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Age-Adjusted Prevalence and Characteristics of Women with Polycystic Ovarian Syndrome in Korea: A Nationwide Population-Based Study (2010–2019)

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Polycystic ovarian syndrome (PCOS) is a common endocrine disorder in women of reproductive age and is associated with an increased risk of obesity, compensatory hyperinsulinemia, dyslipidemia, metabolic syndrome, and endometrial cancer. This study analyzed 544619 women using the Korean Informative Classification of Disease, version 10, codes E28.0–E28.9 in the population-based National Health Information Databases from 2010 to 2019. The age-adjusted incidence and prevalence rates of PCOS over 10 years among Korean women were 2.8% and 4.3%, respectively; and they increased in the late teens, peaked in the 20s, and began to decrease at the age of 30. We also found that the body mass index, levels of fasting blood glucose, and high-density lipoprotein values in the recent two years (2018–2019) were higher in women with PCOS compared to the general population. This is the first study to investigate the prevalence of PCOS in a nationwide population of reproductive-aged Korean women. Further research is needed to examine the short- and long-term health risks and psychological problems associated with PCOS.

Key Words: Polycystic ovarian syndrome, age-adjusted prevalence, population-based study

Polycystic ovarian syndrome (PCOS) is a common endocrine disorder characterized by menstrual dysfunction, anovulation, hyperandrogenism, hirsutism, hyperinsulinemia, hypersecretion of luteinizing hormone, and polycystic ovary in women of reproductive age.[1,2] Although the etiology of PCOS is unknown, it has been associated with increased risk of infertility, type II diabetes mellitus, premature birth, and perinatal death. Moreover, PCOS has been reported to increase the risk of metabolic syndrome, endometrial cancer, ovarian cancer, and cardiovascular disease in the long term.[3-9] The worldwide prevalence of PCOS is reported to range from 2.2% to 26.0%.[10,11] In addition, PCOS has a prevalence rate of 8.7% based on the National Institute of Health (NIH) criteria, 17.8% based on the Rotterdam criteria, and 12% based on the Androgen Excess and PCOS Society (AE-PCOS) definition.[2,12] Knowledge about the prevalence of a disease is useful in understanding and managing its burden in a population.[13] However, most of the studies on the prevalence of PCOS have been derived from Caucasian or other Asian women, and no large-scale community- or population-based studies have been conducted in Korea. Therefore, the present study was conducted to evaluate the prevalence and characteristics of women with PCOS over the past 10 years in Korea.

We used the population-based National Health Information Database (NHID) developed by the Korean National Health Insurance Service (K-NHIS). The NHID contains information on all insurance claims for approximately 97.0% of the population in Korea, and it provides personal information, demographic data, and medical treatment data of Korean citizens, including insured employees, insured self-employed individuals, or medical aid beneficiaries after de-identification.[14] Diagnoses were coded using the Korean Informative Classifica-

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tion of Disease, 10th revision (KICD-10). Initially, we included all PCOS patients in the K-NHIS database from 2010 to 2019. However, due to limitations regarding the amount of data we were able to export, we randomly received 50% of the total number of PCOS patients. Women aged 15–49 years and who had at least one claim per year, under the KICD-10 codes E28.0–E28.9, were included in this study. We excluded women with missing residences (n=9), missing insurance information (n=823), and overlapping cases (n=12385). Among the 603595 PCOS cases, 58976 cases were excluded due to the above-mentioned criteria, and 544619 cases were finally analyzed (Supplementary Fig. 1, only online). All data were analyzed using SAS software (version 9.4; SAS Institute, Inc., Cary, NC, USA). We used the age-adjusted rate to calculate the incidence and prevalence of PCOS. Age confounding occurs when the age distributions of two populations are different and the risk of disease or outcome is different for each age group.[15] To prevent this, the age-adjusted rate is calculated by multiplying the age-specific disease rate by the age-specific weight, and adding the weighting rate across age groups.[15] The age-adjusted rate is a useful statistic for comparing the impact of diseases heavily influenced by age, such as heart disease, cancer, stroke, and diabetes.[16,17] In this study, data from the 2010 Population and Housing Census were used to reflect the age structure of Korean women. The age-adjusted annual prevalence rates of PCOS from 2010 to 2019 were calculated by dividing the number of women with PCOS by the number of Korean women from the 2010 Population and Housing Census. The age-adjusted incidence rate was calculated by dividing the number of new cases of PCOS annually by the number of women at risk. The number of women at risk for each year was calculated using the following equation: [Total number of Korean women from the 2010 Population and Housing Census - (Number of pre-existing cases in the previous year + Half of the number of new cases in the year)]. A Poisson distribution was estimated to calculate the 95% confidence intervals for prevalence and incidence. This study was approved by the Institutional Review Board of the Wonju Severance Christian Hospital Institutional Review Board (IRB no. CR321311).

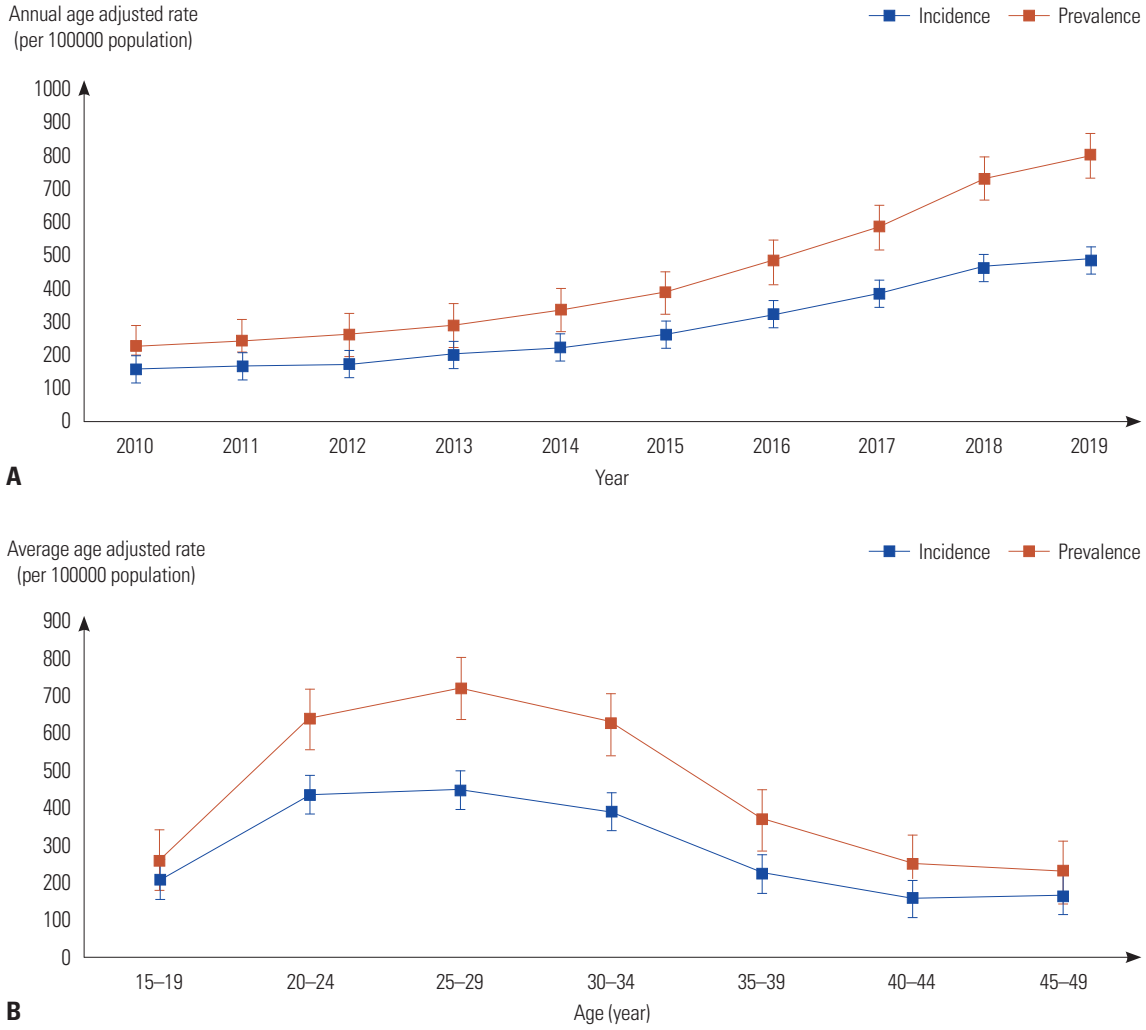

Fig. 1. Age-adjusted prevalence and incidence of PCOS in Korean women aged 15–49 years. (A) Age-adjusted incidence and prevalence of PCOS by year. (B) Age-adjusted incidence and prevalence of PCOS by age. PCOS, polycystic ovarian syndrome.

A total of 544619 PCOS patients were selected for this study. The age-adjusted prevalence and incidence of PCOS by year steadily increased over the past 10 years (Fig. 1). Overall, the age-adjusted incidence and prevalence of women with PCOS among the Korean population were 2.8% and 4.3% over the past 10 years (2010–2019), respectively (Fig. 1 and Supplementary Tables 1 and 2, only online).

These results were similar to those of previous Asian studies, including Korea. According to a community-based epidemiologic study in China and Thailand, the incidence rate of PCOS in each country was 5.6%[8] and 15.5%,[18] respectively. In addition, two previous studies of female university students in Korea reported that the PCOS incidence rates at each university were 4.9% and 5.2%, respectively.[19,20] However, these variations in prevalence may be due to the different study design, race, ethnicity, and diagnostic criteria used.[7,10-12] Deswal, et al.,[10] who systematically reviewed 27 studies on the prevalence of PCOS, reported that the pooled mean prevalence was 21.27% (range, 2.2%–91%). Ding, et al.,[11] who performed a meta-analysis of 13 studies on the prevalence of PCOS according to different ethnicities, reported that the prevalence of PCOS ranged from 5.6% to 16.0%, with the highest prevalence found in the order of black, Middle Eastern, Caucasian, and Chinese women. In a meta-analysis of 30 Iranian women with PCOS, the prevalence of PCOS was reported to be 6.8%, 19.5%, and 4.4% based on the NIH diagnosis, Rotterdam criteria, and ultrasound,[7] respectively. When the distribution was analyzed according to age, the prevalence of PCOS increased from the late teens, peaked in the 20s, and began to decrease from the age of 30 in this study (Fig. 1). This pattern of PCOS was similar to the results of previous studies.[8,21,22] Normally, the ovaries produce large amounts of estrogen and small amounts of androgens.[23] However, when the hormone regulation system is immature in adolescence or endocrine diseases, such as PCOS, are affected, the level of androgens (also called "male hormones") becomes higher than normal.[23,24] These results indicate that if the number of cases of PCOS in teenagers can be reduced, the prevalence and incidence of PCOS in all age groups, and not just those among people in their 20s, can be reduced. Therefore, clinicians, including obstetricians and gynecologists, should pay attention to lowering the overall incidence and prevalence of PCOS through more attention and intervention in teenage PCOS patients.

In the present study, the waist circumference, total levels of cholesterol, low-density lipoprotein (LDL), and triglycerides (TG) in women with PCOS were 72.73–79.16 cm, 118.06–193.59 mg/dL, 105.43–109.33 mg/dL, and 98.73–122.00 mg/dL, respectively, which were similar to those of women of the same age in the 2020 Korea National Health and Nutrition Examination Survey (KNHNES) for the general population (Table 1) and were within the normal range. However, the levels of body mass index (BMI), fasting blood glucose (FBG), and high-density lipoprotein (HDL) in women with PCOS were normal until 2017, but the values in the recent two years (2018–2019) were 24.02, 107.32–110.48 mg/dL, and 57.92–59.37mg/dL, respectively (Table 1), which were higher than the normal values in Korea. This was in line with previous studies, which reported that PCOS is associated with an increased risk of obesity, insulin resistance, compensatory hyperinsulinemia, dyslipidemia (high serum total cholesterol level, high serum LDL level, decreased serum HDL level, or high serum TG level), and metabolic syndrome.[9,14,25-33] A Greek epidemiologic study reported that the BMI, levels of glucose and TG, and blood pressure were significantly higher and that the incidence of metabolic syndrome was 6.6 times higher in women with PCOS than in women without PCOS.[29] A recent population-based study conducted in the United States reported that women with PCOS have an odds ratio of 2.19 [95% confidence interval (CI), 2.02–2.37; ***p<0.001] for GDM,[32] while a meta-analysis study reported that the odds ratio of metabolic syndrome in women with PCOS was 2.57 (95% CI, 2.18–3.02; ***p<0.001).[9]

In summary, this is the first study to investigate the prevalence of PCOS in a nationwide population of reproductive-aged Korean women. The age-adjusted incidence and prevalence of PCOS in Korean women aged 19–49 years were 2.8% and 4.3%, respectively; and the BMI, FBG, and HDL levels in these women were higher than those of the general population. Further research is needed to examine the short- and long-term health risks and psychological problems associated with PCOS.

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AUTHOR CONTRIBUTIONS

Conceptualization: Ju Hee Kim, Min Hyung Jung, and Dae Ryong Kang. Data curation: Nalae Moon, Se Hwa Hong, and Dae Ryong Kang. Formal analysis: Se Hwa Hong and Dae Ryong Kang. Funding acquisition: Ju Hee Kim. Investigation: Ju Hee Kim, Min Hyung Jung, Nalae Moon, and Dae Ryong Kang. Methodology: Ju Hee Kim, Min Hyung Jung, and Dae Ryong Kang. Project administration: Ju Hee Kim. Resources: Ju Hee Kim and Dae Ryong Kang. Software: Ju Hee Kim and Dae Ryong Kang. Supervision: Ju Hee Kim. Validation: Ju Hee Kim, Nalae Moon, and Dae Ryong Kang. Visualization: Ju Hee Kim. Writing—original draft: Ju Hee Kim. Writing—review & editing: Ju Hee Kim, Min Hyung Jung, and Dae Ryong Kang. Approval of final manuscript: all authors.

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Table 1. Medical Characteristics of PCOS

	Year										*p* value
	2010 (n=29740)	2011 (n=31638)	2012 (n=33919)	2013 (n=37376)	2014 (n=42721)	2015 (n=49249)	2016 (n=60479)	2017 (n=72684)	2018 (n=89317)	2019 (n=97496)	
Age (yr)											<0.001*
Mean±SD	31.13±7.80	31.15±8.06	30.96±7.94	31.04±8.18	30.91±8.23	30.97±8.58	30.97±8.77	30.87±8.71	31.05±8.55	31.13±8.53	
Range											
15–19	1931	2091	2273	2591	3043	3640	4485	5273	6101	6335	
20–29	11059	11991	12704	13903	16371	19701	25088	30914	36794	40422	
30–39	12094	12059	13409	14330	15895	16403	18790	22305	29643	32099	
40–49	4656	5479	5533	6552	7412	9505	12116	14192	16779	18640	
Income											<0.001*
Low	12319	13236	13905	15503	17210	19680	24011	28593	35613	38052	
Middle	10634	11275	12178	13378	15233	17828	21560	25913	31883	35066	
High	6787	7127	7836	8495	10278	11741	14908	18178	21821	24378	
Residence											<0.001*
Metropolitan	14759	15580	17003	18624	21072	23998	30671	35958	43627	46445	
Non-metropolitan	14981	16058	16916	18752	21649	25251	11295	36726	45690	51051	
	2010 (n=1385)	**2011 (n=1530)**	**2012 (n=1787)**	**2013 (n=1970)**	**2014 (n=2224)**	**2015 (n=2946)**	**2016 (n=3967)**	**2017 (n=4581)**	**2018 (n=6163)**	**2019 (n=9553)**	**KNHNES 2020**
BMI (kg/m^2)	22.02±3.67	22.34±3.55	22.30±3.83	22.30±3.75	22.59±3.92	22.62±3.87	22.52±3.99	22.85±4.38	24.02±4.14	23.94±3.89	22.64
Waist size (cm)	72.73±8.76	73.22±8.97	73.37±73.37	73.29±9.11	74.10±9.83	74.63±88.42	74.11±22.96	74.77±21.97	79.16±10.69	78.83±14.05	76.52
Fasting blood glucose (mg/dL)	90.02±13.21	90.51±15.16	90.54±15.60	90.46±14.82	91.46±15.39	91.88±15.97	92.01±16.06	92.76±18.51	110.48±34.57	107.32±32.60	92.90
Total cholesterol (mg/dL)	185.32±31.74	118.06±33.69	187.73±32.85	187.42±37.34	189.52±33.55	190.26±35.02	193.59±34.67	191.87±34.88	187.87±41.18	188.52±43.73	189.61
HDL-cholesterol (mg/dL)	62.25±31.95	61.85±14.79	61.72±14.56	63.21±25.51	62.45±15.73	63.40±30.58	65.29±18.48	65.64±18.72	57.92±14.45	59.37±14.51	58.73
LDL-cholesterol (mg/dL)	105.56±33.88	106.30±30.58	105.86±29.23	106.08±54.44	106.62±30.33	106.09±0.33	109.33±42.52	105.43±31.74	-	-	
Triglyceride (mg/dL)	99.45±68.60	98.73±58.19	101.48±74.70	102.01±70.70	103.21±75.46	104.87±15.85	99.70±64.0	105.85±93.03	122.0±70.14	117.24±78.17	127.23

PCOS, polycystic ovarian syndrome; KNHNES, Korea National Health & Nutrition Examination Survey; BMI, body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein.
Data are presented as n or mean±SD.
*Means *p*-value is less than 0.001.

REFERENCES

1. Kim JJ. Update on polycystic ovary syndrome. Clin Exp Reprod Med 2021;48:194-7.
2. Shermin S, Noor A, Jahan S. Polycystic ovary syndrome: a brief review with recent updates. Delta Med Coll J 2019;7:84-99.
3. Teede HJ, Misso ML, Costello MF, Dokras A, Laven J, Moran L, et al. Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. Hum Reprod 2018;33:1602-18.
4. Barry JA, Azizia MM, Hardiman PJ. Risk of endometrial, ovarian and breast cancer in women with polycystic ovary syndrome: a systematic review and meta-analysis. Hum Reprod Update 2014;20:748-58.
5. Gilbert EW, Tay CT, Hiam DS, Teede HJ, Moran LJ. Comorbidities and complications of polycystic ovary syndrome: an overview of systematic reviews. Clin Endocrinol (Oxf) 2018;89:683-99.
6. Hart R, Doherty DA. The potential implications of a PCOS diagnosis on a woman's long-term health using data linkage. J Clin Endocrinol Metab 2015;100:911-9.
7. Jalilian A, Kiani F, Sayehmiri F, Sayehmiri K, Khodaee Z, Akbari M. Prevalence of polycystic ovary syndrome and its associated complications in Iranian women: a meta-analysis. Iran J Reprod Med 2015;13:591-604.
8. Li R, Zhang Q, Yang D, Li S, Lu S, Wu X, et al. Prevalence of polycystic ovary syndrome in women in China: a large community-based study. Hum Reprod 2013;28:2562-9.
9. Otaghi M, Azami M, Khorshidi A, Borji M, Tardeh Z. The association between metabolic syndrome and polycystic ovary syndrome: a systematic review and meta-analysis. Diabetes Metab Syndr 2019;13:1481-9.
10. Deswal R, Narwal V, Dang A, Pundir CS. The prevalence of polycystic ovary syndrome: a brief systematic review. J Hum Reprod Sci 2020;13:261-71.
11. Ding T, Hardiman PJ, Petersen I, Wang FF, Qu F, Baio G. The prevalence of polycystic ovary syndrome in reproductive-aged women of different ethnicity: a systematic review and meta-analysis. Oncotarget 2017;8:96351-8.
12. March WA, Moore VM, Willson KJ, Phillips DI, Norman RJ, Davies MJ. The prevalence of polycystic ovary syndrome in a community sample assessed under contrasting diagnostic criteria. Hum Reprod 2010;25:544-51.
13. Landis SH, Muellerova H, Mannino DM, Menezes AM, Han MK, van der Molen T, et al. Continuing to Confront COPD International Patient Survey: methods, COPD prevalence, and disease burden in 2012-2013. Int J Chron Obstruct Pulmon Dis 2014;9:597-611.
14. Lee J, Lee JS, Park SH, Shin SA, Kim K. Cohort profile: the National Health Insurance Service-National Sample Cohort (NHIS-NSC), South Korea. Int J Epidemiol 2017;46:e15.
15. Gordis L. Epidemiology. 4th ed. Philadelphia: Saunders; 2009.
16. Hu S, He W, Liu Z, Xu H, Ma G. The accumulation of the glycoxidation product N(ε)-carboxymethyllysine in cardiac tissues with age, diabetes mellitus and coronary heart disease. Tohoku J Exp Med 2013;230:25-32.
17. Weir CJ, Murray GD, Dyker AG, Lees KR. Is hyperglycaemia an independent predictor of poor outcome after acute stroke? Results of a long-term follow up study. BMJ 1997;314:1303-6.
18. Avisar I, Gaton DD, Dania H, Stiebel-Kalish H. The prevalence of polycystic ovary syndrome in women with idiopathic intracranial hypertension. Scientifica (Cairo) 2012;2012:708042.
19. Park YJ, Shin H, Jeon S, Cho I, Kim YJ. Menstrual cycle patterns and the prevalence of premenstrual syndrome and polycystic ovary syndrome in Korean young adult women. Healthcare (Basel) 2021;9:56.
20. Byun EK, Kim HJ, Oh JY, Hong YS, Sung YA. The prevalence of polycystic ovary syndrome in college students from Seoul. J Korean Soc Endocrinol 2005;20:120-6.
21. Liu J, Wu Q, Hao Y, Jiao M, Wang X, Jiang S, et al. Measuring the global disease burden of polycystic ovary syndrome in 194 countries: Global Burden of Disease Study 2017. Hum Reprod 2021;36:1108-19.
22. Ganie MA, Rashid A, Sahu D, Nisar S, Wani IA, Khan J. Prevalence of polycystic ovary syndrome (PCOS) among reproductive age women from Kashmir valley: a cross-sectional study. Int J Gynaecol Obstet 2020;149:231-6.
23. Witchel SF, Oberfield SE, Peña AS. Polycystic ovary syndrome: pathophysiology, presentation, and treatment with emphasis on adolescent girls. J Endocr Soc 2019;3:1545-73.
24. Qureshi SS, Gupta JK, Shah K, Upmanyu N. Prevalence and risk factor of polycystic ovarian syndrome. Asian J Pharm Clin Res 2016;9:23-5.
25. Choi YM, Hwang KR, Oh SH, Lee D, Chae SJ, Yoon SH, et al. Progression to prediabetes or diabetes in young Korean women with polycystic ovary syndrome: a longitudinal observational study. Clin Endocrinol (Oxf) 2021;94:837-44.
26. Escobar-Morreale HF, Luque-Ramírez M, González F. Circulating inflammatory markers in polycystic ovary syndrome: a systematic review and metaanalysis. Fertil Steril 2011;95:1048-58.e1-2.
27. Kakoly NS, Khomami MB, Joham AE, Cooray SD, Misso ML, Norman RJ, et al. Ethnicity, obesity and the prevalence of impaired glucose tolerance and type 2 diabetes in PCOS: a systematic review and meta-regression. Hum Reprod Update 2018;24:455-67.
28. Kim JJ, Choi YM. Phenotype and genotype of polycystic ovary syndrome in Asia: ethnic differences. J Obstet Gynaecol Res 2019;45:2330-7.
29. Kyrkou G, Trakakis E, Attilakos A, Panagopoulos P, Chrelias C, Papadimitriou A, et al. Metabolic syndrome in Greek women with polycystic ovary syndrome: prevalence, characteristics and associations with body mass index. A prospective controlled study. Arch Gynecol Obstet 2016;293:915-23.
30. Lizneva D, Kirubakaran R, Mykhalchenko K, Suturina L, Chernukha G, Diamond MP, et al. Phenotypes and body mass in women with polycystic ovary syndrome identified in referral versus unselected populations: systematic review and meta-analysis. Fertil Steril 2016;106:1510-20.e2.
31. Lo JC, Yang J, Gunderson EP, Hararah MK, Gonzalez JR, Ferrara A. Risk of type 2 diabetes mellitus following gestational diabetes pregnancy in women with polycystic ovary syndrome. J Diabetes Res 2017;2017:5250162.
32. Mills G, Badeghiesh A, Suarthana E, Baghlaf H, Dahan MH. Polycystic ovary syndrome as an independent risk factor for gestational diabetes and hypertensive disorders of pregnancy: a population-based study on 9.1 million pregnancies. Hum Reprod 2020;35:1666-74.
33. Carmina E, Nasrallah MP, Guastella E, Lobo RA. Characterization of metabolic changes in the phenotypes of women with polycystic ovary syndrome in a large Mediterranean population from Sicily. Clin Endocrinol (Oxf) 2019;91:553-60.

https://doi.org/10.3349/ymj.2022.63.8.794