



# The Global and Regional Survival Rate of Women With Breast Cancer: A Systematic Review and Meta-analysis

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## Abstract

Breast cancer is the most common cancer among women in the world. The aim of this study was to measure the global and regional survival rates of women with breast cancer. We searched Medline/PubMed, Web of Science, Scopus, and Google Scholar to identify cohort studies on the survival rate of women with primary invasive breast cancer until the end of June 2017. We used random effect models to estimate the pooled 1-, 3-, 5-, and 10-year survival rates. Subgroup analysis and meta-regression models were used to investigate the potential sources of heterogeneity. One hundred twenty-six studies were included in the meta-analysis. Between-study heterogeneities in the 1-, 3-, 5-, and 10-year survival rates were significantly high (all  $I^2s > 50\%$ ;  $P = .001$ ). The global 1-, 3-, 5-, and 10-year pooled survival rates in women with breast cancer were 0.92 (95% confidence interval [CI], 0.90-0.94), 0.75 (95% CI, 0.71-0.79), 0.73 (95% CI, 0.71-0.75), and 0.61% (95% CI, 0.54-0.67), respectively. Subgroup analysis revealed that survival rates varied in different World Health Organization regions, age and stage at diagnosis, year of the studies, and degree of development of countries. Meta-regression indicated that year of the study ( $\beta = 0.07$ ;  $P = .002$ ) and development of country ( $\beta = -0.1$ ;  $P = .0001$ ) were potential sources of heterogeneity. The survival rate was improved in recent decades; however, it is lower in developing regions than developed ones.

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**Keywords:** Breast cancer, Cohort Studies, Kaplan-Meier Estimate, Meta-analysis, Survival rate

## Introduction

Breast cancer is a major health problem and one of the most common cancers among women in the world.<sup>1-3</sup> The new cases and the number of deaths from breast cancer in 2013 were reported to be 1.8 million and 464,000 worldwide, respectively.<sup>4,5</sup> Although it

seems to be a problem only in developed countries, almost 50% of breast cancer cases and 58% of deaths occur in developing countries.<sup>5-7</sup>

The survival rate is one of the main indicators for measuring the effectiveness of treatments. This indicator represents the percentage of people saved from the disease for a specific period after diagnosis.<sup>8,9</sup> Factors such as age, race, and stage at diagnosis, tumor size, hormonal receptor status, and type of treatment can predict the survival rate of patients with breast cancer.<sup>10,11</sup> Stage and age at diagnosis were the 2 important factors associated with the survival rate.<sup>12</sup> The survival rate for breast cancer is very different all over the world; the 5-year survival rate varies from 80% or more in developed countries to 60% in middle-income countries and less than 40% in low-income countries.<sup>13</sup> According to the stage at diagnosis, the 5-year relative survival rate for women with breast cancer varied from 99% for local cancer to 84% for regional cancer and 23% for disease in the metastasis phase in the United States between 2001 and 2007.<sup>14</sup> The findings of different studies showed that the highest relative survival rate is at age 50 years and then decreases with age. For example, the 10-year relative survival rate was 70%

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among women aged 46 to 50 years, whereas it was 60% and 59% in women less than 30 years old and over 75 years old, respectively.<sup>12</sup> Another important factor that has effect on survival is early detection.<sup>15</sup> Thus, the real differences in the survival rate of women with breast cancer between countries are likely to be owing to differences in early detection programs and access to appropriate health care.<sup>14,16</sup> There are a number of studies that have been conducted to estimate the survival rate of women with breast cancer in different parts of the world. However, there is controversy between various studies. The purpose of this study is to estimate the overall 1-, 3-, 5-, and 10-year survival of women with breast cancer in the world using a systematic review and meta-analysis.

## Materials and Methods

We conducted this study according to the preferred items for reporting of systematic review and meta-analysis (PRISMA) guidelines.<sup>17</sup>

### Eligibility Criteria

We included observational cohort studies if: (1) published in the English language; (2) estimated the survival rate in women with primary invasive breast cancer along with the related standard error (SE) or 95% confidence intervals (CIs) or provided enough raw data to calculate them. Whenever necessary, we contacted authors to provide more information to calculate these statistics. Studies that did not report the survival rates or include enough data to calculate them and those that reported the survival rates after relapse were excluded.

### Search Strategy

Systematic search was conducted in several international databases including Medline via PubMed, Web of Science, Scopus, and Google Scholar from inception to the end of June 2017. The search strategy was a combination of key words based on medical subject headings (MeSH) and free texts including: (“Breast Neoplasms”[MeSH] or “breast cancer” or “breast carcinoma” or “breast tumor” or “breast malignant”) AND (“Survival”[MeSH] or “Survival analysis” or “Survival Rate” or “Life Table” or “Kaplan-Meier” or “Proportional Hazard Model” or “Hazard Ratio” or “Cox Model” or “Cox Regression”) AND (“Cohort” or “Prospective” or “Retrospective” or “Follow-up” or “Longitude”). Finally, we reviewed the reference list of all included studies, key journals, and websites such as the World Health Organization (WHO) Global health library to identify additional references.

### Study Selection

The results of systematic search were entered into the reference manager software, and, after exclusion of duplicate articles, 2 reviewers (K.M. and M.K.) screened the retrieved articles by title, abstract, and full text of records independently based on eligibility criteria. Disagreements between the 2 reviewers were resolved by consensus and if required, by the third party.

### Quality Assessment

We used the STROBE (STrengthening the Reporting of OBServational studies in Epidemiology) checklist<sup>18</sup> to assess the risk of bias in retrieved studies that was comprised of the following

recommended items: Part 1: Selection bias: (a) to define clearly how to measure the exposure, (b) to define the source of participant samples and the degree of its generalizability, (c) to describe the eligibility criteria, and (d) to explain how to address the follow up; Part 2: Information bias: to define clearly how to measure the outcome; Part 3: Random error: the sample size and power of the study. Two reviewers (K.H.M. and M.H.K.) assessed the quality of included articles independently. The value of weighted kappa indicated the proper agreement between the 2 reviewers (weighted kappa, 82%). If a manuscript obtained 40% to 59% of the total score, it was considered as low quality; 60% to 79% as middle quality, and more than 80% as high quality. All studies with low, middle, and high quality were included in the main analysis.

### Data Extraction

Two reviewers (K.H.M. and M.K.H.) independently extracted data using predefined sheets consisting of the following information: first author name, year of publication, period of study, country, study design, median follow-up time, source of data, type of statistical analyses, sample size, mean age, and survival rates with their SEs or 95% CIs.

### Statistical Analyses

To estimate the pooled survival rate of women with breast cancer, the 1-, 3-, 5-, and 10-year survival rates and their 95% CIs were used. Because the CI and SE were not provided in some articles, we calculated SEs using binomial distribution.

To assess the between-study heterogeneity we used the  $I^2$  Index as the proportion of total variance owing to between-studies variance,<sup>19</sup> as well as the  $\chi^2$  test at the 10% significance level ( $P < .1$ ). Considering the heterogeneity among the studies, we used the Der-Simonies and Laird random-effect models to calculate the pooled 1-, 3-, 5-, and 10-year survival rate in women diagnosed with breast cancer.<sup>20</sup>

We also performed subgroup analysis based on the year of study, degree of development of the countries, age and stage at diagnosis, and WHO regions consisting of the Eastern Mediterranean region (EMRO), American region (PAHO), European region (EURO), South East Asian region (SAERO), Western Pacific region (WPRO), and African region (AFRO).

To investigate the potential source of heterogeneity, we conducted a meta-regression based on year of study, sample size, quality score of studies, and the degree of development of the countries. To estimate the exact binomial and score—test-based confidence intervals for proportions near boundaries (ie, in this instance, 100% at 1-year survival or zero at stage IV), we used the `metaprop` command.<sup>21</sup>

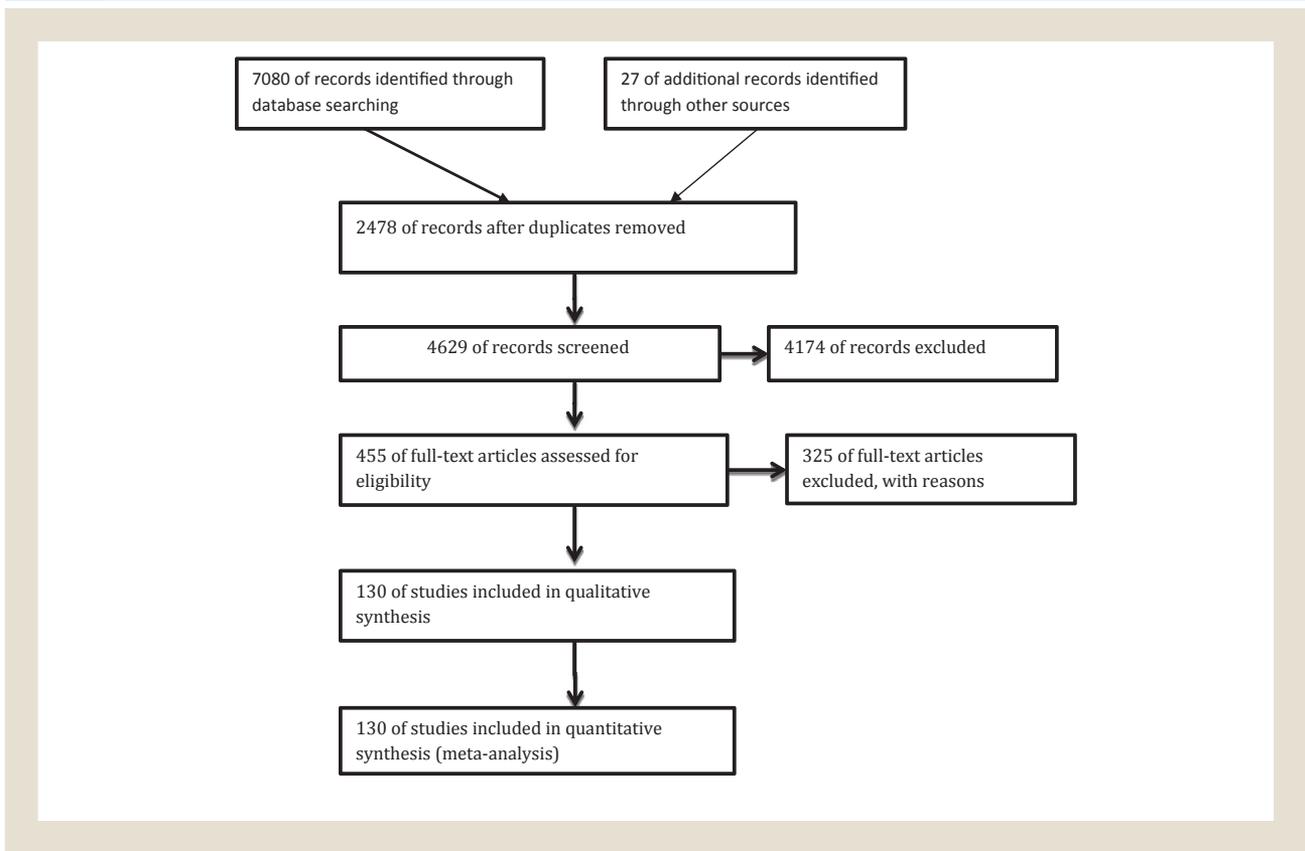
In this study, the publication bias was not assessed because the probability of survival is always a positive number, and therefore, asymmetry in funnel plots is owing to the distribution of all studies on the right side of the vertical line but not the publication bias.<sup>22,23</sup> We used Microsoft Excel 2010 to prepare data extraction sheet. We also used Stata11 (StataCorp, College Station, TX) to perform statistical analyses.

## Results

### Study Characteristics

We found a total of 130 studies<sup>1,11,24-148</sup> from 52 countries (Figure 1), comprising 39 studies from EURO, 33 from EMRO, 29

**Figure 1** PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Flow Diagram Showing the Different Phases Involved in Searching for Relevant Publication to Assess the Survival Rate of Women With Breast Cancer



from WPRO, 15 from PAHO, 10 from SEARO, and 4 studies from AFRO (Table 1). Ninety-seven studies were categorized as high quality and 32 as moderate quality. The 130 included studies consisted of 776,431 women diagnosed with breast cancer in different populations.

### Pooled Survival Rates

In our meta-analysis, the global estimate of pooled 1-, 3-, 5-, and 10-year survival rates were 0.92 (95% CI, 0.90-0.94), 0.75 (95% CI, 0.71-0.79), 0.73 (95% CI, 0.71-0.75), and 0.61 (95% CI, 0.54-0.67), respectively (Table 2). The result of the 10-year survival rate is shown as a forest plot in Figure 2.

### Heterogeneity

The result of the  $\chi^2$  test and the  $I^2$  index indicated that there was a considerable between-study heterogeneity, in 1-year ( $P = .0001$ ;  $I^2 > 99.5\%$ ), 3-year ( $P = .0001$ ;  $I^2 > 99.6\%$ ), 5-year ( $P = .0001$ ;  $I^2 > 99.7\%$ ), and 10-year ( $P = .0001$ ;  $I^2 > 99.7\%$ ) survival rates of women with breast cancer.

### Subgroup Analysis

The results of the subgroup analysis are shown in Table 2. The estimated survival rate in women with breast cancer increased by the

year of the study. During 1960 to 1969, the 5- and 10-year survival rates of women with breast cancer were 0.55 and 0.40, respectively. These amounts increased by 0.74 and 0.59, respectively, during 2010 to 2017.

The results of subgroup analysis based on age group indicated that, in the age group over 50 years, the survival rates were lower than those under age 50 years. As presented in Table 2, the 1-, 3-, 5-, and 10-year survival rates in women older than 50 years were 0.92, 0.80, 0.61, and 0.48, respectively. In addition, these rates for women under 50 years were 0.97, 0.87, 0.69, and 0.61, respectively.

The results of subgroup analysis based on stage at diagnosis showed that the survival rates were reduced by increases in the stage of diagnosis. The 5-year survival rate in women with breast cancer decreased from 0.86 in stage I to 0.32 in stage IV. The results revealed better survival of women with breast cancer in developed countries than developing ones. The 5-year survival rate was 0.76 in developed regions, whereas it was 0.69 in developing regions.

According to an analysis by the different regions of WHO, the lowest 1 and 3-year survival rates were observed in SAERO with 0.85 and 0.63, respectively. On the other hand, the highest 1- and 3-year survival rates were in the EMRO and EURO regions, with 0.95 and 0.80, respectively. The lowest 5-year survival rate was in

**Table 1** Characteristics of Included Studies in Meta-analysis of the Survival Rate of Women With Breast Cancer in the World

| No. | First Author             | Year of Publication | Year of Study | Country     | Sample Size | Mean Age, y ± SD | Median Follow-up Time, mos | 1-Year Survival | 3-Year Survival | 5-Year Survival | 10-Year Survival | Research Quality |
|-----|--------------------------|---------------------|---------------|-------------|-------------|------------------|----------------------------|-----------------|-----------------|-----------------|------------------|------------------|
| 1   | Angeles-Llerenas A et al | 2016                | 2016          | Mexico      | 845         | 52               | 60                         | –               | –               | 0.72            | –                | High             |
| 2   | Plichta JK et al         | 2016                | 2008          | USA         | 584         | NR               | 124                        | –               | –               | 0.93            | 0.86             | High             |
| 3   | El Mistiri M et al       | 2015                | 2005          | Libya       | 365         | NR               | 60                         | –               | –               | 0.56            | –                | High             |
| 4   | Nowikiewicz T et al      | 2015                | 2006          | Poland      | 664         | 58 ± 12          | 79                         | –               | –               | 0.76            | –                | High             |
| 5   | Hajhosseini M et al      | 2015                | 2013          | Iran        | 529         | 47 ± 12          | 120                        | –               | –               | 0.68            | –                | High             |
| 6   | Bender MPF et al         | 2015                | 2013          | Brazil      | 264         | 63 ± 13          | 180                        | –               | –               | 0.56            | 0.41             | High             |
| 7   | Kallel M et al           | 2015                | 2008          | Tunisia     | 83          | 32               | 75                         | –               | –               | 0.67            | –                | High             |
| 8   | Campbell ID et al        | 2015                | 2010          | New Zealand | 10,824      | NR               | 120                        | 0.99            | 0.94            | 0.90            | 0.84             | High             |
| 9   | Andre MD et al           | 2014                | 2005          | Portugal    | 1354        | 61 ± 14          | 60                         | –               | –               | 0.80            | –                | High             |
| 10  | Fong Y et al             | 2014                | 2001          | England     | 1712        | NR               | 120                        | –               | –               | –               | 0.77             | High             |
| 11  | Jackisch C et al         | 2014                | 2011          | Germany     | 11,214      | NR               | 60                         | –               | –               | 0.86            | –                | High             |
| 12  | Karimi A et al           | 2014                | 2012          | Iran        | 229         | 46 ± 11          | 96                         | –               | –               | 0.75            | –                | High             |
| 13  | Kawai M et al            | 2014                | 2002          | Japan       | 3998        | 53 ± 8           | 60                         | –               | –               | 0.88            | –                | High             |
| 14  | Zhu J et al              | 2014                | 2011          | China       | 3398        | NR               | 60                         | 0.83            | 0.67            | 0.59            | –                | High             |
| 15  | Hamadeh RR et al         | 2014                | 2010          | Bahrain     | 1005        | 51               | 120                        | 0.84            | –               | 0.63            | 0.49             | High             |
| 16  | Fallahzadeh H et al      | 2014                | 2007          | Iran        | 200         | 48 ± 12          | 62                         | 0.95            | 0.82            | 0.70            | –                | High             |
| 17  | Rampisheh Z et al        | 2014                | 2013          | Iran        | 300         | 51 ± 14          | 65                         | 0.95            | 0.78            | 0.68            | –                | High             |
| 18  | Fazeli Z et al           | 2014                | 2011          | Iran        | 400         | 50 ± 1           | 60                         | 0.98            | 0.92            | 0.87            | –                | High             |
| 19  | Ademuyiwa FO et al       | 2013                | 2004          | USA         | 73,447      | NR               | 60                         | –               | –               | 0.89            | –                | High             |
| 20  | Chen XY et al            | 2013                | 2012          | China       | 300         | 57 ± 10          | 81                         | –               | –               | 0.83            | –                | High             |
| 21  | Haghighat Sh et al       | 2013                | 2006          | Iran        | 623         | 46 ± 11          | 86.3                       | –               | –               | 0.87            | –                | High             |
| 22  | Abdullah NA et al        | 2013                | 2005          | Malaysia    | 10,230      | 51 ± 12          | 60                         | 0.71            | 0.57            | 0.49            | –                | High             |
| 23  | Li XP et al              | 2013                | 2006          | China       | 3215        | 68               | 72                         | 0.89            | –               | 0.76            | –                | High             |
| 24  | Tannenbaum SL et al      | 2013                | 2007          | USA         | 127,754     | 63               | 60                         | 0.93            | 0.83            | 0.74            | –                | High             |
| 25  | Lan NH et al             | 2013                | 2006          | Vietnam     | 948         | 50 ± 9           | 60                         | 0.94            | 0.83            | 0.74            | –                | High             |
| 26  | Hauth EA et al           | 2012                | 1996          | Germany     | 222         | NR               | 180                        | –               | –               | –               | 0.96             | High             |
| 27  | Movahedi M et al         | 2012                | 2006          | Iran        | 5975        | 50 ± 13          | 88                         | –               | –               | 0.72            | –                | High             |
| 28  | Xue C et al              | 2012                | 2008          | China       | 5809        | 46 ± 10          | 65                         | –               | –               | 0.83            | –                | High             |
| 29  | Vostakolaei AF et al     | 2012                | 2001          | Iran        | 1500        | 46 ± 12          | 60                         | –               | –               | 0.72            | –                | High             |
| 30  | Poum A et al             | 2012                | 2001          | Thailand    | 340         | 48 ± 11          | 40.8                       | 0.83            | 0.59            | –               | –                | High             |
| 31  | Ivanauskienė R et al     | 2012                | 2008          | Lithuania   | 240         | 63               | 24                         | 0.84            | –               | –               | –                | High             |
| 32  | Utada M et al            | 2012                | 2003          | Japan       | 2739        | NR               | 60                         | 0.97            | –               | 0.84            | –                | High             |
| 33  | Gokce T et al            | 2011                | 2008          | Turkey      | 1746        | 51               | 168                        | –               | –               | 0.90            | 0.79             | High             |
| 34  | Li ZS et al              | 2011                | 2003          | China       | 1538        | 62               | 77                         | –               | –               | 0.80            | –                | High             |
| 35  | Taib N et al             | 2011                | 2002          | Malaysia    | 965         | 49               | 60                         | –               | –               | 0.76            | –                | High             |

**Table 1** Continued

| No. | First Author        | Year of Publication | Year of Study | Country     | Sample Size | Mean Age, y ± SD | Median Follow-up Time, mos | 1-Year Survival | 3-Year Survival | 5-Year Survival | 10-Year Survival | Research Quality |
|-----|---------------------|---------------------|---------------|-------------|-------------|------------------|----------------------------|-----------------|-----------------|-----------------|------------------|------------------|
| 36  | Xiang YB et al      | 2011                | 1995          | China       | 5126        | NR               | 74                         | –               | –               | 0.73            | –                | High             |
| 37  | Ahn YO et al        | 2011                | 1997          | Korea       | 5320        | NR               | 67                         | –               | –               | 0.78            | –                | High             |
| 38  | Chia KS et al       | 2011                | 1997          | Singapore   | 3191        | NR               | 64                         | –               | –               | 0.72            | –                | High             |
| 39  | Sumitsawan Y et al  | 2011                | 1997          | Thailand    | 542         | NR               | 60                         | –               | –               | 0.60            | –                | High             |
| 40  | Martin N et al      | 2011                | 2000          | Thailand    | 814         | NR               | 60                         | –               | –               | 0.63            | –                | High             |
| 41  | Eser S et al        | 2011                | 1997          | Turkey      | 1293        | NR               | 72                         | –               | –               | 0.71            | –                | High             |
| 42  | Bhoo Pathy N et al  | 2011                | 2007          | Malaysia    | 4058        | 56               | 60                         | –               | –               | 0.67            | –                | High             |
| 43  | Yeole BB et al      | 2011                | 1999          | India       | 7294        | NR               | 31                         | 0.77            | –               | –               | –                | High             |
| 44  | Laudico A et al     | 2011                | 1995          | Philippines | 415         | NR               | 36                         | 0.85            | 0.63            | –               | –                | High             |
| 45  | Garrote LF et al    | 2011                | 1995          | Cuba        | 2169        | NR               | 60                         | 0.89            | 0.72            | 0.65            | –                | High             |
| 46  | Hamdan NA et al     | 2011                | 1996          | SaudiArabia | 298         | NR               | 60                         | 0.95            | 0.85            | 0.61            | –                | High             |
| 47  | Redaniel MT et al   | 2010                | 2002          | Philippines | 1615        | NR               | 60                         | –               | –               | 0.49            | –                | High             |
| 48  | Abahssain H et al   | 2010                | 2007          | Morocco     | 427         | 32               | 36                         | –               | 0.81            | –               | –                | High             |
| 49  | Arkoob K et al      | 2010                | 1998          | Jordan      | 838         | 50 ± 12          | 60                         | 0.91            | 0.70            | 0.59            | –                | High             |
| 50  | Cheng SH et al      | 2009                | 2001          | Taiwan      | 1378        | NR               | 80                         | –               | –               | 0.89            | –                | High             |
| 51  | Schootman M et al   | 2009                | 1999          | USA         | 7867        | NR               | 60                         | –               | –               | 0.86            | –                | High             |
| 52  | Thalib L et al      | 2009                | 1997          | Sweden      | 300,011     | NR               | 120                        | –               | –               | 0.74            | 0.64             | High             |
| 53  | Tan BKT et al       | 2009                | 1999          | Singapore   | 10,287      | 50 ± 13          | 92                         | –               | –               | 0.64            | –                | High             |
| 54  | Tan BKT et al       | 2009                | 1999          | Sweden      | 17,090      | 62 ± 14          | 104                        | –               | –               | 0.72            | –                | High             |
| 55  | Larranaga N et al   | 2009                | 1996          | Spain       | 622         | 61               | 90                         | 0.94            | –               | 0.74            | –                | High             |
| 56  | Heydari ST et al    | 2009                | 2006          | Iran        | 877         | 47 ± 12          | 120                        | 0.97            | –               | 0.67            | 0.46             | High             |
| 57  | Gentil-Brevet J     | 2008                | 1997          | France      | 1150        | 60               | 108                        | –               | –               | 0.82            | –                | High             |
| 58  | Taib N et al        | 2008                | 1997          | Malaysia    | 413         | 51               | 60                         | –               | –               | 0.59            | –                | High             |
| 59  | Jensen AR et al     | 2008                | 2003          | Denmark     | 1573        | 56               | 128                        | –               | –               | 0.84            | 0.66             | High             |
| 60  | Yaghmaei S et al    | 2008                | 2002          | Iran        | 50          | 52 ± 14          | 120                        | 0.86            | 0.62            | 0.58            | 0.47             | High             |
| 61  | Dabakuyo TS et al   | 2008                | 1997          | France      | 3831        | 61 ± 14          | 108                        | 0.94            | –               | 0.74            | –                | High             |
| 62  | Ganesh B et al      | 2008                | 2001          | India       | 471         | NR               | 60                         | 0.97            | 0.90            | 0.83            | –                | High             |
| 63  | Lee JH et al        | 2007                | 2002          | Korea       | 24,447      | NR               | 60                         | –               | –               | 0.80            | –                | High             |
| 64  | Blamey RW et al     | 2007                | 1999          | England     | 2238        | NR               | 100                        | –               | –               | 0.88            | –                | High             |
| 65  | Clayforth C et al   | 2007                | 1999          | Australia   | 706         | 57               | 72                         | –               | –               | 0.87            | –                | High             |
| 66  | Allgood PC et al    | 2006                | 1999          | England     | 194         | 60               | 120                        | –               | –               | 0.91            | –                | High             |
| 67  | Jayasinghe UW et al | 2005                | 1995          | Australia   | 393         | 54               | 120                        | –               | –               | 0.79            | 0.69             | High             |
| 68  | Babai Gh et al      | 2005                | 1993          | Iran        | 176         | NR               | 60                         | 0.94            | 0.94            | 0.61            | –                | High             |
| 69  | Anan K et al        | 2004                | 1995          | Japan       | 140         | 64               | 90                         | –               | –               | 0.86            | –                | High             |
| 70  | Webb P.M et al      | 2004                | 1994          | Australia   | 520         | 53               | 60                         | –               | –               | 0.83            | –                | High             |

Table 1 Continued

| No. | First Author        | Year of Publication | Year of Study | Country     | Sample Size | Mean Age, y ± SD | Median Follow-up Time, mos | 1-Year Survival | 3-Year Survival | 5-Year Survival | 10-Year Survival | Research Quality |
|-----|---------------------|---------------------|---------------|-------------|-------------|------------------|----------------------------|-----------------|-----------------|-----------------|------------------|------------------|
| 71  | Tejler G et al      | 2004                | 1999          | Sweden      | 7892        | NR               | 120                        | –               | –               | 0.73            | 0.54             | High             |
| 72  | Yeole BB et al      | 2004                | 1994          | India       | 2516        | NR               | 60                         | 0.76            | 0.52            | 0.42            | –                | High             |
| 73  | Minelli L et al     | 2004                | 1999          | Italy       | 2460        | NR               | 180                        | 0.95            | –               | 0.77            | 0.47             | High             |
| 74  | Jensena AR et al.   | 2003                | 1997          | Denmark     | 677         | 59               | 62                         | –               | –               | 0.72            | –                | High             |
| 75  | Vahdaninia F et al  | 2003                | 1997          | Iran        | 128         | 47 ± 14          | 60                         | 0.93            | 0.75            | 0.62            | –                | High             |
| 76  | vanderWal BCH et al | 2002                | 1997          | Netherlands | 453         | 66               | 73                         | –               | –               | 0.85            | –                | High             |
| 77  | Mariotto A et al    | 2002                | 1995          | USA         | 199         | NR               | 60                         | –               | –               | 0.84            | –                | High             |
| 78  | Nennecke A et al    | 2002                | 2003          | Germany     | 9259        | 62               | 60                         | –               | 0.84            | 0.75            | –                | High             |
| 79  | Chie WC et al       | 2002                | 1995          | Taiwan      | 979         | 50               | 63                         | 0.98            | 0.86            | –               | –                | High             |
| 80  | Twelves CJ et al    | 2001                | 1987          | Scotland    | 1617        | NR               | 120                        | –               | –               | 0.71            | 0.52             | High             |
| 81  | Grosclaude P et al  | 2001                | 1996          | France      | 1564        | 60               | 72                         | –               | –               | 0.76            | –                | High             |
| 82  | Barchielli A et al  | 1999                | 1986          | Italy       | 1182        | NR               | 120                        | –               | –               | 0.71            | 0.53             | High             |
| 83  | Graupera BMC et al  | 1999                | 1989          | Cuba        | 2371        | NR               | 60                         | 0.84            | 0.64            | 0.54            | –                | High             |
| 84  | Brenner H et al     | 1998                | 1994          | Germany     | 9523        | NR               | 60                         | –               | –               | 0.69            | –                | High             |
| 85  | Yeole BB et al      | 1998                | 1986          | India       | 2872        | NR               | 84                         | 0.84            | 0.62            | 0.51            | –                | High             |
| 86  | Gajalakshmi et al   | 1997                | 1989          | India       | 1747        | NR               | 60                         | 0.80            | 0.58            | 0.47            | –                | High             |
| 87  | Nandakumar A et al  | 1995                | 1989          | India       | 1368        | NR               | 60                         | 0.95            | 0.55            | 0.42            | –                | High             |
| 88  | Barchielli A et al  | 1994                | 1986          | Italy       | 1236        | NR               | 60                         | 0.91            | 0.78            | 0.68            | –                | High             |
| 89  | Ewertz M et al      | 1993                | 1984          | Denmark     | 2568        | 70               | 72                         | –               | –               | 0.72            | –                | High             |
| 90  | Boffetta P et al    | 1993                | 1981          | Italy       | 4764        | NR               | 60                         | 0.92            | 0.77            | 0.65            | –                | High             |
| 91  | Levi F et al        | 1992                | 1988          | Sweden      | 4199        | NR               | 60                         | 0.92            | –               | 0.63            | –                | High             |
| 92  | Sant M et al        | 1991                | 1981          | Italy       | 1991        | NR               | 132                        | 0.91            | 0.76            | 0.65            | 0.50             | High             |
| 93  | Toikkanen S et al   | 1990                | 1965          | Finland     | 461         | 56               | 324                        | –               | –               | –               | 0.37             | High             |
| 94  | Rodes ND et al      | 1986                | 1980          | USA         | 136         | NR               | 102                        | –               | –               | 0.85            | –                | High             |
| 95  | Adami HO et al      | 1985                | 1963          | Sweden      | 12,319      | NR               | 120                        | –               | –               | 0.55            | 0.38             | High             |
| 96  | Burns P et al       | 1979                | 1972          | USA         | 519         | NR               | 60                         | –               | –               | 0.67            | –                | High             |
| 97  | Heller KS et al     | 1978                | 1976          | USA         | 304         | 65               | 120                        | –               | –               | 0.73            | 0.62             | High             |
| 98  | Faradmal J et al    | 2016                | 2011          | Iran        | 522         | 47 ± 11          | 45                         | 0.90            | 0.73            | 0.62            | –                | High             |
| 99  | Baghestani A et al  | 2015                | 2013          | Iran        | 366         | 48 ± 11          | 120                        | 0.93            | 0.72            | 0.52            | –                | High             |
| 100 | Baghestani A et al  | 2015                | 2012          | Iran        | 438         | 48 ± 11          | 253                        | 0.98            | –               | –               | –                | High             |
| 101 | Fardmal J et al     | 2014                | 2011          | Iran        | 542         | 46 ± 11          | 53                         | 0.96            | 0.58            | –               | –                | Moderate         |
| 102 | Ordng AG et al      | 2013                | 2011          | Denmark     | 2945        | 63               | 60                         | 0.95            | –               | 0.78            | –                | Moderate         |
| 103 | Ziaei JE et al      | 2013                | 2008          | Iran        | 271         | 48               | 180                        | 0.96            | 0.86            | 0.81            | 0.76             | Moderate         |
| 104 | Li BJ et al         | 2012                | 2006          | China       | 84          | 57 ± 11          | 86 ± 49                    | –               | –               | 0.83            | 0.63             | Moderate         |
| 105 | Lietzen LW et al    | 2011                | 2009          | Denmark     | 4424        | 62               | 60                         | 0.94            | 0.83            | 0.75            | –                | Moderate         |

Table 1 Continued

| No. | First Author          | Year of Publication | Year of Study | Country      | Sample Size | Mean Age, y $\pm$ SD | Median Follow-up Time, mos | 1-Year Survival | 3-Year Survival | 5-Year Survival | 10-Year Survival | Research Quality |
|-----|-----------------------|---------------------|---------------|--------------|-------------|----------------------|----------------------------|-----------------|-----------------|-----------------|------------------|------------------|
| 106 | Peng RJ et al         | 2011                | 2008          | China        | 1102        | NR                   | 60                         | –               | –               | 0.83            | –                | Moderate         |
| 107 | Akbari ME et al       | 2011                | 2010          | Iran         | 258         | 50                   | 144                        | –               | –               | 0.88            | –                | Moderate         |
| 108 | MoghadamiFard Z et al | 2011                | 2007          | Iran         | 133         | 51 $\pm$ 11          | 63                         | –               | –               | 0.72            | –                | Moderate         |
| 109 | Hellmann SS et al     | 2010                | 2003          | Denmark      | 528         | 67                   | 94                         | –               | –               | 0.64            | –                | Moderate         |
| 110 | Iqbal J et al         | 2010                | 2006          | Pakistan     | 200         | 45                   | 90                         | –               | –               | 0.52            | –                | Moderate         |
| 111 | Xia LP et al          | 2010                | 2004          | China        | 70          | NR                   | 120                        | –               | –               | 0.91            | 0.73             | Moderate         |
| 112 | Marchal F et al       | 2009                | 2002          | France       | 116         | 66 $\pm$ 12          | 128                        | –               | –               | 0.68            | 0.52             | Moderate         |
| 113 | Rajaeefard AR et al   | 2009                | 2003          | Iran         | 310         | NR                   | 120                        | 0.97            | 0.82            | 0.70            | 0.53             | Moderate         |
| 114 | Rezaianzadeh A et al  | 2009                | 2005          | Iran         | 1148        | 47                   | 36                         | –               | 0.76            | –               | –                | Moderate         |
| 115 | Mosavi-Naieni M et al | 2009                | 2005          | Iran         | 242         | 50 $\pm$ 11          | 78                         | 1               | 0.94            | 0.89            | –                | Moderate         |
| 116 | Aziz Z et al          | 2008                | 2005          | Pakistan     | 525         | 45                   | 60                         | –               | –               | 0.72            | –                | Moderate         |
| 117 | Ueno M et al          | 2007                | 2003          | Japan        | 559         | NR                   | 120                        | –               | –               | 0.85            | 0.75             | Moderate         |
| 118 | Akbari ME et al       | 2006                | 1998          | Iran         | 154         | 48 $\pm$ 12          | 60                         | –               | –               | 0.76            | –                | Moderate         |
| 119 | Ravichandran K et al  | 2005                | 1996          | Saudi Arabia | 316         | 48 $\pm$ 15          | 60                         | 0.94            | 0.82            | 0.60            | –                | Moderate         |
| 120 | El-Tamer MB et al     | 2004                | 1998          | USA          | 52          | 70                   | 63                         | –               | –               | 0.77            | –                | Moderate         |
| 121 | Fakhro AE et al       | 1999                | 1994          | Bahrain      | 93          | 50                   | 120                        | –               | –               | 0.64            | 0.36             | Moderate         |
| 122 | Salmon RJ et al       | 1997                | 1985          | France       | 982         | NR                   | 60                         | –               | –               | 0.85            | –                | Moderate         |
| 123 | Wallgren A et al      | 1997                | 1968          | Sweden       | 75          | NR                   | 120                        | –               | –               | 0.64            | 0.54             | Moderate         |
| 124 | Sriamporn S et al     | 1995                | 1999          | Thailand     | 423         | NR                   | 60                         | 0.87            | 0.60            | 0.45            | –                | Moderate         |
| 125 | Sariego J et al       | 1995                | 1984          | USA          | 81          | NR                   | 120                        | –               | –               | 0.68            | 0.49             | Moderate         |
| 126 | Isard HJ et al        | 1988                | 1980          | USA          | 70          | 57                   | 125                        | –               | –               | 0.80            | 0.70             | Moderate         |
| 127 | Chokunonga E          | 2011                | 1997          | Zimbabwe     | 253         | NR                   | 39.3                       | 0.81            | 0.63            | 0.50            | –                | Low              |
| 128 | Wabinga H             | 2011                | 1997          | Uganda       | 157         | NR                   | 10.9                       | 0.72            | 0.54            | 0.36            | –                | Low              |
| 129 | Basro S               | 2010                | 2008          | South Africa | 141         | NR                   | 18                         | –               | –               | 0.20            | –                | Low              |
| 130 | Bah E                 | 2011                | 1997          | Gambia       | 59          | NR                   | 4.6                        | 0.30            | 0.09            | 0.097           | –                | Low              |

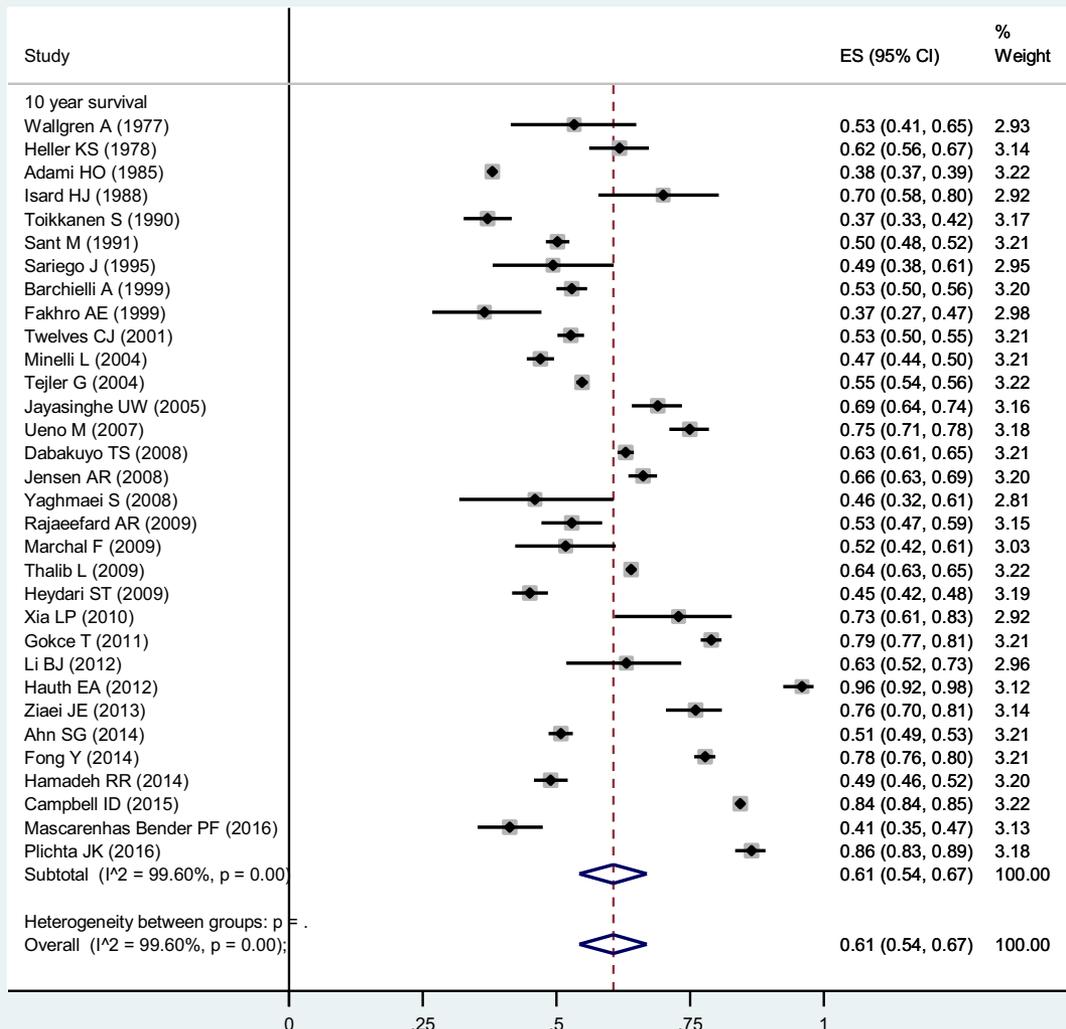
Abbreviation: NR = not reported.

**Table 2** Result of Subgroup Analysis for Estimating the Pooled 1-, 3-, 5-, and 10-year Survival Rates and 95% Confidence Intervals in Women With Breast Cancer in the World

| No. | Title              | Subgroup           | Number of Studies | 1-Year Survival (95% CI) | Number of Studies | 3-Year Survival (95% CI) | Number of Studies | 5-Year Survival (95% CI) | Number of Studies | 10-Year Survival (95% CI) |
|-----|--------------------|--------------------|-------------------|--------------------------|-------------------|--------------------------|-------------------|--------------------------|-------------------|---------------------------|
| 1   | Global             |                    | 126               | 0.92 (0.90-0.94)         | 42                | 0.75 (0.71-0.79)         | 120               | 0.73 (0.71-0.75)         | 46                | 0.61 (0.54-0.67)          |
| 2   | WHO regions        | PAHO               | 4                 | 0.88 (0.79-0.95)         | 3                 | 0.74 (0.60-0.85)         | 17                | 0.75 (0.68-0.80)         | 7                 | 0.63 (0.42-0.82)          |
|     |                    | WPRO               | 8                 | 0.91 (0.81-0.98)         | 7                 | 0.77 (0.61-0.90)         | 37                | 0.76 (0.72-0.81)         | 8                 | 0.70 (0.53-0.84)          |
|     |                    | SEARO              | 8                 | 0.85 (0.80-0.89)         | 8                 | 0.63 (0.56-0.71)         | 17                | 0.50 (0.43-0.58)         | –                 | –                         |
|     |                    | EURO               | 10                | 0.93 (0.92-0.94)         | 6                 | 0.80 (0.78-0.82)         | 37                | 0.74 (0.72-0.76)         | 21                | 0.60 (0.53-0.67)          |
|     |                    | EMRO               | 18                | 0.95 (0.93-0.97)         | 17                | 0.79 (0.74-0.83)         | 46                | 0.69 (0.66-0.73)         | 10                | 0.52 (0.42-0.61)          |
|     |                    | AFRO               | –                 | –                        | –                 | –                        | 4                 | 0.28 (0.13-0.46)         | –                 | –                         |
| 3   | Year of study      | 1969- 1960         | –                 | –                        | –                 | –                        | 2                 | 0.55 (0.54-0.56)         | 3                 | 0.40 (0.35-0.45)          |
|     |                    | 1979- 1970         | –                 | –                        | –                 | –                        | 2                 | 0.69 (0.66-0.72)         | –                 | –                         |
|     |                    | 1989-1980          | 8                 | 0.87 (0.83-0.91)         | 7                 | 0.68 (0.60-0.75)         | 17                | 0.66 (0.61-0.71)         | 7                 | 0.52 (0.48-0.56)          |
|     |                    | 1999-1990          | 15                | 0.91 (0.86-0.94)         | 12                | 0.71 (0.63-0.79)         | 52                | 0.73 (0.70-0.75)         | 13                | 0.67 (0.59-0.74)          |
|     |                    | 2009-2000          | 14                | 0.94 (0.89-0.97)         | 15                | 0.80 (0.74-0.85)         | 57                | 0.76 (0.73-0.80)         | 16                | 0.67 (0.58-0.76)          |
|     |                    | 2017-2010          | 11                | 0.94 (0.89-0.98)         | 8                 | 0.78 (0.63-0.90)         | 14                | 0.74 (0.66-0.80)         | 7                 | 0.59 (0.28-0.87)          |
| 4   | Stage at diagnosis | Stage I            | 3                 | 1 (1-1)                  | 3                 | 0.92 (0.81-0.99)         | 48                | 0.86 (0.82-0.88)         | 15                | 0.82 (0.70-0.92)          |
|     |                    | Stage II           | 4                 | 0.97 (0.92-1)            | 4                 | 0.91 (0.78-0.98)         | 52                | 0.69 (0.63-0.74)         | 20                | 0.67 (0.59-0.74)          |
|     |                    | Stage III          | 4                 | 0.89 (0.78-0.69)         | 4                 | 0.59 (0.38-0.78)         | 28                | 0.51 (0.45-0.57)         | 17                | 0.41 (0.35-0.47)          |
|     |                    | Stage IV           | 2                 | 0.60 (0.59-0.61)         | –                 | –                        | 35                | 0.32 (0.23-0.42)         | 8                 | 0.26 (0.10-0.45)          |
| 5   | Age group          | Under 50 years old | 11                | 0.97 (0.95-0.98)         | 8                 | 0.87 (0.84-0.90)         | 48                | 0.69 (0.66-0.73)         | 15                | 0.61 (0.55-0.67)          |
|     |                    | Over 50 years old  | 10                | 0.92 (0.90-0.93)         | 7                 | 0.80 (0.75-0.85)         | 48                | 0.61 (0.66-0.73)         | 15                | 0.48 (0.39-0.58)          |
| 6   | Development        | Developed regions  | 17                | 0.93 (0.92-0.95)         | 10                | 0.83 (0.78-0.86)         | 67                | 0.76 (0.74-0.79)         | 31                | 0.61 (0.53-0.69)          |
|     |                    | Developing regions | 32                | 0.91 (0.88-0.93)         | 32                | 0.73 (0.69-0.76)         | 80                | 0.69 (0.65-0.73)         | 15                | 0.60 (0.53-0.73)          |

Abbreviations: AFRO = African region; CI = confidence interval; EMRO = Eastern Mediterranean region; EURO = European region; PAHO = Pan American Health Organization; SEARO = South East Asian region; WHO = World Health Organization; WPRO = Western Pacific region.

Figure 2 Forest Plot of Global Pooled 10-Year Survival Rate in Women With Breast Cancer in the World



the AFRO region with 0.28, and the lowest 10-year survival rate was in the EMRO region with 0.52. The highest 5- and 10-year survival rates were in the WPRO region with 0.76 and 0.70, respectively.

**Meta-regression Analysis**

As shown in Table 3, in the univariable meta-regression model, there was a significant association between the sample size, year of study, and development of countries and the pooled 1-year survival rate. In this model, there was a significant association between variables such as year of study, development of countries, and the 3-year survival rate. In addition, there was a significant relation between the 5-year survival rate, the year of study, and the development of countries. In multivariable meta-regression, there was a

significant association between year of study and development of countries only for the 10-year survival rate.

**Discussion**

According to the results of our systematic review and meta-analysis, the global 1-, 3-, 5-, and 10-year pooled survival rates in 130 studies were 0.92, 0.75, 0.73, and 0.61, respectively. There was no similar study that reported the pooled observed survival rate worldwide by systematic review and meta-analysis. The 5-year survival rate for patients with breast cancer reported by the American Cancer Society in 2015 varied from 53% in South Africa to 89% in the United States, which is consistent with the results of our study.<sup>4</sup>

In this meta-analysis, we found better survival rates for women with breast cancer in developed regions than in developing ones. The

**Table 3** Meta-regression Analysis for the Effect of Associated Variables on the Pooled 1-, 3-, 5-, and 10-year Survival Rates in Women With Breast Cancer in the World

| Survival Rate         | Variable      | Univariable Model |       |         | Multivariable Model |       |         |
|-----------------------|---------------|-------------------|-------|---------|---------------------|-------|---------|
|                       |               | B                 | SE    | P Value | β                   | SE    | P Value |
| 1-year survival rate  | Sample size   | 0.05              | 0.017 | .003    | 0.07                | 0.01  | .0001   |
|                       | Year of study | 0.03              | 0.01  | .04     | 0.02                | 0.01  | .09     |
|                       | Quality score | -0.04             | 0.02  | .06     | -0.01               | 0.01  | .35     |
|                       | Development   | -0.04             | 0.02  | .05     | -0.08               | 0.016 | .001    |
| 3-year survival rate  | Sample size   | 0.05              | 0.03  | .11     | 0.09                | 0.03  | .004    |
|                       | Year of study | 0.1               | 0.03  | .004    | 0.1                 | 0.2   | .001    |
|                       | Quality score | -0.01             | 0.04  | .8      | 0.04                | 0.03  | .22     |
|                       | Development   | -0.01             | 0.03  | .006    | -0.14               | 0.03  | .0001   |
| 5-year survival rate  | Sample size   | -0.03             | 0.02  | .18     | -0.008              | 0.02  | .7      |
|                       | Year of study | 0.07              | 0.02  | .002    | 0.12                | 0.02  | .001    |
|                       | Quality score | -0.02             | 0.03  | .47     | -0.01               | 0.02  | .64     |
|                       | Development   | -0.1              | 0.02  | .001    | -0.14               | 0.02  | .001    |
| 10-year survival rate | Sample size   | -0.01             | 0.04  | .7      | 0.05                | 0.05  | .3      |
|                       | Year of study | 0.02              | 0.04  | .56     | 0.13                | 0.05  | .02     |
|                       | Quality score | 0.06              | 0.04  | .19     | 0.09                | 0.06  | .14     |
|                       | Development   | -0.07             | 0.04  | .12     | -0.14               | 0.06  | .02     |

Abbreviation: SE = standard error.

5-year survival rate for women with breast cancer in developing countries was reported to be 0.46 in Uganda, 0.58 in Zimbabwe, and between 0.70 to 0.65 in Costa Rica, Cuba, Saudi Arabia, and some parts of Thailand.<sup>149</sup> Additionally, in developed regions, Siegel and colleagues reported a 5-year survival rate of 91% between the year 2005 and 2011 in the United States.<sup>150</sup> Considering the different regions from the WHO, developed regions like PAHO and EURO had better survival rates than regions like SEARO and AFRO. In a systematic review and meta-analysis conducted in Iran in 2016, the 1-, 3-, 5-, and 10-year survival rates were 0.95, 0.81, 0.69, and 0.66, respectively.<sup>151</sup> These results were consistent with the pooled survival rates in the EMRO region in our study, which were 0.94, 0.79, 0.69, and 0.52, respectively. Variation in survival rates of breast cancer in different regions may be owing to the host factor, tumor factor, and medical factor. But the most important reason for better survival rates in American and European countries compared with Asian and African regions could be owing to the impact of screening programs, early detection, and modern medical care factors.<sup>152-155</sup>

The results of some studies indicated the effect of age as an independent prognostic factor on survival of women diagnosed with breast cancer.<sup>81,94,131</sup> Our study showed that all 1-, 3-, 5-, and 10-year survival rates in women with breast cancer were lower in women older than 50 years compared with younger patients. For example, the 5-year survival rate was 69% in the age group under 50 years and 61% in the age group over 50 years. In a study conducted in Sweden, the 5-year survival rate was 0.87 in patient over than 50 years and 0.88 in patients under 50 years, which was consistent with the results of our study.<sup>156</sup> The difference in survival between younger and older age groups can be owing to a variety of reasons, including hormonal, immunologic, and etiologic differences and host-related factors. The survival rate for women in the age group of 40 to 49 years was higher than other age groups, because many

women in this age group develop estrogen deficiency owing to menopause, which leads to a decrease in tumor growth.<sup>85</sup>

Another independent prognostic factor that affects the survival rate of women with breast cancer is the stage at diagnosis. The findings of this study showed that with an increase in the stage of diagnosis, the survival rate is reduced. In a report from the National Cancer Institute in the United States, the 5-year survival rate of women with breast cancer was reduced from 1 in stage I to 0.22 in stage IV.<sup>157</sup> In the local stage of diagnosis, the size of tumors is too small (< 2 cm), and it is limited to the breast tissue, thus diagnosis and treatment at this stage leads to a high rate of recovery and increased survival.<sup>158</sup>

The results of our study showed that the 1-, 3-, 5-, and 10-year survival rates in 2010 to 2017 were significantly higher than those in the 1969 to 1960 period. In a study from the United Kingdom, the 5-year survival rate increased from 0.52 in 1971 to 1976 to 0.82 in the years 2001 to 2006, which is consistent with the results of our study.<sup>159</sup> This increase may be owing to the development in screening program and progress in therapeutic guidelines in recent decades.

**Limitations**

The limitations of this study were that all 126 studies in this meta-analysis were restricted to 52 countries, and there were no data on the survival rates of women with breast cancer in other countries. Only studies published in English were included in this meta-analysis, which can be considered as a source of bias. Another limitation was that the survival rate was not achieved by a single method in the included studies; instead, various methods such as Kaplan-Meier and life-table were used to estimate the survival rate.

**Conclusions**

This meta-analysis estimated the pooled survival rate of women with breast cancer in the world. The results of our study indicate

that the survival rate in developed regions is higher than that in less developed regions. The 2 important factors that independently affect the survival rate were age and stage at diagnosis, as the survival rate was inversely correlated with a decrease in these 2 factors. The survival rate has increased in recent years owing to improvement in diagnostic methods, screening, and better treatment.

## Disclosure

The authors have stated that they have no conflicts of interest.

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