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Global trends in breast cancer incidence and mortality 1973–1997

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Background Worldwide, breast cancer is the most common cancer and is the leading cause of cancer death among women.

Methods To describe global trends, we compared age-adjusted incidence and mortality rates over three decades (from 1973–77 to 1993–97) and across several continents.

Results Both breast cancer incidence and mortality rates varied 4-fold by geographic location between countries with the highest and lowest rates. Recent (1993–1997) incidence rates ranged from 27/100 000 in Asian countries to 97/100 000 among US white women. Overall, North American and northern European countries had the highest incidence rates of breast cancer; intermediate levels were reported in Western Europe, Oceania, Scandinavia, and Israel; and Eastern Europe, South and Latin America, and Asia had the lowest levels. Breast cancer incidence rose 30–40% from the 1970s to the 1990s in most countries, with the most marked increases among women aged ⩾50 years. Mortality from breast cancer paralleled incidence: it was highest in the countries with the highest incidence rates (between 17/100 000 and 27/100 000), lowest in Latin America and Asia (7–14/100 000), and rose most rapidly in countries with the lowest rates.

Conclusions Breast cancer incidence and mortality rates remain highest in developed countries compared with developing countries, as a result of differential use of screening mammograms and disparities in lifestyle and hereditary factors. Future studies assessing the combined contributions of both environmental and hereditary factors may provide explanations for worldwide differences in incidence and mortality rates.

Keywords Breast cancer, incidence, mortality, time-trends, international

Worldwide, breast cancer is the most common cancer diagnosed among women and is the leading cause of cancer deaths.[1] In 2000 alone, more than one million women were diagnosed (22% of all female cancer diagnoses) and 373 000 women died (14% of all cancer deaths among women) of breast cancer.[1] Global differences in incidence rates and fluctuations in rates within a country are both affected by changes in risk factor prevalence and secular trends in breast cancer diagnosis. For example, adaptation of a western lifestyle has been postulated as being one of the primary reasons for higher breast cancer rates in developed countries and for increasing breast cancer incidence among Asian and Asian American women.[2–4] Delayed childbearing has influenced rates globally and has been associated with particularly large increases observed recently among Hispanic and Hispanic American women.[5,6]

Widespread implementation of screening mammography in the 1980s led to a steady increase in breast cancer diagnoses in most developed countries over the latter decades of the twentieth century.[7] Early detection of tumours by mammography and advances in medical treatment have improved survival such that breast cancer mortality rates previously on the rise in westernized countries have generally become steady during the late 1990s and, in some countries mortality rates have fallen.[1,8] This report comprehensively

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examines trends and patterns of breast cancer incidence and mortality worldwide over the last three decades.

Materials and methods

Incidence data

We obtained incidence data for the 25-year period (1973–1997) summarized in this report from two sources. For the US black and white populations, we used the Surveillance, Epidemiology and End Results (SEER) programme to generate both age-specific and age-adjusted (world standard population) breast cancer incidence rates per 100 000 woman-years. This population-based cancer registry system represents the most reliable source of US incidence statistics, with long-term data available from nine US registries that include about 9.5% of the US population. Incidence data for all other entries, including US Hawaiian Japanese and Puerto Ricans, were abstracted from the International Agency for Research on Cancer (IARC) publication Cancer Incidence in Five Continents (Volumes IV–VIII), covering five time periods: 1973–77, 1978–82, 1983–87, 1988–92, and 1993–97.[9–13] Incidence data in the IARC publications were most often available by region within each country rather than for the country as a whole.

Mortality data

Mortality rates for the same 25-year period, also age-adjusted to the world standard population per 100 000 woman-years, were obtained from SEER for US black and white women and from the World Health Organization (WHO) mortality data bank,[14] for all other countries/ethnic groups. Unlike the incidence rates, mortality rates were based on data from the entire country.

Inclusion criteria

Candidate countries were selected for inclusion in this report based on the quality, completeness, and availability of incidence

Table 1 Age-adjusted incidence rates[a] of female breast cancer by geographic region, 1973–77 and 1993–97

Geographic location Country/region	1973–77 Number	1973–77 Incidence[a]	1973–77 Incidence ratio[b]	1993–97 Number	1993–97 Incidence[a]	1993–97 Incidence ratio[b]	% Change (1973–77 to 1993–97)
North America							
US, whites	41 105	76.4	1.00	71 591	97.4	1.00	27
US, blacks	2726	64.2	0.84	6906	87.9	0.90	37
Canada, British Columbia	5261	72.8	0.95	10 905	79.1	0.81	9
Europe							
Switzerland, Geneva	1021	76.1	1.00	1516	97.0	1.00	27
England, South Thames, UK	15 946	58.4	0.76	22 336	79.4	0.81	36
Italy, Varese Province	648	57.6	0.75	2823	77.0	0.79	34
Spain, Navarra	581	38.2	0.50	1227	61.2	0.63	60
Poland, Warsaw City	2036	36.5	0.48	3952	53.7	0.55	47
Israel, all Jews	4538	59.9	0.78	12 067	87.1	0.89	45
Scandinavia							
Denmark	8698	58.8	0.77	17 082	81.3	0.83	38
Sweden	18 048	55.2	0.72	28 371	76.5	0.79	39
Finland	7756	40.1	0.52	14 974	72.4	0.74	81
Norway	7347	49.6	0.65	10 783	63.2	0.65	27
Oceania							
Australia, New South Wales	7769	53.2	0.70	16 784	80.7	0.83	52
New Zealand	5018	62.6	0.82	9116	75.8	0.78	21
Latin America and Caribbean							
US, Puerto Rico	2006	29.5	0.39	2091	49.7	0.51	68
Colombia, Cali	492	33.2	0.43	1306	37.3	0.38	12
Asia/Origin							
US, Hawaii Japanese	391	47.1	0.62	1068	83.7	0.86	78
Hong Kong	2471	31.1	0.41	6902	36.2	0.37	16
Japan, Miyagi	1024	17.5	0.23	2846	33.1	0.34	89
India, Bombay	987	21.2	0.28	4744	28.9	0.30	36
China, Shanghai	623	19.6	0.26	6638	27.2	0.28	39

[a] Per 100 000 women-years, age-adjusted to the world standard.

[b] Relative to the incidence in United States whites.

and mortality data. A country or a region within a country was considered to have incidence data of high quality if more than 60% of cases were histologically verified during 1973–77 (median = 90%) and 80% during 1993–97 (median = 97%), and data were available for at least 20 of the 25 years between 1973 and 1997. When we identified several regions within a country with high quality data, we included the region with the largest population or with the longest established registry. From this listing, we chose 18 countries spanning several continents and for whom mortality data were also available. Although mortality data were not available from India, we included incidence data from Bombay.

Data analysis

US incidence and mortality rates were calculated using SEER*Stat (version 5.0.18, a statistical package issued by the SEER programme of the National Cancer Institute). Using both incidence and mortality rates, we computed the following comparative statistics to illustrate the differences in absolute rates between countries and the changes in rates over time: rate ratios comparing rates for each country relative to US white women; and percentage change in rates over time within each country [(1993–97 rate minus 1973–77 rate)/1973–77 rate]. In addition, ratios of age-specific incidence rates (1993–97 relative to 1973–77) were calculated by country to further assess whether overall changes in incidence rates were uniform across all ages or more marked for specific age groups. Figures were prepared using a semi-log scale such that a slope of 10° indicates a change of 1% per year.[15]

Results

Table 1 shows the age-adjusted incidence rates in two time periods (1973–77 and 1993–97) for 18 countries, in order of descending rates within region during 1993–97. Substantial differences in rates across countries are evident, with the

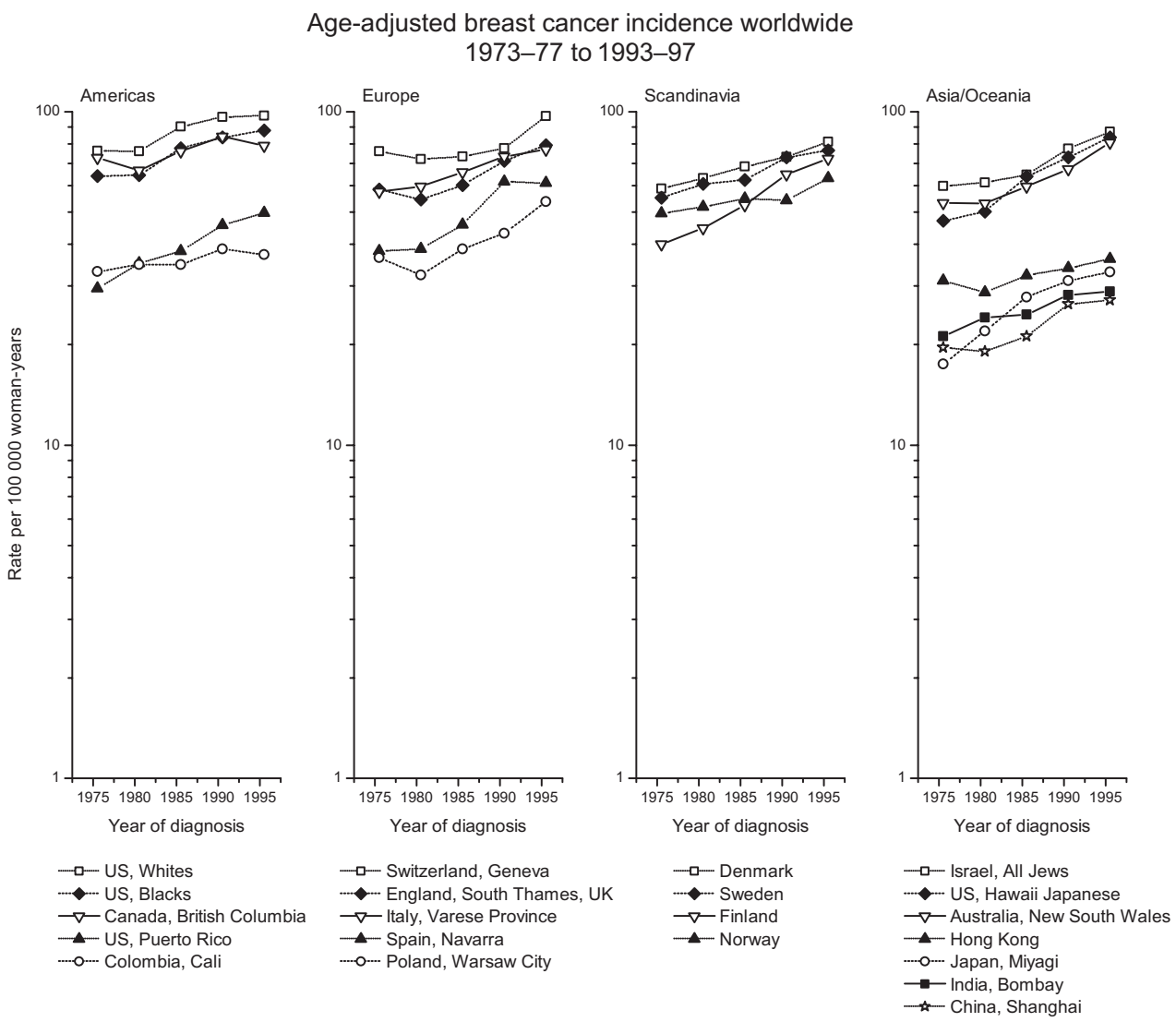

Figure 1 Age-adjusted breast cancer incidence rates for US black and white women generated from nine SEER registries representing 9.5% of the population. Incidence data for all other countries abstracted from IARC Cancer Incidence in Five Continents (1973–77 to 1993–97)

United States, Switzerland, Israel, Denmark, and Australia having rates between 81/100 000 and 97/100 000 woman-years during 1993–97. With the exception of Poland, which had the lowest rate in 1993–97 (53.7), other westernized countries had intermediate rates ranging from 61.2 (Spain) to 79.4 (England, South Thames). Breast cancer was diagnosed less frequently among women living in Puerto Rico (49.7) or Colombia (37.3). Rates were lowest among Asians (27.2–36.2). In both time periods, western countries had the highest rates, which were 3–4 times the rates in Asia.

Over the past three decades, breast cancer incidence rates increased markedly in all 18 countries; however, no clear patterns by geographic location or ethnic origin emerged. Table 1 presents the percentage increases in age-adjusted incidence from 1973–77 to 1993–97; Figure 1 presents age-adjusted incidence trends by geographic location or origin during the 25-year period. Although most countries (10 of 18) experienced 20–40% increase in breast cancer rates from 1973–77 to 1993–97, seven countries experienced increases of >40%, with the most dramatic increases in Japan (89%) and Finland (81%), and among US Hawaiian Japanese (78%). Rates rose substantially among Puerto Ricans (68%), in contrast to much smaller increases in Colombia (12%). Notably large increases in breast cancer incidence also occurred in Australia (52%), Poland (47%), and Israel (45%). In Hong Kong and Canada increases were <20%.

Table 2 shows the ratio of age-specific incidence rates in 1993–97 relative to 1973–77 for each country. In general, countries that experienced large increases in breast cancer incidence overall also had increases in all age groups. Changes were attributable primarily to increases among women ⩾50 years of age in North America, Northern Europe, Scandinavia, and Oceania. In contrast, rate increases in China were more pronounced among women <50 years of age.

Two age-specific incidence patterns predominate worldwide as represented in Figure 2 by Japanese (Asian pattern) and US white women. Steep rates of increase are similar prior to 50 years of age, but diverge thereafter. Breast cancer incidence among US white women continues to rise with age, although at an attenuated rate. In contrast, the rates plateau among Japanese women ⩾50 years of age. The patterns generally were constant over the time periods assessed with increases across all age groups among the Japanese and primarily at ages 50 and older among US whites. Rates among Hawaiian Japanese women were more similar to US white women than those of women from their country of origin (Figure 2).

Table 3 presents age-adjusted mortality rates in 17 countries (except India) in 1973–77 and 1993–97; countries are presented in the same order as shown in Table 1. In all countries, mortality was much lower than incidence. Mortality rates generally paralleled incidence (1993–97), with highest mortality among developed countries and lower mortality in Latin America (9–14/100 000) and Asia (<10). In recent years, women in Denmark had the highest mortality rate (27.3), which was approximately four times the lowest rate of 7.4 among Japanese women. Although incidence in US white women during 1993–97 was highest in the world, the mortality rate (19.7) ranked ninth: lower than in all other high risk countries except Australia (19.5) and lower than four of seven intermediate risk countries (Canada, England, Italy, and New Zealand). In contrast, the mortality rate among US black women was the second highest in the world (26.0).

Table 2 Ratios of age-specific incidence rates of female breast cancer by geographic region, 1993–97 relative to 1973–77

Geographic location	Age group (years)		
Country/region	30–49	50–64	65–79
North America			
US, whites	1.1	1.4	1.5
US, blacks	1.2	1.5	1.6
Canada, British Columbia	1.0	1.0	1.4
Europe			
Switzerland, Geneva	1.1	1.5	1.3
England, South Thames, UK	1.1	1.6	1.3
Italy, Varese Province	1.4	1.4	1.3
Spain, Navarra	1.7	1.6	1.7
Poland, Warsaw City	1.4	1.5	1.6
Israel, all Jews	1.3	1.5	1.6
Scandinavia			
Denmark	1.2	1.7	1.4
Sweden	1.3	1.5	1.5
Finland	1.7	2.1	1.5
Norway	1.2	1.4	1.2
Oceania			
Australia, New South Wales	1.3	1.8	1.5
New Zealand	1.1	1.3	1.2
Latin America and Caribbean			
US, Puerto Rico	1.7	1.7	1.8
Colombia, Cali	1.2	1.0	1.1
Asia/Origin			
US, Hawaii Japanese	1.2	1.8	2.6
Hong Kong	1.4	1.0	1.0
Japan, Miyagi	2.0	1.9	1.7
India, Bombay	1.2	1.4	1.9
China, Shanghai	1.5	1.4	1.3

Contrary to incidence rates, which are on the rise worldwide, mortality rates decreased between 1973–77 and 1993–97 in half of the countries presented in Table 3, although no clear geographic patterns emerged. Mortality rates declined more than 10% among US white, Canadian, and Swedish women. Although generally steady during the first half of the 25-year period, breast cancer mortality also declined since 1983–88 in England, Switzerland, Australia, and Hong Kong (Figure 3). In contrast, mortality rates rose substantially among Japanese (49%), Colombian (37%), Polish (21%), and US black women (17%).

Discussion

Breast cancer incidence and mortality varied as much as 4-fold internationally during 1993–1997. North America had the highest incidence of breast cancer; intermediate levels were reported in Western Europe, Oceania, Scandinavia, and Israel;

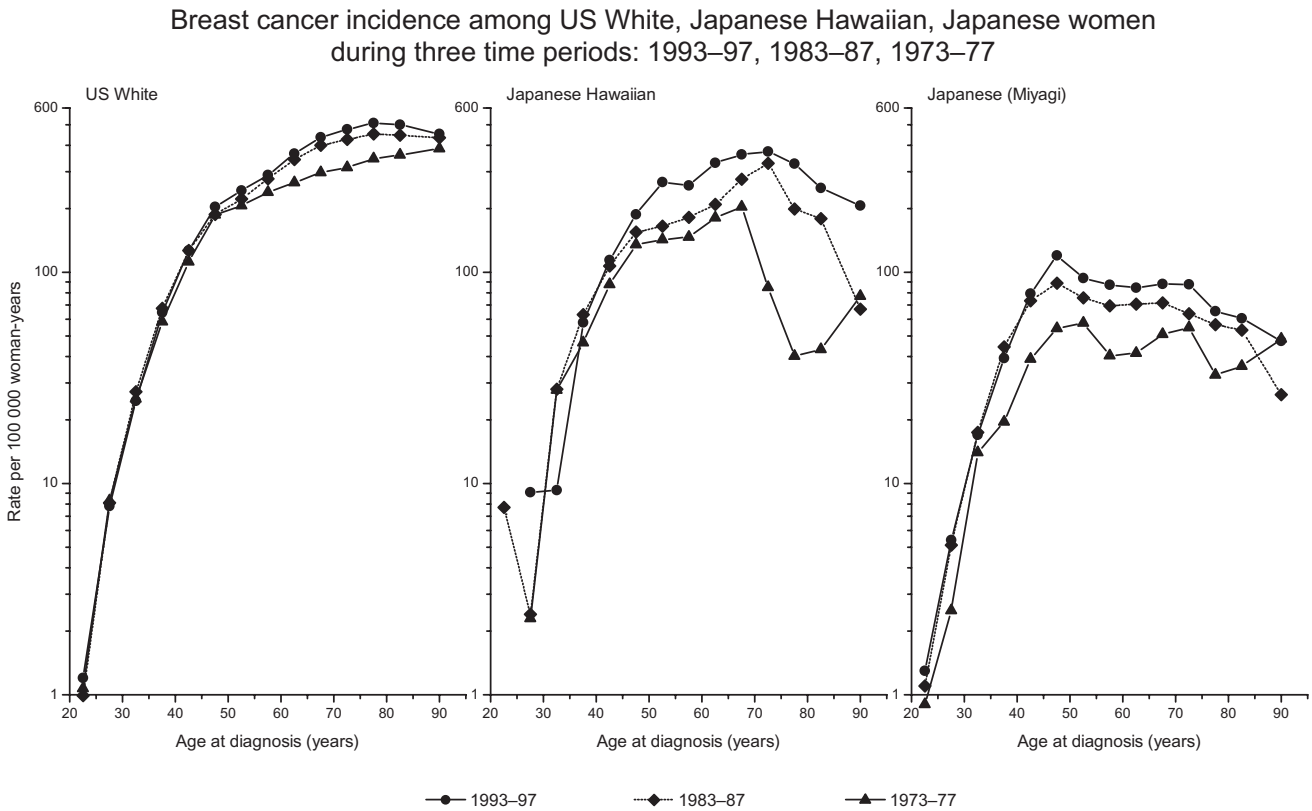

Figure 2 Age-specific breast cancer incidence rates for US white women generated from nine SEER registries. Rates for US Hawaiian Japanese and Japanese (Miyagi) women abstracted from IARC Cancer Incidence in Five Continents (1993–97, 1983–87, 1973–77)

and Eastern Europe, South and Latin America, and Asia had the lowest rates. Countries with intermediate and high incidence rates also had the highest mortality rates, and those with low incidence rates had the lowest mortality rates. Although race and ethnicity are strong predictors of breast cancer,[16] studies assessing determinants of risk for women who migrated from areas of low to high incidence suggest that international differences are social and environmental in addition to hereditary in origin.[3,4]

Much of the variability in global breast cancer rates has been attributed to country-specific differences in the prevalence of risk factors that determine lifetime exposure to oestrogen. Comparatively younger ages at menarche, older ages at first birth and/or menopause, and higher prevalences of post-menopausal obesity have been proposed as explanations for the disparate breast cancer incidence rates among US white (97/100 000) and Asian women (27/100 000).[2,17] Cross-cultural differences in height, diet, alcohol consumption, and exogenous oestrogen use are also believed to contribute to international differences, but to a lesser extent.[18–21] Further augmenting these findings, molecular epidemiological studies have shown that compared with women living in areas of high breast cancer incidence, women from low risk countries have lower plasma oestrogen levels.[22]

Age-related patterns of breast cancer incidence also vary between low, intermediate, and high-risk countries, differences which are particularly pronounced after menopause. For example, US breast cancer incidence rates increase ~100-fold between age 30 and 50 years, but the rate of increase is attenuated between ages 50 and 80 years.[23] A steep rate of increase is also evident among pre-menopausal women residing in Asia; however, the post-menopausal rates plateau and even decrease in some countries. The apparently different behaviour of the curves in older ages previously has been attributed to increasing incidence among young birth cohorts in low-risk countries that was expected to persist such that their incidence curve after age 50 would approach that of the high-risk populations.[24] However, we found that these patterns were constant over the periods assessed by this report, suggesting that they may represent true aetiologic differences between breast cancers diagnosed in respective populations. Age-incidence trends seen among Asian women are similar in shape to those reported for oestrogen receptor-negative tumour types in the US[25] and Denmark.[26] The relative incidence of age-adjusted oestrogen receptor-negative tumours is indeed higher in Asian than Western nations.[27,28]

Between 1973 and 1997 breast cancer incidence increased worldwide, although patterns of increase varied with geographic location. In North America, incidence rates rose through the 1980s, but the increases have slowed in the mid-1990s. Rates throughout the rest of the world generally increased most dramatically after the mid-1980s and continued to rise. The contributions of changes in breast cancer risk factors to overall incidence trends in these countries has been masked by large artefactual increases resulting from changes in the way breast cancer is diagnosed.[29] Over the last 25 years, breast

Table 3 Age-adjusted mortality rates[a] of female breast cancer by geographic region, 1973–77 and 1993–97

Geographic region	1973–77		1993–97		% Change (1973–77 to 1993–97)
	Mortality	Mortality Ratio[b]	Mortality	Mortality Ratio[b]	
North America					
US, whites	22.4	1.00	19.7	1.00	−12
US, blacks	22.3	1.00	26.0	1.32	17
Canada	23.7	1.06	21.1	1.07	−11
Europe					
Switzerland	24.0	1.07	22.2	1.13	−8
England, UK	27.4	1.23	24.9	1.26	−9
Italy	18.6	0.83	19.8	1.01	6
Spain	12.6	0.56	16.9	0.86	35
Poland	13.2	0.59	16.0	0.82	21
Israel	24.2	1.08	24.6	1.25	2
Scandinavia					
Denmark	26.3	1.18	27.3	1.39	4
Sweden	19.6	0.88	16.9	0.86	−14
Finland	15.5	0.69	16.6	0.84	7
Norway	18.0	0.81	19.1	0.97	6
Oceania					
Australia	20.1	0.90	19.5	0.99	−3
New Zealand	24.9	1.11	23.7	1.21	−5
Latin America and Caribbean					
US, Puerto Rico	10.6	0.47	14.2	0.72[c]	34
Colombia	6.7	0.30	9.2	0.47	37
Asia					
Hong Kong	9.4	0.42	8.9	0.45	−5
Japan	4.9	0.22	7.4	0.38	49

[a] Per 100 000 woman-years, age-adjusted to the world standard. Mortality rates were based on data from the entire country (unlike incidence rates summarized in Tables 1 and 2, which in most cases represented only a region of a particular country).

[b] Relative to the mortality in US whites (country total).

[c] 1988–92 mortality data used to calculate mortality–incidence ratio.

cancer incidence rose ~30% in westernized nations where breast screening programs were implemented in the late 1980s and early 1990s.[7] The marked increases in rates have been attributed to predominately small localized breast tumours diagnosed among peri-menopausal women,[30] precisely the women who experienced the largest corresponding increase in screening mammography.[31,32]

Rates of increase in Asia have been more marked than in other regions. Contrary to the westernized countries, where period effects (screening) are predominately operative, analyses using age-period-cohort modelling showed that a cohort effect (exposures and or risk factors) explained most of the increase in incidence in Asia.[33,34] The most striking increases in risk were seen among Japanese populations (78%), although large increases in other Asian countries were also noted (29–35%). Influence of westernization on fertility, diet, and an affluent lifestyle have been hypothesized as an explanation for increasing breast cancer rates.[33,35,36] Although some evidence of period effects exist, rising utilization of mammography probably has not contributed greatly to the observed increases, since in Asia most breast tumours are detected by physical examination (with the exception of Japan where population screening was implemented in 1987).[7]

Increases seen among Latin American and Caribbean countries are attributable to a combination of changes in mammography use and reproductive patterns, namely a shift to later ages at first birth.[5,6] The contribution of each to increases in breast cancer rates is not easily untangled. Because mammography use among US Hispanics lags behind that of US white women, its contribution to rising breast cancer rates may be more limited than in other westernized countries.[37] This is probably the case for both Puerto Rican and US black women who, compared with US white women, have experienced more marked increases in breast cancer incidence over the last few decades. It is noteworthy that breast cancer risk was lower in Latin American and Caribbean countries summarized in this report; unexplainably high rates in Argentina, Chile, Uruguay, and Southern Brazil are comparable with North America.[38]

Although breast cancer incidence is on the rise worldwide, breast cancer mortality has either been stable or decreased in most countries over the same 25-year period. This has contributed to worldwide shift to lower mortality–incidence

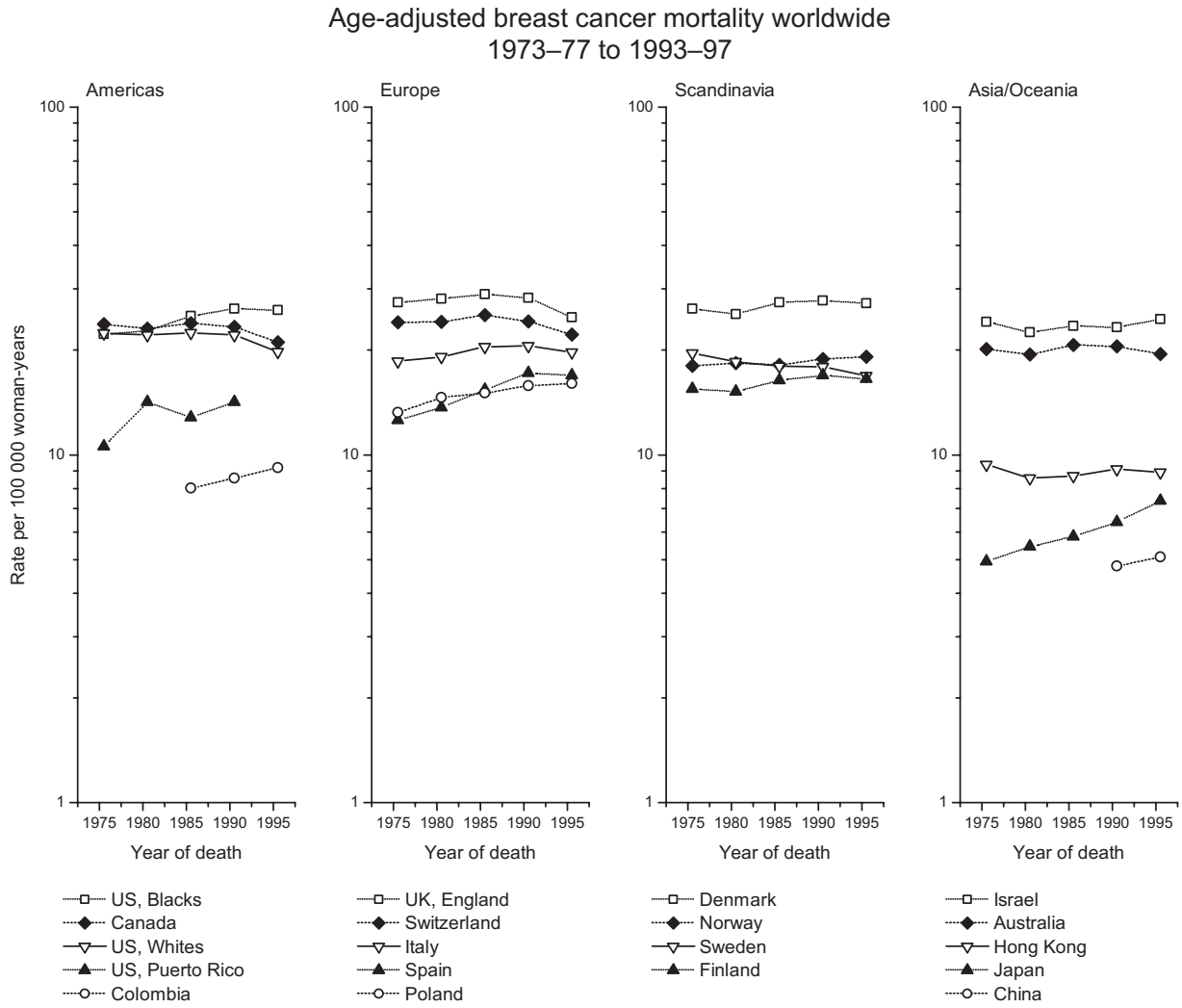

Figure 3 Age-adjusted breast cancer mortality rates for US black and white women generated from nine SEER registries representing 9.5% of the population. Mortality data for all other countries obtained from the World Health Organization mortality data bank (1973–77 to 1993–97)

ratios between 1973–77 and 1993–97. Mortality rate reductions have been attributed to better early detection, mass implementation of screening programmes in the late 1980s and early 1990s, and improved treatment.[39] In contrast to US white women who had moderate reductions in mortality (12%), US black women experienced an increase in mortality rates (17%) during the same time period. Whether this disparity is due to reduced access to care or diagnosis of tumours with less favourable prognosis is unclear.[40] Ecological studies have also found that menstrual, reproductive, and family history explains some of the international differences in breast cancer mortality.[24]

In addition to risk factor prevalence, genetic susceptibility, and secular trends in diagnosis and treatment, some portion of the global breast cancer incidence rate variation may be due to incomplete reporting. In this report we included only countries with high levels of completeness of reporting as well as high levels of histological verification of tumours. Because of the stringency of the inclusion criteria, less affluent nations in underdeveloped parts of the world are underrepresented in this report. Nonetheless, consistent patterns of higher rates in specific regions suggest true differences in underlying breast cancer risk exist worldwide. Country-specific studies correlating ecological data with cancer incidence and mortality may provide additional clues. Ultimately, future epidemiological studies exploring the combined contributions of hereditary and environmental factors are necessary to improve our understanding of breast cancer aetiology and explanations for global differences in incidence and mortality rates.

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