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ORIGINAL RESEARCH

Global Burden and Future Trends of Polycystic Ovary Syndrome: Insights from the GBD 2021 Study

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Background: Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting women of reproductive age, defined by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. It is associated with infertility, metabolic abnormalities, and an increased cardiovascular risk. This study provides an updated and comprehensive analysis of PCOS burden from 1990 to 2021 using the latest Global Burden of Disease (GBD) dataset, focusing on trends, regional disparities, and future projections.

Methods: Data on the prevalence, incidence, and disability-adjusted life years (DALYs) associated with PCOS were obtained from the GBD 2021. Temporal trends were evaluated using estimated annual percentage change (EAPC). Regional disparities were examined by stratifying data according to the socio-demographic index (SDI). Age-Period-Cohort (APC) modeling was employed to investigate disease dynamics across age groups and birth cohorts, while Bayesian Age-Period-Cohort (BAPC) models were utilized to project global burden trends through 2036.

Results: In 2021, there were 65.8 million prevalent cases, 1.18 million incident cases, and 0.58 million DALYs due to PCOS globally. Middle SDI regions showed the highest growth rates in prevalence (EAPC 1.73%), incidence (EAPC 1.39%), and DALYs (EAPC 1.72%). Adolescents aged 15–19 demonstrated the highest incidence rates, while the peak prevalence shifted to women aged 30–34. High SDI regions had the highest age-standardized rates (ASRs), whereas Southeast Asia exhibited the most rapid growth. BAPC models forecast continued increases in PCOS burden, with prevalence projected to reach 77.87 million by 2036, though the age-standardized prevalence rate (ASPR) and age-standardized DALYs rate (ASDR) are expected to decline.

Conclusion: PCOS represents an urgent global health challenge, with rising burdens, especially in middle-income regions. Targeted and equitable interventions are essential to improve early diagnosis, raise public awareness, and mitigate long-term health and socioeconomic consequences.

Keywords: polycystic ovary syndrome, global burden of disease, socio-demographic index, age-period-cohort model, Bayesian age-period-cohort projections, incidence

Introduction

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder in women of childbearing age, affecting 8–12% of them, and is responsible for 50–70% of anovulatory infertility cases.[1] Moreover, PCOS is a lifelong condition associated with various metabolic and psychological comorbidities, such as insulin resistance, type 2 diabetes, cardiovascular diseases, anxiety, and depression, which can impact patients beyond the menopausal transition.[2,3] This multifaceted disorder has a far-reaching impact on the quality of life, reproductive health, and long-term health of millions of women globally. The increasing burden of PCOS is further amplified by modifiable risk factors, including obesity, sedentary lifestyles, and unhealthy dietary patterns, which are becoming more prevalent worldwide, against the backdrop of rapid urbanization and nutritional transitions.

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Recent studies have attempted to quantify the global burden of PCOS. Zhang et al analyzed data from the Global Burden of Disease (GBD) Study 2019, identifying a 54.3% increase in PCOS incidence, rising from 1.4 million cases in 1990 to 2.1 million in 2019.[4] A study by Tong Lin et al found that from 1990 to 2021, the global age-standardized incidence, prevalence, and disability-adjusted life years (DALYs) rates for PCOS all increased by approximately 27–28%, with the highest disease burden observed in high Socio-demographic Index (SDI) regions and among females aged 15–19 years.[5] Some researchers have also studied the disease burden of PCOS in specific regions. For instance, Motlagh Asghari K's study revealed that the age-standardized prevalence and incidence rates of PCOS in the Middle East and North Africa region increased by 37.9% and 33.7%, respectively, from 1990 to 2019.[6] Similarly, DongYi Shen et al analyzed the infertility burden of PCOS in China from 1990 to 2019, revealing a steady increase in the age-standardized prevalence of PCOS-related female infertility during this period.[7] Qing Chen et al found that the prevalence of PCOS showed a significant increasing trend in East and Southeast Asia from 1990 to 2021, with a positive correlation with the SDI, and this trend is projected to continue in East Asia according to the autoregressive integrated moving average (ARIMA) model prediction.[8]

While previous studies have documented the global burden of PCOS, significant knowledge gaps remain. Recent evidence highlights the evolving epidemiology of PCOS in the context of changing lifestyle factors and diagnostic practices, necessitating an updated comprehensive assessment.[9] To address these gaps, this study expands on previous research by utilizing the GBD 2021 database, which provides the most recent and comprehensive data available, enabling a more detailed analysis of the past three decades (1990–2021), and incorporating finer subregional stratification by SDI. Methodologically, the application of Bayesian Age-Period-Cohort (BAPC) models offers a more robust and probabilistic approach to forecasting future burden, capturing uncertainties inherent in long-term projections. Additionally, by utilizing Age-Period-Cohort (APC) models, our study offers a more nuanced understanding of the global trends and determinants of PCOS burden. These improvements allow for a more precise and actionable understanding of PCOS epidemiology across diverse populations and settings. By identifying high-risk regions and populations, as well as projecting future burden trends, the results can inform targeted screening programs, resource allocation, and preventive interventions. This enables healthcare systems to prioritize early diagnosis and multidisciplinary management approaches, ultimately reducing the long-term metabolic and reproductive complications associated with PCOS.

Materials and Methods

Data Sources and Disease Definition

The GBD 2021 study, conducted by the Institute for Health Metrics and Evaluation (IHME), provides a comprehensive and current epidemiological assessment of 371 diseases and injuries across 204 countries and territories. The dataset, including detailed information on statistical models, methodologies, and previously published findings, is freely accessible via the GBD 2021 database (https://ghdx.healthdata.org/gbd-2021/sources).[10] The diagnostic criteria for PCOS lack universal standardization and are primarily categorized into three widely recognized approaches: the National Institutes of Health (NIH) criteria, the Rotterdam criteria and the Androgen Excess and PCOS Society (AE-PCOS) criteria.[11,12] To enable a unified global assessment of disease burden, GBD 2021 adopted the American College of Obstetricians and Gynecologists (ACOG) core definition yet pursued an inclusive strategy that permits the use of multiple mainstream diagnostic criteria (ie NIH, Rotterdam or AE-PCOS) for identifying polycystic ovary syndrome cases—a decision that reflects a nuanced appreciation of the clinical complexity surrounding PCOS diagnosis. Although these mainstream criteria differ in their specific provisions, they all center on the core features of polycystic ovary syndrome—hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology—thereby affording sufficient epidemiological commonality for integrative analyses.

Statistical Analysis

Temporal trends were evaluated using estimated annual percentage change (EAPC), derived from regression analysis on log-transformed age-standardized rates (ASRs).[13] The burden of PCOS was assessed using counts and ASR (per 100,000) for prevalence, incidence, and DALYs, reported with 95% uncertainty intervals (UIs). All statistical analyses and visualizations were performed using R software (version 4.2.2), with a p-value < 0.05 considered statistically significant.

Stratification by SDI

Countries were classified into five SDI levels—low, low-middle, middle, high-middle, and high—based on indicators of income, education, and fertility rates.[14] This stratification enabled the evaluation of disparities in PCOS burden across different development levels. Subnational trends were analyzed for 21 GBD-defined regions and compared within SDI categories to uncover region-specific variations in disease burden.

APC Model Analysis

The APC model analysis provides insights into the incidence rates and trends of PCOS while identifying shifts in disease patterns across different age groups, periods, and birth cohorts.[15–17] In APC analyses, the age and period intervals are typically equal, with this study utilizing 5-year age groups paired with 5-year periods. Data from the GBD 2021 database, spanning the past 30 years (1992–2021), was used to evaluate PCOS incidence among women of childbearing age (WCBA), defined as those aged 15–49 years. The WCBA population was divided into seven age groups: 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, and 45–49 years. The study period (1992–2021) was segmented into six 5-year intervals: 1992–1996, 1997–2001, 2002–2006, 2007–2011, 2012–2016, and 2017–2021. Additionally, 12 overlapping 5-year birth cohorts, ranging from 1947–1951 to 2002–2006, were analyzed.

Within the APC model, age effects are represented by age-specific incidence rates aligned with birth cohorts, while period and cohort effects are expressed as relative risks of prevalence. These are calculated by comparing the age-specific incidence rate for each period or cohort to that of a reference period or cohort. The selection of the reference period or cohort is arbitrary and does not affect the interpretation of the results.

Prediction Models

To project the global burden of PCOS, a BAPC model was employed. The model was parameterized using Integrated Nested Laplace Approximation (INLA) with weakly informative priors specified to improve stability without imposing strong prior beliefs. Model fit was assessed using posterior predictive checks, and validation was performed by comparing projections against holdout data from the most recent five-year period (2017–2021), confirming satisfactory predictive accuracy. The BAPC model was selected for its probabilistic framework, which explicitly quantifies uncertainty in long-term projections essential for public health planning. It robustly handles hierarchical and sparse data across regions and time by leveraging information sharing between strata. Furthermore, it uniquely disentangles age, period, and cohort effects, providing more interpretable and nuanced trend forecasts than simple extrapolation methods. Using this approach, we forecasted the incidence, prevalence, and DALYs associated with PCOS through 2036.[18]

Results

Global, SDI, and Regional Disease Burden of PCOS in Women of Reproductive AgeIn 2021, the global burden of PCOS in women of reproductive age included 65,767,553 prevalence cases (95% UI: 46,839,857 to 91,498,217), 1,175,074 incident cases (95% UI: 711,336 to 1,887,246), and 576,045 DALYs (95% UI: 255,577 to 1,200,185). These figures represent increases of 30,961,045, 388,120, and 268,101 cases, respectively, compared to 1990. The corresponding ASRs were 3,364.53 (95% UI: 2,395.08 to 4,681.81) for prevalence, 64.44 (95% UI: 39.07 to 103.40) for incidence, and 29.51 (95% UI: 13.09 to 61.49) for DALYs per 100,000 population, reflecting increases of 736.05, 12.44, and 6.39 per 100,000, respectively, compared to 1990. From 1990 to 2021, the estimated annual percentage changes (EAPCs) for prevalence, incidence, and DALYs were 0.74 (95% CI: 0.70 to 0.77), 0.65 (95% CI: 0.62 to 0.69), and 0.72 (95% CI: 0.68 to 0.75), respectively (Table S1 and Figure 1).

Based on the SDI region classification, the Middle SDI regions recorded the highest incidence counts of PCOS in both 1990 (254,927 cases; 95% UI: 155,240 to 412,625) and 2021 (378,024 cases; 95% UI: 231,674 to 605,405). The EAPC in incidence across each SDI category was positive, with the highest and lowest values recorded in the Middle SDI (EAPC = 1.39; 95% CI: 1.34 to 1.43) and High SDI (EAPC = 0.21; 95% CI: −0.04 to 0.45) regions, respectively. A similar trend was observed in the EAPC prevalence and DALYs estimates. In 1990, the High SDI regions reported the highest prevalence of PCOS (13,171,901 cases; 95% UI: 9,494,101 to 18,373,076), whereas in 2021, the prevalence in

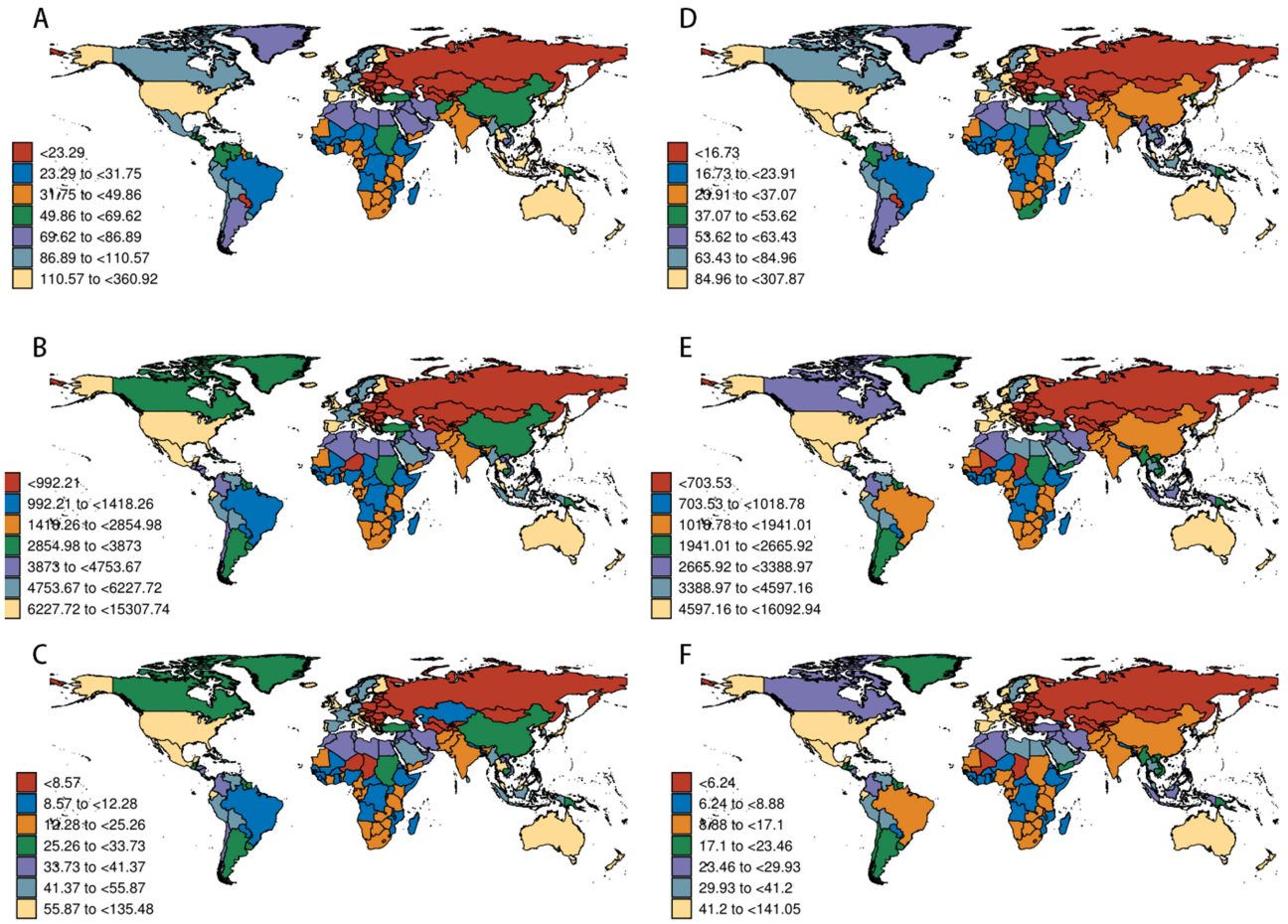

Figure 1 National burden of PCOS. (**A**) Incidence of PCOS in 2021; (**B**) Prevalence of PCOS in 2021; (**C**) DALYs of PCOS in 2021; (**D**) Incidence of PCOS in 1990; (**E**) Prevalence of PCOS in 1990; (**F**) DALYs of PCOS in 1990.

these regions ranked second (16,702,141 cases; 95% UI: 12,287,896 to 22,846,787), with the Middle SDI regions exhibiting the highest prevalence (23,243,046 cases; 95% UI: 16,338,136 to 32,445,094). Similarly, in 1990, the highest DALYs were reported in the High SDI regions (116,846; 95% UI: 52,341 to 242,343), but by 2021, the highest DALYs shifted to the Middle SDI regions (203,158; 95% UI: 88,681 to 427,656). Across all five SDI levels, the highest age-standardized incidence, prevalence, and DALYs rates were consistently observed in the High SDI regions for both 1990 and 2021 (Table S1 and Figure 2).

Among the 21 GBD regions categorized by SDI in 2021, South Asia reported the highest incidence of PCOS, with 220,589 cases (95% UI: 130,245 to 364,108), a prevalence of 10,749,370 cases (95% UI: 7,755,172 to 15,115,145), and 94,328 DALYs (95% UI: 40,615 to 197,255). In contrast, Southeast Asia reported the second-highest figures for PCOS incidence (185,096 cases; 95% UI: 111,567 to 301,458), prevalence (9,998,315 cases; 95% UI: 7,018,879 to 14,135,473), and DALYs (88,125; 95% UI: 38,490 to 182,967). The high-income Asia-Pacific region ranked first in age-standardized incidence (308.16; 95% UI: 171.53 to 485.83), prevalence (10,116.87; 95% UI: 7,086.92 to 14,260.97), and DALYs rate (10,116.87; 95% UI: 7,086.92 to 14,260.97). Australasia reported the second highest age-standardized incidence (219.55; 95% UI: 128.92 to 364.51), prevalence (9,156.94; 95% UI: 6,439.94 to 12,788.23), and DALYs rate (79.97; 95% UI: 35.5 to 166.66). Notably, Southeast Asia exhibited the fastest growth in PCOS incidence (EAPC = 1.89; 95% CI: 1.80 to 1.99), prevalence (EAPC = 2.30; 95% CI: 2.20 to 2.40), and DALYs (EAPC = 2.26; 95% CI: 2.17 to 2.36) (Table S1 and Figure 3).

Figure 4 illustrates the global burden of PCOS from 1990 to 2021, highlighting the relationship between the SDI and the incidence, prevalence, and DALYs. A moderate positive correlation was observed between SDI and PCOS incidence

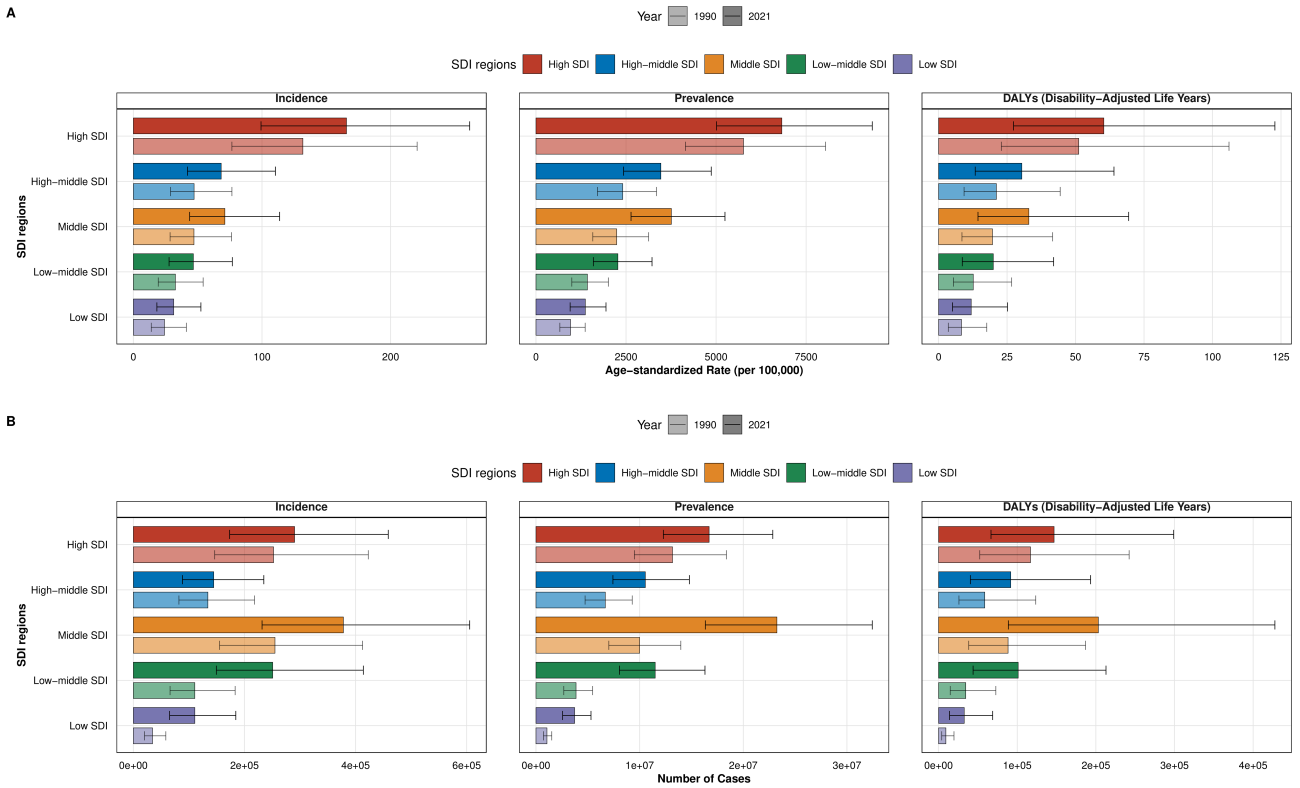

Figure 2 Age-standardized rates and number of cases for incidence, prevalence, and DALYs of PCOS by SDI region in 1990 and 2021. (**A**) age-standardized rates; (**B**) number of cases.

(A), prevalence (B), and DALYs (C), with correlation coefficients (ρ) of 0.51, 0.50, and 0.50, respectively (all p-values < 0.001). This indicates that regions with higher levels of SDI generally exhibit greater PCOS disease burden.

Disease Burden of PCOS by Age Group

Figure 5 presents the number of incidence, prevalence, and DALY cases, along with the corresponding ASR for different age groups from 1990 to 2021. Over this 31-year period, a significant increase in the incidence, prevalence, and DALYs of PCOS is observed across most age groups.Regarding incidence, individuals aged 15 to 19 had the highest rates in both 1990 and 2021, with incidence numbers of 699,967 (95% UI: 431,670 to 1,111,989) and 1,056,349 (95% UI: 659,123 to 1,642,603) for the respective years. This age group also exhibited the highest ASIR, with 273 cases (95% UI: 168 to 435) in 1990 and 347 cases (95% UI: 217 to 540) in 2021. For prevalence, the highest number of cases was observed in the 20–24 age group in 1990 (6,348,599; 95% UI: 4,514,512 to 8,839,642), but by 2021, the highest prevalence shifted to the 30–34 age group (10,763,002; 95% UI: 7,711,792 to 14,968,295). In terms of age-standardized prevalence, the highest rates were seen in the 40–44 age group in both 1990 (3,041; 95% UI: 2,196 to 4,233) and 2021 (3,687; 95% UI: 2,637 to 5,121). The distribution of DALYs followed a pattern similar to prevalence, with the highest burden observed in the same age groups.

Age, Period and Birth Cohort Effects on PCOS Incidence in WCBA

Figure 6 illustrates the annual percentage change in ASR for each age group, quantified as the local drift calculated through the APC model. Globally, the incidence of PCOS in WCBA initially declined and then stabilized. In the five SDI regions, a similar trend was observed across all age groups in the low and low-middle SDI areas. However, in the high-middle and middle SDI, there was an upward trend after 35 to 39 years old and 40 to 44 years old, respectively. In high SDI regions, after experiencing a relatively flat trend, there was a slight downward trend after 40 to 44 years of age.

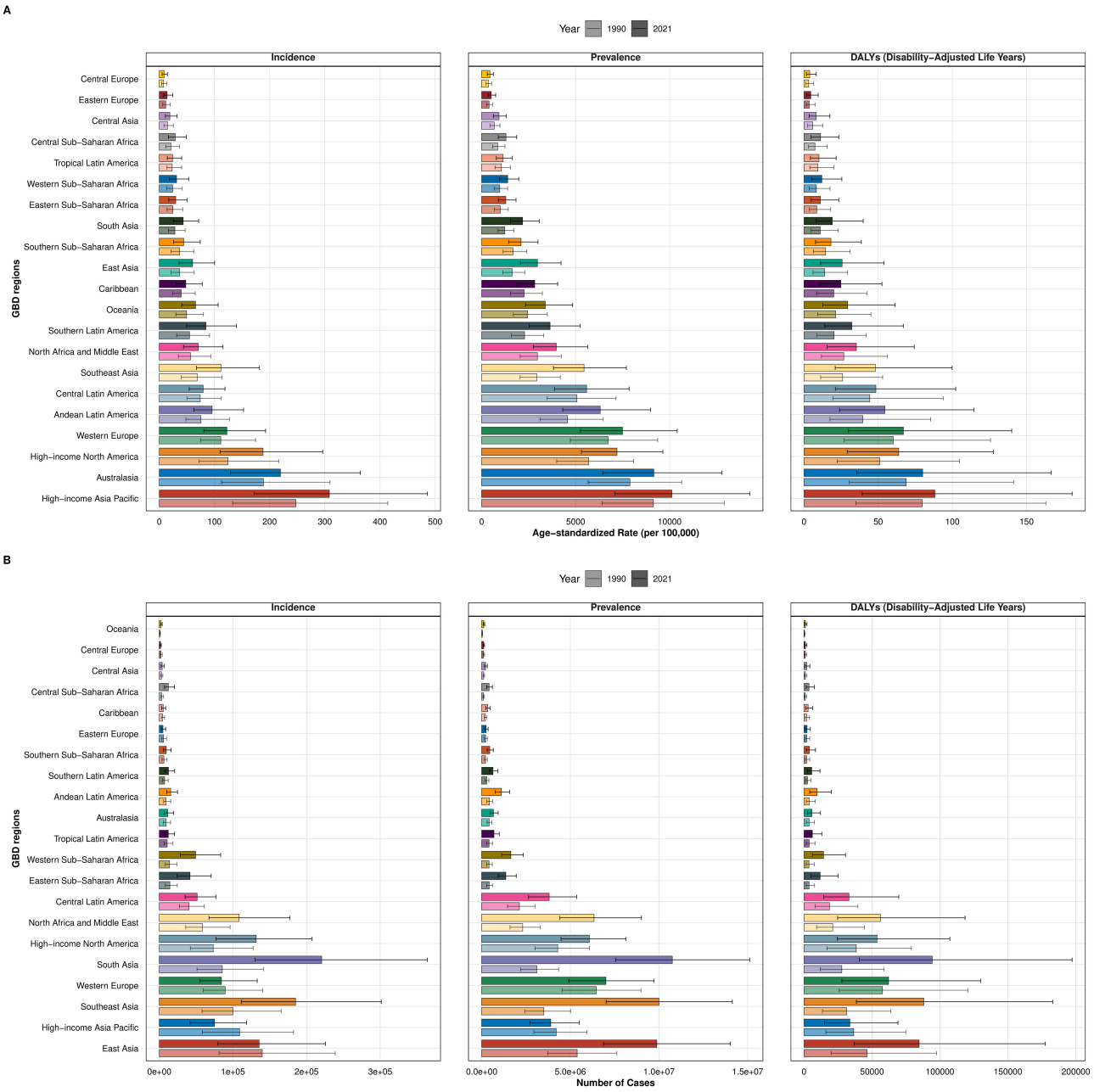

Figure 3 Global burden of PCOS by region: incidence, prevalence, and DALYs in 1990 and 2021. (**A**) age-standardized rates; (**B**) number of cases.

The age, period, and birth cohort effects on PCOS incidence, as analyzed through the APC model, are shown in Figure 7. The age effect across different SDI regions follows a similar pattern. The risk is highest among teenagers aged 15–19, gradually decreasing with age. After 20–24 years, the risk levels off and remains stable Notably, the 15–19 age group in high SDI regions experiences the highest risk, while the same age group in low SDI regions faces the lowest risk. For other age groups, the differences in risk between regions are less pronounced.

Throughout the study period, high SDI regions predominantly experienced favorable period risks, while regions with lower SDI generally faced unfavorable period risks. Overall, the global period effect initially increased and then decreased, a trend also observed across high-middle SDI, middle SDI, low-middle SDI, and low SDI regions. However, high SDI regions exhibited the opposite pattern. Compared to individuals in the reference period (1992–1996),

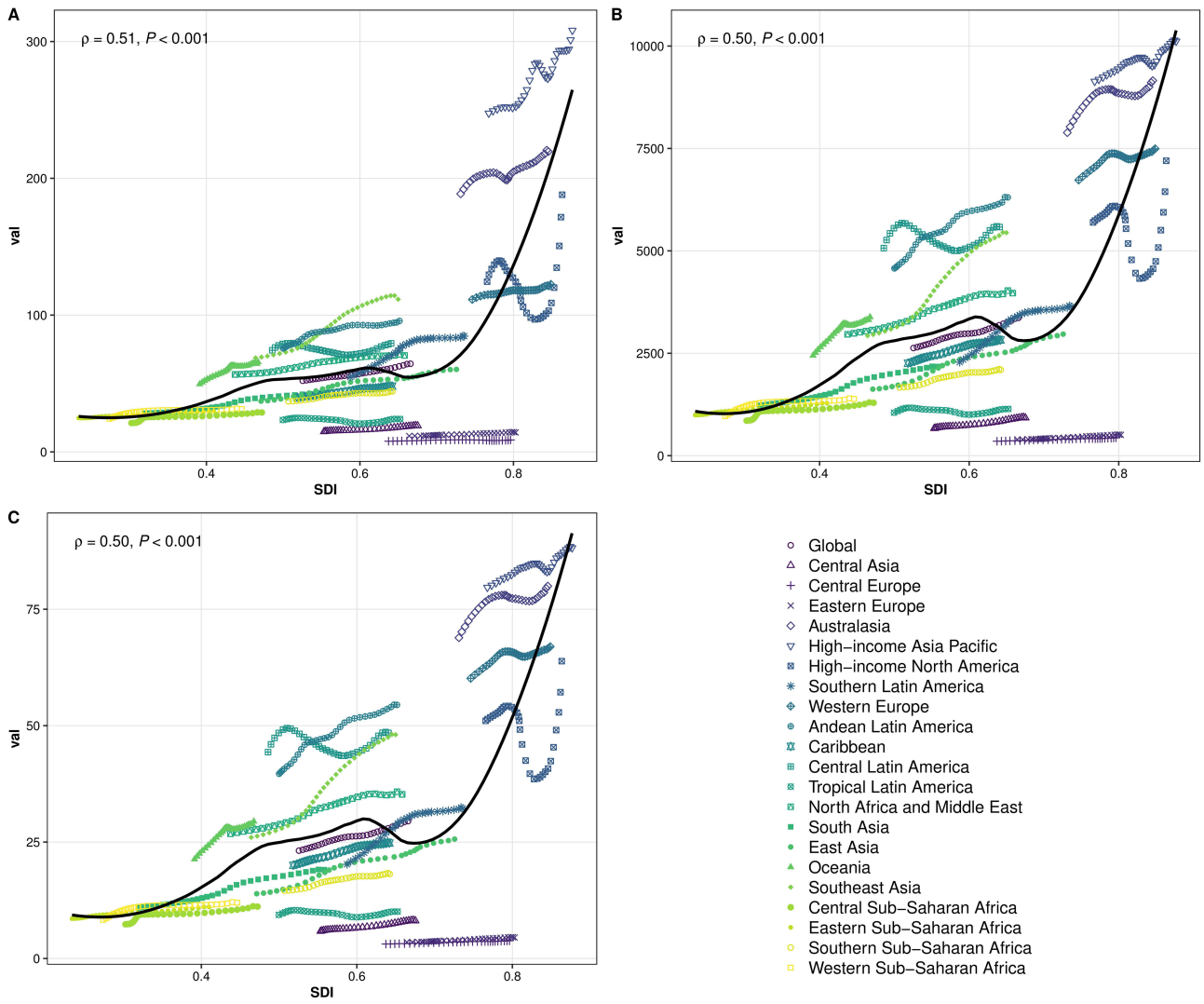

Figure 4 The relationship between the SDI and three key epidemiological metrics of PCOS from 1990 to 2021. (**A**) incidence; (**B**) prevalence; (**C**) DALYs.

the relative period risk for those in the 2007–2011 period was 0.939 (95% CI: 0.919 to 0.959) in high SDI regions and 1.149 (95% CI: 1.085 to 1.216) in low-middle SDI regions.

Regarding the birth cohort effect, a clear pattern emerged in which incidence risk initially declined and then increased across successive birth cohorts globally. In the four SDI regions, excluding the high SDI region, this trend mirrored the global pattern. Specifically, for individuals born before the 1972–1976 cohort, the decline in incidence risk was less pronounced. However, a marked reduction in risk occurred after this period, particularly for the 1977–1981 cohort. Afterward, the risk gradually increased for individuals born after the 1977–1981 cohort. Notably, in high SDI regions, the risk for individuals born before the 1992–1996 cohort steadily decreased, while the risk for those born after this cohort gradually increased.

Global Disease Burden Prediction for PCOS to 2036

Using the BAPC models, predictions for PCOS incidence,prevalence and DALYs were generated for the period 2022 to 2036. The BAPC model predicted a smooth rise in incidence number and ASIR.The projected number of new cases is anticipated to reach 1680774.90 (95%UI: 1004384.26 to 2357165.53), while the ASIR is expected to escalate to 74.48 (95% CI: 45.10 to 105.85) by the year 2036.Subsequently, we also estimated the prevalence number and ASPR of global PCOS from 2022 to 2036. Over time, the prevalence of individuals with the condition exhibited a consistent upward

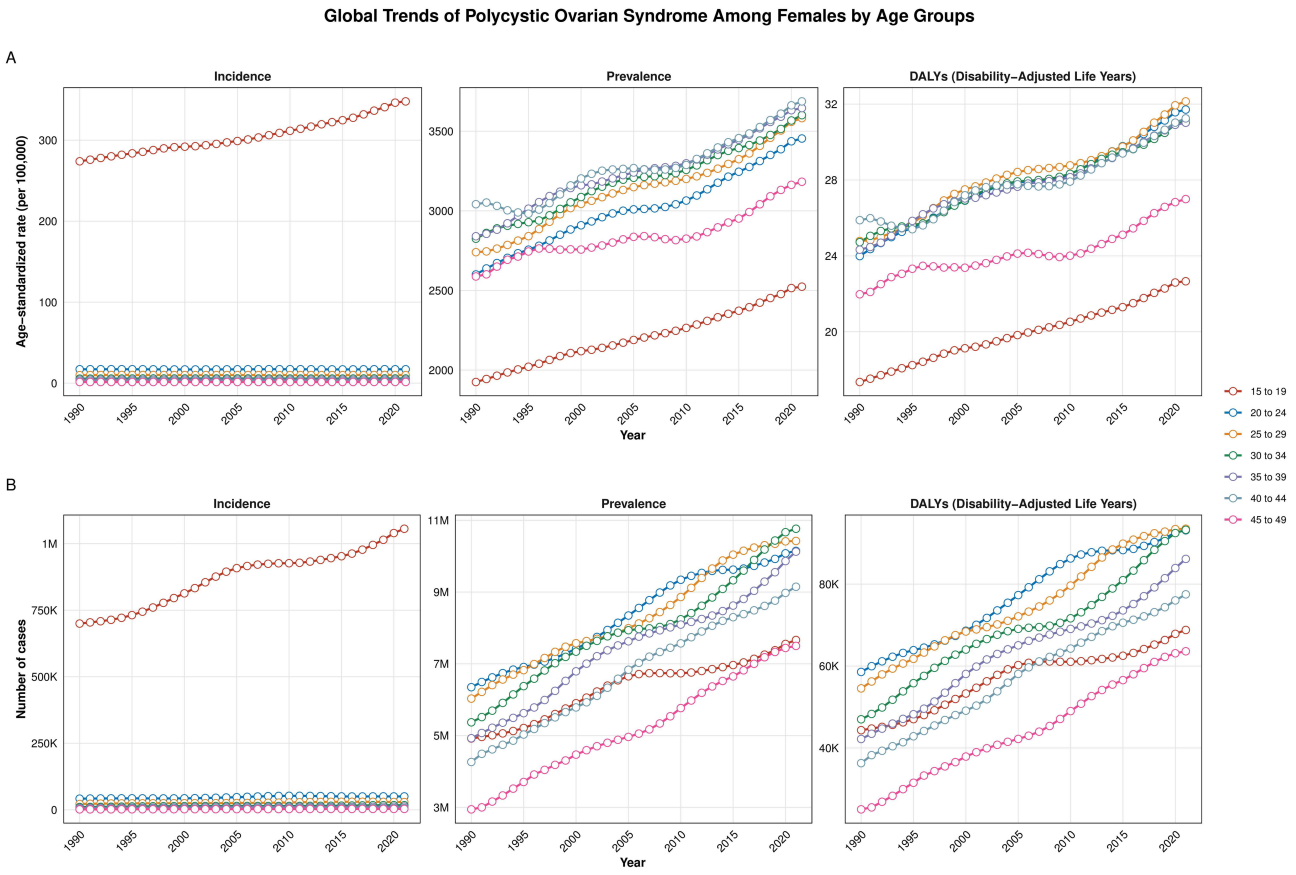

Figure 5 Global trends in the incidence, prevalence, and DALYs of PCOS across various age groups from 1990 to 2021. (**A**) age-standardized rates; (**B**) number of cases.

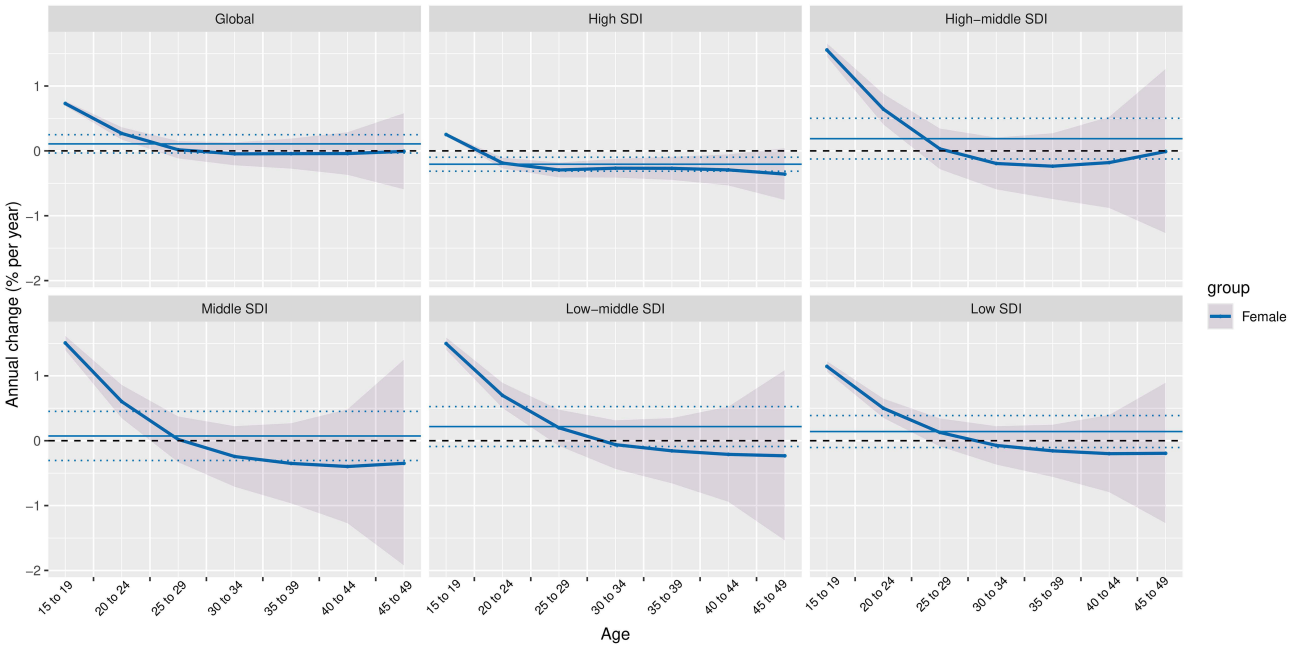

Figure 6 Local drift in PCOS incidence from 1990 to 2021 in WCBA, categorized by seven age groups.

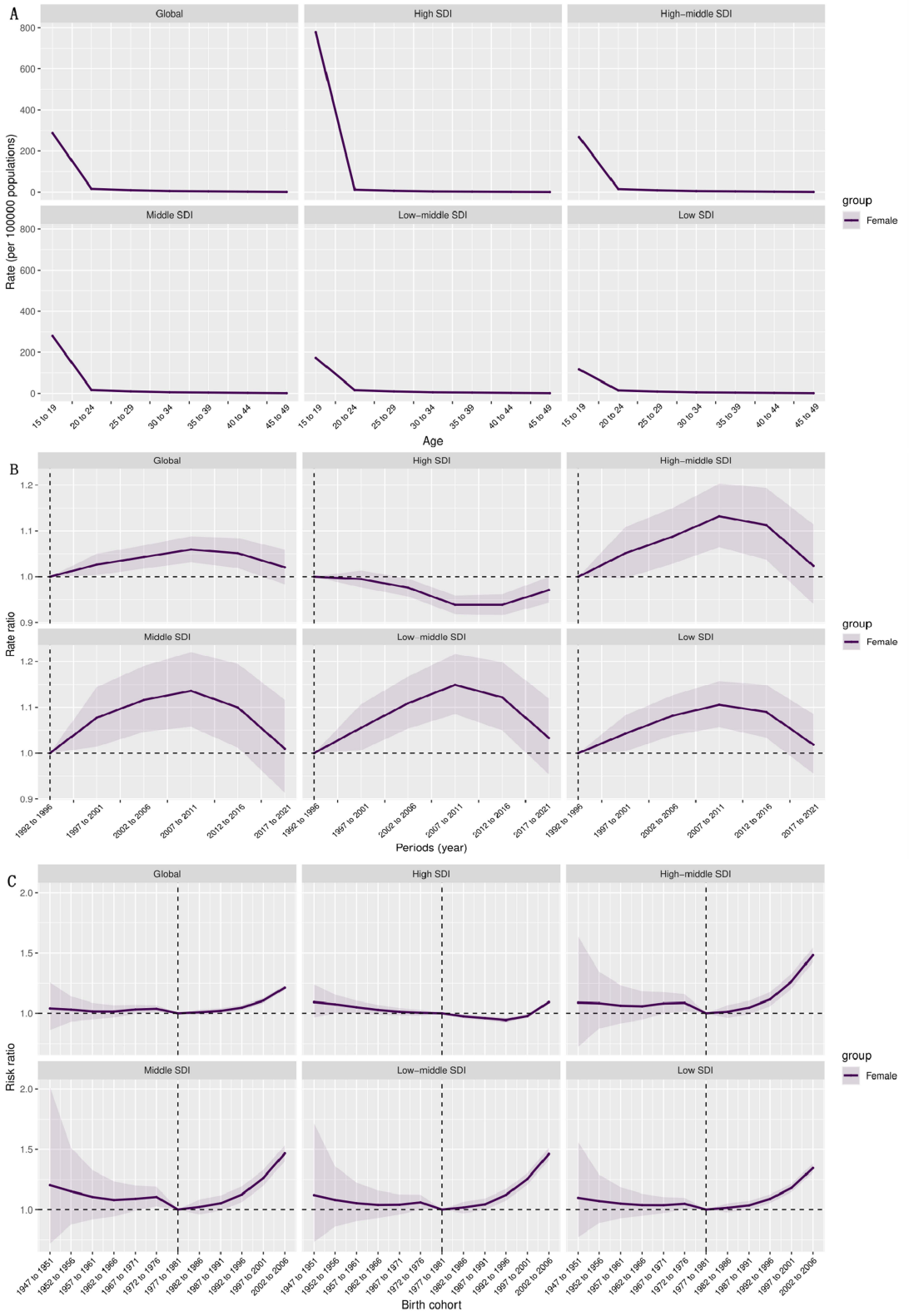

Figure 7 Age, period, and birth cohort effects on PCOS incidence in WCBA as analyzed by APC models. (**A**) Age effect; (**B**) Period effect; (**C**) Birth cohort effect.

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trajectory, while the age-standardized prevalence demonstrated a gradual decline. Projections indicate that by 2036, the number of affected individuals will reach 77872199.94 (95%UI: 50992502.87 to 104751897.01), whereas the ASPR is expected to decrease to 1090.53 (95% CI: 687.77 to 1493.30). This pattern was also observed in terms of DALYs and ASDR for PCOS on a global scale. By 2026, it is anticipated that DALYs will increase to 423753.97 (95%UI: 265722.11 to 581785.84), while ASDR are projected to decline to 9.49 (95% CI: 5.95 to 13.04) (Figure 8).

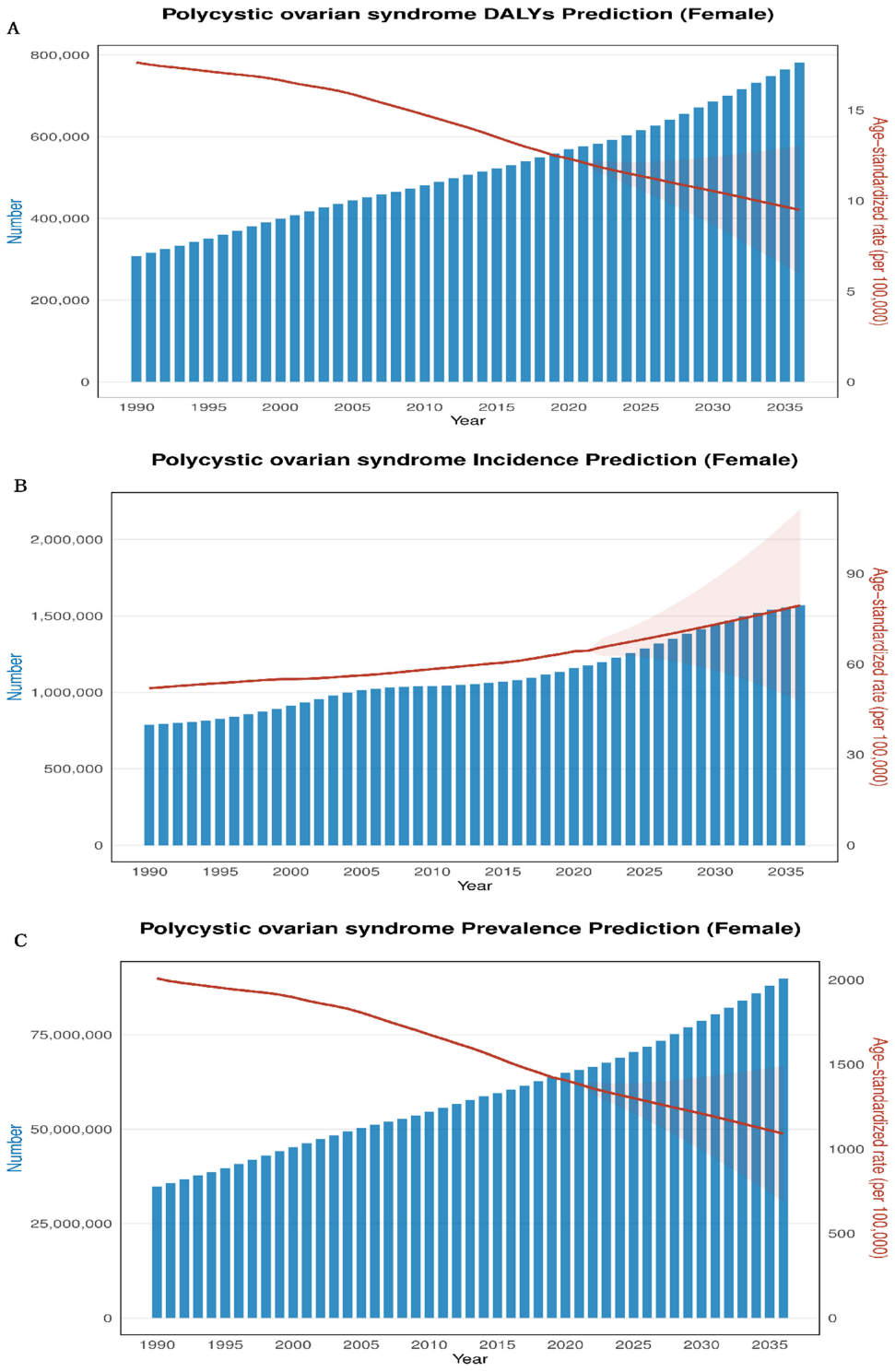

Figure 8 BAPC prediction of PCOS burden in WCBA from 2022 to 2036. (**A**) PCOS incidence prediction; (**B**) PCOS prevalence prediction; (**C**) PCOS DALYs prediction.

Discussion

This study provides a comprehensive analysis of the global burden of PCOS from 1990 to 2021. Our findings demonstrate a significant increase in the incidence, prevalence, and DALYs attributable to PCOS over this 31-year period. By 2021, the global prevalence reached 65.8 million cases, representing a substantial rise from 1990. The most pronounced increases were observed in middle SDI regions, whereas high SDI regions exhibited the highest ASRs across all metrics. A consistent, moderate positive correlation was identified between SDI and the incidence, prevalence, and DALYs of PCOS, underscoring the link between socioeconomic development and the reported burden of this condition. These trends align with findings from prior studies, such as Safiri et al and likely reflects a combination of true increasing incidence, evolving diagnostic practices, and improved case identification, particularly in regions with expanding healthcare access.[19]

The stark disparities in PCOS burden across SDI regions stem from a complex interplay of demographic, behavioral, and healthcare system factors. Middle SDI regions, characterized by large populations and rapid economic transition, are experiencing improved healthcare resources leading to higher diagnosis rates, concurrently with rising prevalence of lifestyle risk factors like obesity due to nutritional transitions.[20] In contrast, high SDI regions benefit from greater awareness and easier access to diagnostic technologies, resulting in more complete case ascertainment and higher ASRs.[21] The notably high burden and rapid growth in regions like South and Southeast Asia, consistent with the findings of Prakasini Satapathy et al, can be partly explained by their younger demographic profiles and the accelerating impact of urbanization on dietary patterns and physical activity levels.[22,23] Notably, the observed increases in PCOS incidence and prevalence should be interpreted as reported diagnosis rates rather than true population-level disease burden. Significant underdiagnosis is likely, particularly in low-resource settings where limited access to specialized healthcare (eg, endocrinology services, pelvic ultrasonography) and low disease awareness contribute to substantial missed cases. Beyond these factors, differences in health system capacity for primary care, cultural perceptions surrounding menstrual health, which may delay help-seeking, and varying levels of national policy focus on women's health are also likely critical contributors to the observed disparities.

A critical finding of our analysis is the distinct age-specific pattern of PCOS burden. The peak incidence in adolescents (15–19 years) coincides with the post-pubertal unmasking of underlying endocrine dysfunction, driven by Gonadotropin-Releasing Hormone-Luteinizing Hormone (GnRH-LH) axis hyperactivity and insulin resistance.[24,25] Furthermore, our study reveals, for the first time in a global analysis, a shift in the peak prevalence from the 20–24 to the 30–34 age group, which corresponds to women being in their main reproductive years.[26] This suggests a widespread delay in diagnosis, often until women seek care for infertility or metabolic concerns during their peak reproductive years.[27] This diagnostic delay can exacerbate long-term sequelae,[28] as evidenced by the highest ASPR in the 40–44 age group, a period associated with an elevated risk of metabolic syndrome, type 2 diabetes, and cardiovascular disease.[29] The distribution of DALYs, mirroring prevalence trends, highlights the substantial impact of these metabolic and psychological comorbidities on quality of life. The multisystemic nature of PCOS necessitates a comprehensive clinical approach; for instance, the interaction with comorbid conditions like Hashimoto's thyroiditis can exacerbate ovarian morphology and clinical complexity, as highlighted by Gencer et al, reinforcing the need for integrated management.[30]

The APC analysis provides deeper insights into these trends. The highest age-effect risk among adolescents (15–19) in high-SDI regions likely reflects more intensive screening, while the lower risk in comparable low-SDI age groups suggests significant under-diagnosis.[31] The favorable period effects in high-SDI regions indicate the success of public health policies targeting obesity and promoting healthy lifestyles.[32,33] Conversely, the rising period effects in lower SDI regions signal increasing exposure to risk factors. The steady increase in PCOS risk among younger birth cohorts globally, particularly outside high-SDI regions, underscores the growing impact of modern environmental and lifestyle factors, reinforcing the imperative for preventive strategies.

The BAPC model projections indicate a continued rise in the absolute global burden of PCOS through 2036, coupled with a decline in ASRs (ASPR and ASDR). This divergence can be attributed to demographic shifts, such as population aging, and the positive effects of early intervention and management strategies in high-SDI settings.[34] The key drivers of the rising absolute burden—rapid urbanization, poor dietary habits, sedentary lifestyles, and endocrine-disrupting chemicals—call for a multi-tiered intervention strategy. Policy-level actions (eg, sugar taxes, active urban design),[35] community-based programs (eg, school screening, food environment improvements),[36] and individual-level

approaches (eg, digital health tools, personalized lifestyle interventions)[37] are all necessary to mitigate the future impact of PCOS across diverse socioeconomic contexts.

Despite the actionable insights provided by these projections, several limitations of our study must be considered. First, our estimates are constrained by the GBD's reliance on clinically reported data, which systematically underestimates burden in regions with low medical capacity.[38] The classification of PCOS as a "non-communicable gynecological condition" in GBD, further obscures its multisystemic impacts (eg, cardiometabolic sequelae), leading to incomplete DALY calculations. Second, the projections made using the BAPC model are based on historical trends and assumptions that may not fully capture future changes in healthcare policies, diagnostic criteria, or treatment advancements. Additionally, the interpretation of temporal trends and geographical comparisons in PCOS burden is fundamentally challenged by the absence of a universally agreed-upon definition and significant variations in diagnostic practices over time and across regions. The evolution of diagnostic criteria—from the 1990 NIH criteria, which required both hyperandrogenism and ovulatory dysfunction, to the broader 2003 Rotterdam criteria, and subsequent refinements by professional societies—has directly influenced recorded prevalence rates and temporal comparability. Moreover, regional differences in the adoption of these guidelines, availability of diagnostic technologies (eg, ultrasound, androgen assays), and clinical awareness further fragment the epidemiological landscape.[39,40] Finally, while the age and cohort effects provide insights into the evolving burden of PCOS, the impact of environmental factors, such as lifestyle and diet changes, which are increasingly recognized as important in the pathophysiology of PCOS, was not directly considered in our model.[37] To mitigate this limitations, future studies should adopt standardized diagnostic criteria such as the 2023 International Evidence-based Guideline on the Assessment and Management of PCOS. In addition, future research must prioritize clinical subtyping of PCOS into actionable phenotypes (eg, metabolic-dominant vs reproductive-dominant) to enable personalized management, while quantifying environmental influences across these subtypes.[41] Concurrently, technology-enabled detection through machine learning analysis of real-world data should be leveraged for early subtype identification and intervention.

Conclusion

Grounded in GBD 2021 estimates, this study quantifies the mounting global burden of PCOS, delineates pronounced regional and age-specific disparities, and forecasts its future trajectory. The findings establish PCOS as an urgent, multifaceted public-health challenge. Our results call for coordinated, multilevel action: governments must embed PCOS in national health strategies, allocate resources proportionate to burden, upgrade diagnostic capacity in low-income settings, and harmonize case definitions; clinicians should implement life-course management protocols spanning adolescent screening to long-term metabolic surveillance; and researchers must target data-poor regions, elucidate drivers of observed inequities, and develop effective, sustainable interventions. This work provides the evidence base required to formulate and implement strategies that mitigate the worldwide impact of PCOS.

Abbreviations

APC, Age-Period-Cohort (model); ARIMA, Autoregressive Integrated Moving Average; ASDR, Age-Standardized DALYs Rate; ASIR, Age-Standardized Incidence Rate; ASPR, Age-Standardized Prevalence Rate; ASRs, Age-Standardized Rates; BAPC, Bayesian Age-Period-Cohort (model); DALYs, Disability-Adjusted Life Years; EAPC, Estimated Annual Percentage Change; GBD, Global Burden of Disease; GnRH, Gonadotropin-Releasing Hormone; IHME, Institute for Health Metrics and Evaluation; INLA, Integrated Nested Laplace Approximation; LH, Luteinizing Hormone; PCOS, Polycystic Ovary Syndrome; SDI, Socio-demographic Index; UI, Uncertainty Interval; WCBA, Women of Childbearing Age.

Data Sharing Statement

The datasets generated and analyzed during the current study are all derived from the publicly available GBD database, which can be accessed at: https://ghdx.healthdata.org/gbd. No additional unpublished data were generated by the authors in this analysis.

Ethics Statement

This study utilized publicly available, anonymized, and aggregated data from the GBD 2021 database. As no individual-level data were involved, this study was exempt from ethical approval according to Article 32, Items 1 and 2 of the Measures for Ethical Review of Life Science and Medical Research Involving Human Subjects (issued by the National Health Commission of the People's Republic of China on February 18, 2023).

Consent for Publication

We hereby confirm that all accompanying images have been reviewed by the individuals who provided consent for publication.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests for this work.

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