	21.5
	Bachelor's degree	773	72.4
	Postgraduate	65	6.1
Occupation			
	Student	421	39.4
	Employed in the governmental sector	204	19.1
	Employed in the private sector/business	118	11.0
	Housewife	160	15.0
	Unemployed and looking for a job	102	9.6
	Retired	63	5.9
Region of residence			
	Central province	506	47.4
	Eastern province	166	15.5
	Western Province	219	20.5
	Northern province	103	9.6
	Southern province	74	6.9
Urban or rural			
	Urban	991	92.8
	Rural	77	7.2
Income status			
	Enough and can save money	279	26.1
	Enough	597	55.9
	Not enough	95	8.9
	Not enough and have a debt	97	9.1
Nationality			
	Saudi	982	91.9
	Non-Saudi	86	8.1
Access to healthcare			
Medical insurance status			
	Have medical insurance	358	33.5
	Non-insured & use public hospitals and clinics	362	33.9
	Non-insured & use private hospitals and clinics (out-of-pocket)	348	32.6
Health behaviors			
Smoking status			
	Current smoker	44	4.1
	Past smoker	27	2.5
	Non-smoker	997	93.4
Following a healthy diet			
	No	834	78.1
	Yes	234	21.9
Exercises/physical activities			

Table 1 (continued)

Characteristics	Frequency	%
No exercises	463	43.4
1 or 2 times per week	344	32.2
3 or 4 times per week	179	16.8
≥ 5 times per week	82	7.7
Health status and medication use		
Wight status based on body mass index (BMI)		
Underweight	87	8.1
Normal weight	435	40.7
Overweight	312	29.2
Obese	234	21.9
Diagnosis with PCOS		
No	828	77.5
Yes	240	22.5
Presence of chronic physical illnesses		
No	802	75.1
Yes	263	24.6
Presence of chronic psychological illnesses		
No	944	88.4
Yes	118	11.0
Medications use		
No	819	76.7
Yes	249	23.3
Herbal remedies use		
No	906	84.8
Yes	162	15.2
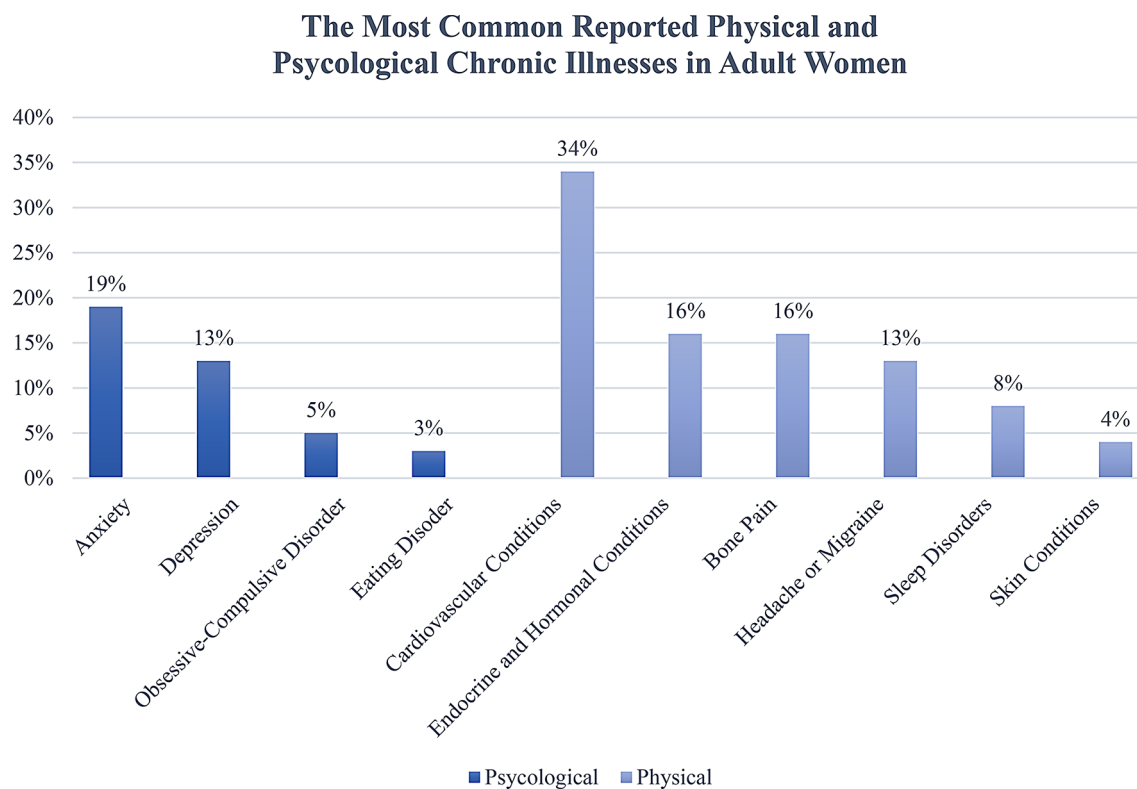
Fig. 2 The most commonly reported physical and physiological chronic illness in adult women
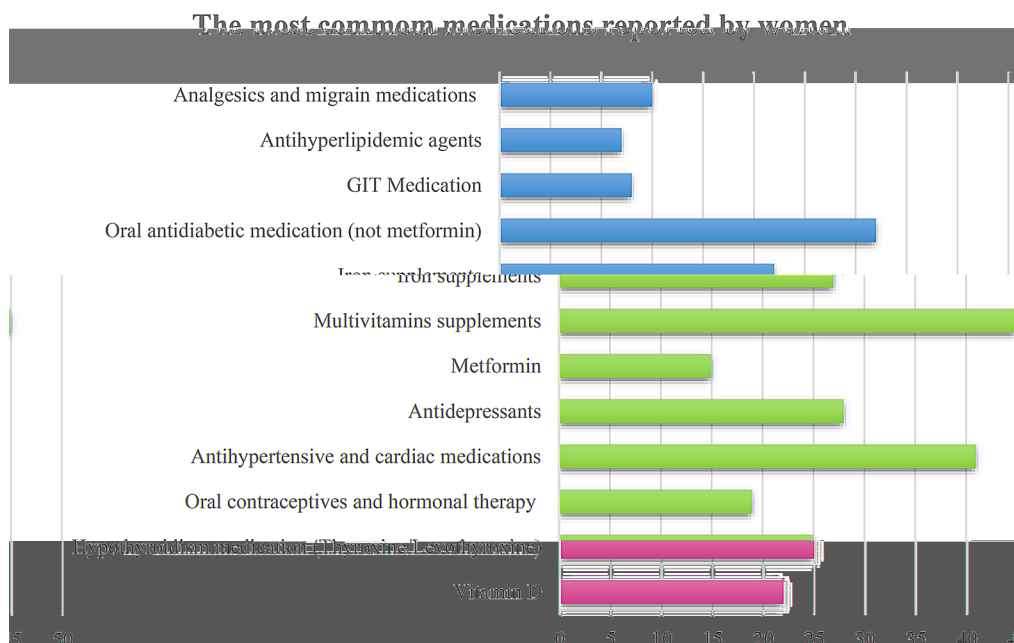
Fig. 3 The most commonly used medications were reported by women in our sample
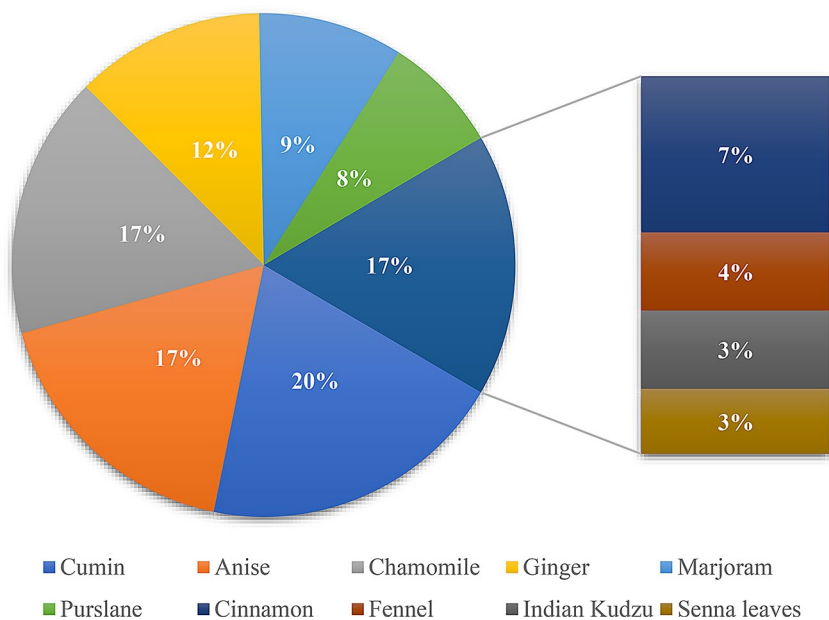
Fig. 4 The most common herbal remedies used by women in our sample

a past smoker (22.81±7.90), had not followed a healthy diet (20.05±7.90), had no exercise or physical activity (20.26±6.52), and reported having a physical illness (20.44±7.13) and psychological illness (24.99±5.52) were greater than those of their counterparts.

Adjusted association of PCOS risk with sample characteristics

The results of multivariate analysis of the associations between PCOS risk and sample characteristics are shown in Table 4. The sample characteristics significantly associated with PCOS risk were age, region of residence, income status, weight status, smoking status, presence of physical and physiological conditions, medication use, use of herbal remedies, and perceived stress. The risk of PCOS was lower in women with enough income (OR=0.54; 95% CI=0.32–0.92) than in women with low income. Similarly, women who were underweight (odds ratio [OR]=0.34; 95% CI=0.18–0.68), had a normal weight (OR=0.43; 95% CI=0.27–0.69), or were

Table 2 Unadjusted association of PCOS risk with sociodemographic factors, health behaviors, access to health care, and health status of the included women (*N* = 1068)

Characteristics		Categories of PCOS risk				P value
		Low risk	Suspected risk	High risk	Diagnosed	
		N (%)	N (%)	N (%)	N (%)	
Total		441 (41.3)	356 (33.3)	31 (2.9)	240 (22.5)	
Demographic and socioeconomic factors						
Age (years)						0.001*
	From 18 to less than 23	146 (43.5)	114 (33.9)	14 (4.2)	62 (18.5)	
	From 23 to less than 30	102 (37.2)	99 (36.1)	8 (2.9)	65 (23.7)	
	From 30 to less than 40	71 (43.6)	36 (22.1)	3 (1.8)	53 (32.5)	
	From 40 to less than 50	69 (42.1)	50 (30.5)	2 (1.2)	43 (26.2)	
	> 50	53 (40.5)	57 (43.5)	4 (3.1)	17 (13.0)	
Marital status						0.01*
	Single	222 (41.4)	192 (35.8)	19 (3.5)	103 (19.2)	
	Married	188 (40.8)	137 (29.7)	9 (2.0)	127 (27.5)	
	Divorced/widowed	31 (43.7)	27 (38.0)	3 (4.2)	10 (14.1)	
Pregnancy						0.33*
	Not pregnant	424 (41.2)	347 (33.7)	29 (2.8)	229 (22.3)	
	Pregnant	17 (43.6)	9 (23.1)	2 (5.1)	11 (28.2)	
Educational level						0.85*
	Less than or quals to high school	92 (40.0)	82 (35.7)	9 (3.9)	47 (20.4)	
	Bachelor's degree	322 (41.7)	254 (32.9)	21 (2.7)	176 (22.8)	
	Postgraduate	27 (41.5)	20 (30.8)	1 (1.5)	17 (26.2)	
Occupation						0.016*
	Student	182 (43.2)	148 (35.2)	15 (3.6)	76 (18.1)	
	Employed in governmental sector	93 (45.6)	48 (23.5)	4 (2.0)	59 (28.9)	
	Employed in private sector/business	50 (42.4)	39 (33.1)	2 (1.7)	27 (22.9)	
	Housewife	56 (35.0)	60 (37.5)	5 (3.1)	39 (24.4)	
	Unemployed and looking for a job	32 (31.4)	36 (35.3)	4 (3.9)	30 (24.4)	
	Retired	28 (44.4)	25 (39.7)	1 (1.6)	9 (14.3)	
Region of residence						< 0.001*
	Central province	199 (39.3)	155 (30.6)	14 (2.8)	138 (27.3)	
	Eastern province	78 (47.0)	61 (36.7)	2 (1.2)	25 (15.1)	
	Western province	106 (48.4)	71 (32.4)	10 (4.6)	32 (14.6)	
	Northern province	33 (32.0)	49 (47.6)	2 (1.9)	19 (18.4)	
	Southern province	25 (33.8)	20 (27.0)	3 (4.1)	26 (35.1)	
Urban or rural						0.508*
	Urban	409 (41.3)	335 (33.8)	29 (2.9)	218 (22.0)	
	Rural	32 (41.6)	21 (27.3)	2 (2.6)	22 (28.6)	
Income status						0.043*
	Enough and can save money	119 (42.7)	90 (32.3)	8 (2.9)	62 (22.2)	
	Enough	259 (43.4)	179 (30.0)	18 (3.0)	141 (23.6)	
	Not enough	31 (32.6)	43 (45.3)	4 (4.2)	17 (17.9)	
	Not enough and have a debt	32 (33.0)	44 (45.4)	1 (1.0)	20 (20.6)	
Nationality						0.988*
	Saudi	404 (41.1)	327 (33.3)	29 (3.0)	222 (22.6)	
	Non-Saudi	37 (43.0)	29 (33.7)	2 (2.3)	18 (20.9)	
Access to healthcare						
Medical insurance status						0.155

Table 2 (continued)

Characteristics		Categories of PCOS risk				P value
		Low risk	Suspected risk	High risk	Diagnosed	
		N (%)	N (%)	N (%)	N (%)	
Total		441 (41.3)	356 (33.3)	31 (2.9)	240 (22.5)	
	Have medical insurance	141 (39.4)	115 (32.1)	13 (3.6)	89 (24.9)	
	Non-insured & use public hospitals and clinics	148 (40.9)	137 (37.8)	10 (2.8)	67 (18.5)	
	Non-insured & use private hospitals and clinics (out-of-pocket)	152 (43.7)	104 (29.9)	8 (2.3)	84 (24.1)	
Health behaviors						
Smoking status						0.011*
	Current smoker	16 (36.4)	11 (25.0)	3 (6.8)	14 (31.8)	
	Past smoker	10 (37.0)	10 (37.0)	4 (14.8)	3 (11.1)	
	Non-smoker	415 (41.6)	335 (33.6)	24 (2.4)	223 (22.4)	
Following a healthy diet						0.586
	No	342 (41.0)	281 (33.7)	27 (3.2)	184 (22.1)	
	Yes	99 (42.3)	75 (32.1)	4 (1.7)	56 (23.9)	
Exercises/physical activities						0.205*
	No exercises	188 (40.6)	154 (33.3)	17 (3.7)	104 (22.5)	
	1 or 2 times per week	151 (43.9)	104 (30.2)	5 (1.5)	84 (24.4)	
	3 or 4 times per week	66 (36.9)	68 (38.0)	5 (2.8)	40 (22.3)	
	≥ 5 times per week	36 (43.9)	30 (36.6)	4 (4.9)	12 (14.6)	
Health status and medication use						
Weight status based on body mass index (BMI)						< 0.001
	Underweight	40 (46.0)	27 (31.0)	1 (1.1)	19 (21.8)	
	Normal weight	204 (46.9)	141 (32.4)	16 (3.7)	75 (24.0)	
	Overweight	132 (42.3)	96 (30.8)	9 (2.9)	75 (24.0)	
	Obese	65 (27.8)	92 (39.3)	5 (2.1)	72 (30.8)	
Presence of chronic physical illnesses						< 0.001
	No	362 (45.1)	258 (32.2)	23 (2.9)	159 (19.8)	
	Yes	77 (29.3)	97 (36.9)	8 (3.0)	81 (30.8)	
Presence of chronic psychological illnesses						< 0.001*
	No	408 (43.2)	311 (32.9)	24 (2.5)	201 (21.3)	
	Yes	30 (25.4)	44 (37.3)	7 (5.9)	37 (31.4)	
Medications use						< 0.001*
	No	364 (44.4)	274 (33.5)	23 (2.8)	158 (19.3)	
	Yes	77 (30.9)	82 (32.9)	8 (3.2)	82 (32.9)	
Herbal remedies use						< 0.001*
	No	393 (43.4)	302 (33.3)	30 (3.3)	181 (20.0)	
	Yes	48 (29.6)	54 (33.3)	1 (0.6)	59 (36.4)	
Perceived stress		18 ± 6.27	20.81 ± 6.49	20.55 ± 7.67	20.93 ± 6.98	< 0.001

* Fisher's exact test was used

overweight (OR=0.53; 95% CI=0.33–0.83) were at lower risk of PCOS than obese women. Women who were diagnosed with physical (OR=1.59; 95% CI=1.04–2.42) or psychological (OR=1.71; 95% CI=1.01–2.88) conditions were more likely to be at suspected risk of PCOS than women without these conditions. The likelihood of being at high risk of PCOS was significantly greater in patients who were past smokers (OR=5.93; 95% CI=1.31–26.91) and had any psychological illness (OR=3.06; 95% CI=1.06–8.84) than in their counterparts. The diagnosis

of PCOS was significantly associated with younger age, region of residence, weight status, presence of any physical or psychological conditions, medication use, and herbal remedy use. Women aged less than 23 years were 6 times more likely to be diagnosed with PCOS than women aged 50 years and older. Women who lived in the eastern region were 60% less likely to be diagnosed with PCOS than those in the southern region (OR=0.42; 95% CI=0.19–0.91). Underweight women (OR=0.37; 95% CI=0.17–0.79), women with normal weight (OR=0.29;

Table 3 Bivariate associations of perceived stress with the sample's characteristics (*N*=1068)

Characteristics		Mean (19.71)	SD (6.68)	*P* value
Demographic and socioeconomic factors				
Age (years)				<0.001
	From 18 to less than 23	21.28	6.27	
	From 23 to less than 30	20.85	6.98	
	From 30 to less than 40	19.34	6.21	
	From 40 to less than 50	17.48	6.16	
	>50	16.55	6.45	
Marital status				<0.001
	Single	21.18	6.61	
	Married	18.03	6.33	
	Divorced/widowed	19.55	6.96	
Pregnancy				**<0.244**
	Not pregnant	19.76	6.62	
	Pregnant	18.49	8.23	
Educational level				**0.02**
	Less than or equals to high school	19.72	5.93	
	Bachelor's degree	19.90	6.77	
	Postgraduate	17.49	7.78	
Occupation				**<0.001**
	Student	21.33	6.50	
	Employed in the governmental sector	18.34	6.57	
	Employed in the private sector/business	19.37	6.96	
	Housewife	18.24	5.90	
	Unemployed and looking for a job	21.05	6.65	
	Retired	15.49	6.10	
Region of residence				**<0.422**
	Central province	19.51	6.70	
	Eastern province	19.86	6.63	
	Western province	20.07	6.43	
	Northern province	19.01	6.84	
	Southern province	20.69	7.16	
Urban or rural				**0.983**
	Urban	19.71	6.74	
	Rural	19.73	5.95	
Income status				<0.001
	Enough and can save money	18.01	7.07	
	Enough	19.75	6.37	
	Not enough	22.57	6.13	
	Not enough and have a debt	21.59	6.54	
Nationality				0.011
	Saudi	19.56	6.67	
	Non-Saudi	21.47	6.58	
Access to healthcare				
Medical insurance status				0.621
	Have medical insurance	19.53	6.77	
	Non-insured & use public hospitals and clinics	19.62	6.57	
	Non-insured & use private hospitals and clinics (out-of-pocket)	19.99	6.72	
Health behaviors				
Smoking status				0.021
	Current smoker	20.93	7.41	
	Past smoker	22.81	7.90	
	Non-smoker	19.57	6.59	
Following a healthy diet				0.002

Table 3 (continued)

Characteristics		Mean (19.71)	SD (6.68)	*P* value
	No	20.05	6.64	
	Yes	18.51	6.69	
Exercises/physical activities				0.003
	No exercises	20.26	6.52	
	1 or 2 times per week	19.81	6.43	
	3 or 4 times per week	19.13	7.19	
	≥5 times per week	17.46	6.99	
Health status and medication use				
Weight status based on body mass index (BMI)				0.294
	Underweight	21.02	6.71	
	Normal weight	19.61	6.61	
	Overweight	19.52	6.78	
	Obese	19.66	6.66	
Presence of chronic physical illnesses				0.046
	No	19.49	6.52	
	Yes	20.44	7.13	
Presence of chronic psychological illnesses				<0.001
	No	19.05	6.54	
	Yes	24.99	5.52	
Medications use				0.257
	No	19.58	6.59	
	Yes	20.13	6.97	
Herbal remedies use				0.093
	No	19.57	6.71	
	Yes	20.52	6.48	

95% CI=0.17–0.49), or overweight women (OR=0.45; 95% CI=0.27–0.74) were less likely to be diagnosed with PCOS than obese women. On the other hand, the presence of any physical or psychological conditions and the use of medications or herbal remedies were associated with an increased likelihood of a PCOS diagnosis. Women who reported having physical illness were two times more likely to be diagnosed with PCOS than women without physical chronic conditions (OR=2.01; 95% CI=1.28–3.16). Similarly, women who reported having a psychological illness were two times more likely to be diagnosed with PCOS than women without chronic psychological conditions (OR=2.12; 95% CI=1.19–3.16). Women who used medication were 1.67 more times to be diagnosed with PCOS (95% CI=1.07–2.61), and women who used herbal remedies were 2.15 more times (95% CI=1.34–3.43) to be diagnosed with PCOS than women who did not use medication or herbal remedies.

Discussion

This study provided valuable insights into the prevalence of polycystic ovary syndrome (PCOS) risk among a sample of Saudi women and its associations with various sociodemographic factors, health behaviors, access to healthcare, and health status.

The participants' sociodemographic profile revealed that most women were Saudi citizens, predominantly younger than 50 years old, single or married with enough income, educated, resided in urban areas, and were employed or students. Access to healthcare varied, with a significant portion relying on public hospitals/clinics or medical insurance. While a positive finding was the high prevalence of non-smokers and a reported absence of physical and psychological illness in most participants, a significant portion of the women did not adhere to healthy dietary practices or engage in regular physical activity. This highlights the need for public health campaigns and interventions explicitly targeting these behaviors to promote the adoption of a healthy lifestyle among women.

The study revealed that more than a third of the sample was at low risk, while a notable proportion of the participants were either at suspected risk (one-third) or diagnosed with PCOS (a quarter), and a tiny portion was at high risk. These results could refer to high awareness about PCOS as there were few individuals at high risk for PCOS who had not been diagnosed. However, the considerable percentage of diagnosed women underscores the importance of understanding the factors contributing to PCOS risk within the female population.

Table 4 Adjusted association of PCOS risk with sociodemographic factors, health behaviors, access to health care, and health status of the included women (*N* = 1068)

Characteristics		Categories of PCOS RISK					
		Suspected risk		High risk		Diagnosed	
		OR (95%CI)	*P* value	OR (95%CI)	*P* value	OR (95%CI)	*P* value
Demographic and socioeconomic factors							
Age (years)							**0.002**
	From 18 to less than 23	0.84 (0.33, 2.14)	0.720	2.88 (0.26, 32.12)	0.390	6.32 (2.01, 19.82)	0.002
	From 23 to less than 30	1.14 (0.51, 2.56)	0.748	1.48 (0.19, 11.75)	0.708	6.31 (2.36, 16.81)	<0.001
	From 30 to less than 40	0.71 (0.35, 1.44)	0.341	0.58 (0.08, 4.03)	0.579	5.39 (2.25, 12.95)	<0.001
	From 40 to less than 50	0.85 (0.49, 1.79)	0.851	0.42 (0.06, 2.95)	0.383	3.29 (1.44, 7.55)	0.005
	> 50	Reference group					
Marital status							**0.167**
	Single	1.51 (0.69, 3.32)	0.302	0.38 (0.057, 2.66)	0.333	1.82 (0.68, 4.87)	0.236
	Married	0.97 (0.51, 1.83)	0.924	0.31 (0.06, 1.57)	0.157	2.05 (0.88, 4.78)	0.095
	Divorced/widowed	Reference group					
Pregnancy							**0.737**
	Not pregnant	1.34 (0.54, 3.34)	0.528	0.61 (0.09, 4.04)	0.607	1.45 (0.59, 3.55)	0.417
	Pregnant	Reference group					
Educational level							**0.914**
	Less than or quals to high school	0.75 (0.35, 1.62)	0.751	0.64 (0.27, 1.49)	0.301	1.20 (0.10, 14.58)	0.301
	Bachelor's degree	0.73 (0.37, 1.44)	0.361	0.61 (0.29, 1.28)	0.187	1.19 (0.11, 12.50)	0.187
	Postgraduate	Reference group					
Occupation							**0.376**
	Student	1.14 (0.45, 2.94)	0.781	0.80 (0.24, 2.73)	0.725	0.80 (0.24, 2.73)	0.725
	Employed in governmental sector	0.80 (0.36, 1.76)	0.572	1.29 (0.46, 3.62)	0.634	1.29 (0.46, 3.62)	0.634
	Employed in private sector/business	1.11 (0.47, 2.66)	0.811	1.08 (0.34, 3.39)	0.896	1.08 (0.34, 3.39)	0.896
	Housewife	1.50 (0.69, 3.25)	0.309	5.74 (0.48, 69.22)	0.169	1.27 (0.45, 3.59)	0.654
	Unemployed and looking for a job	1.55 (0.59, 4.04)	0.372	4.60 (0.26, 82.20)	0.300	1.87 (0.57, 6.22)	0.305
	Retired	Reference group					
Region of residence							**0.005**
	Central province	0.85 (0.43, 1.68)	0.639	0.75 (0.15, 3.79)	0.732	0.91(0.45, 1.78)	0.772
	Eastern province	0.93 (0.45, 1.93)	0.846	0.21 (0.03, 1.64)	0.137	0.41 (0.19, 0.91)	0.028
	Western province	0.83 (0.40, 1.70)	0.604	0.96 (0.17, 5.36)	0.964	0.48 (0.22, 1.03)	0.060
	Northern province	1.76 (0.79, 3.91)	0.168	0.80 (0.10, 6.80)	0.840	0.99 (0.41, 2.37)	0.982
	Southern province	Reference group					
Urban or rural							**0.398**
	Urban	1.41 (0.43, 1.68)	0.275	1.01 (0.20, 4.99)	0.992	0.78 (0.41, 1.47)	0.441
	Rural	Reference group					
Income status							0.054
	Enough and can save money	0.61(0.34, 1.11)	0.104	3.59 (0.38, 33.67)	0.263	1.189 (0.58, 2.45)	0.640
	Enough	0.54 (0.32, 0.92)	0.024	3.98 (0.47, 34.06)	0.207	1.09 (0.56, 2.11)	0.798
	Not enough	0.99 (0.49, 1.98)	0.977	5.11 (0.48, 54.23)	0.176	0.89 (0.37, 2.15)	0.789
	Not enough and have a debt	Reference group					
Nationality							0.736
	Saudi	1.24 (0.69, 2.22)	0.469	2.16 (0.41, 11.21)	0.362	1.19 (0.59, 2.42)	0.626
	Non-Saudi	Reference group					
Access to healthcare							
Medical insurance status							0.242

Table 4 (continued)

Characteristics		Categories of PCOS RISK					
		Suspected risk		High risk		Diagnosed	
		OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value
	Have medical insurance	1.39 (0.94 2.06)	0.099	2.05 (0.7, 5.77)	0.173	1.28 (0.83, 1.97)	0.270
	Non-insured & use public hospitals and clinics	1.36 (0.94, 1.97)	0.104	1.33 (0.46, 3.84)	0.595	0.89 (0.57, 1.37)	0.582
	Non-insured & use private hospitals and clinics (out-of-pocket)	Reference group					
Health behaviors							
Smoking status							0.092
	Current smoker	0.78 (0.34, 1.79)	0.551	3.44 (0.74, 16.02)	0.116	1.64 (0.71, 3.79)	0.25
	Past smoker	0.93 (0.35, 2.48)	0.885	5.93 (1.31, 26.91)	0.021	0.59 (0.14, 2.42)	0.46
	Non-smoker	Reference group					
Following a healthy diet							0.295
	Yes	Reference group					
	No	1.22 (0.83, 1.79)	0.309	2.82 (0.82, 9.68)	0.099	1.12 (0.73, 1.74)	0.598
Exercises/physical activities							0.279
	No exercises	0.79 (0.44, 1.43)	0.793	0.56 (0.15, 2.19)	0.406	1.43 (0.66, 3.10)	0.361
	1 or 2 times per week	0.72 (0.40, 1.31)	0.227	0.23 (0.05 1.06)	0.059	1.38 (0.63, 3.00)	0.418
	3 or 4 times per week	1.15 (0.61, 2.17)	0.674	0.46 (0.10, 2.22)	0.336	1.65 (0.72, 3.78)	0.235
	≥5 times per week	Reference group					
Health status and medication use							
Weight status based on body mass index (BMI)							<0.001
	Underweight	0.35 (0.18, 0.68)	0.002	0.26 (0.02, 2.74)	0.260	0.37 (0.17, 0.79)	
	Normal weight	0.43 (0.27, 0.69)	<0.001	0.88 (0.24, 3.20)	0.850	0.29, (0.17, 0.49)	
	Overweight	0.53 (0.33, 0.83)	0.006	1.27 (0.35, 4.65)	0.720	0.45 (0.27, 0.74)	
	Obese	Reference group					
Presence of chronic physical illnesses							0.017
	Yes	1.59 (1.04, 2.42)	0.031	1.54 (0.53, 4.53)	0.427	2.01 (1.28, 3.16)	0.002
	No	Reference group					
Presence of chronic psychological illnesses							0.024
	Yes	1.71 (1.01, 2.88)	0.046	3.06 (1.06, 8.84)	0.039	2.12 (1.19, 3.16)	0.010
	No	Reference group					
Medications use							0.078
	Yes	1.00 (0.66, 1.52)	0.995	1.58 (0.55, 4.55)	0.393	1.67 (1.07, 2.61)	0.023
	No	Reference group					
Herbal remedies use							0.003
	Yes	1.34 (0.86, 2.11)	0.201	0.29 (0.04, 2.28)	0.239	2.15 (1.34, 3.43)	0.001
	No	Reference group					

Several sociodemographic factors were associated with the risk of PCOS. Age emerged as a significant determinant, with younger women being more susceptible to the condition. Specifically, women under 30 years exhibited a higher likelihood of being diagnosed with PCOS compared to those in older age groups. This finding aligns with the literature highlighting the greater prevalence of PCOS among younger women than among older women [23].

Region of residence and income status also exhibited significant associations with PCOS risk, emphasizing the multifactorial nature of this syndrome. For example,

living in the eastern region of Saudi Arabia was associated with a 59% decrease in the risk of PCOS diagnoses as compared to living in the southern region. For other regions, there was no significant difference in the risk of PCOS after controlling for other variables (sociodemographic variables, health behavior, health status, and access to healthcare).

Although there was heterogeneity in access to health care, this discrepancy had no significant impact on the risk of PCOS or PCOS diagnosis.

In terms of healthy behaviors, smoking was significantly associated with PCOS. In contrast, dietary habits

and physical activity did not correlate substantially with PCOS risk after adjusting for other independent variables such as obesity. Consistent with our results, a previous study conducted in the USA revealed that physical activity and diet were not associated with the risk of PCOS [24].

For health status, perceived stress, weight status, and the presence of any chronic physical and/or psychological conditions were significantly associated with the risk of PCOS after controlling for other independent variables. Higher perceived stress levels were significantly linked to an increased risk of PCOS. Compared to the average women, women with a high risk of PCOS had higher stress levels while women with a low risk of PCOS had lower levels of stress. As shown in a previous study, chronic stress can cause the generation of excessive harmful amounts of free radicals (reactive oxygen species) that could lead to oxidative stress, which is an imbalance in antioxidant capacity [25]. Murri et al. reported a significantly elevated level of the circulating marker of oxidative stress in women with PCOS compared to that in women without PCOS [26]. These consistent and interrelated findings demonstrated the intricate interplay between psychological factors and reproductive health outcomes. Therefore, understanding the risk factors associated with stress could be crucial for reducing the risk of PCOS. Thus, our analyses revealed that younger, single women with low education and low-income levels, non-Saudi nationality, a history of smoking, unhealthy lifestyle behaviors, and those diagnosed with physical and/or psychological illnesses experienced higher levels of stress compared to their counterparts. Therefore, stress management strategies should address these factors to reduce the risk of PCOS in women without the condition and to help manage the disease in those diagnosed with PCOS.

Further, women with existing chronic illnesses, whether physical or psychological, exhibited a 2- to 3-fold greater risk of being diagnosed with PCOS compared to women without any chronic conditions. This underscores the importance of addressing comorbidities in the management and treatment of PCOS. Regarding chronic conditions, anxiety, and depression emerged as the most prevalent mental health issues, while cardiovascular and metabolic disorders were the most common physical health concerns among women.

Interestingly, the study also revealed that the use of medications and herbal remedies significantly increased the likelihood of a PCOS diagnosis. The medications predominantly used included multivitamin supplements, antihypertensive/cardiac medications, and oral antidiabetic medications. Moreover, a substantial portion of the sample preferred herbal remedies.

A few limitations should be considered when interpreting the study's findings. First, using a convenient sample may limit the generalizability of the results to all women in Saudi Arabia. Also, the data related to chronic diseases were based on self-reported diagnoses, which could be prone to recall bias. Furthermore, our study's survey-based nature may not capture the full spectrum of PCOS symptoms, as it relied on women's understanding and perception of their condition. Although Haq's Scale for Clinical Evaluation is intended to provide an overview of potential risk factors rather than definitive susceptibility for those already diagnosed with PCOS, it is a useful screening instrument to categorize women based on reported symptoms that align with the Rotterdam criteria of PCOS diagnosis. Also, this research was a cross-sectional study, no causal relationship can be inferred between the risk of PCOS and the discussed risk factors. However, the multivariate levels of analyses revealed evidence of significant associations with the abovementioned risk factors.

Despite these limitations, our study has multiple strengths. First, this study provided a comprehensive overview of PCOS risk and examined its association with all potential factors, including sociodemographic variables, health behaviors, access to healthcare services, and health status. Second, the sample size was large and robust, with a high response rate of 95.9%, resulting in 1,068 women meeting the study's eligibility criteria. Furthermore, there was variability in the sample's characteristics, with a broad sociodemographic profile representing most women in Saudi Arabia.

Conclusion

The findings of this study underscore the complex interplay of various factors in determining women's health outcomes, particularly about perceived stress and PCOS risk. The study provides valuable insights for healthcare professionals and policymakers in developing targeted interventions and support strategies to mitigate these risks and improve women's health and well-being.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12905-024-03446-9.

Supplementary Material 1

Author contributions

EOA have conceptualized and designed the study. Data analysis has been conducted by EOA. Interpretation of data was done by EOA, NHA, EHA, and AKA. The first draft of the manuscript was prepared by EOA, NHA, EHA, and AKA. All authors reviewed the manuscripts critically. All authors (EOA, NHA, EHA, and AKA) have approved the final version.

Data availability
The submitted manuscript included all essential data. The utilized or analyzed data in this study can be requested from the corresponding author.

Declarations

Ethics approval and consent to participate
Per the Declaration of the Declaration of Helsinki, all procedures and documents were reviewed and approved by the Institutional Review Board (IRB) at Princess Nourah Bint Abdulrahman University (IRB log No. 23–0975). Participants provided informed consent before taking part in the survey. The online survey required participants to confirm their consent by checking a box on the first page before continuing.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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