Preplanned Studies

Female Breast Cancer Incidence and Association with Socioeconomic Status in a Population-Based Cohort — China, 2018–2024

Heling Bao[1,&]; Liwen Fang[2,&]; Shu Cong[2]; Xiaolei Guo[3]; Zhentao Fu[3]; Xiaoli Liu[4]; Weiwei Shi[4]; Hongjian Liu[5]; Hui Liu[1,#]; Xuening Duan[6,#]; Linhong Wang[2,#]

Summary

What is already known about this topic?

Breast cancer has emerged as the most prevalent cancer among women globally and is increasingly affecting younger populations. However, the relationship between individual socioeconomic status (SES) and breast cancer risk remains incompletely understood.

What is added by this report?

This population-based cohort study revealed a breast cancer incidence rate of 48.9 per 100,000 person-years. Women with high SES demonstrated a significantly elevated risk of breast cancer compared to those with low SES [hazard ratio (*HR*)=1.42, 95% confidence interval (*CI*): 1.05, 1.92]. Self-perceived SES appeared to moderate this association, with an increased breast cancer risk particularly evident among women who had both low objectively assessed and self-perceived SES.

What are the implications for public health practice?

These findings underscore the need for tailored breast cancer screening programs and targeted health education initiatives that account for differences across SES groups.

ABSTRACT

Introduction: Breast cancer has emerged as the most prevalent cancer among women globally. However, the relationship between individual socioeconomic status (SES) and breast cancer risk remains incompletely understood.

Methods: This population-based cohort study recruited women aged 30–70 years from Shandong, Hebei, and Jiangsu provinces in China during 2008 and 2018. We developed a composite SES measure through latent class analysis incorporating household income, education level, and health insurance type, stratifying participants into low and high SES groups. Self-perceived SES was evaluated using a Likert scale. We employed Cox proportional hazards regression to estimate hazard ratios (*HR*s) and 95% confidence intervals (*CI*s) for the association between SES and breast cancer incidence.

Results: Among 62,350 participants followed for an average of 6.1 person-years, we identified 300 incident breast cancer cases. The overall incidence rate was 48.9 per 100,000 person-years. Women with high SES demonstrated significantly elevated breast cancer risk compared to those with low SES (*HR*=1.42, 95% *CI*: 1.05–1.92). Self-perceived SES appeared to modify this relationship, with increased breast cancer risk observed among women categorized as both objectively and subjectively low SES.

Conclusions: These findings underscore the need for SES-specific approaches to breast cancer screening programs and targeted health education initiatives.

Breast cancer has emerged as the predominant cancer affecting women worldwide and in China (*1*). While several established risk factors exist (including alcohol consumption, reproductive history, family history, and age at menarche and menopause), the relationship between socioeconomic status (SES) and breast cancer risk remains complex. Recent evidence suggests that women with high SES may face an increased risk of breast cancer, potentially due to delayed childbearing, having fewer children, and shorter breastfeeding duration (*2*). However, other studies have demonstrated an inverse association, highlighting the intricate interplay of lifestyle factors, environmental conditions, and healthcare accessibility in determining disease patterns (*3*–*4*). In China, cohort studies examining this relationship are limited. Our previous research revealed low health literacy and screening rates among women with low SES,

underscoring the uncertainty surrounding this issue (5–6). Understanding these relationships is crucial for developing targeted interventions to reduce breast cancer incidence in high-risk populations.

This population-based cohort study, encompassing 62,350 participants with 300 incident breast cancer cases during a mean follow-up of 6.1 person-years, revealed that women with high SES demonstrated an elevated risk of developing breast cancer compared to those with low SES. The relationship appeared to be moderated by self-perceived SES, with the effect primarily driven by an increased breast cancer risk among women who were classified as having both low objectively assessed and self-perceived SES compared to their counterparts. These findings emphasize the importance of implementing tailored screening programs and health education strategies across different SES groups.

The participants were recruited from the Breast Cancer Cohort in Chinese Women (BCCS-CW) (5). We enrolled 63,219 women aged 30–70 years from 8 counties and 6 districts across Shandong, Hebei, and Jiangsu provinces in 2008 and 2018. Follow-up occurred in two phases: Phase I (2018–2020) comprised clinician-based examinations and household surveys for the 2008 cohort, while Phase II (2020–2024) linked both recruitment waves to cancer and death registries. Participants were followed until breast cancer diagnosis, death, loss to follow-up, or November 2024.

SES assessment incorporated three dimensions: household income per capita, individual education level, and health insurance type. Each dimension was categorized as low, medium, or high based on self-reported data and sample distribution. Following *Pan* et al. (7), we derived a composite SES measure using latent class analysis, which identified two distinct classes: low and high. Additionally, we assessed self-perceived SES using a 5-point Likert scale question: "How would you describe yourself economically in this community?" Responses were categorized as low, medium, or high. This study collected comprehensive covariate data through questionnaires, including demographic characteristics, physical examination findings, reproductive history, alcohol consumption, family history, and hormone exposure.

The study calculated overall breast cancer incidence rates stratified by SES and covariates, with χ^2 tests evaluating between-group differences. A Cox proportional hazards regression model was employed to calculate hazard ratio (*HR*) and 95% confidence interval (*CI*) for breast cancer risk by objectively assessed and self-perceived SES, adjusting for covariates. The marginaleffect package in R software was used to calculate the change in breast cancer risk per one-unit increase in independent variables. Missing data were handled using Markov chain Monte Carlo algorithm for continuous variables and mode imputation for categorical variables. All analyses were conducted using SAS (version 9.4; SAS Institute, Cary, USA) and R software (version 4.4.1; R Foundation for Statistical Computing, Vienna, Austria).

Among the 62,350 participants included in the analysis, with a total follow-up of 612,972.8 person-years (median 6 person-years), the demographic distribution showed that 35% were aged <40 years, 35% were between 40–49 years, and 15% were aged ≥ 60 years. Additionally, 9% were unmarried or divorced, 18% were unemployed, and 5% experienced menopause after age 55. Latent class analysis categorized 16,869 participants (27%) into the high SES group and 45,481 (73%) into the low SES group. Regarding self-perceived SES, 3,751 participants identified as low, 47,821 as middle, and 10,778 as high.

The overall breast cancer incidence rate was 48.9 per 100,000 person-years (Table 1). The highest incidence rate of 68.1 per 100,000 person-years was observed among women aged 40–49 years, with a significantly elevated risk compared to those aged <40 years (*HR*=1.80, 95% *CI*: 1.35, 2.40). Women who experienced menopause after age 55 demonstrated an incidence rate of 65.5 per 100,000 person-years, higher than their counterparts (*HR*=1.34, 95% *CI*: 0.85, 2.12). A notably elevated incidence rate of 125.1 per 100,000 person-years was observed among women with a family history of breast or ovarian cancer, corresponding to a significantly increased risk (*HR*=2.42, 95% *CI*: 1.28, 4.55) compared to those without such history.

Analysis by SES revealed an incidence rate of 47.5 per 100,000 person-years in the low SES group compared to 53.7 per 100,000 person-years in the high SES group, yielding an adjusted *HR* of 1.42 (95% *CI*: 1.05, 1.92). Conversely, breast cancer incidence showed an inverse relationship with self-perceived SES. The highest incidence rate of 75 per 100,000 person-years was observed among participants with low self-perceived SES, while those with moderate self-perceived SES showed an incidence rate of 48.5 per 100,000 person-years (*HR*=0.67, 95% *CI*: 0.46, 0.99). The lowest incidence rate of 39.7 per 100,000 person-

TABLE 1. Baseline characteristics of women in the cohort.

Characteristics	Participants	Case	Person-years	Incident rate per 100,000	Hazards ratios (95% *CI*)	
					Age adjusted[¶]	Full adjusted**
All	62,350	300	612,972.8	48.9	NA	NA
Age group						
<40	16,889	76	197,710.1	38.1	1	1
40–49	18,983	126	184,919.2	68.1	1.91 (1.43, 2.54)	1.80 (1.35, 2.40)
50–59	17,703	73	154,841.7	47.1	1.37 (0.99, 1.89)	1.26 (0.90, 1.78)
≥60	8,775	25	73,501.8	34.0	0.99 (0.63, 1.56)	0.92 (0.57, 1.50)
Marital status						
Married	56,375	273	547,530.7	49.9	1	1
Others*	5,975	27	65,442.1	41.3	0.82 (0.55, 1.24)	0.78 (0.52, 1.18)
Occupation						
No work	17,773	102	190,484.4	53.5	1.13 (0.87, 1.46)	1.16 (0.90, 1.51)
Farmer	30,419	136	295,673.1	46.0	1	1
Other work	14,158	62	126,815.4	48.9	1.11 (0.82, 1.50)	1.08 (0.77, 1.52)
BMI						
Normal or thin	22,710	99	223,896.4	44.2	1	1
Overweight[†]	39,640	201	389,076.4	51.7	1.13 (0.89, 1.44)	1.12 (0.88, 1.43)
Menopause after 55						
No	59,530	279	580,920.9	48.0	1	1
Yes	2,820	21	32,052.0	65.5	1.32 (0.84, 2.09)	1.34 (0.85, 2.12)
Family history[§]						
No	61,511	290	604,978.2	47.9	1	1
Yes	839	10	7,994.6	125.1	2.68 (1.43, 5.03)	2.42 (1.28, 4.55)
MET						
Low	31,098	152	302,281.0	50.3	1	1
High	31,252	148	310,691.8	47.6	0.93 (0.74, 1.17)	0.93 (0.74, 1.17)
SES						
Low	45,481	223	469,514.8	47.5	1	1
High	16,869	77	143,458.0	53.7	1.25 (0.96, 1.63)	1.42 (1.05, 1.92)
Self-perceived SES						
Low	3,751	31	41,319.7	75.0	1	1
Moderate	47,821	232	478,538.8	48.5	0.67 (0.46, 0.98)	0.67 (0.46, 0.99)
High	10,778	37	93,114.4	39.7	0.58 (0.36, 0.94)	0.55 (0.33, 0.90)

Abbreviation: *CI*=confidence interval; SES=socioeconomic status; BMI=body mass index; MET=metabolic equivalent of task; NA=not applicable.
* Others included single, separated, divorced, and widowed;
† Overweight included overweight and obese categories;
§ Family history of cancer refers to second-degree relatives;
¶ Models are adjusted for age only;
** Models are adjusted for age, marital status, race, occupation, BMI, physical exercise, red meat consumption, drinking, smoking, family history, radiation therapy to chest, menarche, menopause, and self-perceived SES.

years was found among participants with high self-perceived SES (*HR*=0.55, 95% *CI*: 0.33, 0.90).

Subgroup analyses (Table 2) revealed that the positive association between high SES and breast cancer incidence was more pronounced among several demographic groups: women aged 40–49 years compared to those under 40, married women versus other marital statuses, unemployed women versus

TABLE 2. Associations between socioeconomic status and breast cancer risk by subgroup analysis in the cohort.

Characteristics	Low SES		High SES		Adjusted HRs (95% *CI*)	
	Person-years	Incident rate per 100,000	Person-years	Incident rate per 100,000	High *vs.* Low[¶]	*P*
Age group, years						
<40	131,645.7	45.6	68,064.4	23.5	0.72 (0.40, 1.28)	0.27
40–49	136,848.0	59.2	48,071.2	93.6	2.09 (1.41, 3.08)	**<0.001**
50–59	132,166.0	46.2	22,675.7	52.9	1.39 (0.72, 2.70)	0.33
≥60	68,855.1	30.5	4,646.7	86.1	2.52 (0.83, 7.68)	0.10
Marital status						
Married	412,481.9	48.2	135,048.8	54.8	1.56 (1.16, 2.08)	**0.003**
Others*	57,032.9	42.1	8,409.2	35.7	0.61 (0.17, 2.28)	0.47
Occupation						
No work	159,430.1	47.0	31,054.2	86.9	2.05 (1.27, 3.29)	**0.003**
Farmer	258,864.9	47.5	36,808.2	35.3	0.90 (0.50, 1.64)	0.74
Other work	51,219.9	48.8	75,595.5	48.9	1.52 (0.88, 2.63)	0.14
BMI						
Normal or thin	161,317.2	43.4	62,579.3	46.3	1.39 (0.86, 2.25)	0.17
Overweight[†]	308,197.7	49.6	80,878.7	59.3	1.51 (1.07, 2.15)	**0.02**
Menopause after 55						
No	27,787.1	57.6	4,264.9	117.2	2.44 (0.80, 7.42)	0.12
Yes	441,727.7	46.9	139,193.1	51.7	1.40 (1.20, 1.92)	**0.04**
Family history[§]						
No	464,835.9	46.7	140,142.4	52.1	1.39 (1.02, 1.90)	**0.04**
Yes	4,678.9	128.2	3,315.6	120.6	1.24 (0.28, 5.50)	0.78
MET						
Low	227,134.6	48.9	75,146.4	54.6	1.41 (0.92, 2.17)	0.11
High	242,380.3	46.2	68,311.5	52.7	1.53 (0.99, 2.38)	0.06
Self-perceived SES						
Low	39,037.9	76.8	2,281.8	43.8	0.45 (0.06, 3.50)	0.45
Moderate	380,150.1	45.8	98,388.7	58.9	1.50 (1.06, 2.12)	**0.02**
High	50,326.8	37.8	42,787.5	42.7	1.67 (0.80, 3.48)	0.17

Note: The bold texts represets *P*<0.05.
Abbreviation: *HR*=hazard ratio; *CI*=confidence interval; SES=socioeconomic status; BMI, body mass index; MET=metabolic equivalent of task.
* Others included single, separated, divorced, and widowed;
† Overweight included overweight and obese;
§ Family history of cancer in second-degree relatives;
¶ Models adjusted for all covariates except the stratification variable.

farmers, overweight or obese women versus those of normal weight, women without a family history of breast cancer versus those with such history, and women with relatively high self-perceived SES versus those with low self-perceived SES. Notably, an inverse association emerged between high SES and breast cancer incidence among women with low self-perceived SES, yielding a HR of 0.45 (95% *CI*: 0.06, 3.50).

Figure 1 illustrates the incremental change in breast cancer risk associated with unit increases in age, BMI, physical exercise, and self-perceived SES, stratified by SES groups. The analysis demonstrated consistently elevated breast cancer risk among women in the high SES group compared to those with low SES across all examined parameters.

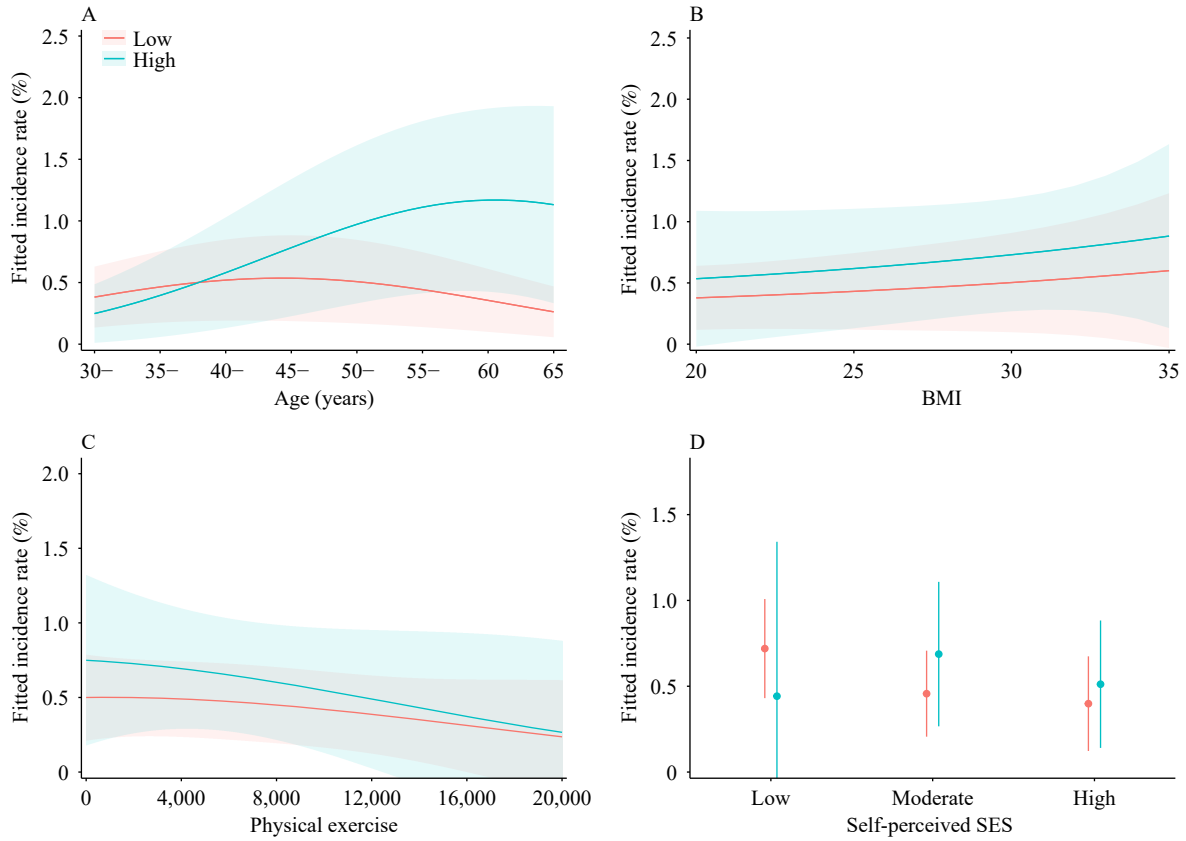

FIGURE 1. Differences in breast cancer incidence by socioeconomic status subgroups among women in the cohort. (A) Age-stratified predictions; (B) BMI-stratified predictions; (C) Physical activity level (MET) predictions; (D) Self-perceived socioeconomic status predictions.
Abbreviation: SES=socioeconomic status; BMI=body measurement index; MET=metabolic equivalent of task.

DISCUSSION

In this cohort study of over 60,000 participants followed for a median of 6 person-years, we observed a cumulative breast cancer incidence of 48.9 per 100,000 person-years. Using latent class analysis of individual education level, household income, and health insurance status, we identified two distinct SES groups. Women in the high SES group demonstrated significantly higher breast cancer incidence compared to those in the low SES group. Notably, this pattern was inversed when examining self-perceived SES, where women who perceived themselves as having low SES exhibited significantly higher breast cancer incidence than those with higher self-perceived SES.

The breast cancer incidence rate observed in this study was modestly lower than rates reported in both the national cancer registry and previous Chinese cohort studies (*8*–*9*). This discrepancy likely stems from our stringent case definition criteria, which excluded cases diagnosed within one year of enrollment to distinguish incident from prevalent cases and account for diagnostic delays. Additionally, our baseline survey incorporated clinician-based breast examinations, which enhanced early detection of breast abnormalities and potential early-stage cancers. Consequently, our cohort represents a screened population with inherently lower breast cancer risk compared to the general population.

This study revealed that women with high SES demonstrated a higher breast cancer incidence compared to those with low SES, aligning with recent systematic review findings (*2*). While some studies attribute this increased risk among high-SES women to enhanced healthcare access, earlier detection capabilities, and specific lifestyle factors including dietary patterns and physical activity levels (*10*), this pattern should not diminish attention to low-SES populations. Delayed diagnosis among low-SES groups often results in more advanced-stage breast cancer presentations and elevated mortality rates. European research (*4*) has documented pronounced socioeconomic disparities in cancer survival, with breast cancer patients from low-SES backgrounds

experiencing significantly shorter survival times.

Beyond objectively assessed SES, this investigation examined the relationship between self-perceived SES and breast cancer incidence, revealing an inverse association. Subgroup analyses identified that this pattern was primarily driven by elevated breast cancer risk among women who were classified as low SES and also perceived themselves as having low socioeconomic status. This phenomenon may be explained by the documented impact of low self-perceived SES on mental health outcomes, particularly depression and anxiety, which are established independent risk factors for female breast cancer (*11*). Further research is warranted to elucidate the underlying mechanistic pathways of this association.

This study has several limitations. The relatively short follow-up period limited statistical power for many subgroup analyses. Additionally, potential residual confounding factors, particularly detailed lifestyle variables, warrant further investigation regarding their role in mediating the SES-breast cancer relationship. Furthermore, the cohort may not fully represent Chinese women from western and central regions, potentially limiting generalizability.

In conclusion, this population-based cohort study demonstrated that women with high SES had an elevated risk of breast cancer compared to those with low SES, with self-perceived SES potentially moderating this association. These findings suggest the need for tailored screening programs and targeted health education strategies across different SES groups to optimize breast cancer prevention and early detection efforts.

Conflicts of interest: No conflicts of interest.

Acknowledgment: All research personnel from participating Centers for Disease Control and Prevention, hospitals, and health centers for their valuable contributions to this project.

Funding: Supported by the National Key R&D Program of China (2016YFC0901300, 2016YFC0901301), IMICAMS Youth Talent Development Fund under Number 2024YT02, and the Strategic Research and Consultancy Project of the Chinese Academy of Engineering (2023-JB-11).

doi: 10.46234/ccdcw2025.055

[#] Corresponding authors: Hui Liu, liuhui@pumc.edu.cn; Xuening Duan, duanxuening@pku.edu.cn; Linhong Wang, linhong@ncwchnhc.org.cn.

[1] Institute of Medical Information, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China; [2] National Center for Chronic and Non-communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China; [3] Shandong Center for Disease Control and Prevention, Jinan City, Shandong Province, China; [4] Hebei Center for Disease Control and Prevention, Shijiazhuang City, Hebei Province, China; [5] Taixing Center for Disease Control and Prevention, Taixing City, Jiangsu Province, China; [6] Peking University First Hospital, Beijing, China.

[&] Joint first authors.

Submitted: January 24, 2025
Accepted: February 17, 2025
Issued: March 07, 2025

REFERENCES

1. Lei SY, Zheng RS, Zhang SW, Chen R, Wang SM, Sun KX, et al. Breast cancer incidence and mortality in women in China: temporal trends and projections to 2030. Cancer Biol Med 2021;18(3):900 – 9. https://doi.org/10.20892/j.issn.2095-3941.2020.0523.
2. Li S, He YX, Liu JF, Chen KF, Yang YZ, Tao K, et al. An umbrella review of socioeconomic status and cancer. Nat Commun 2024;15(1):9993. https://doi.org/10.1038/s41467-024-54444-2.
3. Sandoval JL, Franzoi MA, Di Meglio A, Ferreira AR, Viansone A, André F, et al. Magnitude and temporal variations of socioeconomic inequalities in the quality of life after early breast cancer: results from the multicentric French CANTO cohort. J Clin Oncol 2024;42(24):2908 – 17. https://doi.org/10.1200/JCO.23.02099.
4. Jansen L, Erb C, Nennecke A, Finke I, Pritzkuleit R, Holleczek B, et al. Socioeconomic deprivation and cancer survival in a metropolitan area: an analysis of cancer registry data from Hamburg, Germany. Lancet Reg Health Eur 2021;4:100063. https://doi.org/10.1016/j.lanepe.2021.100063.
5. Bao HL, Liu LY, Cong S, Wang F, Yu LX, Fang LW, et al. Breast cancer awareness and association with frequency of screening among women - China, 2020. China CDC Wkly 2023;5(15):327 – 32. https://doi.org/10.46234/ccdcw2023.063.
6. Zhang M, Bao HL, Zhang X, Huang ZJ, Zhao ZP, Li C, et al. Breast cancer screening coverage - China, 2018-2019. China CDC Wkly 2023;5(15):321 – 26. https://doi.org/10.46234/ccdcw2023.062.
7. Zhang YB, Chen C, Pan XF, Guo JY, Li YP, Franco OH, et al. Associations of healthy lifestyle and socioeconomic status with mortality and incident cardiovascular disease: two prospective cohort studies. Chin Ed BMJ 2021;24(12):695 – 705. https://doi.org/10.3760/cma.j.issn.1007-9742.2021.12.108.
8. Sun KX, Lei L, Zheng RS, Zhang SW, Zeng HM, Wang SM, et al. Trends in incidence rates, mortality rates, and age-period-cohort effects of female breast cancer - China, 2003-2017. China CDC Wkly 2023;5(15):340 – 6. https://doi.org/10.46234/ccdcw2023.065.
9. Wei YX, Lv J, Guo Y, Bian Z, Gao M, Du HD, et al. Soy intake and breast cancer risk: a prospective study of 300,000 Chinese women and a dose-response meta-analysis. Eur J Epidemiol 2020;35(6):567 – 78. https://doi.org/10.1007/s10654-019-00585-4.
10. Cao W, Qin K, Li F, Chen WQ. Socioeconomic inequalities in cancer incidence and mortality: an analysis of GLOBOCAN 2022. Chin Med J 2024;137(12):1407 – 13. https://doi.org/10.1097/CM9.0000000000003140.
11. Burgess C, Cornelius V, Love S, Graham J, Richards M, Ramirez A. Depression and anxiety in women with early breast cancer: five year observational cohort study. BMJ 2005;330(7493):702. https://doi.org/10.1136/bmj.38343.670868.D3.