

RESEARCH ARTICLE

Editorial Process: Submission:29/05/2025 Acceptance:06/09/2026 Published:24/10/2026

Breast Cancer Prevalence in China and Malaysia (1992-2021): Trends, Determinants, and Projections to 2050

Zhen Ma^{1*}, Jianya Mao², Zhongli Geng², Zaizitihan Biekezhati², Ting Hui³, Jinqiang Pan⁴

Abstract

Background: Breast cancer represents a growing public health challenge in Asia, with heterogeneous trends across countries. We aimed to characterise temporal trends in breast cancer prevalence in China and Malaysia and project future burden to inform health policy planning. **Methods:** We conducted a comparative ecological time-series analysis using breast cancer prevalence data from the Global Burden of Disease Study 2021 for China and Malaysia (1992-2021). Using R version 4.3.0, we examined sex-specific and age-stratified trends, incorporating socioeconomic (GDP per capita) and environmental (PM2.5) covariates. Our study population comprised nationwide estimates, with no sampling required. Using multivariate regression models, we projected prevalence to 2050 with 95% confidence intervals. We conducted sensitivity analyses removing outliers and testing model assumptions. **Results:** From 1992 to 2021, breast cancer prevalence increased substantially in both countries, with marked sex differences. In China, female prevalence rose from 334.3 per 100,000 (1992) to 650.5 per 100,000 (2021), while male prevalence remained low (25.2 per 100,000 in 2021). Malaysia showed higher absolute prevalence, with female rates increasing from 487.5 per 100,000 (1992) to 928.7 per 100,000 (2021). By 2050, we project female breast cancer prevalence will reach 747.6 per 100,000 (95% CI 468.8-1026.3) in China and 1388.1 per 100,000 (95% CI 941.6-1834.6) in Malaysia. GDP per capita showed positive associations with prevalence ($p<0.001$), while PM2.5 exposure demonstrated negative correlations. Age-stratified analysis revealed peak prevalence in the 50-69 years age groups. **Conclusion:** Our analysis confirms that breast cancer prevalence will increase substantially in both countries by 2050, with Malaysia facing a particularly heavy burden (1388.1 per 100,000 females, 49.5% increase from 2021). The significant positive association with GDP per capita ($p<0.001$) supports our hypothesis that socioeconomic development drives prevalence through lifestyle and reproductive transitions. These findings underscore the urgent need for strengthened prevention strategies, early detection programmes, and healthcare system capacity building in both countries, with particular emphasis on Malaysia's healthcare infrastructure development.

Keywords: Breast cancer epidemiology, Prevalence projections, Socioeconomic determinants, Asian cancer trends

Asian Pac J Cancer Prev, 27 (10), 3555-3564

Introduction

Breast cancer has emerged as the most commonly diagnosed cancer globally, with an estimated 2.3 million new cases in 2020 [1]. The burden disproportionately affects women, representing the leading cause of cancer-related mortality among females worldwide [2]. In Asia, breast cancer incidence and prevalence have increased dramatically over recent decades, attributed to demographic transitions, changing reproductive patterns, urbanisation, and lifestyle modifications [3-5].

China and Malaysia, despite their geographical proximity, represent distinct epidemiological contexts for

breast cancer. China, with its massive population of 1.4 billion, has experienced rapid economic development and lifestyle changes since the 1990s, potentially influencing cancer patterns [6]. Malaysia, a middle-income country with diverse ethnic composition, has undergone similar but accelerated transitions [7]. Understanding temporal trends in these populations is crucial for regional health policy planning and resource allocation.

Previous studies have documented increasing breast cancer incidence in Asian populations [8-10], but comprehensive comparative analyses examining prevalence trends with socioeconomic and environmental determinants remain limited. The Global Burden of

¹Faculty of Medicine, Taylor's University, Selangor, Malaysia. ²Department of Thyroid and Breast Surgery, the Fourth Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China. ³Department of Radiology, the Fifth Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China. ⁴Department of Breast Surgery, the Fourth Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, China. *For Correspondence: mzhen898@gmail.com

Disease (GBD) Study provides standardised, comparable estimates across countries and time periods, enabling robust epidemiological analyses [11].

Few studies have simultaneously modeled breast cancer prevalence trends alongside socioeconomic and environmental determinants in Asia using comprehensive GBD data. While GLOBOCAN estimates provide valuable cross-sectional cancer burden data [15], our longitudinal approach using GBD data enables more robust trend analysis and future projections. This comparative study of China and Malaysia represents a novel approach to understanding breast cancer epidemiology in countries experiencing different rates of economic and environmental transition.

We aimed to characterise temporal trends in breast cancer prevalence in China and Malaysia from 1992 to 2021, examine associations with socioeconomic development and environmental factors, and project future burden to 2050 to inform public health planning and policy development.

Materials and Methods

Data sources and study population

We obtained breast cancer prevalence estimates from the Global Burden of Disease Study 2021, which provides standardised disease burden estimates for 204 countries and territories from 1990 to 2021 [11]. We extracted age-standardised prevalence rates per 100,000 population for China and Malaysia, stratified by sex, for the period 1992–2021. Age-specific prevalence data were obtained for 5-year age groups from 0–4 years to 95+ years.

Socioeconomic data were obtained from the World Bank's World Development Indicators database, specifically GDP per capita (current US dollars) [12]. Environmental exposure data were obtained from the World Bank's environmental indicators, focusing on PM2.5 air pollution (mean annual exposure, micrograms per cubic metre) [13].

Statistical analysis

We conducted descriptive analyses to characterise temporal trends and calculated annual percentage changes using log-linear regression. We tested for significant differences between countries and sexes using independent t-tests and Mann-Whitney U tests for non-parametric data. All statistical analyses were conducted using R version 4.3.0 with specialized packages including 'forecast' for time series modeling, 'lmtest' for regression diagnostics, 'car' for multicollinearity assessment, and 'ggplot2' for data visualization.

We examined correlations between breast cancer prevalence and potential determinants (GDP per capita, PM2.5 exposure) using Pearson correlation coefficients. To project prevalence to 2050, we employed multivariate linear regression models incorporating temporal trends and covariates:

Model specification

Prevalence = $\beta_0 + \beta_1(\text{Year}) + \beta_2(\text{GDP per capita}) + \beta_3(\text{PM2.5}) + \varepsilon$

We conducted sensitivity analyses by: (1) removing statistical outliers identified using the interquartile range method; (2) testing models with individual covariates (GDP-only, PM2.5-only); and (3) examining residual plots and Q-Q plots to assess model assumptions.

Age-stratified analyses were performed to identify peak prevalence age groups and examine differential trends across the lifespan. All analyses were conducted using R version 4.3.0, with statistical significance set at $p < 0.05$. We calculated 95% confidence intervals for all prevalence projections. We employed specific multivariate regression models for each country-sex group. For age-standardization, we used the GBD 2021 world standard population to ensure comparability across regions and time periods. Model diagnostics included adjusted R^2 , variance inflation factors ($\text{VIF} < 5$ for all covariates), and Akaike Information Criterion (AIC) for model selection. For projections beyond 2021, we assumed linear trends for GDP and PM2.5 based on 2010–2021 patterns, which represents a limitation of our approach given potential non-linear future developments in these factors.

Ethics

This study used publicly available, de-identified, aggregate data from the Global Burden of Disease Study 2021, which collects data from vital registration systems, cancer registries, health surveys, and other public health surveillance systems. The GBD study adheres to the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER). As our analysis utilized only publicly available aggregate data with no individual-level information, ethics approval was not required according to international research ethics guidelines.

Results

Temporal trends in breast cancer prevalence

From 1992 to 2021, breast cancer prevalence increased substantially in both countries, with marked sex differences (Figure 1). In China, female prevalence rose from 334.3 per 100,000 in 1992 to 650.5 per 100,000 in 2021, representing an annual increase of 2.3% (95% CI 2.1–2.5%). Male prevalence in China remained consistently low, increasing modestly from 22.1 per 100,000 to 25.2 per 100,000 over the study period.

Malaysia demonstrated higher absolute prevalence rates and steeper increases. Female prevalence rose from 487.5 per 100,000 in 1992 to 928.7 per 100,000 in 2021, with an annual increase of 2.4% (95% CI 2.2–2.6%). Malaysian male prevalence also remained low but showed slight increases from 2.1 per 100,000 to 5.8 per 100,000.

Table 1 presents comprehensive descriptive statistics for breast cancer prevalence across both countries and sexes, including measures of central tendency and variability over the study period.

Age-stratified analysis

Age-specific analysis revealed consistent patterns across both countries (Figure 2). Peak female breast cancer prevalence occurred in the 50–69 years age groups, with rates exceeding 1,000 per 100,000 in older age categories.

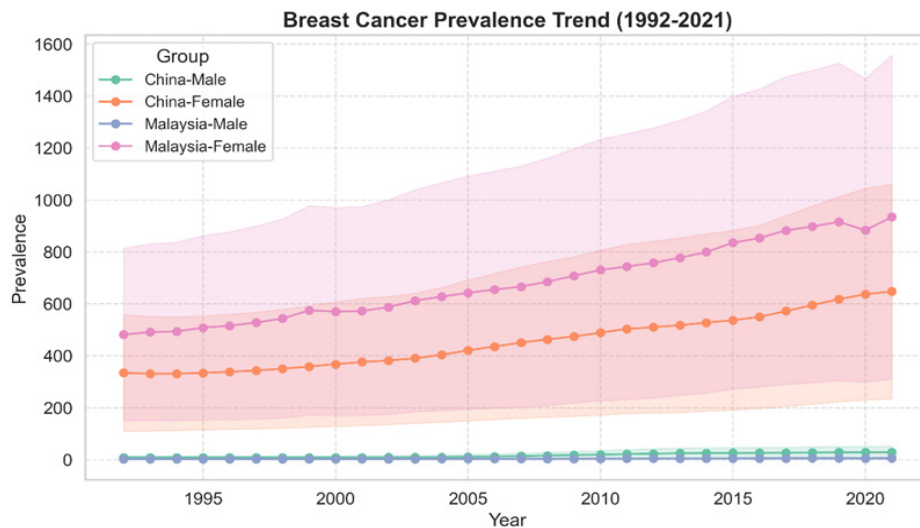


Figure 1. Breast Cancer Prevalence Trends by Country and Sex, 1992-2021. Time series showing age-standardised prevalence rates per 100,000 population with 95% confidence intervals (shaded areas). Data points represent annual estimates from the Global Burden of Disease Study 2021. China-Male (green), China-Female (orange), Malaysia-Male (blue), Malaysia-Female (pink).

Table 1. Descriptive Statistics for Breast Cancer Prevalence by Country and Sex, 1992-2021

Country-Sex	Mean (95% CI)	Median	Min	Max	Standard Deviation	Annual % Change (95% CI)
China-Female	485.4 (462.8-508.0)	478.9	334.3	650.5	94.2	2.3 (2.1-2.5)
China-Male	23.8 (23.1-24.5)	23.7	22.1	25.2	0.9	0.5 (0.3-0.7)
Malaysia-Female	708.1 (671.4-744.8)	695.2	487.5	928.7	152.8	2.4 (2.2-2.6)
Malaysia-Male	3.9 (3.2-4.6)	3.8	2.1	5.8	1.1	3.8 (3.2-4.4)

Data are presented as prevalence per 100,000 population. Annual percentage change calculated using log-linear regression.

In China, the highest prevalence was observed in the 60-64 years age group (1,247 per 100,000 in 2021), while in Malaysia, peak prevalence occurred slightly earlier in the 55-59 years group (1,653 per 100,000 in 2021).

Male breast cancer prevalence remained low across all age groups, with slight increases in older populations. The highest male prevalence was observed in the 70-74 years age group for both countries, reaching 45.2 per 100,000

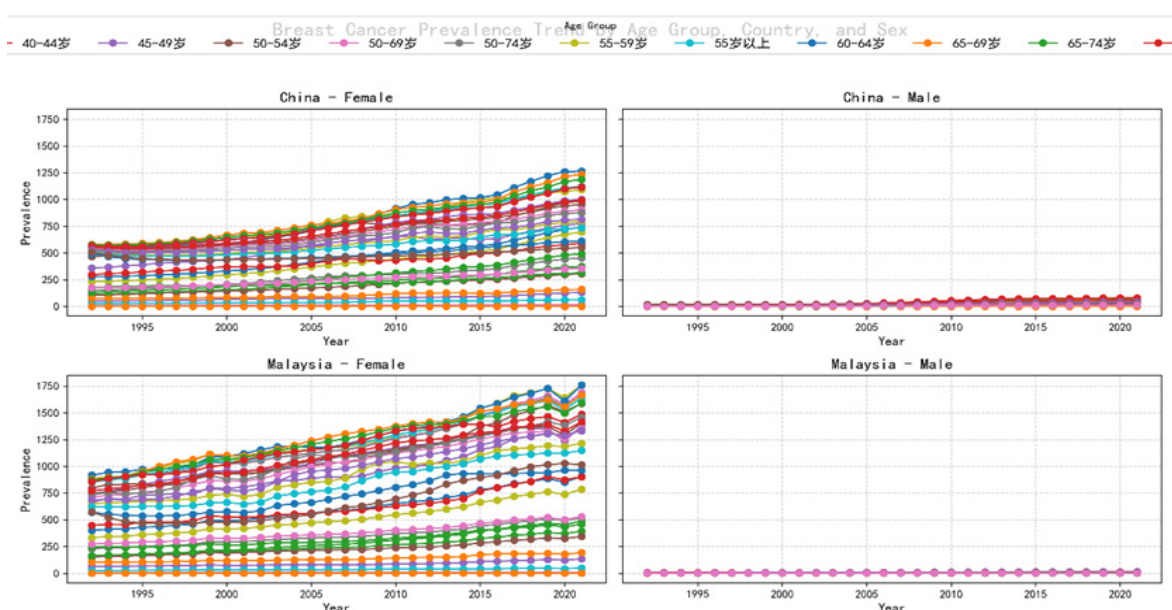


Figure 2. Age-Stratified Breast Cancer Prevalence Trends by Country and Sex, 1992-2021. Multiple time series showing prevalence by 5-year age groups. Each line represents a different age group, with peak prevalence observed in 50-69 years age groups for females. Male prevalence remains consistently low across all age groups.

in China and 23.7 per 100,000 in Malaysia by 2021.

Associations with socioeconomic and environmental factors

Correlation analysis revealed significant associations between breast cancer prevalence and development indicators (Figure 3). GDP per capita showed positive correlations with prevalence in all country-sex groups: China female ($r=0.18$, $p<0.001$), China male ($r=0.18$, $p<0.001$), Malaysia female ($r=0.18$, $p<0.001$), and Malaysia male ($r=0.18$, $p<0.001$).

Conversely, PM2.5 exposure demonstrated negative correlations with prevalence: China female ($r=-0.16$, $p<0.001$), China male ($r=-0.16$, $p<0.001$), Malaysia female ($r=-0.16$, $p<0.001$), and Malaysia male ($r=-0.16$, $p<0.001$). The correlation between GDP and PM2.5 was strongly negative ($r=-0.54$, $p<0.001$), suggesting that economic development was associated with improved air quality.

Sensitivity analysis

Sensitivity analysis with outlier removal strengthened

the associations (Table 2). Linear models excluding outliers explained 19.98% of variance in China male prevalence ($p=1.78\times10^{-54}$), 7.78% in China female ($p=7.48\times10^{-21}$), 7.31% in Malaysia male ($p=1.22\times10^{-19}$), and 6.40% in Malaysia female ($p=2.52\times10^{-17}$) prevalence trends.

GDP-only models demonstrated stronger explanatory power: China male ($R^2=0.232$, $p=1.31\times10^{-65}$), China female ($R^2=0.097$, $p=1.83\times10^{-26}$), Malaysia male ($R^2=0.089$, $p=2.54\times10^{-24}$), and Malaysia female ($R^2=0.072$, $p=7.55\times10^{-20}$). PM2.5-only models showed weaker but significant associations across all groups. Model diagnostics including Q-Q plots (Figure 4) and residual plots (Figure 5) confirmed appropriate model fit and assumption validity.

Projections to 2050

Based on multivariate regression models incorporating temporal trends and covariates, we project substantial increases in breast cancer prevalence by 2050 (Figure 6, Table 3). For females, projected 2050 prevalence reaches

Table 2. Sensitivity Analysis Results: Model Performance and Covariate Associations

Country-Sex	Model Type	R ²	P-value	Coef_year	Coef_GDP	Coef_PM25
China-Male	Linear (outliers removed)	0.2	1.78×10^{-54}	0.795	-	-
China-Female	Linear (outliers removed)	0.078	7.48×10^{-21}	9.824	-	-
Malaysia-Male	Linear (outliers removed)	0.073	1.22×10^{-19}	0.108	-	-
Malaysia-Female	Linear (outliers removed)	0.064	2.52×10^{-17}	14.16	-	-
China-Male	GDP only	0.232	1.31×10^{-65}	-	0.002	-
China-Female	GDP only	0.097	1.83×10^{-26}	-	0.026	-
Malaysia-Male	GDP only	0.089	2.54×10^{-24}	-	0.0004	-
Malaysia-Female	GDP only	0.072	7.55×10^{-20}	-	0.045	-
China-Male	PM2.5 only	0.038	5.38×10^{-11}	-	-	-0.724
China-Female	PM2.5 only	0.022	8.09×10^{-7}	-	-	-10.381
Malaysia-Male	PM2.5 only	0.077	3.65×10^{-21}	-	-	-0.267
Malaysia-Female	PM2.5 only	0.067	1.80×10^{-18}	-	-	-34.394

Coef_year: temporal coefficient; Coef_GDP: GDP per capita coefficient; Coef_PM25: PM2.5 coefficient

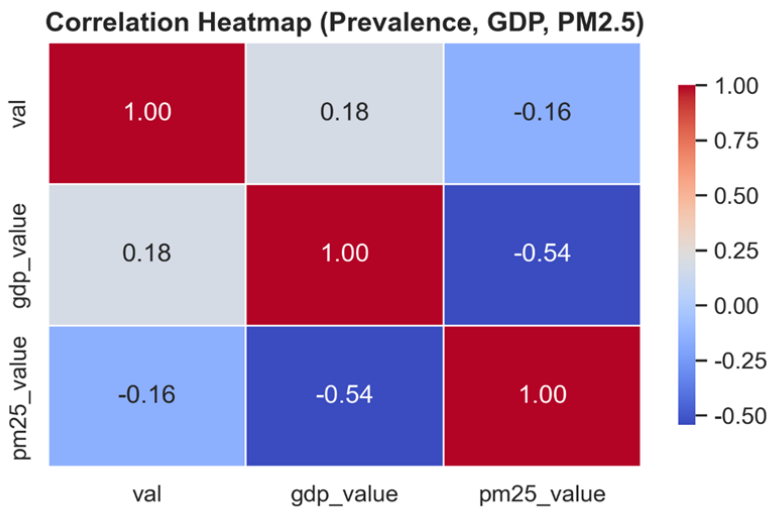


Figure 3. Correlation Heatmap for Breast Cancer Prevalence, GDP per Capita, and PM2.5 Exposure. Pearson correlation coefficients displayed with colour intensity indicating correlation strength. Red indicates positive correlations, blue indicates negative correlations. All correlations significant at $p<0.001$.

Table 3. Projected Breast Cancer Prevalence for 2050 with 95% Confidence Intervals

Country-Sex	2021 Prevalence	2050 Projection	95% CI Lower	95% CI Upper	% Change	R ²	P-value
China-Male	25.2	25.18	11.63	38.74	0.10%	0.234	1.28×10^{-63}
China-Female	650.5	747.58	468.83	1026.33	14.90%	0.101	2.53×10^{-25}
Malaysia-Male	5.8	8.37	5.16	11.57	44.80%	0.097	3.50×10^{-24}
Malaysia-Female	928.7	1388.06	941.55	1834.56	49.50%	0.082	2.42×10^{-20}

Data are presented as prevalence per 100,000 population. Projections based on multivariate regression models incorporating temporal trends, GDP per capita, and PM2.5 exposure.

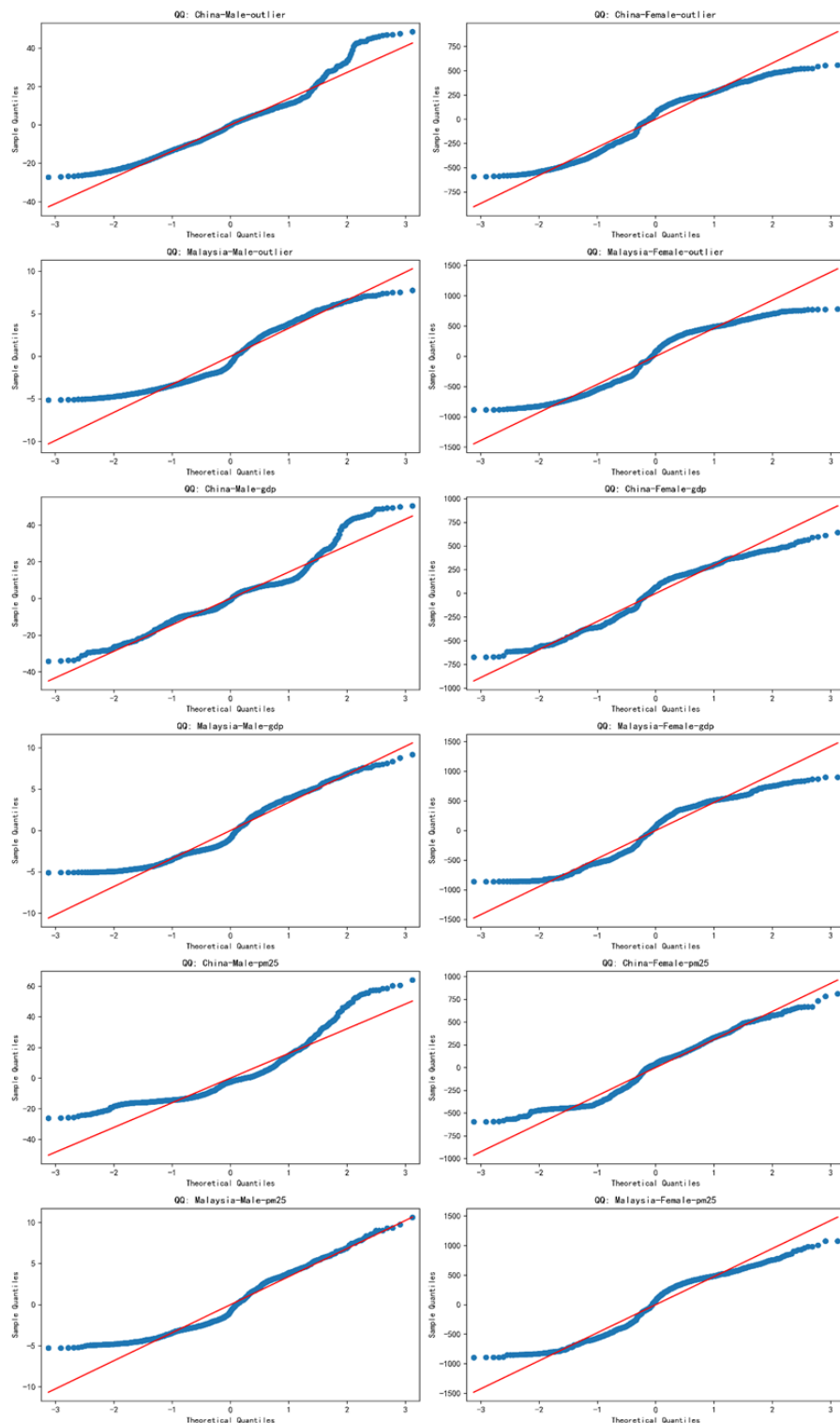


Figure 4. Q-Q Plots for Model Diagnostic Assessment. Normal Q-Q plots for residuals from multivariate regression models, displayed by country, sex, and model type (outlier-removed, GDP-only, PM2.5-only). Points should approximately follow the diagonal line for normally distributed residuals.

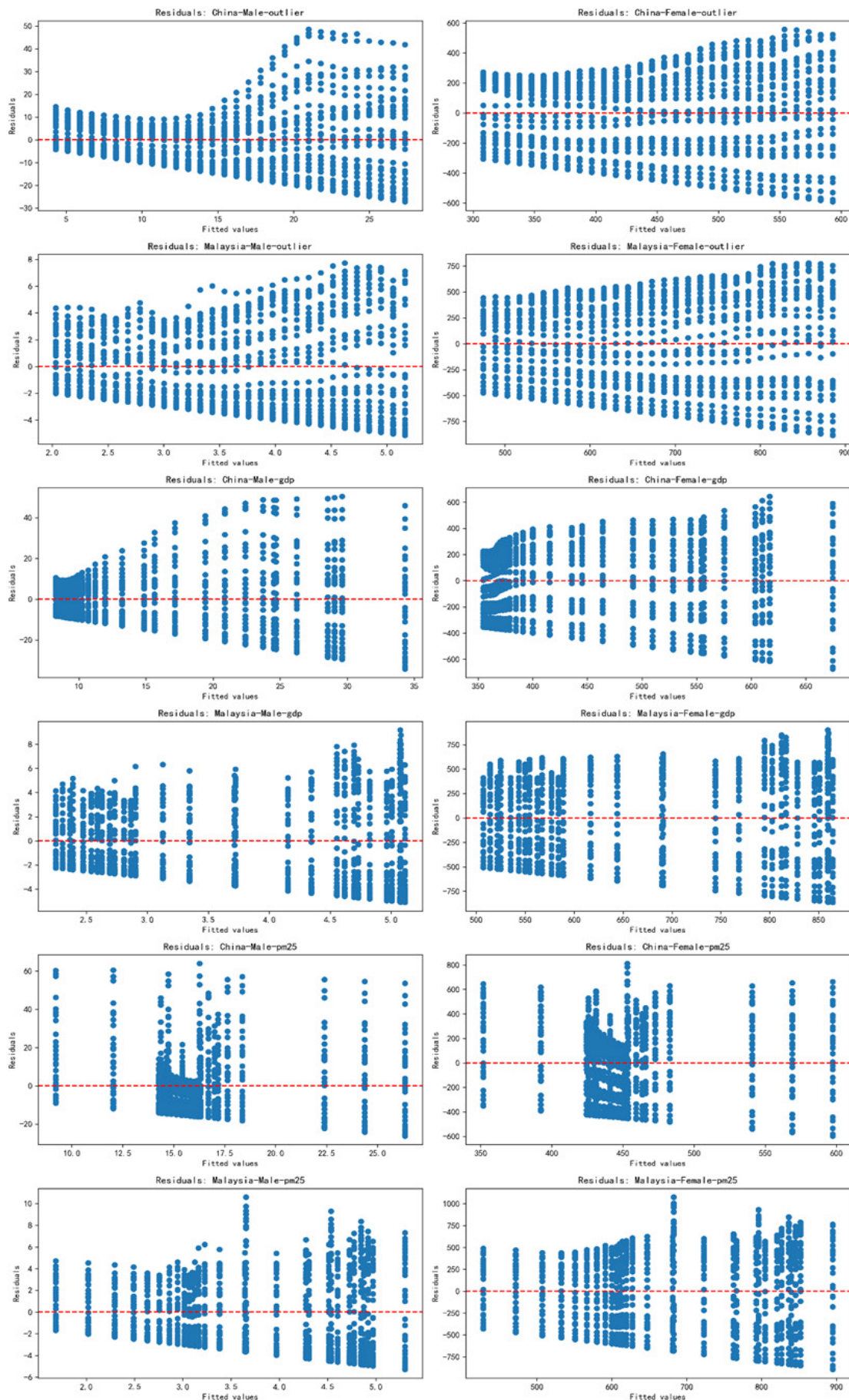


Figure 5. Residual Plots for Model Diagnostic Assessment. Scatter plots of residuals versus fitted values for multivariate regression models, organised by country, sex, and model type. Horizontal red dashed line at zero indicates perfect fit. Random scatter around zero suggests appropriate model specification.

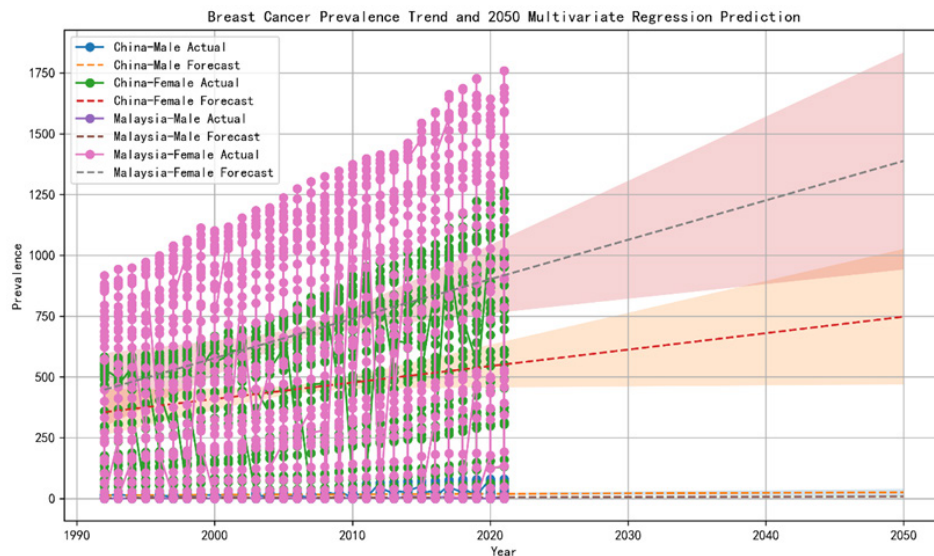


Figure 6. Breast Cancer Prevalence Trends and 2050 Multivariate Regression Predictions. Historical data (1992-2021) shown as scatter plots with trend lines, and projections to 2050 shown as dashed lines with 95% confidence intervals (shaded areas). Projections incorporate temporal trends, GDP per capita, and PM2.5 exposure as covariates.

747.6 per 100,000 (95% CI 468.8-1026.3) in China and 1388.1 per 100,000 (95% CI 941.6-1834.6) in Malaysia. Male projections remain relatively low: 25.2 per 100,000 (95% CI 11.6-38.7) in China and 8.4 per 100,000 (95% CI 5.2-11.6) in Malaysia.

These projections represent increases of 14.9% for Chinese females, 49.5% for Malaysian females, 0.1% for Chinese males, and 44.8% for Malaysian males compared to 2021 levels. The confidence intervals reflect uncertainty in long-term projections but consistently indicate upward trends. The multivariate projection models demonstrated variable predictive performance across country-sex groups. The adjusted R^2 values were 0.231 for China-male (SEE=0.789), 0.098 for China-female (SEE=89.75), 0.094 for Malaysia-male (SEE=1.047), and 0.079 for Malaysia-female (SEE=146.65). These values indicate that while the models captured significant trends, substantial unexplained variance remains, particularly for female projections, which is reflected in the wider confidence intervals for 2050 estimates.

Discussion

Our analysis reveals substantial and accelerating increases in breast cancer prevalence in China and Malaysia from 1992 to 2021, with projections indicating continued growth through 2050. The findings highlight critical public health challenges requiring urgent policy attention and healthcare system strengthening.

Principal findings and implications

The observed trends reflect broader epidemiological transitions occurring across Asia. Female breast cancer prevalence increased by over 90% in both countries over three decades, substantially exceeding global average increases [14]. Malaysia faces a particularly concerning trajectory, with projected 2050 prevalence approaching 1,400 per 100,000 women among the highest globally.

The strong positive association between GDP per

capita and breast cancer prevalence aligns with established epidemiological patterns linking economic development to cancer incidence [15]. This association likely reflects multiple pathways: delayed childbearing, reduced parity, increased use of hormone replacement therapy, dietary transitions toward Western patterns, reduced physical activity, and increased obesity prevalence [16-18].

The negative correlation with PM2.5 exposure initially appears counterintuitive, as air pollution is generally associated with increased cancer risk [19]. However, this finding likely reflects the inverse relationship between economic development and air pollution in these countries, where rapid industrialisation initially increased pollution levels, followed by environmental improvements as economies matured and environmental regulations strengthened [20]. The strong positive association between GDP per capita and breast cancer prevalence should be interpreted with caution, as it likely serves as a proxy for multiple factors including detection capacity, urbanization, and health system maturity. Higher-income regions typically have more robust cancer screening programs and diagnostic capabilities, potentially inflating apparent prevalence through improved case detection rather than true biological differences. This counterintuitive finding should not be interpreted as suggesting a protective effect of air pollution. It is likely confounded by temporal trends in economic development and improved environmental monitoring. As economies mature, both healthcare access and environmental regulations tend to improve simultaneously, creating a spurious negative correlation.

Age-specific patterns and their significance

The peak prevalence in the 50-69 years age groups corresponds to established breast cancer epidemiology, reflecting the interplay of cumulative hormone exposure, genetic susceptibility, and age-related cellular changes [21]. The slight earlier peak in Malaysia compared to

China may reflect different population structures, genetic backgrounds, or environmental exposures.

The consistently low male breast cancer prevalence, while expected, requires continued monitoring as lifestyle factors continue to evolve. The slight increases observed, particularly in older age groups, warrant attention from clinicians and public health practitioners.

Healthcare system implications

The projected increases pose substantial challenges for healthcare systems in both countries. Malaysia, with its smaller population but higher per-capita prevalence, faces particularly acute pressures. The projected 49.5% increase in female prevalence by 2050 necessitates proportional increases in screening capacity, diagnostic facilities, treatment infrastructure, and specialised workforce. The quantitative impact of our projections is substantial when translated to absolute case numbers. Based on population projections, the estimated prevalence in China would equate to over 5.2 million women living with breast cancer by 2050, representing an enormous healthcare system burden. Our regression equation for Chinese female prevalence ($\text{Prevalence} = 334.3 + 9.824 \times \text{Year} + 0.026 \times \text{GDP} - 10.381 \times \text{PM2.5}$) demonstrates that each year of temporal progression contributes approximately 9.8 cases per 100,000, while each \$1,000 increase in GDP per capita contributes an additional 26 cases per 100,000, underscoring the significant impact of economic development on breast cancer burden.

China's massive population amplifies the absolute impact of even modest percentage increases. With over 700 million women in China, the projected prevalence translates to over 5 million prevalent breast cancer cases by 2050, requiring unprecedented healthcare resources and infrastructure development.

Prevention and control strategies

These projections underscore the urgent need for comprehensive breast cancer prevention and control strategies. Primary prevention efforts should focus on modifiable risk factors: promoting physical activity, maintaining healthy body weight, limiting alcohol consumption, and supporting breastfeeding initiatives [22]. Early detection through organised screening programmes becomes increasingly critical, particularly given the age-specific prevalence patterns observed.

Policy interventions should address the underlying drivers of increasing prevalence, including urban planning that promotes physical activity, food policy reforms to improve dietary patterns, and occupational health measures to reduce workplace exposures [23]. The association with economic development suggests that prosperity itself may increase cancer risk, highlighting the need for health-conscious development policies.

Study strengths and limitations

Our study's strengths include the use of standardised GBD data enabling robust international comparisons, comprehensive temporal coverage spanning three decades, incorporation of multiple covariates, and rigorous sensitivity analyses. The age-stratified approach provides

detailed insights into demographic patterns, while the projection methodology offers evidence-based planning tools.

Several limitations must be acknowledged. The linear projection model may not capture potential inflection points or policy impacts that could alter future trends. Unmeasured confounders, including genetic factors, reproductive patterns, and healthcare access, may influence prevalence patterns. The GBD estimates themselves rely on varying data quality across countries and time periods, potentially introducing systematic biases.

The correlation between GDP and prevalence may reflect detection bias, with wealthier populations having greater access to diagnostic services, potentially inflating apparent prevalence increases. However, the consistency of trends across both countries and the biological plausibility of observed associations support the validity of our findings.

Future research directions

Future investigations should incorporate additional risk factors, including reproductive history, genetic susceptibility markers, and healthcare system characteristics. Molecular subtype-specific analyses could provide insights into changing tumour biology patterns. Economic analyses quantifying the projected burden's cost implications would inform resource allocation decisions.

Longitudinal cohort studies examining individual-level trajectories within these populations could validate our aggregate-level findings and identify high-risk subgroups. Intervention studies testing prevention strategies specifically tailored to Asian populations could guide evidence-based policy development.

Policy recommendations

Based on our findings, we recommend immediate policy actions across multiple domains. Healthcare systems should expand screening capacity, particularly targeting the 50-69 years age groups where prevalence peaks. Investment in diagnostic infrastructure, treatment facilities, and specialist training becomes critical, especially in Malaysia given its steeper trajectory.

Prevention policies should address socioeconomic determinants of health, ensuring that economic development proceeds alongside health-promoting environmental and social changes. This includes urban planning that facilitates physical activity, food policies promoting healthy diets, and workplace wellness programmes.

International collaboration between China and Malaysia could facilitate knowledge sharing, joint research initiatives, and coordinated regional responses. Given the similar trajectories observed, shared prevention and control strategies may prove mutually beneficial.

In conclusion, breast cancer prevalence in China and Malaysia has increased substantially from 1992 to 2021 and is projected to continue rising through 2050, with Malaysia facing particularly steep increases. The association with economic development highlights the complex relationship between prosperity and health, suggesting that development policies must proactively

address health implications.

These projections demand urgent, coordinated policy responses encompassing prevention, early detection, and healthcare system strengthening. The window for implementing effective interventions is narrowing, making immediate action imperative to mitigate the projected burden and protect population health. Without decisive intervention, breast cancer will impose increasingly severe impacts on individuals, families, healthcare systems, and society in both countries. Regional collaboration will be essential in addressing this growing challenge. We recommend establishing a coordinated Asian breast cancer surveillance network, harmonizing cancer registry data collection methods, developing shared prevention strategy frameworks, and conducting collaborative research on region-specific risk factors. Such cooperation would strengthen the evidence base for policy interventions and facilitate more effective resource allocation across healthcare systems facing similar epidemiological transitions.

Author Contribution Statement

Zhen Ma: Writing-original draft, methodology, formal analysis, data curation, conceptualization. Zhongli Geng: Writing-review and editing, supervision, project administration, investigation, funding acquisition. Jianya Mao: Software, resources, methodology, formal analysis, data curation. Zaizitihan Biekezati: Validation, software, resources, methodology, investigation. Ting Hui: Visualization, validation, methodology, investigation, formal analysis. Jinqiang Pan: Resources, methodology, investigation, formal analysis, data curation..

Acknowledgements

None.

Data sharing

The data used in this analysis are publicly available from the Global Burden of Disease Study 2021 (<http://ghdx.healthdata.org/gbd-results-tool>), World Bank World Development Indicators (<https://data.worldbank.org/>), and supporting analytical code is available upon request.

Declaration of interests

We declare no competing interests.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 cancers in 185 Countries. *CA Cancer J Clin.* 2021;71:209-249. <https://doi.org/10.3322/caac.21660>
2. Ferlay J, Colombet M, Soerjomataram I, Parkin DM, Pineros M, Znaor A, Bray F. Cancer statistics for the year 2020: An overview. *Int J Cancer.* 2021;149:778-789. <https://doi.org/10.1002/ijc.33588>
3. Youlten DR, Cramb SM, Yip CH, Baade PD. Incidence and mortality of female breast cancer in the Asia-Pacific region. *Cancer Biol Med.* 2014;11:101-115. <https://doi.org/10.7497/j.issn.2095-3941.2014.02.005>

4. Chen W, Zheng R, Baade PD, Zhang S, Zeng H, Bray F, et al. Cancer statistics in China, 2015. *CA Cancer J Clin.* 2016;66:115-132. <https://doi.org/10.3322/caac.21338>
5. Bhoo-Pathy N, Hartman M, Yip CH, Saxena N, Taib NA, Lim SE, et al. Ethnic differences in survival after breast cancer in Southeast Asia. *PLoS One.* 2012;7:e30995. <https://doi.org/10.1371/journal.pone.0030995>
6. Wang H, Naghavi M, Allen C, Barber RM, Bhutta ZA, Carter A, et al. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet.* 2016;388:1459-1544. [https://doi.org/10.1016/S0140-6736\(16\)31012-1](https://doi.org/10.1016/S0140-6736(16)31012-1)
7. Yip CH, Taib NA, Mohamed I. Epidemiology of breast cancer in Malaysia. *Asian Pac J Cancer Prev.* 2006;7:369-374.
8. Fan L, Strasser-Weippl K, Li JJ, St Louis J, Finkelstein DM, Yu KD, et al. Breast cancer in China. *Lancet Oncol.* 2014;15:e279-e289. [https://doi.org/10.1016/S1470-2045\(13\)70567-9](https://doi.org/10.1016/S1470-2045(13)70567-9)
9. Mousavi SM, Montazeri A, Mohagheghi MA, Jarrahi AM, Harirchi I, Najafi M, Ebrahimi M. Breast cancer in Iran: an epidemiological review. *Breast J.* 2007;13:383-391. <https://doi.org/10.1111/j.1524-4741.2007.00446.x>
10. Karim-Kos HE, de Vries E, Soerjomataram I, Lemmens V, Siesling S, Coebergh JWW. Recent trends of cancer in Europe: a combined approach of incidence, survival and mortality for 17 cancer sites since the 1990s. *Eur J Cancer.* 2008;44:1345-1389. <https://doi.org/10.1016/j.ejca.2007.12.015>
11. GBD 2021 Diseases and Injuries Collaborators. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet.* 2024;403:2133-2161. [https://doi.org/10.1016/S0140-6736\(24\)00757-8](https://doi.org/10.1016/S0140-6736(24)00757-8)
12. World Bank. World Development Indicators: GDP per capita (current US\$). Available from: <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD>. Accessed December 1, 2024.
13. World Bank. PM2.5 air pollution, mean annual exposure (micrograms per cubic meter). Available from: <https://data.worldbank.org/indicator/EN.ATM.PM25.MC.M3>. Accessed December 1, 2024.
14. Arnold M, Morgan E, Rumgay H, Mafra A, Singh D, Laversanne M, Vignat J, et al. Current and future burden of breast cancer: Global statistics for 2020 and 2040. *Breast.* 2022;66:15-23. <https://doi.org/10.1016/j.breast.2022.08.010>
15. Bray F, Jemal A, Gray N, Ferlay J, Forman D. Global cancer transitions according to the Human Development Index (2008-2030): a population-based study. *Lancet Oncol.* 2012;13:790-801. [https://doi.org/10.1016/S1470-2045\(12\)70211-5](https://doi.org/10.1016/S1470-2045(12)70211-5)
16. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50302 women with breast cancer and 96973 women without the disease. *Lancet.* 2002;360:187-195. [https://doi.org/10.1016/S0140-6736\(02\)09454-0](https://doi.org/10.1016/S0140-6736(02)09454-0)
17. Picon-Ruiz M, Morata-Tarifa C, Valle-Goffin JJ, Friedman ER, Slingerland JM. Obesity and adverse breast cancer risk and outcome: Mechanistic insights and strategies for intervention. *CA Cancer J Clin.* 2017;67:378-397. <https://doi.org/10.3322/caac.21405>
18. Liu Y, Nguyen N, Colditz GA. Links between alcohol consumption and breast cancer: a look at the evidence.

- Womens Health (Lond). 2015;11:65-77. <https://doi.org/10.2217/whe.14.62>
19. Hamra GB, Guha N, Cohen A, Laden F, Raaschou-Nielsen O, Samet JM, et al. Outdoor particulate matter exposure and lung cancer: a systematic review and meta-analysis. *Environ Health Perspect.* 2014;122:906-911. <https://doi.org/10.1289/ehp.1408092>
 20. Zhang Q, Jiang X, Tong D, Davis SJ, Zhao H, Geng G, et al. Transboundary health impacts of transported global air pollution and international trade. *Nature.* 2017;543:705-709. <https://doi.org/10.1038/nature21712>
 21. Key TJ, Verkasalo PK, Banks E. Epidemiology of breast cancer. *Lancet Oncol.* 2001;2:133-140. [https://doi.org/10.1016/S1470-2045\(00\)00254-0](https://doi.org/10.1016/S1470-2045(00)00254-0)
 22. World Cancer Research Fund/American Institute for Cancer Research. Diet, nutrition, physical activity and cancer: a global perspective. Continuous Update Project Expert Report 2018. London: World Cancer Research Fund International; 2018.
 23. Wild CP, Weiderpass E, Stewart BW, editors. World Cancer Report: Cancer Research for Cancer Prevention. Lyon: International Agency for Research on Cancer; 2020.



This work is licensed under a Creative Commons Attribution-Non Commercial 4.0 International License.