Relationship Between Human Development Index and Breast Cancer Prognosis in Chinese Women: A Multi-Regional Retrospective Cohort Analysis

Wanting Wang[1]; Yuanqin Yuan[1]; Anqi Yuan[2]; Zhe Hu[2]; Chenhui Zheng[2]; ZhibaoZheng[2]; Yin Pan[2]; Weizhen Liang[2]; Baofu Chen[2*]; Changjiang Zhang[1*]; Yuzhu Zhang[2*]

[1]Schoolofartificialintelligence,TaizhouUniversity, [2]TaizhouCentralHospital(TaizhouUniversityHospital)

Introduction

Breast cancer is the most frequently diagnosed cancer and leading cause of cancer mortality among women globally. In 2022, China accounted for 18.2% of global new cases and 18.6% of deaths, bearing the heaviest absolute burden. While global survival rates are improving, these gains are concentrated in high-income countries, leaving a widening gap with low- and middle-income regions.

The Human Development Index (HDI), a composite metric of life expectancy, education, and income, is a powerful tool to explore socioeconomic disparities in health outcomes. Although national-level ecological studies exist, large-scale, multicenter analyses within a single country that adjust for individual clinical characteristics are lacking.

China exhibits vast internal regional disparities, with HDI ranging from 0.53 to 0.88. This study aims to fill this critical gap by investigating the association between prefecture-level HDI and breast cancer prognosis in a large, real-world Chinese cohort, adjusting for key clinical and demographic confounders.

Methods and Materials

Study Design & Population: A retrospective cohort study using data from 40 breast cancer centers across 184 Chinese cities (2000-2021). After exclusions (n=8,585), 25,514 patients were included.

Exposure: Residential Human Development Index (HDI) at the prefecture-level city, sourced from the China Human Development Report. HDI was analyzed both as a continuous variable (per 0.05-unit increase) and categorized into tertiles: Low (≤0.762), Medium (0.763-0.818), High (≥0.819).

Outcomes: Progression-Free Survival (PFS) and Overall Survival (OS).

Statistical Analysis:

Survival Analysis: Kaplan-Meier curves with log-rank tests.
Association: Multivariate Cox proportional hazards models to calculate Hazard Ratios (HR) and 95% Confidence Intervals (CI). Models were sequentially adjusted for pathological type, Ki67, molecular subtype, TNM stage, age, family history, and history of other tumors (Model 3 = fully adjusted).
Subgroup Analysis: Stratified by age, pathological type, Ki67, molecular subtype, TNM stage, family history, and tumor history.

Results

Study Design & Population: A retrospective cohort study using data from 40 breast cancer centers across 184 Chinese cities (2000-2021). After exclusions (n=8,585), 25,514 patients were included.

Exposure: Residential Human Development Index (HDI) at the prefecture-level city, sourced from the China Human Development Report. HDI was analyzed both as a continuous variable (per 0.05-unit increase) and categorized into tertiles: Low (≤0.762), Medium (0.763-0.818), High (≥0.819).

Outcomes: Progression-Free Survival (PFS) and Overall Survival (OS).

Statistical Analysis:

Survival Analysis: Kaplan-Meier curves with log-rank tests.
Association: Multivariate Cox proportional hazards models to calculate Hazard Ratios (HR) and 95% Confidence Intervals (CI). Models were sequentially adjusted for pathological type, Ki67, molecular subtype, TNM stage, age, family history, and history of other tumors (Model 3 = fully adjusted).
Subgroup Analysis: Stratified by age, pathological type, Ki67, molecular subtype, TNM stage, family history, and tumor history.

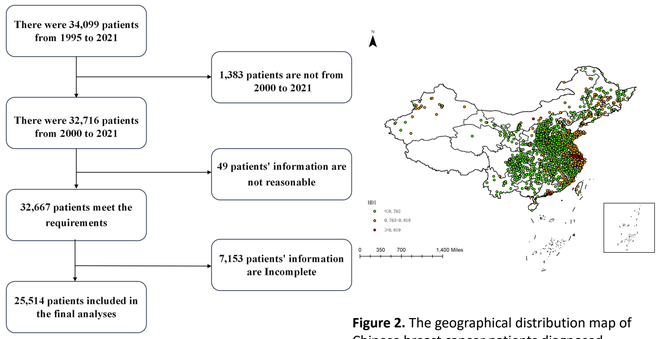


Figure 1. Flow chart of patients enrollmentfor the Breast Cancer study.

Figure 2. The geographical distribution map of Chinese breast cancer patients diagnosed in the database.

Discussion

This study demonstrates that even within a single country with a unified healthcare framework, subtle regional socioeconomic disparities, as measured by HDI, are a powerful and independent predictor of long-term breast cancer survival. The 46% lower mortality risk in high-HDI regions highlights a profound structural determinant of health.

The effect is most evident in "intervenable" disease stages (I-III) and subtypes (Luminal, HER2+), suggesting high-HDI regions excel in the full cancer care continuum: upstream (public health literacy, screening), midstream (access to specialists, standardized/targeted therapy), and downstream (follow-up, adherence support).

These findings underscore that improving breast cancer outcomes requires more than just clinical guidelines; it necessitates addressing the underlying social and economic determinants of health through targeted resource allocation and policies aimed at reducing regional development gaps.

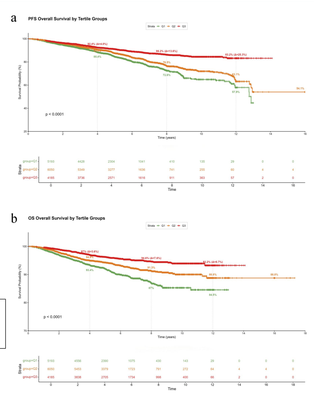


Figure 3. Kaplan–Meier survival curves of (a) PFS and (b) OS in breast cancer patients stratified by residential HDI tertiles.

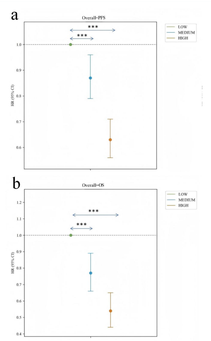


Figure 5. Box plots showing (a) progression-free survival (PFS) and (b) overall survival (OS) by tertiles of residential human development index (HDI) in breast cancer patients. *P < 0.05, **P < 0.01, ***P < 0.001.

Conclusions

Regional Human Development Index (HDI) is a significant and independent prognostic factor for breast cancer survival among Chinese women. Higher HDI is robustly associated with superior progression-free and overall survival, even after adjusting for key clinical and biological variables. This quantifiable relationship provides a crucial foundation for developing differentiated prevention and control strategies, optimizing healthcare resource allocation, and ultimately advancing health equity in breast cancer care across diverse regions.

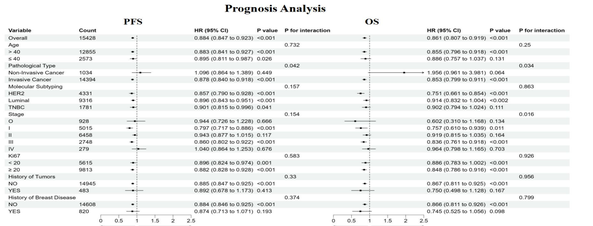


Figure 4. Forest plot of subgroup analyses to explore the impact of human development index (HDI) per 0.05-unit higher on prognosis in breast cancer patients.

Table 1. Hazard ratios (95% CIs) for breast cancer prognosis per 0.05-unit higher HDI and by HDI tertiles in four adjustment models.

PFS		HDI			
	Per 0.05 increase	Low	Meidium	High	P trend
Model 0 (N=25515)	0.828(0.798 to 0.859)	1.0(referent)	0.889(0.816 to 0.970)	0.545(0.492 to 0.604)	<0.001
Model 1 (N=15823)	0.879(0.843 to 0.917)	1.0(referent)	0.868(0.789 to 0.955)	0.620(0.549 to 0.699)	<0.001
Model 2 (N=15823)	0.886(0.849 to 0.924)	1.0(referent)	0.875(0.795 to 0.963)	0.633(0.561 to 0.715)	<0.001
Model 3 (N=15428)	0.884(0.847 to 0.923)	1.0(referent)	0.871(0.788 to 0.962)	0.628(0.555 to 0.711)	<0.001

OS		HDI			
	Per 0.05 increase	Low	Meidium	High	P trend
Model 0 (N=25515)	0.830(0.785 to 0.878)	1.0(referent)	0.823(0.722 to 0.938)	0.509(0.436 to 0.595)	<0.001
Model 1 (N=15823)	0.871(0.819 to 0.927)	1.0(referent)	0.799(0.696 to 0.918)	0.535(0.445 to 0.644)	<0.001
Model 2 (N=15823)	0.871(0.818 to 0.927)	1.0(referent)	0.798(0.695 to 0.917)	0.534(0.444 to 0.644)	<0.001
Model 3 (N=15428)	0.861(0.807 to 0.919)	1.0(referent)	0.765(0.661 to 0.886)	0.538(0.444 to 0.651)	<0.001

a Low: ⩽0.762 ; Medium: 0.763 to 0.818; High:⩾ 0.819
CI ,confidence interval; HR, hazard ratio; HDI, Human Development Index
b model 0: Models adjusted for Pathological type
c model 1: Models adjusted for ki67, Pathological type, Molecular subtyping, stage
d model 2: Models adjusted for ki67, Pathological type, Molecular subtyping, stage, age
e model 3: Models adjusted for ki67, Pathological type, Molecular subtyping, stage, Family history of breast cancer, History of tumors, age

Contact

<Wanting Wang>
<your organization>
Email:466802817@qq.com
Website:https://jxgcxy.tzc.edu.cn/index.htm
Phone:+86 15867660228

References

1. Parkin DM, Stjernswärd J, Muir CS. Estimates of the worldwide frequency of twelve major cancers. Bull World Health Organ. 1984;62(2):163-82. PMID: 6610488; PMCID: PMC2536293.
2. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, Jemal A. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024 May-Jun;74(3):229-263. doi: 10.3322/caac.21834. Epub 2024 Apr 4. PMID: 38572751.
3. Allemani C, Matsuda T, Di Carlo V, Harewood R, Matz M, Nikšić M, Bonaventure A, et al. Global surveillance of trends in cancer survival 2000-14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. Lancet. 2018 Mar 17;391(10125):1023-1075. doi: 10.1016/S0140-6736(17)33326-3. Epub 2018 Jan 31. PMID: 29395269; PMCID: PMC5879496.
4. GBD 2023 Cancer Collaborators. The global, regional, and national burden of cancer, 1990-2023, with forecasts to 2050: a systematic analysis for the Global Burden of Disease Study 2023. Lancet. 2025 Sep 24:S0140-6736(25)01635-6. doi: 10.1016/S0140-6736(25)01635-6. Epub ahead of print. PMID: 41015051.
5. Ramadan MM, Alkhatatbeh HA, Abpeikar O, Alaa S, Alsiary RA. Burden, and trends of breast cancer along with attributable risk factors in Gulf Cooperation Council countries from 1990 to 2019 and its projections. PLoS One. 2025 Oct 6;20(10):e0331198. doi: 10.1371/journal.pone.0331198. PMID: 41052148; PMCID: PMC12500115.
6. Bellanger M, Zeinomar N, Tehranifar P, Terry MB. Are Global Breast Cancer Incidence and Mortality Patterns Related to Country-Specific Economic Development and Prevention Strategies? J Glob Oncol. 2018 Jul;4:1-16. doi: 10.1200/JGO.17.00207. PMID: 30085889; PMCID: PMC6223528.
7. Liao L. Inequality in breast cancer: global statistics from 2022 to 2050. Breast. 2025;79:103851. doi:10.1016/j.breast.2024.103851.
8. Salehi AM, Shahbazi F, Garavand R, Kamkari S, Jenabi E. Global socioeconomic inequalities in breast, cervical, ovarian, and uterine cancers incidence, mortality, disability-adjusted life year's rates: a relative concentration index analysis. BMC Womens Health. 2025 Sep 25;25(1):433. DOI: 10.1186/s12905-025-03961-3.
9. Kim J, Harper A, McCormack V, Sung H, Houssami N, Morgan E, et al. Global patterns and trends in breast cancer incidence and mortality across 185 countries. Nat Med. 2025 Apr;31(4):1154-1162. DOI: 10.1038/s41591-025-03502-3
10. [Mohammadian M, Pakzad R, Towhidi F, Makhyoji BR, Ahmadi A, Salehinya H. Incidence and mortality of kidney cancer and its relationship with HDI (Human Development Index) in the world in 2012. Clujul Med. 2017;90(3):286-293. doi: 10.15386/cjmed-691. Epub 2017 Jul 15. PMID: 28781525; PMCID: PMC5536208.
11. Fattollahi F, Khazaei Z, Abbasi M, Goodarzi E. Burden of prostate cancer and relationship with the human development index (HDI) in Asia: A study of Global Burden disease in 2019. Caspian J Intern Med. 2023 Fall;14(4):710-719. doi: 10.22088/cjim.14.4.710. PMID: 38024182; PMCID: PMC10646363.

This presentation is the intellectual property of the author/presenter. Contact them at <<466802817@qq.com>> for permission to reprint and/or distribute.

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com