

Temporal Trends of Polycystic Ovary Syndrome Burden in the East and Southeast Asia from 1990 to 2021: An Analysis from the Global Burden of Disease Study 2021

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Purpose: Polycystic ovary syndrome (PCOS) is one of the most prevalent endocrine disorders among women of reproductive age. This study aims to assess the current burden of PCOS in East and Southeast Asia and analyze its spatiotemporal trends over the past three decades.

Patients and Methods: Data on the prevalence, incidence, and years lived with disability (YLDs) due to PCOS from 1990 to 2021 were extracted from the GBD 2021. The spatiotemporal trends of PCOS were comprehensively analyzed across multiple levels. Age-Period-Cohort (APC) models were utilized to assess the influence of age, period, and birth cohort on the burden of PCOS, and the future burden of PCOS in the next 10 years was predicted using the autoregressive integrated moving average (ARIMA) model.

Results: In 2021, the estimated number of prevalent cases of PCOS was approximately 10,490,358.5 (95% UI: 7,423,407.5–14,808,757.1) in East Asia and 10,520,027.7 (95% UI: 7,378,813.9–14,809,823.5) in Southeast Asia. The age-standardized prevalence rates (ASPR) of PCOS in East and Southeast Asia were 1548.4 per 100,000 women (95% UI: 1085.5–2170.7) and 2842.7 per 100,000 women (95% UI, 1993.2–3997.5), respectively. Moreover, the ASPR of PCOS exhibited an upward trend from 1990 to 2021. The burden of PCOS varied substantially between countries and age groups, and was positively correlated with SDI levels. PCOS burden showed an increased trend with age, and the period and cohort risk also showed a significant upward trend when compared to the reference groups. Additionally, the burden of PCOS is expected to continue to increase in East Asia by 2031, while it remains stable in Southeast Asia.

Conclusion: The increasing burden of PCOS has become a public health problem in the East and Southeast Asia region. The development of appropriate health measures and strategies to prevent and manage PCOS has become extremely urgent.

Keywords: PCOS/YLDs/prevalence, incidence, SDI

Introduction

PCOS is one of the most common disorders of the endocrine system among women of childbearing, also one of the main causes of infertility.¹ The primary symptoms of PCOS include menstrual irregularities, infertility, excessive hair growth, acne, and obesity.² Research indicates that women with PCOS have a notably higher risk of developing obesity, dyslipidemia, impaired glucose tolerance, and long-term complications like diabetes, endometrial cancer, and cardiovascular disease.^{3,4} Despite understanding that both genetic and environmental factors may contribute to PCOS, its precise cause remains unknown.⁵

Women with PCOS frequently encounter subfertility, body image concerns, and psychological symptoms, all of which can significantly reduce their health-related quality of life.⁶ Despite various interventions aimed at alleviating these symptoms and preventing associated health issues, the medical, emotional, and financial burdens are substantial. It was reported that the direct healthcare annual costs for the mental health disorders associated with PCOS exceeds 4 billion

USD in 2021 for the US population alone.⁷ Considering the similar prevalence of PCOS across the world, the worldwide economic burden of PCOS can be assumed to be enormous. A deeper understanding of the current epidemic trend of PCOS is crucial for enhancing clinical awareness and improving intervention measures for PCOS.

Recent studies have reviewed the disease burden of PCOS in various regions and countries,^{8,9} highlighting its significance in understanding the current global impact of the condition. A study based on GBD 2019 data reported a global age-standardized incidence rate of 59.8 per 100,000 among women of childbearing, a 29.5% increase from 1990.¹⁰ Apart from the Global Burden of Disease (GBD) project, no other studies have provided comprehensive data on the global, regional, and national burden of PCOS or its association with socioeconomic status. The GBD data has been updated from 2019 to 2021, yet, to our knowledge, there are no detailed quantitative estimates of PCOS prevalence, incidence, and associated Years Lived with Disability (YLDs) by age and Socio-Demographic Index (SDI) for East and Southeast Asia.

Age is a significant factor contributing to PCOS prevalence,¹¹ alongside advancements in medical technology that have influenced treatment quality over time. However, the interplay of these time-related factors complicates the quantification of their individual impacts in epidemiological studies. Age-period-cohort (APC) models help isolate these interactions to better illustrate prevalence trends.^{12,13} Currently, no comprehensive studies have examined longitudinal PCOS trends by age, period, and cohort. This study aims to analyze the temporal trends of PCOS burden in East and Southeast Asia from 1990 to 2021, assess the influences of age, period, and cohort effects, and project future burden estimates.

Materials and Methods

Data Source

The data in this study were collected from the GBD 2021 study (<https://vizhub.healthdata.org/gbd-results/>), which estimated key epidemiological parameters—such as incidence, prevalence, mortality, and DALYs—for 204 countries and territories. The relevant data were anonymized and publicly accessible, this study has been reviewed and granted an exemption by the Ethics Committee of the Second Affiliated Hospital of Xi'an Jiaotong University. These estimates were derived through the systematic collection and analysis of published literature, surveys, and epidemiological data by researchers across multiple nations.¹⁴ Detailed methodologies for estimating the burden of diseases, injuries, and risk factors in GBD 2021 have been extensively documented in prior publications.^{15,16} The 204 countries were categorized into five regions according to the Socio-Demographic Index (SDI): low SDI, low-middle SDI, middle SDI, high-middle SDI, and high SDI.

The Social Development Index serves as a comprehensive metric for evaluating the socio-economic progress of each country. It is computed based on three key parameters: average years of education for individuals aged 15 and older, the total fertility rate among women under 25, and income per capita, all scaled from 0 to 1. An SDI of 1 represents the highest levels of education, fertility, and income, while an SDI of 0 indicates the theoretical minimum level of health-related development. All estimates were reported with a 95% uncertainty interval (UI) to reflect the precision and variability of the data.

Case Definition

Polycystic ovary syndrome is one of the most common endocrine and metabolic disorders affecting women of reproductive age. Its typical features include hyperandrogenism, ovulatory dysfunction, and the presence of polycystic ovaries.¹⁷ Presently, there is no consensus on the definition of PCOS; diagnostic criteria include those established by the National Institutes of Health (NIH),¹⁸ the Rotterdam criteria, and the Androgen Excess and PCOS Society (AE-PCOS) criteria.¹⁹ All three sets of diagnostic criteria mandate the presence of multiple signs or symptoms, with the exclusion of secondary potential causes such as congenital adrenal hyperplasia, hyperprolactinemia, and androgen-secreting neoplasms.

In the Global Burden of Disease Study 2021 (GBD 2021), the diagnostic criteria for PCOS were standardized, adopting the American College of Obstetricians and Gynecologists (ACOG) criteria. However, a diagnosis of PCOS can be made using any of the three diagnostic approaches (NIH, Rotterdam, or AE-PCOS).¹⁷ The Rotterdam and AE-PCOS criteria include mild phenotypes, which may result in higher prevalence estimates.²⁰ The NIH criteria stipulate the presence of the following three signs: 1) hyperandrogenism and/or hyperandrogenemia; 2) oligoovulation; 3) the exclusion of other known disorders.

Years Lived with Disability

The Global Burden of Disease Disability Weight survey assessment is founded on comprehensive descriptions of sequelae, which emphasize the principal functional ramifications and symptomatic manifestations of PCOS.²¹ Disability-adjusted life years (DALYs) serve as a standardized metric for quantifying the burden of disease, representing the sum of years of life lost due to premature mortality (YLL) and years lived with disability (YLDs).¹⁰ As there was no evidence indicating that PCOS leads to mortality, the estimates for YLDs and DALYs were identical. The YLDs of PCOS were estimated by multiplying the point prevalence by the appropriate disability weight.

Age–Period–Cohort Model

The age-period-cohort (APC) model, which assumes a Poisson distribution, was employed to independently evaluate the impacts of age, period, and birth cohort on the burden of PCOS. The model was constructed using the R packages “magrittr” and “dplyr”. In this analysis, the age factor is defined by the influence of aging-related factors, while period factors reflect changes in anthropogenic influences over specific time intervals. The cohort factor captures variations in population exposure conditions across different birth periods. For this study, age, period, and birth cohort intervals were each set at 5 years. The net drift quantifies the overall temporal trend, with a p-value ≤ 0.05 indicating statistical significance. The longitudinal age curve was utilized to evaluate age-specific changes in disease burden. Period rate ratios (RR) and cohort RR were employed to assess period and birth cohort effects, respectively. An RR > 1 signifies a higher relative risk of disease compared to the reference cohort, whereas an RR < 1 indicates a lower risk.

Autoregressive Integrated Moving Average Model

The Autoregressive Integrated Moving Average (ARIMA) model was employed to forecast the prevalence of PCOS over the next decade. The ARIMA model integrates three key components: autoregressive (AR), moving average (MA), and differencing (d). It operates on the assumption that time series data consist of random variables that evolve over time, with their autocorrelation patterns effectively captured by the ARIMA framework.²² A fundamental feature of the model is its ability to predict future values based on historical data. The ARIMA model is defined by three parameters: p, d, and q. Here, p represents the order of the autoregressive term, d indicates the degree of differencing required to achieve stationarity, and q denotes the order of the moving average term. Differencing, a core aspect of ARIMA, transforms non-stationary time series into stationary ones, thereby enhancing the model’s accuracy and reliability.²³ The ARIMA model was fitted using the “forecast”, “tseries”, and “ggplot2” packages in R (version 4.4.3).

Statistical Analysis

The data are reported as estimates with 95% uncertainty intervals (UIs), determined by the 2.5th and 97.5th percentiles of the draw-level values, with 1000 simulations performed for each metric.²⁴ The association between the burden of PCOS and SDI was assessed using smoothing splines models. All statistical analyses and visualizations were conducted using GraphPad Prism 8 or R Studio (version 4.4.3) and $P < 0.05$ were considered statistically significant.

Ethics Approval

Ethics approval was not required for this study, as the data utilized were obtained from publicly available sources and did not involve any personal information or privacy concerns. The research adhered to the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) and followed best practices for cross-sectional studies.

Results

The Burden of PCOS in the East and Southeast Asia Region

In 2021, there were 10,490,358.5 (95% UI, 7,423,407.5–14,808,757.1) prevalent cases of PCOS disorders in East Asia (Table 1), and resulted in 89,991.4 (95% UI, 39,441.8–185,701.9) YLDs (Table S2). The age standardized rate (ASR) for prevalence and YLDs were 1548.4 (95% UI, 1085.5–2170.7) and 13.4 (95% UI, 5.9–27.6), respectively. For Southeast Asia, the number of prevalence and YLDs of PCOS in 2021 was 10,520,027.7 (95% UI, 7,378,813.9–14,809,823.5) and 92,605.7

Table 1 The Prevalence Number and Age-Standardized Prevalence of PCOS in 1990 and 2021, and Its Temporal Trends from 1990 to 2021

Location	1990		2021		1990–2021	
	Prevalence Number (95% UI)	ASR per 100,000 (95% UI)	Prevalence Number (95% UI)	ASR per 100,000 (95% UI)	ASR per 100,000 (95% UI)	EAPC (95% CI)
Global	36,651,157.2 (26,227,943.2–50,603,929.8)	1372.8 (984.6–1891.6)	69,473,252.4 (49,531,420.9–95,724,479.2)	1757.8 (1253.4–2421.3)	1757.8 (1253.4–2421.3)	0.74 (0.7–0.77)
East Asia	5,607,180.9 (3,957,250.2–7,863,221.6)	845.6 (600.9–1185.5)	10,490,358.5 (7,423,407.5–14,808,757.1)	1548.4 (1085.5–2170.7)	1548.4 (1085.5–2170.7)	2.04 (1.89–2.19)
People's Republic of China	5,335,329.9 (3,760,542.1–7,501,008.8)	832.9 (591–1169.2)	10,077,520 (7,120,017.1–14,249,277.3)	1544.2 (1081.8–2169.8)	1544.2 (1081.8–2169.8)	2.08 (1.92–2.24)
Taiwan (Province of China)	171,953.6 (115,344.3–249,042.5)	1540.7 (1034.6–2232.9)	281,539 (199,611.4–384,540.6)	2489.9 (1762.4–3400)	2489.9 (1762.4–3400)	1.79 (1.71–1.86)
Democratic People's Republic of Korea	99,897.4 (70,129.4–144,887)	874.9 (614.7–1268.6)	131,299.5 (90,384.9–184,878)	980.6 (674.6–1378.3)	980.6 (674.6–1378.3)	0.32 (0.24–0.41)
Republic of Korea	510,373.3 (358,575.9–733,120.7)	2011.1 (1412.8–2882.3)	749,041.2 (521,395.3–1,062,722.4)	3117.9 (2187.3–4453.2)	3117.9 (2187.3–4453.2)	1.11 (0.78–1.43)
Japan	3,845,218.1 (2,749,649.5–5,341,889.8)	5931 (4259.1–8254.5)	3,234,636.1 (2,310,710.4–4,540,640.1)	6334.1 (4579.7–8798.7)	6334.1 (4579.7–8798.7)	0.2 (0.15–0.24)
Southeast Asia	3,682,948.8 (2,589,198.8–5,201,509.9)	1522.3 (1075.3–2154.4)	10,520,027.7 (7,378,813.9–14,809,823.5)	2842.7 (1993.2–3997.5)	2842.7 (1993.2–3997.5)	2.31 (2.21–2.41)
Democratic Socialist Republic of Sri Lanka	175,610.9 (124,012.7–251,375)	1895 (1335.1–2718)	360,441.9 (254,149.6–503,919.1)	3164.2 (2231.8–4418.5)	3164.2 (2231.8–4418.5)	1.87 (1.66–2.08)
Democratic Republic of Timor-Leste	4651.3 (3242.3–6531.9)	1237.8 (863.3–1736.1)	14,238.9 (10,026.9–20,540.7)	2052.1 (1441.4–2978.8)	2052.1 (1441.4–2978.8)	1.97 (1.87–2.08)
Kingdom of Cambodia	58,608 (40,480.7–83,500.4)	1159.8 (803.4–1661.5)	183,686.4 (127,720.3–263,849.3)	2006.8 (1398.7–2881.2)	2006.8 (1398.7–2881.2)	1.89 (1.86–1.93)
Kingdom of Thailand	576,816.3 (403,601.4–825,251.6)	1787.5 (1248.1–2560.4)	1,145,788.1 (805,847.9–1,629,052.6)	3482.2 (2427.8–4950.7)	3482.2 (2427.8–4950.7)	2.26 (2.11–2.41)
Lao People's Democratic Republic	25,492.2 (17,804.2–35,868.7)	1307.3 (916.4–1836.9)	97,477.7 (68,813–140,227)	2434.5 (1718.6–3501.9)	2434.5 (1718.6–3501.9)	2.23 (2.17–2.29)
Malaysia	216,826 (152,245.2–312,869.4)	2395.2 (1691.7–3456.2)	701,853.9 (489,841.8–1,003,730.5)	4126 (2878.5–5885.4)	4126 (2878.5–5885.4)	1.89 (1.74–2.04)
Mauritius	14,185.8 (9948.4–20,580.4)	2339.8 (1639.3–3402.8)	24,029.6 (16,784.2–34,202)	3769.9 (2642.6–5384.1)	3769.9 (2642.6–5384.1)	1.68 (1.56–1.79)
Brunei Darussalam	3293.3 (2289.6–4790.6)	2426.7 (1692.1–3533.5)	9654.4 (6789–13,508.2)	3797.3 (2681.3–5309)	3797.3 (2681.3–5309)	1.51 (1.36–1.66)
Republic of Indonesia	1,447,748.8 (1,023,213.1–2,041,964.1)	1499.4 (1061.7–2116.9)	4,368,497.5 (3,082,597–6,153,283.6)	2876.6 (2028.5–4056.9)	2876.6 (2028.5–4056.9)	2.39 (2.3–2.47)
Republic of Maldives	1359.9 (935.1–1912.1)	1414.2 (981.8–1979.6)	7696.1 (5304.2–11,085.8)	3297.1 (2261.4–4751)	3297.1 (2261.4–4751)	3.41 (3.14–3.69)
Republic of Singapore	43,470.7 (30,583.6–62,227.8)	2295.5 (1619.1–3282)	111,651 (78,448.4–161,172.9)	3694.7 (2599.4–5295.4)	3694.7 (2599.4–5295.4)	1.54 (1.4–1.69)
Republic of the Philippines	512,458.3 (356,796.3–724,345.5)	1644.3 (1149–2331.8)	1,658,829.5 (1,159,118.3–2,353,345.3)	2801.9 (1957.6–3975.8)	2801.9 (1957.6–3975.8)	2.17 (2.03–2.3)
Republic of the Union of Myanmar	253,072.2 (176,756.8–364,161.1)	1205.6 (838.3–1732.9)	758,041.4 (531,570.9–1,064,624.7)	2487.7 (1744.4–3493.6)	2487.7 (1744.4–3493.6)	2.77 (2.64–2.91)
Seychelles	912.7 (639.2–1305.8)	2498.6 (1750.5–3572.5)	1728.2 (1206.9–2450.3)	3523.9 (2459.9–5007.5)	3523.9 (2459.9–5007.5)	1.08 (1.03–1.14)
Socialist Republic of Viet Nam	389,878.8 (269,102.8–551,551.2)	1133.2 (781.2–1595.7)	1,183,045.2 (824,669.3–1,688,238.3)	2281.4 (1589.8–3247.1)	2281.4 (1589.8–3247.1)	2.81 (2.63–2.99)

Abbreviations: ASR, age standardized rate; CI, confidence interval; EAPC, estimated annual percentage change; UI, uncertainty interval.

(95% UI, 41,149–191,024.1). The ASR of the prevalence and YLDs were 2842.7 (95% UI, 1993.2–3997.5) and 25.1 (95% UI, 11.1–51.7), respectively. Moreover, from 1990 to 2021, the ASR of the prevalence and YLDs of East Asia and Southeast Asia were all increased. The EAPC of prevalence and YLDs in East Asia were 2.04 (95% CI, 1.89–2.19) and 2.06 (95% CI, 1.91–2.21), and the EAPC of prevalence and YLDs in Southeast Asia were 2.31 (95% CI, 2.21–2.41) and 2.28 (95% CI, 2.18–2.37), respectively (Tables 1 and S2). In addition, similar to the trends of prevalence, the incidence of PCOS also showed an upward trend from 1990 to 2021 (Table S1).

The Burden of PCOS at the National Level

In 2021, the ASR for prevalence, incidence, and YLDs of PCOS varied substantially by countries in East and Southeast Asia regions (Figures 1A and S1A, C). Japan had the highest ASR of prevalence (6334.1, 95% UI: 4579.7–8798.7), incidence (266.5, 95% UI: 189.7–375.5) and YLDs (55.1, 95% UI: 25.1–112.0), however, North Korea, had the lowest ASR of prevalence (980.6, 95% UI: 674.6–1378.3), incidence (38.2, 95% UI: 26.4–53.3) and YLDs (8.5, 95% UI: 3.6–17.7). (Tables 1 and S1, S2).

From 1990 to 2021, the ASR for prevalence, incidence, and YLDs of PCOS presented increasing trends in all countries (Figures 2 and S2A, B). Across these countries, the Maldives showed the largest increases in the ASR of prevalence (EAPC=3.41, 95% CI: 3.14–3.69), incidence (EAPC=3.47, 95% CI: 3.2–3.75) and YLDs (EAPC=3.41, 95% CI: 3.14–3.69), while no countries exhibited a decline during the study period (Tables 1, S1, S2 and Figures 1B, S1B, D).

Age Distribution of PCOS Disease Burden

In 2021, the prevalence, incidence, and YLDs of PCOS among different age groups in East and Southeast Asia displayed similar patterns. The higher prevalence is predominantly observed in the 20–44 age group. For East Asia, the peak of the prevalence rate was in the 25–29 age group, while the prevalence rate of PCOS in Southeast Asia peaked in the 20–24 age group (Figure 3A). The incidence rate of PCOS in the East and Southeast Asia regions peaked in the 15–19 age group, after which it declined sharply (Figure 3B). Moreover, the age distribution trend of YLDs is similar to the prevalence of PCOS in East and Southeast Asia (Figure 3C). In addition, across all age groups, Southeast Asia demonstrated a notably higher prevalence and YLD rates than East Asia.

Association Between PCOS Disease Burden and Socio-Demographic Index

At the national level, a generally positive correlation was observed between the SDI and the ASR for YLD of PCOS from 1990 to 2021, suggesting the ASR of YLD increased with their own SDI (Figure 4A). Countries such as Japan, Cambodia, Sri Lanka, Thailand, Malaysia, and Mauritius had higher than expected YLD rate from 1990 to 2021, while countries like North Korea, Indonesia, Taiwan (province of China), South Korea, Singapore, and Viet Nam had a lower than expected

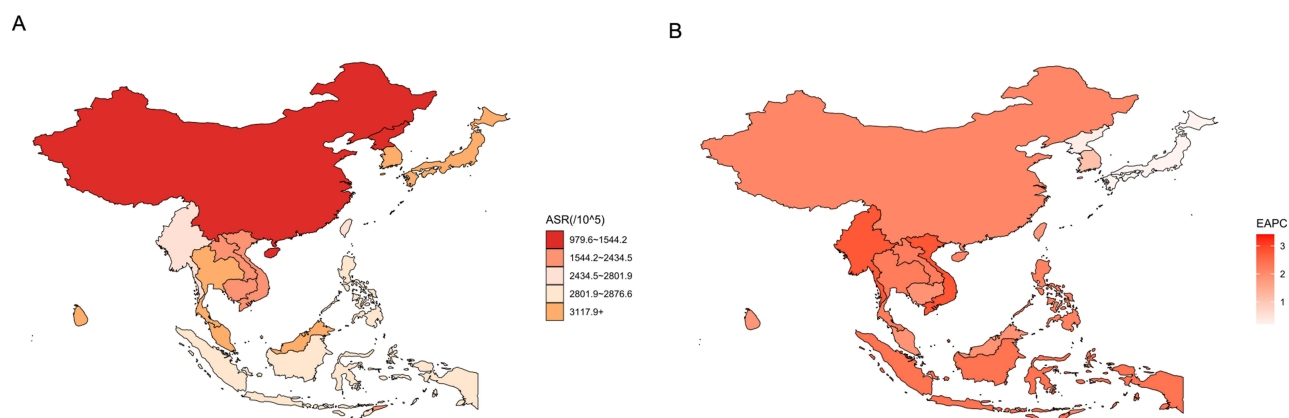


Figure 1 The burden of PCOS prevalence in the East and Southeast Asia. (A) The ASR of prevalence per 100,000 women in 2021; (B) EAPC of prevalence in different country.

Abbreviations: ASR, age standardized rate; EAPC, estimated annual percentage change.

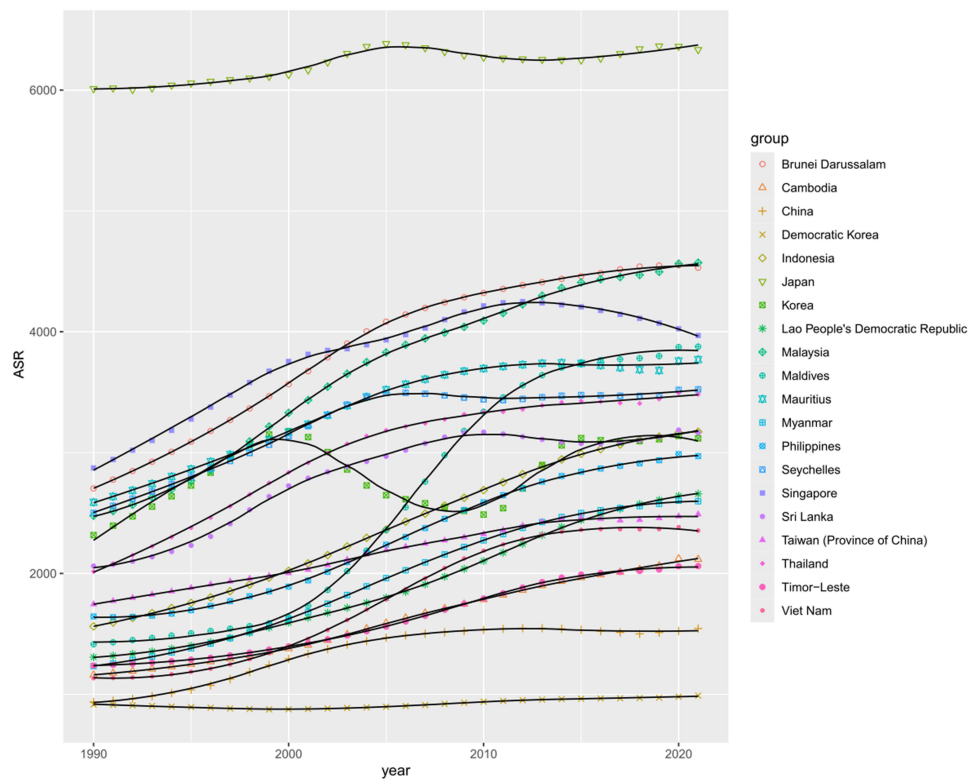


Figure 2 The ASR of prevalence for PCOS (per 100,000 women) in the East and Southeast Asia region from 1990 to 2021, by country.
Abbreviation: ASR, age standardized rate.

ASR of YLD. Moreover, in 2021, there was a positive association between each country's SDI and their ASR of YLDs. Malaysia, Mauritius, Seychelles, Thailand, Maldives, Myanmar, and Laos had much higher than expected age-standardized YLDs, however, North Korea, China, Taiwan (province of China), South Korea, Singapore, and other many countries had lower than expected age-standardized YLDs (Figure 4B). Similar to the above results, the ASR for prevalence and incidence of PCOS were all positively associated with SDI (Figure S3).

Age, Period and Cohort Effects on PCOS Burden

The age-period-cohort model was employed to analyze the effects of age, period, and cohort on the burden of PCOS. Figure 5A showed that the prevalence rate of PCOS in East Asia escalates with advancing age, suggesting an upward trend of the age effect of PCOS. The period rate ratio (RR) demonstrated a gradual increase over time, reflecting a relatively slow rise in risk. Similarly, the cohort RR displayed a significant upward trajectory, with 1975 as the reference birth cohort. The age, period, and cohort effect of PCOS prevalence in Southeast Asia were similar to the overall patterns seen in East Asia (Figure 5B). However, the age, period, and cohort effects on incidence rates of PCOS exhibited various patterns. As for the age factor, incidence rapidly decreased after the 15–19 age. In terms of period effects, the period rate ratio (RR) exhibited an inverted V-shaped pattern, with the 2005–2009 period serving as the reference. For birth cohorts, using 1975 as the reference year, the cohort RR showed a gradual increase. The incidence burden of PCOS remains stable for women born before 1990 and increases for women born in subsequent years (Figure S4A). Moreover, the trends of age-period-cohort effect of PCOS YLDs rate were also similar to the overall trend of prevalence (Figure S4B).

Prediction of PCOS Burden Through 2031

The trends of PCOS burden over the following 10 years in East and Southeast Asia were projected using the ARIMA model. The ASR of prevalence in East Asia was expected to remarkably increase from 1548.43 per 100,000 in 2021 to 1807.25 per 100,000 in 2031 (Figure 6A). However, the ASR of prevalence in Southeast Asia was expected to slightly decrease from 2842.65 per 100,000 in 2021 to 2832.42 per 100,000 in 2031 (Figure 6B). Moreover, the ASR of incidence

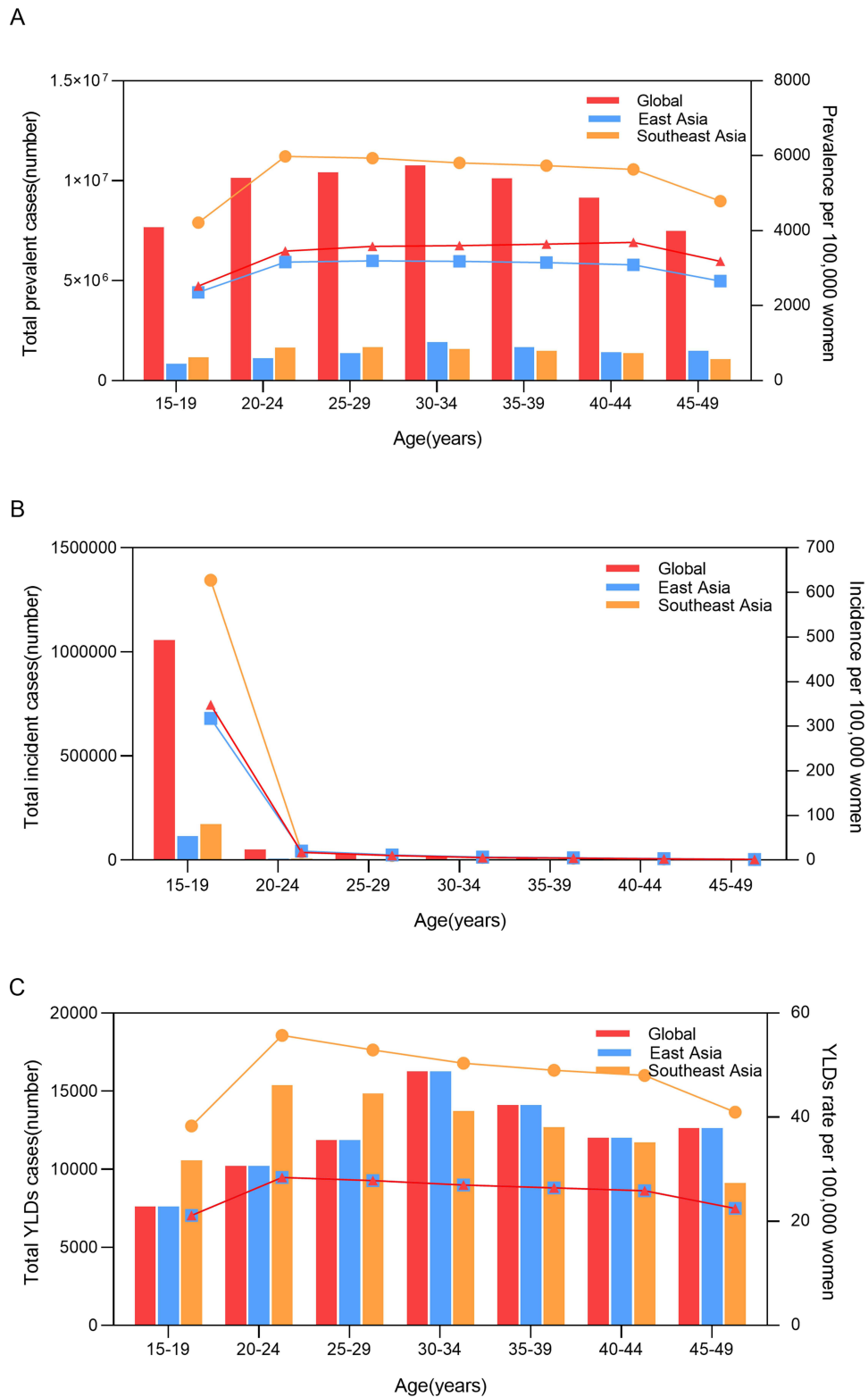


Figure 3 Number of prevalent cases and prevalence, number of incident cases and incidence rate and number of YLDs and YLD rate of PCOS per 100,000 women in the East and Southeast Asian region, by age in 2019. **(A)** Number of prevalent cases and prevalence rate. **(B)** Number of incident cases and incidence rate. **(C)** Number of YLDs and YLD rate.

Abbreviation: YLD, years lived with disability.

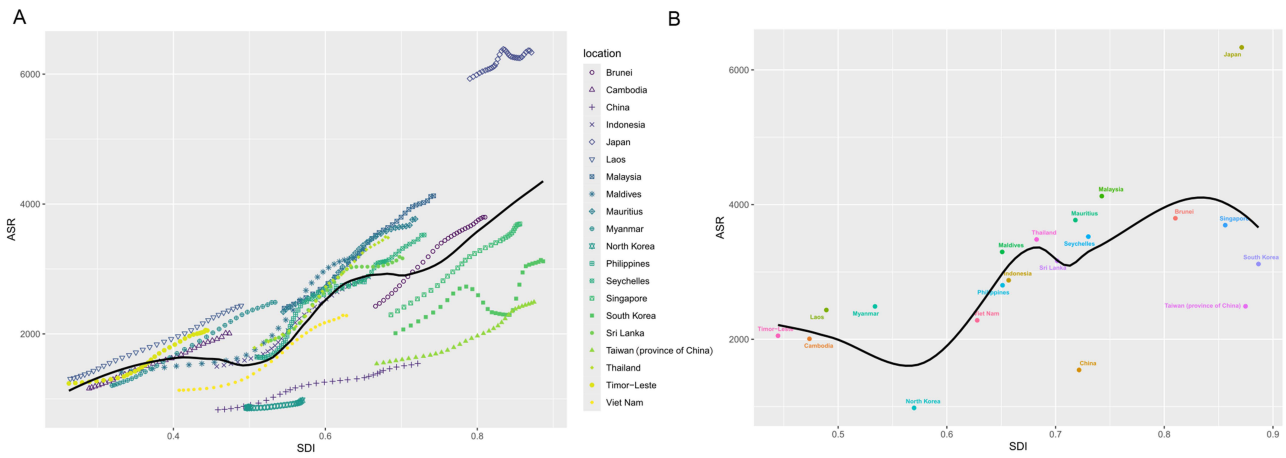


Figure 4 Correlation between age-standardized prevalence rates of PCOS and SDI for 20 countries in the East and Southeast Asian regions. **(A)** ASR of prevalence by SDI from 1990 to 2021. **(B)** ASR of prevalence by SDI in 2021. Expected values based on the SDI and disease rates in all locations are shown as the black line. **Abbreviations:** ASR, age standardized rate; SDI, socio-demographic index.

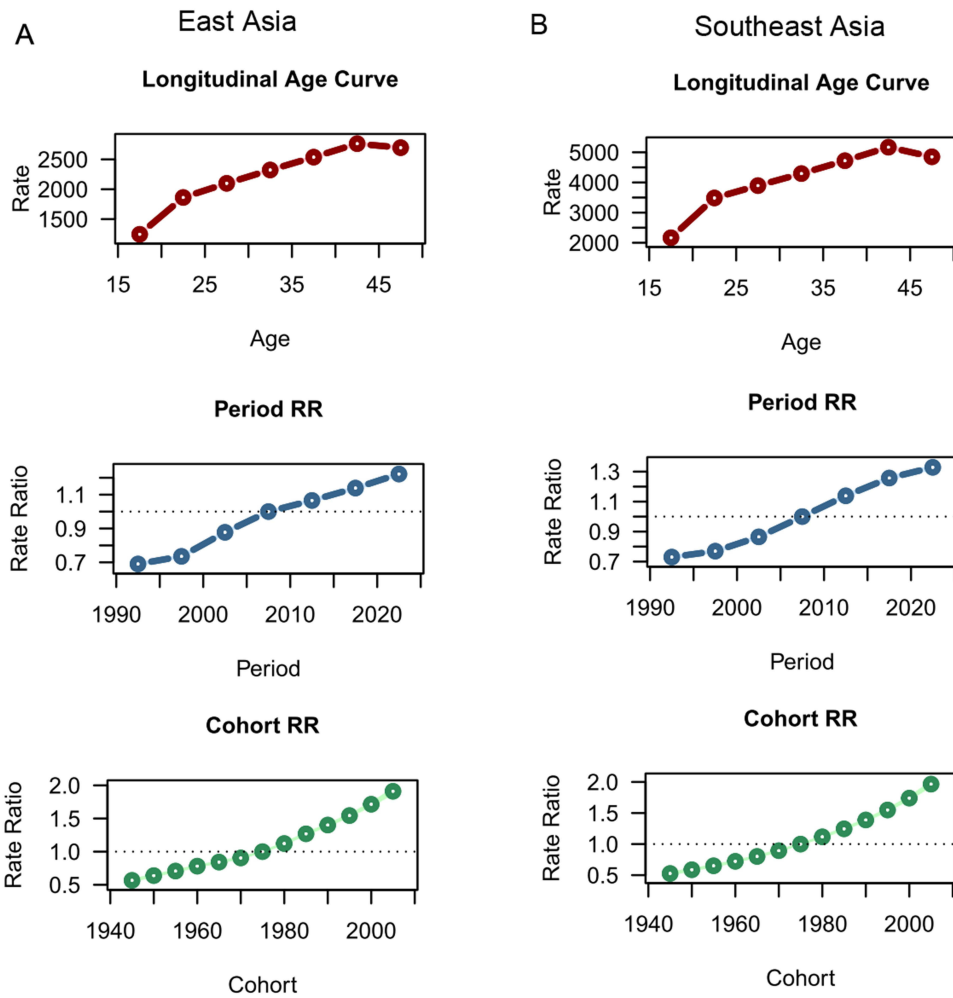


Figure 5 Age–period–cohort effect of burden for ASR of PCOS prevalence. **(A)** Age–period–cohort model of prevalence for East Asia. **(B)** Age–period–cohort model of prevalence for Southeast Asia. Red reflects the age factor, blue is the period factor, and green is the birth cohort factor.

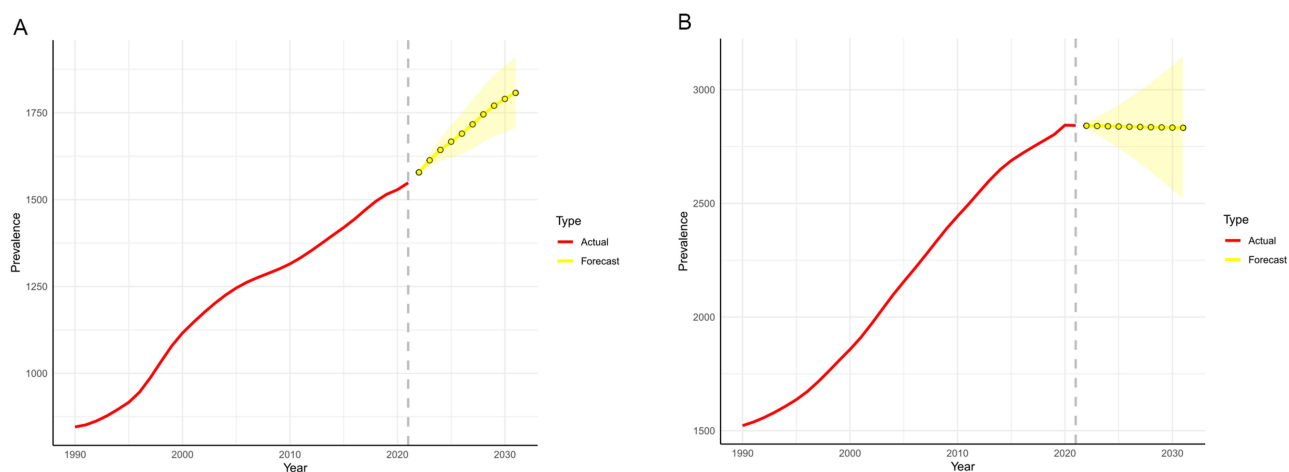


Figure 6 Predicted trends of PCOS prevalence rate over the next 10 years. **(A)** Predicted trends of prevalence rate in East Asia; **(B)** Predicted trends in prevalence rate in Southeast Asia. Red lines represent the true trend of PCOS prevalence rate during 1990–2021; yellow dot lines and shaded regions represent the predicted trend and its 95% CI.

and YLDs of East Asia is also predicted to increase trend, with estimates potentially reaching 67.30 per 100,000 and 15.53 per 100,000 by 2031 ([Figure S5A and B](#)), but the ASR of incidence and YLDs of Southeast Asia is expected to remain overall stable ([Figure S5C and D](#)).

Discussion

PCOS is the most common endocrine disorder among women of reproductive age, impacting systemic metabolism, disrupting the immune system, causing inflammation, and increasing the risk of infertility.²⁵ Recent studies indicate that signaling pathways related to cell apoptosis, such as PI3K-Akt, MAPK/ERK, TNF, and NF- κ B, play significant roles in the pathogenesis and progression of PCOS, although the exact mechanisms were not fully understood.^{26,27} PCOS causes both physical and psychological distress for women of reproductive age, and understanding its long-term disease burden is crucial for raising awareness about prevention. Our study provides a comprehensive analysis of PCOS burden across 20 countries in East and Southeast Asia over three decades, along with a trend forecast for the next 10 years. The findings revealed a progressive increase in the disease burden, with approximately an 80% rise in the ASR of prevalence and YLDs over the past 30 years. In 2021, the number of PCOS prevalent and incident cases was 19.9 million and 320.6 thousand, respectively, and leading to 172.8 thousand YLDs in these regions.

Although previous studies had analyzed the global burden of PCOS based on the data from GBD 2019,²⁸ in this study, various data sources and methodologies were employed in the modeling process. Particularly, we focused on the burden of PCOS in East and Southeast Asia. The ASR for prevalence and YLDs of PCOS showed an obvious increase from 1990 to 2021 in the East and Southeast Asia regions. However, the prevalence and YLDs burden exhibited significant variation across different countries. For example, the higher prevalence and YLDs of PCOS were observed in developed countries, such as Japan, but the burdens were lower in developing countries, such as North Korea, suggesting regional differences. Furthermore, the rate of increase in the burden of PCOS varied significantly across countries, with the Maldives exhibiting the highest percentage change in the ASR of prevalence, incidence, and YLDs. This substantial rise in PCOS incidence may be attributed to factors such as population growth, resource availability, healthcare access, and increasing rates of obesity.²⁹ Previous studies have reported that higher detection rates and greater resource availability caused by rapid social and economic development are an important contributor to the increase in the global burden of PCOS.^{30,31} The rising prevalence of obesity has emerged as a significant contributing factor to the increased incidence of PCOS.³² Numerous studies have established a clear correlation between obesity and higher incidence rates of PCOS, with evidence demonstrating that weight reduction strategies can lead to notable improvements in key PCOS symptoms.³³ This association is particularly concerning given the dramatic global increase in obesity rates among women over the past three decades.³⁴ Since 1980, the worldwide prevalence of obesity has more than doubled, escalating into a major public health challenge with far-reaching implications for conditions like PCOS.³⁵

This study revealed a distinct epidemiological pattern of PCOS in East and Southeast Asia, with the highest prevalence and YLD rates observed in the 20–44 age group, followed by a sharp decline after age 19. The increasing prevalence of overweight individuals, particularly among adolescent girls, coupled with recent findings of elevated hyperandrogenemia in peripubertal adolescents with obesity, suggests this population faces significant risk for PCOS development.³⁶

The analysis further demonstrated a positive correlation between PCOS YLD rates and theSDI, indicating that the disease burden escalates with increasing income levels, educational attainment, and declining fertility rates. Lower SDI countries exhibited reduced PCOS burden, potentially attributable to underdeveloped healthcare infrastructure, limited diagnostic capabilities, and insufficient clinical awareness of the condition.³⁷ Conversely, the elevated PCOS burden in higher SDI nations may reflect more comprehensive healthcare systems, improved diagnostic accuracy, and lifestyle factors associated with rapid economic development.³¹

The rising burden of PCOS can be attributed to a complex interplay of genetic predisposition, environmental influences, and evolving diagnostic criteria over recent decades.³⁸ While genetic factors establish susceptibility, environmental components appear to play a more substantial role in triggering PCOS development in genetically predisposed individuals.³⁹ To systematically evaluate temporal trends, this study employed an age-period-cohort model to assess the impact of demographic factors on PCOS prevalence. The analysis revealed that age-related effects exerted the strongest influence on PCOS risk, particularly among women of reproductive age, indicating a potential escalation of PCOS-related health challenges as populations age. Furthermore, the study identified a consistent upward trend in PCOS prevalence risk across East and Southeast Asia between 1990 and 2021, with later birth cohorts demonstrating elevated risk profiles. These findings underscore the enduring challenge of PCOS prevention and management, highlighting the necessity for comprehensive strategies that account for both societal context and demographic shifts. The persistent increase in PCOS burden emphasizes the need for sustained public health efforts to address this growing reproductive health concern.

Surveillance of disease epidemics and forecasting their trajectories constitute a critical component in the prevention and control of diseases. Based on ARIMA modeling projections, the ASR in East Asia is predicted to reach 1807.25 cases per 100,000 women by the year 2031, representing a significant increase compared to 2021, and the predicted prevalence in Southeast Asia will remain at a relatively high level. However, there is a lack of attention to PCOS by public health authorities and the general public in East and Southeast Asia. The limited awareness and subsequent inadequate treatment accessibility may have contributed to the observed increase in PCOS prevalence in recent years.

To effectively mitigate the disease burden of PCOS and improve health outcomes, a multifaceted strategy should be implemented. This approach should encompass: (1) risk factor management through smoking and alcohol cessation, adoption of low-salt and low-fat diets, regular physical activity, and promotion of other healthy lifestyle behaviors; (2) targeted PCOS screening programs for young and high-risk women; and (3) improved access to high-quality medical services. However, challenges remain in accurately assessing PCOS prevalence due to the condition's clinical heterogeneity, inconsistent diagnostic criteria across ethnic groups, and varying levels of healthcare provider knowledge.⁴⁰ These factors necessitate the development and implementation of standardized, culturally sensitive diagnostic criteria to enable reliable cross-national comparisons of PCOS epidemiology.

This study represents a significant advancement in PCOS research as the first comprehensive analysis to employ modeling techniques in estimating the disease burden across all 20 countries in East and Southeast Asia, incorporating both demographic and non-demographic variables. Nevertheless, several limitations should be acknowledged. First, as with all GBD studies, potential inaccuracies in data registries and collection systems may result in either underestimation or overestimation of the true PCOS burden. Second, the variability in diagnostic criteria across different countries poses challenges for precise inter-country comparisons.

Conclusions

The epidemiological burden of PCOS in East and Southeast Asia demonstrates a concerning upward trend, surpassing global averages. Analysis reveals a consistent increase in PCOS incidence across all countries in this region, with the most pronounced rise observed among adolescents aged 15–19 years. These findings underscore the critical necessity for implementing targeted preventive strategies, particularly focusing on adolescent populations and high SDI nations within

the region. Furthermore, future research should prioritize comprehensive evaluations of country-specific PCOS-related healthcare infrastructure and policy frameworks to inform more effective intervention strategies.

Data Sharing Statement

The data utilized in this study is publicly accessible through the GBD 2021 database. (<https://vizhub.healthdata.org/gbd-results/>).

Ethics Approval and Consent to Participate

This study has passed the review and exemption of the Ethics Committee of the Second Affiliated Hospital of Xi'an Jiaotong University and did not involve individual participants.

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Disclosure

The authors declare no potential conflicts of interest in this work.

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