RESEARCH

Diabetes screening among women with polycystic ovary syndrome: a descriptive study of commercial claims, 2011–2019

Jacklyn Vollmer[1], W. Jay Christian[1] and Mary E. Lacy[1*]

Abstract

Background Polycystic ovary syndrome (PCOS) is a hormonal disorder that affects 6–12% of United States women of reproductive age. Because women with PCOS are at an increased risk of developing type 2 diabetes, clinical practice guidelines from a number of organizations (e.g. American Diabetes Association, American College of Obstetricians and Gynecologists, US Preventive Services Task Force) recommend that individuals with PCOS are routinely screened for diabetes. Guidelines further indicate that an oral glucose tolerance test (OGTT) should be used for diabetes screening in women with PCOS as opposed to an A1C or fasting plasma glucose test. The purpose of this study is two-fold: 1) to estimate rates of diabetes screening among a nationwide sample of commercially insured women with PCOS and 2) to report the percentage of women screened using each test (OGTT, A1C, fasting plasma glucose) among those who were screened.

Methods We used the MarketScan Commercial Claims database (2011–2019) to identify a sample of women aged 18–64 years with PCOS who were free from diabetes at baseline and had ≥ 5 years of continuous enrollment in their insurance plan. PCOS was ascertained using International Classification of Disease diagnosis codes (ICD-9: 256.4; ICD-10: E28.2). Diabetes screening was ascertained using Current Procedural Terminology (CPT) codes (A1C: 8303683037; Fasting blood sugar: 82947; OGTT: 82950). Diabetes screening rates were calculated for the overall study sample as well as across subgroups defined by age, overweight/obesity, hypertension, hypercholesterolemia, and vascular disease.

Results In our sample of 191,110 commercially insured women with PCOS, 73.40% were screened at least once for diabetes during a five-year period. Among the women screened, 19.24% were screened using the Androgen Excess Society (AES)-recommended OGTT, 61.58% were screened using A1C, and 23.37% were screened using fasting blood sugar.

Conclusions In a sample of commercially insured individuals spanning the timeframe 2011–2019, nearly 75% of women with PCOS complied with the ACOG screening guidelines for diabetes. Although OGTT is recommended as the preferred screening tool for women with PCOS it was less commonly used than A1C and fasting blood sugar tests.

Keywords PCOS, Diabetes, Screening, Women, Hormonal disorder

*Correspondence:
Mary E. Lacy
mary.lacy@uky.edu
[1]University of Kentucky, Lexington, KY, USA

Vollmer *et al. BMC Endocrine Disorders*   (2024) 24:194

Page 2 of 6

Background

Polycystic ovary syndrome (PCOS) is a hormonal disorder characterized by the ovaries producing an abnormal amount of androgen (male sex hormones) [1]. PCOS impacts 6–12% of US women of reproductive age and causes symptoms such as irregular periods, excess body hair, weight gain, acne, and infertility [1, 2]. In addition to these symptoms, PCOS also increases the risk of long-term complications like heart disease, endometrial and other cancers, and diabetes [1, 3, 4]. By the age of 30 years, ~25–30% of women with PCOS will have impaired glucose tolerance [2, 5]. Because of this increased risk of diabetes, the American College of Obstetricians and Gynecologists (ACOG), the American Diabetes Association (ADA), and the American Association of Clinical Endocrinology (AACE) recommend that all women with PCOS should be screened for diabetes at PCOS diagnosis and, upon normal results, screening should be repeated at a minimum of 3 year intervals [2, 5, 6]. More frequent screening is recommend for women with additional risk factors [6].

Screening for diabetes can be conducted using measures of hemoglobin A1C, fasting glucose, random glucose, or the oral glucose tolerance test (OGTT) [7]. However, an expert panel appointed by the Androgen Excess Society (AES) recommends that women with PCOS be screened for diabetes with an OGTT rather than other screening measures [8]. This recommendation is based on prior studies showing that, in women with PCOS, fasting glucose failed to recognize glucose intolerance in 58% of cases screened positive by OGTT [3, 8].

Despite the importance of screening in this population of women at high risk for developing diabetes, few studies have estimated compliance with screening guidelines. One study identified patients with PCOS (n=547) at an academic medical center in 2006 and 2011 and, in both time periods, reported that ≤25% completed laboratory screening tests for diabetes [9]. Another study reported that less than 57% of gynecologists and 71% of reproductive endocrinologists screened for diabetes in women newly diagnosed with PCOS [4]. Even fewer of these gynecologists (49%) and reproductive endocrinologists (53%) performed re-screening for diabetes following the initial screen at PCOS diagnosis [10]. Another study reported similar low rates, with ≤25% of PCOS patients undergoing any screening [11]. Understanding current compliance with clinical guidelines for diabetes screening in this high-risk population is important to inform next steps. In this study, we estimated rates of diabetes screening among a nationwide sample of commercially insured women with PCOS in the U.S., and among those who were screened, determined the percentage of women screened using each type of test (OGTT, A1C, fasting plasma glucose). We also compared how screening rates differ among women with PCOS alone versus PCOS plus additional diabetes risk factors (age, overweight or obesity, hypertension, hypercholesterolemia, and vascular disease).

Methods

Study population and data

We conducted a cross-sectional, descriptive study using the Merative MarketScan database to examine rates of diabetes screening among women with PCOS. Merative MarketScan is a claims database that includes data on approximately 3 million enrollees annually who have employer-sponsored insurance. For the current study, we identified all women aged 18–64 years who were free from documented diabetes (no history of diabetes-related diagnoses: ICD-9: 249–250; ICD-10: E08-E13) at the time of their first documented PCOS diagnosis (ICD-9 256.4 or ICD-10 E28.2) during the study period (1/1/2011 to 12/31/2019). This resulted in an initial sample of 301,902 women. We then restricted the population to women with a minimum of five years of continuous enrollment in the MarketScan database, starting from the time of first PCOS diagnosis, to create a population of women with PCOS who were free from diabetes and, based on ACOG, ADA, and AACE guidelines, should have been screened for diabetes at least once during the study period; this resulted in a final analytic sample of n=191,110 women [2, 5, 6].

Outcome ascertainment

The primary outcome was diabetes screening ascertained via Current Procedural Terminology (CPT) codes (83036, 83037, 82947, 82950). CPT codes were extracted starting on the date of first PCOS diagnosis during the study period up to a maximum of five years following PCOS diagnosis. As a secondary analysis, among those who were screened for diabetes, we examined what type of screening test was performed using CPT codes (A1C: 83036, 83037; fasting blood sugar: 82947; OGTT: 82950).

Covariates

In addition to PCOS, we examined presence/absence of select diabetes risk factors that may influence compliance with screening guidelines, including age; overweight or obesity (ICD-9: 278.0, ICD-10: E66); hypertension (ICD-9: 401, ICD-10: I10); hypercholesterolemia (ICD-9: 272, ICD-10: E78); and vascular disease (myocardial disease, congenital heart disease, stroke (ICD-9: 410, 430, 431, 433.x1, 434.x1, 435, 436, 362.3, 414.9, ICD-10: I21.09, I21.19, I21.11, I21.29, I21.4, I21.9, I60, I61, I63, I64, H34.1, G45.1, I25)).

Table 1 Distribution of baseline characteristics of women aged 18–64 with PCOS, Merative MarketScan claims database (2011–2019)

	N = 191,110
Demographics	
Age at first PCOS diagnosis (years), mean (SD)	30.82 (±9.13)
Average time in study (years), mean (SD)	4.31 (±0.71)
Region, n (%)	
North Central	34,485 (18.04)
Northeast	41,195 (21.56)
South	86,809 (45.05)
West	27,268 (14.27)
Unknown	1773 (0.93)
Risk Factors, n (%)	
Age ≥ 45*	13,198 (6.91)
Overweight/Obese*	52,736 (27.59)
Hypertension*	28,321 (14.82)
Hypercholesterolemia*	34,513 (18.06)
Vascular Disease*	1379 (0.72)

PCOS, Polycystic Ovary Syndrome; SD, Standard Deviation; ICD, International Classification of Disease.

*Risk factors for diabetes ascertained via ICD9 and ICD10 codes.

Statistical analysis

We tabulated the distribution of demographic and clinical covariates of the overall sample. Next, we examined the prevalence of diabetes screening overall, by test type and across categories of number of additional diabetes risk factors among women with PCOS.

In addition to PCOS, we categorized participants based on presence/absence of select diabetes risk factors (overweight/obesity, hypertension, hypercholesterolemia, vascular disease, age ≥ 45 years). We examined screening patterns across categories of a summary score of the number of additional risk factors present in addition to PCOS: 0 additional risk factors, 1 additional risk factor, 2 additional risk factors, 3 additional risk factors, and ≥ 4 additional risk factors. We also calculated the time from a patient's first PCOS diagnosis in the study period to their first diabetes screening test performed in the study period. Finally, we examined the association between diabetes screening and presence/absence of individual risk factors using logistic regression models (crude as well as adjusted for age and time in the study). Statistical significance was set at p ≤ 0.05. Data were analyzed using SAS Studio Release 3.8 (Enterprise Edition) (SAS Institute Inc., Cary, NC, USA. 2012–2018).

Results

Selected demographic, clinical, and social characteristics of study participants are displayed in Table 1. Study participants had a mean age of 30.82 years old (±9.13) at PCOS diagnosis, with 6.91% of the population aged 45 years or older. The average time enrolled for our study participants was 4.31 (±0.71) years. The most common risk factor for our sample was overweight/obesity (27.59%), followed by hypercholesterolemia (18.06%), hypertension (14.82%), and vascular disease (0.72%).

The majority of women in our sample (73.40%) were screened at least once for diabetes during the study period (Fig. 1). The most commonly used diabetes test was A1C, with 61.58% of women in our sample screened by A1C. Fasting plasma glucose (23.37%) was the second most common test, followed by OGTT (19.24%). Some
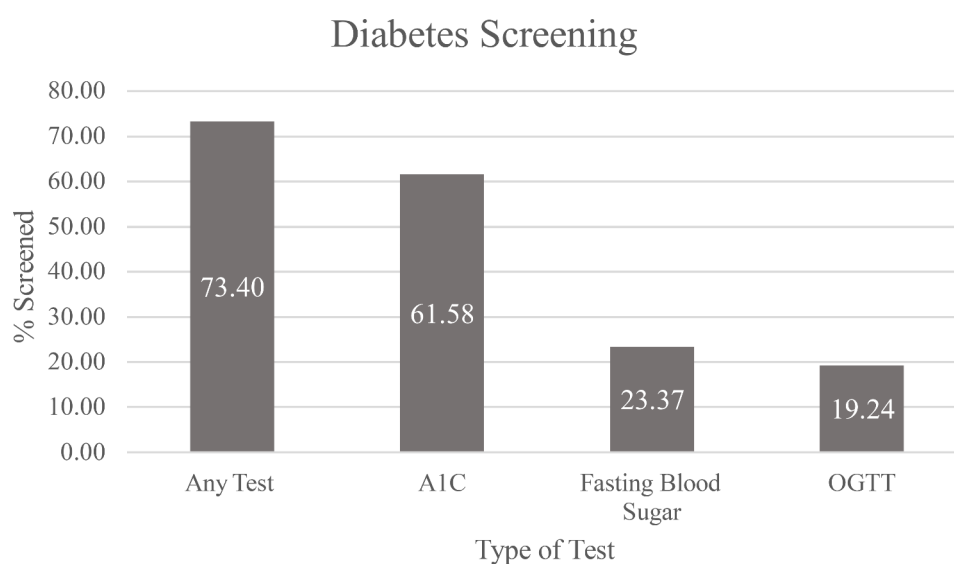

Fig. 1 Prevalence of diabetes screening among women aged 18–64 with PCOS, 2011–2019. Prevalence of diabetes screening, overall and by type of screening test, among women aged 18–64 with PCOS from the Merative MarketScan Commercial Claims and Encounters Database, 2011–2019; Abbreviations: A1c: hemoglobin A1c; OGTT: oral glucose tolerance test

Vollmer *et al. BMC Endocrine Disorders*   (2024) 24:194

Page 4 of 6

individuals (35.37%) were screened by two or more of these tests.

Table 2 displays the prevalence of diabetes screening overall and average time to screening from diagnosis by test type, and across categories of additional diabetes risk factors. The percentage of women ever screened increases as the number of risk factors increases. Women with four or more risk factors in addition to PCOS had the highest prevalence of diabetes screening (86.07%) while those with zero additional risk factors had the lowest (68.40%). Across all risk factor groups, A1C was the most commonly used screening test and OGTT was the least commonly used. The average time to screening from PCOS diagnosis decreased as the number of risk factors increased. Women with one risk factor had a longer time to screening (339.22 days) than women with 4 or more risk factors (243.52 days).

Finally, in logistic regression models, we examined odds of diabetes screening based on presence/absence of additional diabetes risk factors (Table 3). The highest screening rates were found in women with hypercholesterolemia (80.93%), followed by women who were overweight/obese (79.84%), women with hypertension (79.15%), and those with vascular disease (77.30%). In crude and adjusted models, presence of additional risk factors increased odds of screening. In adjusted models, women with PCOS who were also overweight or obese were 1.66 (CI:1.62, 1.70) times more likely to be screened for diabetes than women with PCOS who were not overweight/obese. Presence of hypercholesterolemia (OR=1.68; CI: 1.63,1.73), hypertension (OR=1.44; CI: 1.40, 1.49), and vascular disease 1.23 (1.08, 1.39) were also associated with greater odds of screening as compared to women with PCOS but without the additional risk factor. Women with PCOS who were≥45 years old were less likely to be screened than those with PCOS who were<45 years old (OR=0.96; 95% CI: 0.92, 0.99).

Discussion

In a sample of 191,110 women from the Merative MarketScan database, 73.40% of women with PCOS were screened at least once for diabetes during our 5-year study period. Out of women who were screened, however, only 19.24% were screened using the AES-recommended OGTT [8]; A1C and fasting glucose, which are less reliable tests for women with PCOS, were nonetheless more commonly used to screen for diabetes. Screening for diabetes in women with PCOS is crucial as these women have a higher risk of developing diabetes [2, 3, 8, 10]. In a retrospective analysis, the crude incidence rate of diabetes was 14.25/1000 person-years in women with PCOS compared to 3.45 in those without PCOS [12]. Additionally, a similar study found that PCOS in women

Table 2 Prevalence of diabetes screening by additional diabetes risk factors among women with PCOS

Number of diabetes risk factors	Total, n (%)	Screened for diabetes		Type of Test		
		Yes (%)	Time to first screening (days), mean (SD)	A1C (%)	Fasting glucose (%)	OGTT (%)
Overall		73.40	361.61(±430.47)	61.58	23.37	19.24
0	99,217 (51.92)	68.40	404.85(±449.89)	52.60	22.88	22.43
1	56,488 (29.56)	77.01	339.22(±419.04)	67.91	24.40	17.83
2	24,607 (12.88)	80.77	302.70(±393.49)	75.09	23.67	13.95
3	8688 (4.55)	83.11	281.98(±378.74)	79.30	21.88	9.86
≥4	2110 (1.10)	86.07	243.52(±346.81)	83.51	21.18	7.20

PCOS, Polycystic Ovary Syndrome; A1C, Hemoglobin A1C; OGTT, Oral Glucose Tolerance Test; SD, Standard Deviation.

*Risk factors are in addition to PCOS and include age≥45, overweight/obese, hypertension, hypercholesterolemia, vascular disease.

Vollmer *et al. BMC Endocrine Disorders*   (2024) 24:194

Page 5 of 6

Table 3 Association between diabetes risk factors and odds of diabetes screening among women with PCOS

	Odds of diabetes screening		
	Screened n (%)	Crude Odds Ratio (95% CI)	Adjusted OR (95% CI)
Age			
Age < 45	130,706 (73.47)	Ref	Ref
Age ≥ 45	9570 (72.51)	0.95 (0.92,0.99)	0.96 (0.92, 0.99)*
Overweight/Obese			
No	98,174 (70.95)	Ref	Ref
Yes	42,102 (79.84)	1.62 (1.58, 1.66)	1.66 (1.62, 1.70)†
Hypertension			
No	117,860 (72.40)	Ref	Ref
Yes	22,416 (79.15)	1.45 (1.40, 1.49)	1.44 (1.40, 1.49)†
Hypercholesterolemia			
No	112,343 (71.74)	Ref	Ref
Yes	27,933 (80.93)	1.67 (1.62,1.72)	1.68 (1.63, 1.73)†
Vascular Disease			
No	139,210 (73.37)	Ref	Ref
Yes	1066 (77.30)	1.24 (1.10, 1.40)	1.23 (1.08, 1.39)†

PCOS, Polycystic Ovary Syndrome; CI, Confidence Interval.

*Model only adjusted for time in study.

†Model adjusted for time in study and age at PCOS diagnosis.

was associated with a twofold higher odds of incident diabetes [13].

Overall, a relatively high percentage of the women in our study were screened at least once for diabetes. Though literature is limited, two prior studies reported lower rates of diabetes screening among women with PCOS. One study of PCOS patients identified at an academic medical center in 2006 and 2011 and, in both time periods, reported that ≤ 25% of PCOS patients completed laboratory screening tests for diabetes [9]. Another study surveyed obstetrician-gynecologists to better understand their routine screening practices for patients with PCOS; this study reported that approximately half of respondents (53.2%) stated that they would order diabetes screening tests at least every 5 years on their patients with PCOS following initial results being normal (53.2% stated they would order A1c testing at least every five years; 53.8% fasting glucose testing; 47.1% OGTT) [10]. Many factors may contribute to the high "screened at least once" rate in this study. First, we are evaluating screening over an extended time frame (up to 5 years); current guidelines recommend screening for diabetes upon PCOS diagnosis and upon normal results repeat screening at a minimum of 3- year intervals [2, 5, 6]. Second, this is a population of commercially insured individuals who may have better access to preventive

care than the general US population. Third, in our study population, roughly half of women had additional diabetes-related risk factors beyond PCOS. Screening recommendations for these additional risk factors may have also prompted women in the study to be screened for diabetes. Indeed, rates of diabetes screening increased with each additional diabetes-related risk factor, ranging from 68% in those with no additional risk factors to 86% in those with ≥ 4 risk factors.

We found that the A1C test was the test that was most frequently used to screen for diabetes in this sample. A1C testing offers a number of advantages over glucose-based tests. One of the main advantages of using an A1C test is that fasting is not required and factors such as diet, stress, and exercise do not affect results [11]. A1C testing has also been found to be superior to measure chronic hyperglycemia as opposed to two assessments of fasting blood sugar or OGTT tests [6]. In addition, the stability of A1C tests from whole blood samples is greater than plasma glucose tests [6]. Despite these advantages, however, prior guidelines from an expert panel appointed by the Androgen Excess Society (AES) recommends that women with PCOS be screened for diabetes with OGTT rather than other screening measures as it is more accurate at identifying glucose intolerance [3, 8]. Our findings reveal relatively high overall rates of diabetes screening in this population but highlight a gap in compliance with guideline-recommended OGTT use.

Study strengths include a population drawn from across the US and use of diagnostic and CPT data rather than self-reported data on diabetes screening. Despite these strengths, there are a number of limitations. One limitation of this study was the inability to obtain information on additional diabetes risk factors such as race and ethnicity, family history of diabetes, and physical activity levels. These additional risk factors may have influenced screening frequency and type of test, but these variables were not available through the Merative MarketScan database. We were also unable to differentiate between overweight and obese, which also could have impacted screening type and frequency. In addition, our ascertainment of PCOS was based on diagnosis codes alone. The data in the Merative MarketScan database are claims-based data and, as such, were collected for reasons other than research. It is possible that our study population included some women with a PCOS diagnosis that was a "rule-out" diagnosis and, likewise, it is possible that some women who truly had PCOS were not captured if they did not have a diagnosis code indicative of PCOS during the study period. This study also has a limitation on its generalizability as it only includes data from commercially insured individuals. Future studies should include individuals with publicly funded insurance such as Medicare or Medicaid to fully understand the patterns

Vollmer *et al. BMC Endocrine Disorders*   (2024) 24:194

Page 6 of 6

in these different groups. Finally, in 2022, the ADA broadened diabetes screening guidelines to include all adults aged 35 and older regardless of presence of additional risk factors, including PCOS; previous guidelines recommended screening starting at age 45. As a result, this analysis does not conform to the new guidelines and, as such, does not explicitly examine screening patterns in those 35 and older.

Conclusion

In this study of almost 200,000 women with PCOS, we found that nearly 75% of women were screened for diabetes at least once in a five-year period. We also found that, while OGTT is the recommended screening test for this population, OGTT was the least commonly used screening test. To further explore this area and to better understand diabetes testing within women with PCOS, future research might explore provider recommendations and interactions with their patients. Additional research should also examine the frequency and type of tests and their relationship with PCOS in combination with all additional risk factors for diabetes that were not available within the Merative MarketScan database, such as race/ethnicity, family history, and physical activity levels.

Abbreviations

PCOS	Polycystic Ovary Syndrome
ACOG	American College of Obstetricians and Gynecologists
OGTT	Oral Glucose Tolerance Test
A1C	Hemoglobin A1C
ICD	International Classification of Diseases
CPT	Current Procedural Terminology
AES	Androgen Excess Society
ADA	American Diabetes Association
OR	Odds ratio
CI	Confidence interval

Authors' contributions
ML, JV, and WJC contributed to the study design, interpretation of results and revisions to the manuscript. JV and ML had full access to the data, JV performed statistical analyses. All authors approved the version to be published.

Availability of data and materials
The data that support the findings of this study are available from Merative Truven MarketScan but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are available from the vendor: https://marketscan.truvenhealth.com/marketscanportal/#

Declarations

Ethics approval and consent to participate
Our analysis involved de-identified data from a pre-existing database; the University of Kentucky Institutional Review Board (IRB) waived the need for informed consent and approved the use of this de-identified database under IRB protocol number 43542.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

References
1. Centers for Disease Control and Prevention. PCOS (Polycystic Ovary Syndrome) and Diabetes. [Updated 12/30/2022]. Available from: https://www.cdc.gov/diabetes/basics/pcos.html#:~:text=What%20is%20PCOS%3F,beyond%20the%20child%2Dbearing%20years.
2. Polycystic Ovary Syndrome. ACOG Practice Bulletin, Number 194. Obstet Gynecol. 2018;131(6):e157–71.
3. Legro RS, Kunselman AR, Dodson WC, Dunaif A. Prevalence and predictors of risk for type 2 Diabetes mellitus and impaired glucose tolerance in polycystic ovary syndrome : A prospective, controlled study in 254 affected women. J Clin Endocrinol Metab. 1999;84(1):165–9.
4. Abdel-Rahman MY, Jackson LW, Rodewald KJ, Abdellah MA, Ismail SA, Hurd WW. Polycystic ovary syndrome and diabetes screening: a survey of gynecologists and reproductive endocrinologists. Eur J Obstet Gynecol Reprod Biol. 2012;162(2):178–81.
5. American Diabetes Association Professional Practice Committee; 2. Diagnosis and classification of diabetes: Standards of care in diabetes—2024. Diabetes Care. 2024;47(Supplement_1):S20–42. https://doi.org/10.2337/dc24-S002.
6. Samson SL, Vellanki P, Blonde L, Christofides EA, Galindo RJ, Hirsch IB, … & Valencia WM. American Association of Clinical Endocrinology Consensus Statement: comprehensive type 2 diabetes management algorithm–2023 update. Endocrine Practice 2023;29(5):305–340.
7. Prevention CDC. Diabetes Tests Centers for Disease Control and Prevention [updated 8/10/2021.] Available from: https://www.cdc.gov/diabetes/basics/getting-tested.html.
8. Salley KE, Wickham EP, Cheang KI, Essah PA, Karjane NW, Nestler JE. Glucose intolerance in polycystic ovary syndrome–a position statement of the Androgen Excess Society. J Clin Endocrinol Metab. 2007;92(12):4546–56.
9. Mott MM, Kitos NR, Coviello AD. Practice patterns in screening for metabolic disease in women with PCOS of diverse race-ethnic backgrounds. Endocr Pract. 2014;20(9):855–63.
10. American DA. Standards of medical care in diabetes—2022 abridged for primary care providers. Clin Diabet. 2022;40(1):10–38.
11. Bonora E, Tuomilehto J. The pros and cons of diagnosing diabetes with A1C. Diabetes Care. 2011;34(Suppl 2):S184.
12. Ng NY, Wu H, Lau ES, Zhang X, Yang A, Tsang AY, Yau TT, Kong AP, Ng K, Chung JP, Chow EY. Young-onset diabetes in women with polycystic ovary syndrome: a territory-wide retrospective analysis in Hong Kong. Diabetes Res Clin Pract. 2023;1(199):110640.
13. Wang ET, Calderon-Margalit R, Cedars MI, Daviglus ML, Merkin SS, Schreiner PJ, Sternfeld B, Wellons M, Schwartz SM, Lewis CE, Williams OD. Polycystic ovary syndrome and risk for long-term diabetes and dyslipidemia. Obstet Gynecol. 2011;117(1):6.

Publisher's Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.