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**Title:** The descriptive epidemiology of female breast cancer: an international comparison of screening, incidence, survival and mortality

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## **Abstract**

This paper presents the latest international descriptive epidemiological data for invasive breast cancer among women, including incidence, survival and mortality, as well as information on mammographic screening programs. Almost 1.4 million women were diagnosed with breast cancer worldwide in 2008 and approximately 459,000 deaths were recorded. Incidence rates were much higher in more developed countries compared to less developed countries (71.7/100,000 and 29.3/100,000 respectively, adjusted to the World 2000 Standard Population) whereas the corresponding mortality rates were 17.1/100,000 and 11.8/100,000. Five-year relative survival estimates range from 12% in parts of Africa to almost 90% in the United States, Australia and Canada, with the differential linked to a combination of early detection, access to treatment services and cultural barriers. Observed improvements in breast cancer survival in more developed parts of the world over recent decades have been attributed to the introduction of population-based screening using mammography and the systemic use of adjuvant therapies. The future worldwide breast cancer burden will be strongly influenced by large predicted rises in incidence throughout parts of Asia due to an increasingly “westernised” lifestyle. Efforts are underway to reduce the global disparities in survival for women with breast cancer using cost-effective interventions.

**Key words:** breast cancer; international; incidence; mortality; survival; mammographic screening.

## **Introduction**

Every day, thousands of women around the world from all walks of life are diagnosed with breast cancer. It is by far the most common cancer among females worldwide and is also the leading cause of cancer-related mortality [1, 2].

This paper provides an overview of current geographical patterns and recent trends in the screening, incidence, survival and mortality of invasive female breast cancer using published data, with the aim of providing researchers with a clear picture of the relationships between these various measures. For example, breast cancer screening rates using mammography can give a better understanding of differences in both incidence and survival. An international perspective has been provided wherever possible; however, there are topics for which information is only available for specific countries (such as incidence by stage at diagnosis).

## **Screening**

Population screening aims to detect breast cancer at an early stage among asymptomatic women [3], thereby reducing the morbidity and mortality from the disease. Mammographic screening is the most effective method available for identifying breast cancer at an early stage [3, 4], often before any symptoms can be identified by a physical examination. Early detection has been shown to be important due to the strong association between stage at diagnosis (or tumour size) and survival [4, 5]. For most types of breast cancer the likelihood of lymph node invasion and worsening tumour grade increases as tumour size increases [6, 7], leading to poorer long-term survival.

Breast cancer screening can be delivered through organised population-based screening programs or by opportunistic case finding. The opportunistic approach occurs when a screening test is offered to an individual without symptoms of breast cancer when they present to their health care practitioner for unrelated reasons [8, 9]. In contrast, organised screening programs typically have national policies that specify those women who are eligible for screening, the interval for screening and a defined diagnostic process that includes the histological assessment required to confirm or exclude breast

cancer [3]. The coordination of activities across the entire pathway are essential elements if a screening program is to attain similar outcomes to those achieved in a research setting. This includes the required infrastructure and information systems to manage and monitor clinical quality as well as handling the invitation of eligible women and recall at the prescribed intervals for screening [9].

#### *Establishment of breast cancer screening programs*

Evidence for establishing breast cancer screening programs using mammography came from several randomised controlled trials during the 1980s and 1990s. The Swedish Two-County Trial was the primary study, reporting a 31% reduction in mortality due to breast cancer [10]. Other randomised controlled trials of mammographic screening also demonstrated a 25-30% reduction in breast cancer mortality [11].

Organised screening programs using mammography were subsequently established from the mid-1980s onwards [3, 12] and hence have now been in operation for 20 years or more in several developed countries. Details about the type of program, year of commencement, target age group and participation rate of existing mammography-based screening programs are presented in Table 1 [13-15]. Most programs focus on women aged 50-69 years old with an interval of two years between screening episodes [16, 17]. The latest published participation rates in organised mammographic screening range from under 20% in Turkey, the Slovak Republic and Japan to over 80% in the United States, The Netherlands and Finland [14, 15].

Mammographic screening is the only evidence-based early detection method for breast cancer, though it is not always feasible to implement [18]. This is especially true for developing countries that lack the resources and appropriate follow-up and treatment services required for such programs [18, 19] or where a large portion of the burden of breast cancer lies in younger women where mammography is not as effective [20]. Alternatives to mammographic screening for countries with basic or limited resources include increasing breast health awareness along with clinical breast examination [21] and ultrasound [19, 22]. Unlike mammography, these methods have not been demonstrated to improve

breast cancer mortality in randomized trials [19]. The goal of such interventions would be the down-staging of symptomatic disease [19, 21, 22] with the inference that this will lead to better treatment outcomes [23].

### *Outcomes of screening*

Several countries have conducted studies evaluating the effectiveness of their breast cancer screening programs. A reduction in mortality of between 21-28% due to screening was reported in Australia [24], while Denmark, England and Wales, the Netherlands and Sweden all reported decreases in mortality of between 19% and 32% [17]. These results are consistent with other research which concluded that mammographic screening programs in operation for at least a decade achieve a similar mortality reduction to that observed in randomised controlled trials, although it may take up to 25 years before the effect of population screening for breast cancer can be fully measured [11].

Despite the sizeable body of favourable evidence obtained from randomised controlled trials and population-based evaluations of screening services, debate has continued to occur around the potential disadvantages caused by over-diagnosis and over-treatment of breast cancers which would not normally have been diagnosed in a woman's lifetime without mammographic screening [25-27].

Over-diagnosis has been estimated to range between 1% and 54%, with a large part of this variation appearing to stem from methodological differences [28]. Researchers from The Netherlands recently suggested that the rate of overdiagnosis peaked at 27% for women aged 49-69 during the implementation phase of the screening program and then decreased to around 10% in a steady-state screening situation [28]. In terms of overtreatment, a review by Gøtzsche and Neilsen concluded that women who were screened for breast cancer using mammography were 31% more likely to undergo breast surgery compared to an unscreened control group [29]. However, proponents of mammographic screening argue that the benefits outweigh any drawbacks, with a study in England estimating that at least 2 lives were saved for every over-diagnosed case [30].

## **Incidence**

An estimated total of 1,384,000 females were diagnosed with breast cancer globally in 2008 [31], corresponding to an age-standardised rate of 42.3 new cases per 100,000 population (using the 2000 World Standard Population [32]). This represented almost a quarter (23%) of all invasive cancers diagnosed among females that year (excluding non-melanoma skin cancers), and compared to the 2002 estimates [33], was an increase in terms of both the number of cases and the incidence rate (1,152,000 and 40.4/100,000 in 2002, respectively). Breast cancer had the highest incidence of any cancer among females in most regions of the World, with the exception of several countries in Eastern and Western Africa as well as parts of Central and South America and Southern Asia (most notably India), where cervical cancer was more common, while the incidence of lung cancer was estimated to be higher in a few countries including China and Vietnam [31].

Although the overall number of new diagnoses were similar in more developed countries compared to less developed countries, incidence rates were almost two and a half times higher in the former (71.7/100,000 and 29.3/100,000 respectively) after adjusting for population size and age structure (Figure 1 and Table 2) [31]. The highest incidence rates were recorded in Western Europe, Australia/New Zealand and Northern Europe, while rates were lowest in Eastern Africa, Middle Africa and Melanesia [31].

A range of factors influence this large regional variation in breast cancer incidence rates, particularly relating to lifestyle [34-36]. Women in more developed countries tend to have fewer children, give birth at an older age and are less likely to breastfeed [36], all of which add to their risk of breast cancer. Higher population levels of obesity, alcohol consumption, use of oral contraceptives and hormone replacement therapy, along with lower levels of physical activity, may also contribute [34-36]. The impact of lifestyle factors is reinforced by studies of female migrants from areas with lower incidence rates, who experience a subsequent rise in breast cancer risk when they move to a more developed country [35, 36]. An increase in the incidence of breast cancer across successive migrant

generations has also been observed [35]. Genetic factors may also account for a small part of the worldwide variation in the incidence of breast cancer [35].

As mentioned previously, organised screening programs in developed regions of the world are responsible for the over-diagnosis of some cancers that may otherwise have remained undetected [37, 38]. This is illustrated by a published review of incidence rates from several countries including the United Kingdom, Canada, Australia, Sweden and Norway, which showed that after a sharp increase coinciding with the introduction of population screening, incidence remained significantly higher than expected in subsequent years [39].

Finally, the lower incidence of breast cancer reported in some less developed countries may be related to a proportion of cases remaining undiagnosed due to a lack of diagnostic and health care facilities [40, 41]. This is exacerbated by incomplete data stemming from the absence of a comprehensive cancer registration system in many of these countries [41, 42], although this problem also occurs to some extent in developed parts of the world as well.

#### *Incidence by age*

Globally, 89% of breast cancers are diagnosed from the age of 40 onwards [31]. This distribution again varies markedly between more developed (95%) and less developed (84%) countries [31].

Breast cancers which develop at a younger age are generally larger, less well differentiated and more likely to metastasise [20, 43]. As suggested by the disparity in the age distribution, these aggressive, early-onset tumours comprise a higher proportion of cases in Asia and Africa compared to North America or Europe [44, 45].

#### *Incidence by stage*

International data on breast cancer stage at diagnosis are limited. However, the available data suggests that the proportion of breast cancers diagnosed early is generally much higher in more developed countries than in less developed countries. While 50-60% of cases diagnosed in the United States and

Australia were localised [46, 47], it has been estimated that as few as 25% of breast cancers in some less developed countries are diagnosed at an early stage [48, 49]. This has serious implications in terms of the outcome (see section on “Survival”).

Much of the variation between countries in stage at diagnosis can be directly attributed to public awareness as well as the availability and utilisation of organised breast cancer screening [40, 48]. Another major factor is the availability and quality of primary health care services; even when women in less developed countries present early, they may still receive delayed or inadequate treatment [40, 48]. Over-diagnosed cases in more developed countries are also likely to contribute to some of the international differences by stage.

#### *Incidence trends*

Trends in breast cancer incidence rates for selected countries for which data was available by age group and year of diagnosis ([50-57] and Thames Cancer Registry (personal communication)) are presented in Figure 2 for all ages combined and separately for women aged 50-69 years (the target group for breast cancer screening). Corresponding annual percentage changes for the most recent trends are given in Table 3.

The trends tended to vary by broad geographical region. Overall incidence rates were generally stable in the European countries shown, but were increasing gradually among females aged 50-69 years old, except for Sweden where there was a significant decrease within this age group from 2002 onwards. Incidence had also stabilised in the United States after a sharp decline between 1999-2003, while decreases were recorded for females in Canada and Australia (significant for the 50-69 age group only).

In contrast, large increases in incidence rates were observed in both Japan and Hong Kong (Figure 2 and Table 3). Published trend data has also shown that the incidence of breast cancer has been rising rapidly in several other Asian countries [58, 59]. For example, Shin *et. al.* [58] estimated that between



1993-2002 there were increases of 4.4%, 6.1% and 7.9% per year in the incidence rates for women aged 20 year and over in Singapore, Taiwan and the Republic of Korea, respectively. In particular, significant upward trends for breast cancer among women aged 50-59 years were recorded in each of these countries as well as for Shanghai, China (+5.6% per year) and Thailand (+6.9% per year). Similarly, trend estimates in India between 1990-2003 for women of all ages combined showed significant annual increases for the cancer registries located in Delhi (+1.1%), Bangalore (+2.3%) and Chennai (+3.6%) [59].

Factors that have led to increases in breast cancer incidence rates include the introduction of population-based screening using mammography (especially in relation to trends among women aged 50 to 69 years) [16, 60], as well as the increasing prevalence of known risk factors such as obesity, earlier age at puberty, excessive alcohol consumption, reduced physical activity and having children (if any) at an older age [34, 35, 58]. Conversely, significant decreases that have been observed in the incidence rate of breast cancer within the 50 to 69 age group in several developed countries over the last decade appear consistent with a reduction in the use of hormone replacement therapy [61, 62], following on from the results of a large, prospective randomized trial [63]. Other possible reasons for a decrease in breast cancer incidence include a plateau in participation rates for mammographic screening [64, 65] and a decline in the pool of cases that were diagnosed by screening prior to becoming symptomatic [66].

## **Survival**

The rate of survival for female breast cancer is higher than for most other types of cancer, with the majority of patients in developed countries remaining alive for at least 5 years following diagnosis. However, longer term survivors experience an ongoing survival deficit compared to the general population due to late recurrences and metastases [6, 67]. To illustrate this, relative survival for breast cancer among women in Europe decreased from an average of 82% after 5 years to 72% after 10 years [68].

One of the most important determinants of survival is stage at diagnosis, which takes into account factors such as tumour size and whether the cancer has spread to the lymph nodes or beyond. For women with breast cancer in the United States between 2001-2007, 5-year relative survival varied from 99% for localised tumours to 84% for regional disease and 23% for distant stage disease [69]. Similar results have also been reported elsewhere in the world [47, 70]. Other prognostic and predictive factors that are associated with better breast cancer survival include being aged 40-69 years old at diagnosis, lower tumour grade (well-differentiated), absence of comorbidities (such as cardiovascular disease, diabetes and other cancers), favourable genetic profile, human epidermal growth factor receptor type 2 (*HER2/neu*) not overexpressed and positive oestrogen/progesterone receptor status [6, 71, 72].

International comparisons of survival have to be interpreted with some caution due to variation in factors such as the time period being considered, population coverage, data quality, statistical methodology and the possibility of lead- and length-time biases for cancers detected by population-based screening [73]. Even so, it is clear that there are considerable differences between countries in the prognosis for female breast cancer. Five-year relative survival estimates for selected countries are presented in Table 4 [47, 68, 70, 74-78]. In developed countries, breast cancer survival tended to be higher (between 85%-90%) in North America, Australia, Japan and Northern Europe, and lower (between 75%-80%) in Eastern Europe and the United Kingdom.

The limited data that is available for Asia, Africa and South America generally indicates much lower rates of survival for female breast cancer compared to more developed countries, although there are some exceptions. Sankaranarayanan et. al. [70] estimated that in Asia during the 1990s, 5-year relative survival ranged from 82% in China and 79% in the Republic of Korea to 52% in India and 47% in the Philippines. Published information on survival throughout Central/South America and Africa includes estimates for Cuba (84%), Costa Rica (70%), Brazil (58%), Uganda (46%), Algeria (39%) and The Gambia (12%) [70, 78].

Much of the variation in breast cancer survival between countries is likely to be caused by disparities in early detection programs and access to appropriate treatment services [34, 68, 70, 78]. In particular, the extent of breast cancer screening using mammography is instrumental in determining the proportion of early stage tumours [34, 68], which in turn impacts on survival. Educational and cultural barriers also exist for women in less developed countries which often lead to late presentation, such as a lack of awareness of breast cancer, an incorrect belief that the disease is incurable or contagious, the stigma of having a mastectomy and fear of rejection by their partner or community [49, 79].

#### *Survival by period of diagnosis*

Significant and continuing improvements have been reported in survival for female breast cancer in North America, Europe and Australia over recent decades [47, 80-83]. For example, there was an absolute increase of at least 22% in 5-year relative survival within each Nordic country between 1964-2003 [81]. Survival rates have generally increased over time for all age groups (although by varying amounts), but changes in survival have been mixed by stage of disease [80-83]. There is also emerging evidence of large gains in breast cancer survival among females in some Asian countries since the early to mid-1990s [84, 85], despite some of the barriers mentioned above.

Studies from different parts of the world have indicated that the improvements in survival for breast cancer patients have been driven by a combination of earlier diagnosis (due to mammographic screening of asymptomatic women) and advances in treatment [11, 86, 87], although the extent of the contribution of each of these factors remains unclear [88-91]. The survival benefit from organised screening programs can be difficult to prove due to some women failing to comply with the screening interval. Nonetheless, population screening has been shown to significantly increase survival, even after taking other potential biases into account [92, 93].

Hundreds of randomized trials conducted from 1980 onwards consistently demonstrated the value of hormonal therapy and chemotherapy in treating early stage breast cancer [94], while a modest effect

was also shown for the use of post-mastectomy radiotherapy [95]. Clinical guidelines for the use of systemic adjuvant therapy were subsequently developed [96]. The resultant widespread introduction of hormonal agents, such as tamoxifen, raloxifene and aromatase inhibitors, has been successful in lowering the risk of recurrence among women with oestrogen receptor-positive tumours, thus improving survival [97, 98]. Further progress has also been made in the field of chemotherapy with the implementation of drug regimes that are more effective in reducing tumour size and increasing disease-free recurrence [97, 99, 100].

### **Mortality**

Almost 459,000 females were estimated to have died from breast cancer worldwide during 2008, an age-standardised rate of 13.9 deaths per 100,000 [31]. This compares with 411,000 deaths (14.4/100,000) due to female breast cancer in 2002 [33]. Despite this decrease in the mortality rate, breast cancer remains the leading cause of cancer-related mortality among females internationally, responsible for almost 14% of all cancer deaths. However, similar to incidence, the mortality rate was higher for cervical cancer in some less developed regions of the World, including many countries in Eastern, Middle and Western Africa, Central and South America and Southern Asia [31]. Lung cancer was the most common cause of cancer-related death among females in some Asian countries (particularly China, Japan, the Republic of Korea and Vietnam) [31] and has also surpassed mortality due to breast cancer in several more developed countries, including the United States and Canada since the late 1980s [31, 46] and within the last few years in Australia [101] and parts of Europe such as Denmark, Hungary, Iceland, the Netherlands, Norway, Poland, Sweden, and the United Kingdom [102].

Although more breast cancer deaths occurred in less developed countries (269,000 or 59%), the mortality rate was generally higher among developed countries (11.8 and 17.1 deaths per 100,000, respectively) [31]. There was a threefold variation in mortality by region of the world, with rates in excess of 20 deaths per 100,000 in Southern Africa, Western Africa and Northern Europe in contrast to 7 deaths per 100,000 in Eastern Asia (Figure 3 and Table 2) [31].

### *Mortality-Incidence rate ratio*

The ratio of the mortality rate to the incidence rate (denoted MR:IR) gives an indication of the prognostic prospects of breast cancer patients and further highlights some of the survival differences between countries discussed in the previous section. On average, MR:IR was 0.24 in more developed countries compared to 0.40 in less developed countries, and was as high as 0.62 in Eastern Africa (Table 2) [31].

### *Premature mortality*

Premature mortality is a measure used to quantify the burden of disease. It compares life expectancy to the actual age at death, and is expressed in terms of “years of life lost”. The World Health Organization has estimated that female breast cancer resulted in a total of 5,884,000 years of life lost globally during 2004 [103]. This represented just over 1% of all premature mortality among females, but there was a large amount of variation in this proportion between regions, ranging from around 8% in parts of Europe to less than 0.5% in Africa (Figure 4) [103]. A number of factors contribute to this disparity, particularly differences in the proportion of deaths due to communicable, maternal, perinatal and nutritional conditions; these diseases collectively caused 80% of total premature mortality in Africa [103].

### *Mortality trends*

Trends in mortality broadly reflect the combined effect of changes in incidence and survival. Mortality rate trends between 1980-2009 for breast cancer deaths among all women and for those aged 50-69 years at death within 24 selected countries are shown in Figure 5 and Table 5 [104]. Countries were selected on the basis of having data of sufficient quality (at least 75% of the country was included and at least 85% of deaths were registered) and quantity (300 or more deaths per year). The trends can be summarised as follows:

- Significantly increasing for all females and the 50-69 age group – Japan and the Republic of Korea;

- Stable for all females but significantly increasing in the 50-69 age group – Russian Federation and Singapore;
- Stable for all females and the 50-69 age group – Hong Kong and Ukraine;
- Stable for all females but significantly decreasing in the 50-69 age group – Greece and Kazakhstan;
- Significantly decreasing for all females but stable in the 50-69 age group – Poland and Romania; and,
- Significantly decreasing for all females and the 50-69 age group – Australia, Canada, Denmark, France, Germany, Hungary, Ireland, Israel, Italy, the Netherlands, Spain, Sweden, the United Kingdom and the United States.

Of the countries included in Figure 5, the largest increase was in the Republic of Korea, where overall breast cancer mortality rates were trending upwards by 2.5% per year, including a 3.0% annual increase for women aged 50-69. Rapid increases in mortality have also been reported in other parts of Asia, Africa and Central/South America [105, 106], which have been attributed to rising incidence in conjunction with lower survival rates. This contrasts with widespread decreasing trends in breast cancer mortality rates of between 2.0%-3.0% per year throughout North America, parts of Europe and Australia that generally commenced around the late 1980s/early 1990s [80, 107].

Studies conducted in the United States [108] and Australia [109] have found that women diagnosed with breast cancer were no more likely to die from other causes of mortality than women in the general population. However, the opposite was reported in a recent study from Sweden [110], where a diagnosis of breast cancer was associated with an increased risk of dying of various non-cancer causes, including diseases of the cardiovascular and gastrointestinal systems. The reasons for these differing results are not clear.

## Conclusions

It has been predicted that the international incidence of female breast cancer will reach approximately 3.2 million new cases per year by 2050 [34]. Aside from population growth, breast cancer incidence rates are expected to further increase within many less developed countries due to longer life expectancy coupled with the adoption of a more “westernised” lifestyle, involving higher levels of alcohol consumption, less physical activity and delays in childbearing [111]. As a consequence, the worldwide breast cancer burden is likely to be heavily influenced by changes to incidence in the Asia region, particularly China [112] and India [113].

On a more positive note, the gains achieved in the treatment of breast cancer over the previous 20 to 30 years appear set to continue, led by the prospect of better tailoring therapies to individual patients through molecular profiling [114, 115]. A related development has been an improved understanding of those breast cancers that are not amenable to either hormonal therapy or therapies that target HER2 receptors (called “triple-negative” breast cancer), which has provided new insights into management and treatment options for women with these tumours [116-118].

Strategies which have been successful in improving outcomes following breast cancer within more developed countries are not always feasible in the context of developing nations due to issues such as resource constraints, younger age distribution and lack of social acceptance [41, 119]. Alternative approaches are therefore required. In recognition of this, the Breast Health Global Initiative [119] has established evidence-based guidelines for low and middle income countries which centre around practical, cost-effective actions for early detection, diagnosis and treatment that can be integrated within existing health care structures [19]. For example, while the introduction of population-based breast cancer screening using mammography may be out of reach in a country with limited resources, implementing public awareness initiatives combined with a program of clinical breast examination could be a more realistic objective [41, 120]. It is anticipated that these interventions will work to reduce the global disparities that currently persist for women diagnosed with breast cancer.

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Figure 1: Estimated age-standardised incidence rates of female breast cancer by country, 2008. Data taken from GLOBOCAN [31]. Rates were age-standardised to the WHO World Standard population and expressed per 100,000 female population [32]. The numbers in brackets within the legend show how many countries are included in each incidence range.

Figure 2: Trends in female breast cancer incidence rates (all ages and ages 50-69 years) for selected countries/registry areas, 1980-2009. Data taken from refs. [50-57] and Thames Cancer Registry (personal communication). Countries were selected based on the availability of incidence data by age group and year of diagnosis. Y-axis represents 'Incidence rate per 100,000 females per year' and is portrayed on a log base 10 scale, while x-axis represents 'Year'. Rates were age-standardised to the WHO World Standard population [32] and trends were modelled using the Joinpoint Regression Program (version 3.4.3), National Cancer Institute .

Figure 3: Estimated age-standardised mortality rates of female breast cancer by country, 2008. Data taken from GLOBOCAN [31]. Rates were age-standardised to the WHO World Standard population and expressed per 100,000 female population [32]. The numbers in brackets within the legend show how many countries are included in each mortality range.

Figure 4: Percent of total years of life lost (YLLs) due to female breast cancer by WHO region, 2004. Data taken from ref. [103]. Countries are grouped within each WHO region according to five mortality strata (denoted A to E). Definitions of mortality strata are available at [www.who.int/whr/2004/annex/topic/en/annex\\_member\\_en.pdf](http://www.who.int/whr/2004/annex/topic/en/annex_member_en.pdf).

Figure 5: Trends in female breast cancer mortality rates (all ages and ages 50-69 years) for selected countries, 1980-2009. Data taken from ref [104]. Countries were selected on the basis of having data of sufficient quality (at least 75% of the country covered and at least 85% of all deaths registered) and quantity (an average of at least 300 cases diagnosed each year). Y-axis represents 'Mortality rate per 100,000 females per year' and is portrayed on a log base 10 scale, while x-axis represents 'Year'. Rates were age-standardised to the WHO World Standard population [32] and trends were modelled using the Joinpoint Regression Program (version 3.4.3), National Cancer Institute.

Table 1: Program type, year of commencement, target age group and participation rate for existing mammography-based screening programs by country<sup>a</sup>

Country	Program Type <sup>b</sup>	Year of Commencement	Target age group	Screening Frequency	Participation Rate	Year
Australia	NS	1991	50-69	2 years	54.9%	2008
Belgium	NS	2001	50-69	2 years	59.0%	2005
Canada <sup>c</sup>	NS	1988	50-69	2 years	36.5%	2004
Chile	N	2005	50-70	2 years	31.8%	2008
Czech Republic	N	2002	45-69	2 years	48.5%	2009
Denmark	S	1991	50-69	2 years	73.7%	2008
Estonia	N	2002	50-65	2 years	52.0%	2009
Finland	N	1986	50-69	2 years	84.4%	2007
France	N	2003	50-74	2 years	54.5%	2008
Germany	NS	2005	50-69	2 years	54.0%	2007
Hungary	N	2002	45-64	2 years	49.1%	2009
Iceland	N	1987	40-69	2 years	61.0%	2009
Ireland	N	2000	50-64	2 years	73.1%	2009
Israel	N	1997	50-74	2 years	69.5%	2009
Italy	NS	2002	50-69	2 years	60.0%	2009
Japan	N	2000	40-75+	2 years	17.7%	2005
Korea	N	2002	40-75+	2 years	51.4%	2008
Luxembourg	N	1992	50-69	2 years	61.0%	2009
Netherlands	N	1989	50-74	2 years	82.1%	2009
New Zealand	N	1998	45-69	2 years	66.9%	2009
Norway	N	1996	50-69	2 years	74.1%	2009
Portugal	S	1990	45-69	2 years	63.0%	2005
Slovak Republic	O	NA	40-69	2 years	16.0%	2009
Slovenia <sup>c</sup>	N	2008	50-69	2 years	47.2%	2009
Spain <sup>c</sup>	S	1990	45-69	2 years	71.8%	2009
Switzerland	S	1999	50-69	2 years	43.6%	2005
Turkey	NS	1999	50-69	2 years	12.4%	2009
United Kingdom	N	1988	50-70	3 years	75.0%	2009
United States <sup>c</sup>	O	1995	40-75+	1-2 years	81.1%	2008
Uruguay	O	1990	40-69	1 year	75.0%	2005

<sup>a</sup> Data taken from refs [13-15].

<sup>b</sup> Program types: NS = National screening policy with state/provincial/regional screening program implementation; N = National screening policy with national program implementation; S = State/Provincial/Regional screening and program implementation; O = Other.

<sup>c</sup> Participation rates obtained from survey data.

Table 2: Estimated counts and age-standardised rates for incidence and mortality of female breast cancer by World region, 2008.<sup>a</sup>

Incidence			Mortality			
Region	Cases	ASR <sup>b</sup>	Region	Deaths	ASR <sup>b</sup>	MR:IR <sup>c</sup>
World	1,384,155	42.3	World	458,503	13.9	0.33
More developed regions	692,634	71.7	More developed regions	189,455	17.1	0.24
Less developed regions	691,521	29.3	Less developed regions	269,048	11.8	0.40
Western Europe	148,940	97.0	Southern Africa	4,465	21.7	0.52
Australia/New Zealand	16,119	92.0	Western Africa	16,342	20.3	0.60
Northern Europe	70,515	90.8	Northern Europe	18,420	20.1	0.22
North America	205,515	83.5	Western Europe	37,458	19.7	0.20
Southern Europe	91,118	74.4	Northern Africa	14,564	19.5	0.55
Polynesia	167	63.6	Central/Eastern Europe	47,149	18.6	0.38
Micronesia	132	62.2	Australia/New Zealand	3,359	17.2	0.19
Central/Eastern Europe	114,574	48.7	Southern Europe	25,710	17.2	0.23
South America	88,400	48.3	North America	45,563	16.7	0.20
Caribbean	8,996	42.7	Polynesia	40	16.0	0.25
Southern Africa	9,012	42.0	Caribbean	3,402	15.9	0.37
Northern Africa	27,993	35.3	Western Asia	12,342	15.7	0.45
Western Asia	28,694	35.1	South America	27,060	14.8	0.31
Western Africa	29,436	33.9	South-Eastern Asia	36,775	14.6	0.44
South-Eastern Asia	86,940	33.2	Melanesia	337	14.5	0.59
Central America	17,502	28.0	Middle Africa	4,664	14.2	0.62
Eastern Asia	240,318	27.1	South-Central Asia	82,638	13.1	0.51
South-Central Asia	172,975	25.8	Micronesia	27	12.9	0.21
Melanesia	637	24.8	Eastern Africa	9,956	12.4	0.60
Middle Africa	8,276	23.0	Central America	6,490	10.5	0.38
Eastern Africa	17,896	20.7	Eastern Asia	61,742	6.9	0.25

<sup>a</sup> Data taken from GLOBOCAN [31].

<sup>b</sup> ASR = age standardised rate per 100,000 population, using the WHO World Standard Population [32].

<sup>c</sup> MR:IR = ratio of mortality rate to incidence rate for the region specified in the mortality column.

Table 3: Current trends (expressed as annual percentage change) in breast cancer incidence rates among females (all ages and ages 50-69 years) for selected countries.<sup>a-c</sup>

Country	All ages		Ages 50-69 years	
	Most recent trend	Annual percentage change (95% CI) <sup>d</sup>	Most recent trend	Annual percentage change (95% CI) <sup>d</sup>
Australia	2002-2007	-1.1 (-2.3,+0.2)	2001-2007	-1.3 (-2.5,-0.1)
Canada	1999-2005	-1.0 (-2.0,-0.0)	1999-2005	-1.6 (-2.8,-0.4)
Hong Kong	1983-2008	+1.7 (+1.5,+1.9)	1991-2008	+3.0 (+2.6,+3.5)
Ireland	2002-2007	+0.1 (-1.6,+1.8)	1994-2007	+0.6 (+0.1,+1.1)
Japan	1999-2005	+5.7 (+4.5,+6.9)	1997-2005	+6.5 (+5.7,+7.3)
Netherlands	1994-2008	+0.8 (+0.5,+1.0)	1998-2008	+1.3 (+0.9,+1.7)
South-East England	1996-2009	+0.2 (-0.2,+0.6)	1991-2009	+0.7 (+0.5,+1.0)
Sweden	2003-2008	+0.3 (-1.4,+2.1)	2002-2008	-1.1 (-1.8,-0.3)
United States of America	2003-2008	-0.4 (-1.2,+0.5)	2003-2008	-0.8 (-1.7,+0.1)

<sup>a</sup> Data taken from refs. [50-57] as well as Thames Cancer Registry (personal communication). Countries were selected based on the availability of incidence data by age group and year of diagnosis.

<sup>b</sup> Rates were age-standardised to the WHO World Standard population [32].

<sup>c</sup> Trends modelled using Joinpoint Regression Program (version 3.4.3), National Cancer Institute. Only the most recent trend period is shown for each country.

<sup>d</sup> 95% CI = 95% confidence interval.

Table 4: Estimates of 5-year relative survival for female breast cancer in selected countries.<sup>a</sup>

Country	Years	Method	Ages	5-year relative survival (%) (95% confidence interval <sup>b</sup> )
USA	2005-2007	Period	All ages	89.2 (89.0 - 89.5)
Australia	2000-2006	Cohort	All ages	88.3 (88.0 - 88.6)
Canada <sup>c</sup>	2004-2006	Period	15-99	88 (87 - 88)
Sweden	2000-2002	Period	15-99	86.8 (85.8 - 87.8)
Japan	1997-1999	Cohort	0-99	85.5 (84.7 - 86.3)
Finland	2000-2002	Period	15-99	85.2 (83.8 - 86.6)
Switzerland	2000-2002	Period	15-99	84.5 (82.5 - 86.5)
Norway	2000-2002	Period	15-99	84.1 (82.7 - 85.5)
Cuba	1990-1994	Cohort	15-99	84.0 (82.9 - 85.2)
Italy	2000-2002	Period	15-99	83.7 (83.1 - 84.3)
Netherlands	2000-2002	Period	15-99	83.3 (82.1 - 84.5)
New Zealand	1994-2007	Cohort	15-99	82.8 (82.3 - 83.4)
Spain	2000-2002	Period	15-99	82.8 (79.9 - 85.7)
Austria	2000-2002	Period	15-99	82.3 (81.1 - 83.5)
China <sup>c</sup>	1991-2001	Period	0-74	82 n.a.
Belgium	2000-2002	Period	15-99	79.7 (78.5 - 80.9)
Northern Ireland	2000-2002	Period	15-99	79.5 (77.0 - 82.0)
Republic of Korea <sup>c</sup>	1993-2001	Period	0-74	79 n.a.
Germany	2000-2002	Period	15-99	78.7 (75.8 - 81.6)
Wales	2000-2002	Period	15-99	78.4 (76.8 - 80.0)
England	2000-2002	Period	15-99	77.8 (77.4 - 78.2)
Scotland	2000-2002	Period	15-99	77.3 (75.9 - 78.7)
Turkey <sup>c</sup>	1995-1997	Period	0-74	77 n.a.
Ireland	2000-2002	Period	15-99	76.2 (74.2 - 78.2)
Poland	2000-2002	Period	15-99	76.0 (73.5 - 78.5)
Singapore <sup>c</sup>	1993-1997	Period	0-74	76 n.a.
Slovenia	2000-2002	Period	15-99	75.3 (72.6 - 78.0)
Costa Rica <sup>c</sup>	1995-2000	Period	0-74	70 n.a.
Czech Republic	2000-2002	Period	15-99	67.4 (62.9 - 71.9)
Saudi Arabia <sup>c</sup>	1994-1996	Period	0-74	64 n.a.
Thailand <sup>c</sup>	1990-2000	Period	0-74	63 n.a.
Brazil	1990-1994	Cohort	15-99	58.4 (52.7 - 64.6)
India <sup>c</sup>	1990-2000	Period	0-74	52 n.a.
Philippines <sup>c</sup>	1994-1997	Period	0-74	47 n.a.
Uganda <sup>c</sup>	1993-1997	Period	0-74	46 n.a.
Algeria	1992-1994	Cohort	15-99	38.8 (31.4 - 46.2)
The Gambia <sup>c</sup>	1993-1997	Period	0-74	12 n.a.

<sup>a</sup> Data taken from refs. [47, 68, 70, 74-78].

<sup>b</sup> Confidence intervals are not intended for comparative purposes, but rather to indicate the precision of the estimate.

<sup>c</sup> Country estimates were only provided to integer precision.

n.a. = not available.

Table 5: Current trends (expressed as annual percentage change) in breast cancer mortality rates among females (all ages and ages 50-69 years) for selected countries.<sup>a-c</sup>

Country	All ages		Ages 50-69 years	
	Most recent trend	Annual percentage change (95% CI) <sup>d</sup>	Most recent trend	Annual percentage change (95% CI) <sup>d</sup>
Australia	1991-2006	-2.4 (-2.8,-2.0)	1990-2006	-2.3 (-2.8,-1.8)
Canada	1989-2004	-2.3 (-2.6,-2.1)	1988-2004	-2.5 (-2.8,-2.3)
Denmark	1996-2006	-2.6 (-3.4,-1.8)	1995-2006	-2.9 (-3.9,-2.0)
France	1999-2007	-1.6 (-2.0,-1.2)	1995-2007	-1.6 (-1.9,-1.3)
Germany	1999-2006	-1.6 (-2.0,-1.1)	1995-2006	-1.8 (-2.1,-1.4)
Greece	1980-2009	+0.0 (-0.2,+0.2)	1994-2009	-1.5 (-2.0,-1.1)
Hong Kong	1980-2009	-0.1 (-0.3,+0.2)	1980-2009	+0.2 (-0.2,+0.5)
Hungary	1997-2009	-2.3 (-2.9,-1.8)	1999-2009	-2.4 (-3.4,-1.3)
Ireland	1991-2009	-1.8 (-2.3,-1.3)	1995-2009	-2.6 (-3.5,-1.7)
Israel	1995-2007	-2.4 (-2.9,-1.8)	1994-2007	-2.1 (-3.0,-1.2)
Italy	1991-2007	-1.7 (-1.9,-1.5)	1991-2007	-1.8 (-2.0,-1.6)
Japan	1997-2009	+1.2 (+0.9,+1.4)	1997-2009	+2.0 (+1.6,+2.3)
Kazakhstan	1998-2008	-0.6 (-1.3,+0.2)	2000-2008	-0.2 (-1.9,+1.6)
Netherlands	1994-2009	-2.3 (-2.6,-2.0)	1993-2009	-2.2 (-2.5,-2.0)
Poland	1994-2008	-0.7 (-0.9,-0.4)	1980-2008	-0.0 (-0.2,+0.1)
Republic of Korea	1993-2009	+2.5 (+2.1,+3.0)	1995-2009	+3.0 (+2.2,+3.8)
Russian Federation	1997-2006	+0.2 (-0.2,+0.5)	1998-2006	+0.6 (+0.1,+1.2)
Singapore	1980-2006	+0.2 (-0.2,+0.7)	1980-2006	+0.6 (+0.1,+1.0)
Spain	1993-2008	-2.3 (-2.6,-2.1)	1993-2008	-2.8 (-3.0,-2.5)
Sweden	1980-2008	-1.0 (-1.1,-0.8)	1980-2008	-1.0 (-1.2,-0.8)
United Kingdom	1997-2009	-2.2 (-2.4,-2.1)	1999-2009	-2.5 (-2.9,-2.2)
Ukraine	1994-2009	+0.1 (-0.1,+0.3)	2003-2009	-0.1 (-0.8,+0.6)
United States of America	1999-2005	-2.0 (-2.3,-1.7)	1999-2005	-1.8 (-2.2,-1.4)

<sup>a</sup> Data taken from ref. [104]. Countries were selected on the basis of having data of sufficient quality (at least 75% of the country covered and at least 85% of all deaths registered) and quantity (an average of at least 300 deaths each year).

<sup>b</sup> Rates were age-standardised to the WHO World Standard population [32].

<sup>c</sup> Trends modelled using Joinpoint Regression Program (version 3.4.3), National Cancer Institute. Only the most recent trend period is shown for each country.

<sup>d</sup> 95% CI = 95% confidence interval.

Figure 1

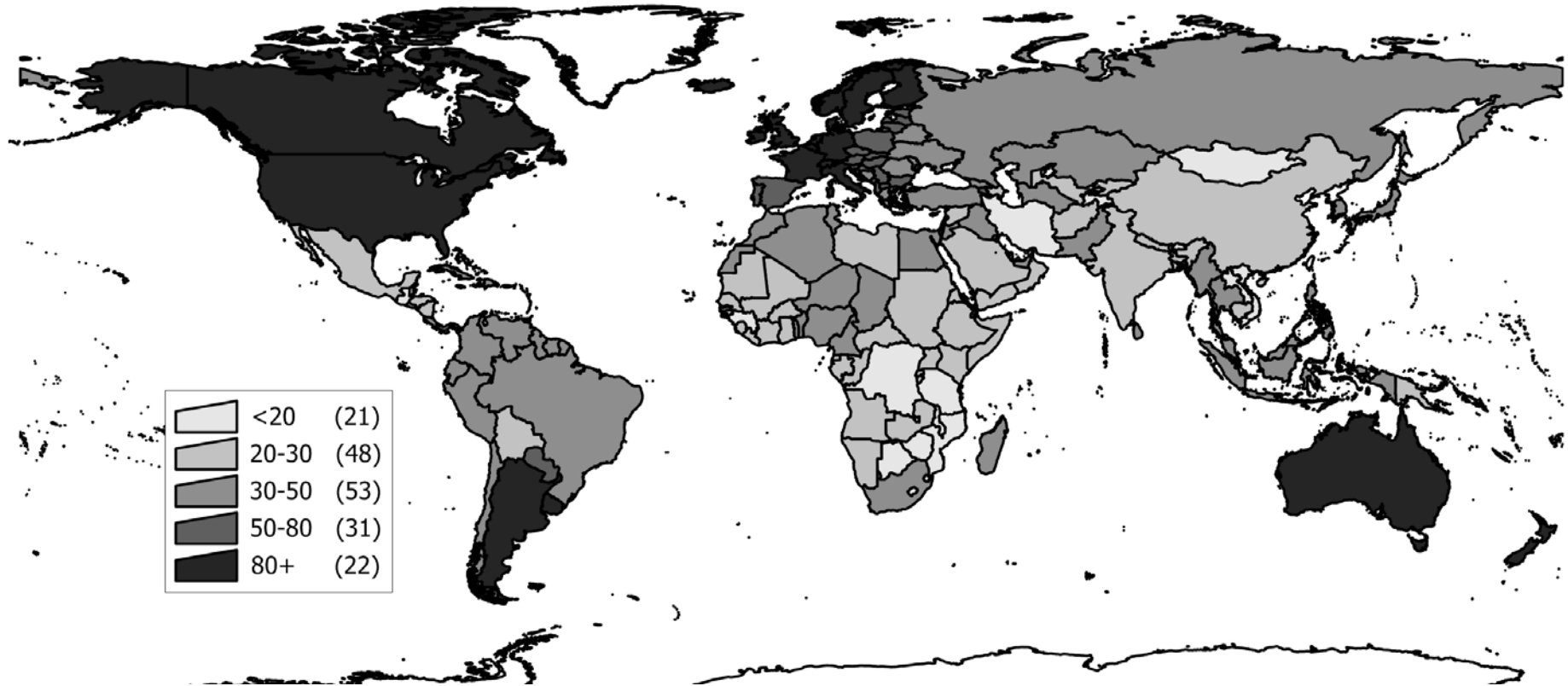


Figure 2

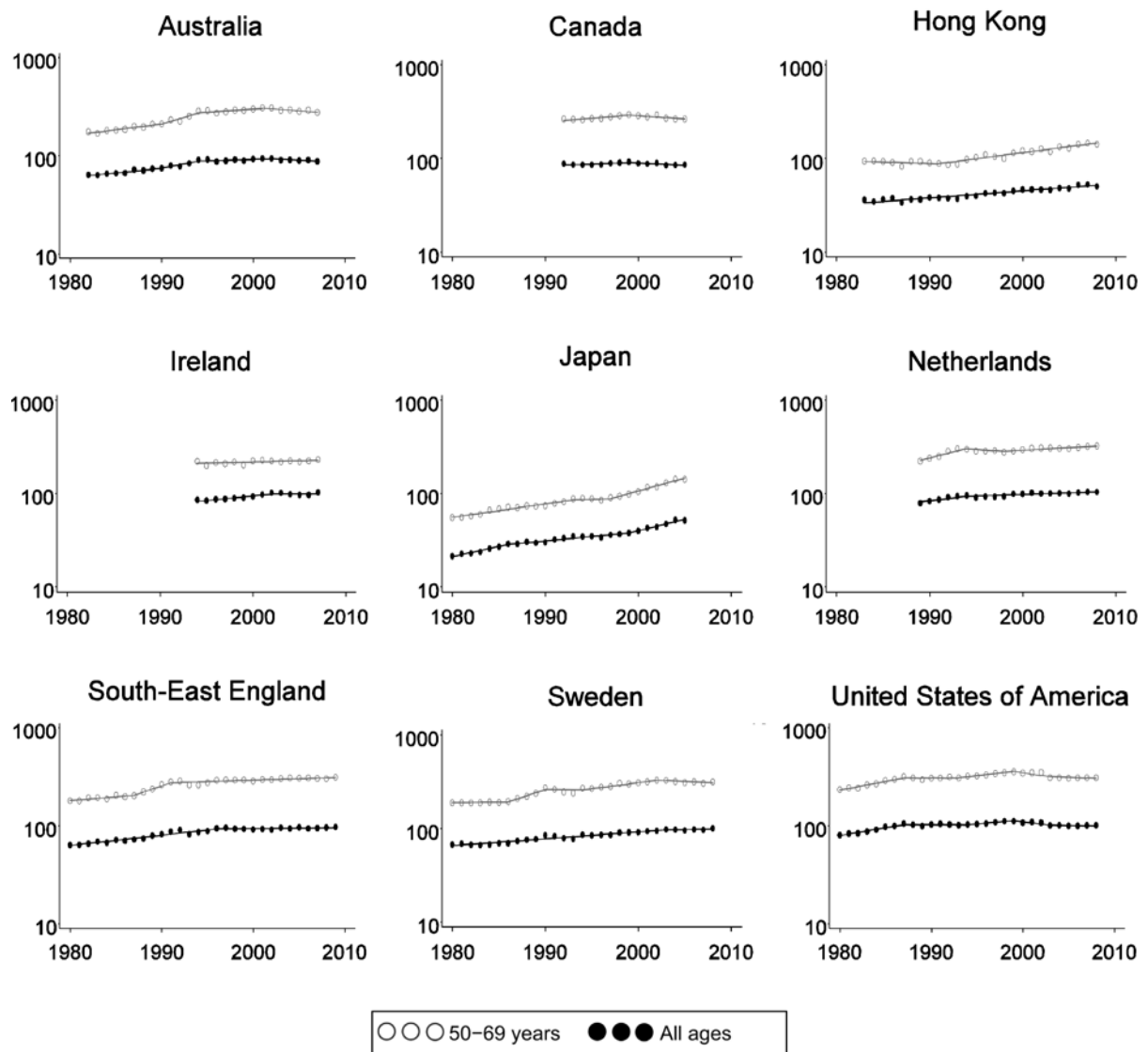




Figure 3

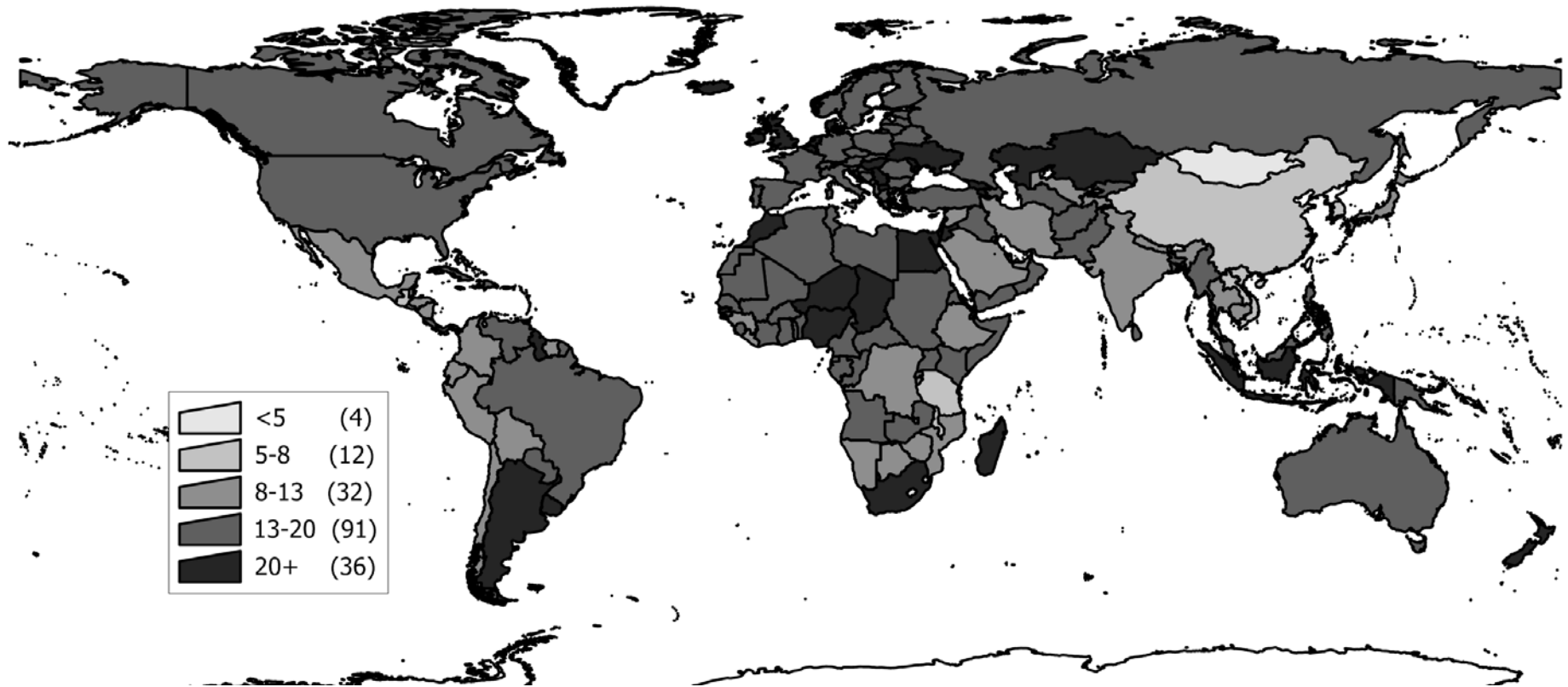


Figure 4

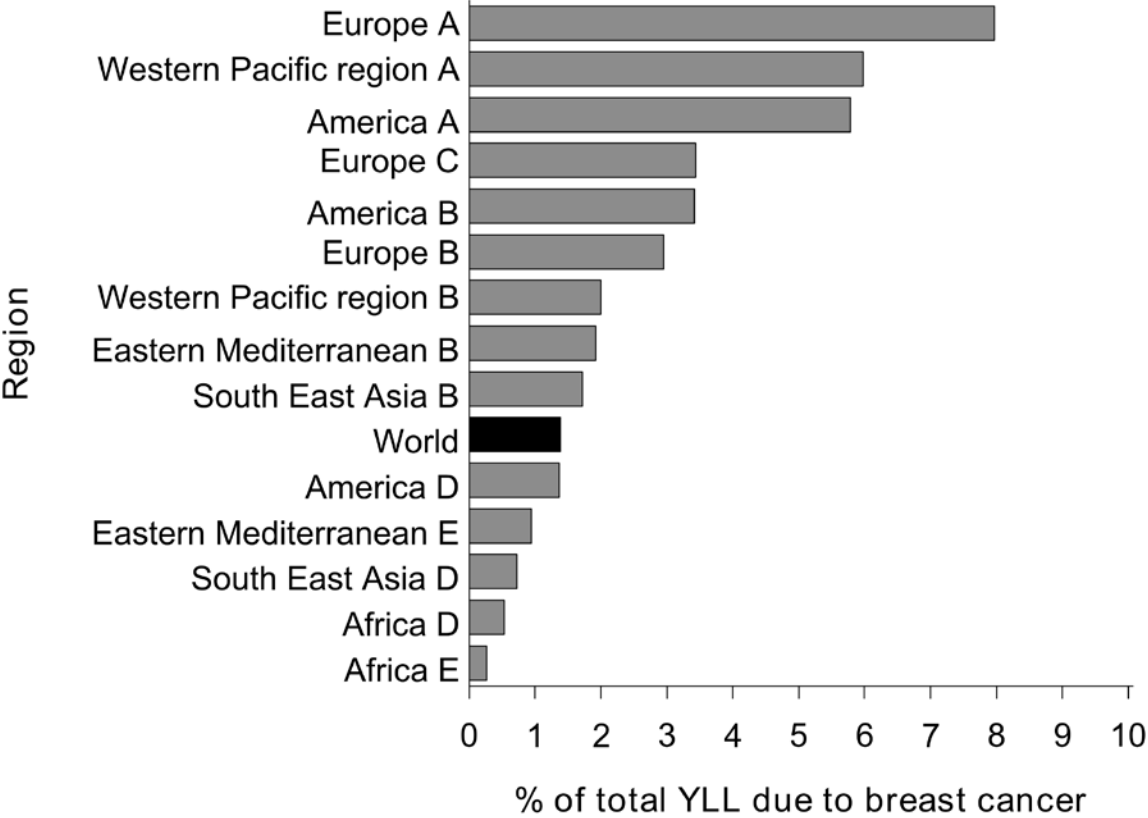


Figure 5

