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Breast cancer incidence and stage at diagnosis in the six US-Affiliated Pacific Islands

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Abstract

Background: Breast cancer is the most common cancer diagnosed among women globally and in the United States (US); however, its incidence in the six US-Affiliated Pacific Islands (USAPI) remains less characterized.

Methods: We analyzed data from a population-based cancer registry using different population estimates to calculate incidence rates for breast cancer among women aged >20 years in the USAPI. Rate ratios and 95% confidence intervals (CI) were calculated to compare incidence rates between the USAPI and the US (50 states and the District of Columbia).

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Declaration of Competing Interest
Authors declare no conflicts of interest related to the content of this work.

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The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Appendix A. Supplementary material

Results: From 2007 to 2020, 1,118 new cases of breast cancer were diagnosed in the USAPI, with 66.3% (n = 741) of cases reported in Guam. Age-standardized incidence rates ranged from 66.4 to 68.7 per 100,000 women in USAPI and 101.1 to 110.5 per 100,000 women in Guam. Compared to the US, incidence rates were lower in USAPI, with rate ratios ranging from 0.38 (95% CI: 0.36, 0.40) to 0.39 (95% CI: 0.37, 0.42). The proportion of late-stage cancer was significantly higher in the USAPI (48.7%) than in the US (34.0%), particularly in the Federated States of Micronesia (78.7%) and Palau (73.1%).

Conclusions: Breast cancer incidence rates were lower in the USAPI than in the US; however, late-stage diagnoses were disproportionately higher. Low incidence and late-stage cancers may signal challenges in screening, cancer surveillance, and health care access and resources. Expanding access to timely breast cancer screening, diagnosis, and treatment could reduce the proportion of late-stage cancers and improve survival in the USAPI.

Keywords

Breast cancer; cancer disparities; cancer incidence; cancer screening; Pacific Islands

1. Introduction

Breast cancer is the most commonly diagnosed cancer globally [1] and in the United States (US) [2], excluding cancers of the skin. In 2020, 2,261,419 new cases of breast cancer (incidence rate of 47.8 per 100,000 women) were reported globally, accounting for 11.7% of all cancers diagnosed [1]. In the same year, 239,612 new cases of breast cancer (incidence rate of 119.2 per 100,000 women) were reported in the US, accounting for 14.9% of all cancers diagnosed [2].

In the US-Affiliated Pacific Islands (USAPI), which is composed of three US territories (American Samoa, the Commonwealth of the Northern Mariana Islands [CNMI], and Guam) and three freely associated states (Federated States of Micronesia [FSM], the Republic of the Marshall Islands [RMI], and the Republic of Palau [Palau]), data on breast cancer burden is limited. In the latest International Agency for Research on Cancer GLOBOCAN cancer statistics update, breast cancer incidence data was only available for Guam among all USAPI [3]. In Guam, breast cancer incidence has been reported to be 86.0 per 100,000 women from 2013 to 2017 [4]. In other USAPI, data are limited or aggregated at the regional level [5].

Stage at diagnosis can influence breast cancer prognosis [6]. Several studies have shown that relative survival decreases with increasing stage at diagnosis [6, 7]. The World Health Organization (WHO) established the Global Breast Cancer Initiative to reduce breast cancer mortality by prioritizing early detection [8]. The initiative highlights strategies for countries to diagnose at least 60% of invasive breast cancers with early-stage disease [8]. Understanding variation in cancer stage at diagnosis can guide prevention and control strategies in the USAPI.

Breast cancer screening is associated with a reduction in advanced stage disease and mortality [9–11]. Increased awareness, availability, and access to breast cancer screening,

diagnosis, and treatment services in the USAPI could increase earlier detection of cancer, expand treatment benefits, and improve survival. In the US, approximately 25% of the reduction in breast cancer mortality was attributed to screening mammography [12]. The WHO [13] and the US Preventive Services Task Force (USPSTF) [14] recommend breast cancer screening among eligible adults. However, mammography screening services are limited or even unavailable in some USAPI.

The USAPI are home to over 440,000 people living on hundreds of islands and atolls spanning millions of square miles in the Pacific Ocean. Despite their cultural and linguistic diversity, these islands share common geographic, economic, and resource limitations that may impede access to cancer screening and follow-up services [15, 16]. Residents of these islands also experience several barriers accessing health care [16]. These factors can affect breast cancer screening, detection, and incidence. Motivated by the paucity of data and unique challenges in these islands, we calculated and examined female breast cancer incidence rates in the USAPI using population estimates from three different sources. We also compared these age-standardized incidence rates and stage at diagnosis in the USAPI with those in the US to quantify any disparities.

2. Methods

2.1. Data source

We analyzed breast cancer incidence data from the Pacific Regional Central Cancer Registry (PRCCR). PRCCR is a population-based cancer registry that collects data on cancers reported from the six USAPI. More information about the structure of the cancer registry as well as data collection, reporting, and evaluation are available elsewhere [17]. Briefly, each USAPI population-based registry collects, enters, and monitors incident cancer data. Cases are then reported to PRCCR for additional quality control and preparation for data submission. In a data quality evaluation audit, PRCCR data were highly concordant [18]. In the latest submission years, missing race, unknown age, and unknown sex were 0%. However, the 12-month completeness (based on the observed-to-expected cases) was lower due to differences in medical records systems and off-island referrals with variable timeliness of receipt of off-island clinical documentation. The proportion of death certificate-only cases was slightly higher than the National Program of Cancer Registries National Data Quality Standard. We analyzed incidence data from 2007 to 2020, covering the period from the registry's inception to the most recent available data. We analyzed population-based incidence data for the US (50 states and the District of Columbia) from the United States Cancer Statistics.

2.2. Cancer and variable definitions

Breast cancer cases were restricted to females. Invasive female breast cancer cases were defined according to the International Classification of Diseases for Oncology, Third Edition, primary site codes (C50.0–C50.9), excluding histology codes (9050–9055, 9140, 9590–9993). Breast cancer incidence rates were examined by age and stage. Age at diagnosis was categorized into three groups: 20–39, 40–59, and >60 years. Stage at diagnosis was classified as localized, regional, and distant using a merged variable that

spans the periods when three different staging schemes were used, including Surveillance, Epidemiology, and End Results (SEER) Summary Stage 2000, Derived SEER Summary Stage 2000, and Summary Stage 2018. Approximately 19% of cases in the USAPI were unstaged or had an unknown stage and were excluded from stage-specific analyses. Late-stage cancer included regional and distant stage diagnoses.

2.3. Statistical analyses

Age-standardized incidence rates were estimated and expressed per 100,000 women. Rates were age standardized to the 2000 US standard population by the direct method. As decennial census data may not accurately reflect the demographic changes in the USAPI beyond the census years, we obtained annual population estimates for the denominator from three sources: US Census International Database, the official government source of population estimates for the US territories in the Pacific [19]; United Nations Population Division [20]; and Pacific Data Hub [21]. Age-standardized incidence rates were estimated for all three population estimates. To assess the relative difference in the overall incidence rates between the USAPI and the US (50 states and the District of Columbia), we calculated rate ratios (RR) and 95% confidence intervals (CI). We also compared incidence rates between women in the USAPI and Asian and Pacific Islander women in the US and Hawaii. The likelihood ratio chi-square test was used to compare the distribution of late-stage (regional and distant stages) cases between the USAPI and the US. Statistics from counts of fewer than six cases were suppressed due to rate stability and confidentiality concerns. All analyses were performed using SAS, version 9.4 (SAS Institute, Inc.) and R, version 4.2.1 (R Foundation for Statistical Computing).

2.4. Reporting

Although we use the anglicized versions of USAPI in this manuscript, we acknowledge the indigenous names and spellings of Hawaʻi, Sāmoa, Guåhan.

3. Results

From 2007 to 2020, a total of 1,118 new cases of breast cancer were diagnosed in the six USAPI among women aged >20 years, with 66.3% (n = 741) of these reported in Guam (Table 1). The overall age-standardized incidence rate in the USAPI ranged from 66.4 to 68.7 per 100,000 women, depending on the population estimate. Incidence rates were highest in Guam, ranging from 101.1 to 110.5 per 100,000 women, and lowest in RMI (ranging from 24.6 to 33.7 per 100,000 women) and FSM (ranging from 30.5 to 32.6 per 100,000 women). The median age of breast cancer diagnosis in the USAPI was 56.0 years (interquartile range [IQR], 48.0–66.0) (Appendix Table S1). The proportion of women diagnosed at age 60 years or older was higher in the US compared to the USAPI.

The overall breast cancer incidence rate in the USAPI was significantly lower than the rate reported in the US (175.5 per 100,000 women), with rate ratios ranging from 0.38 (95% CI: 0.36, 0.40) to 0.39 (95% CI: 0.37, 0.42) (Table 2). Compared to the US, incidence rates were significantly lower in all USAPI, and were lowest among RMI (rate ratios ranging from 0.14 to 0.21) and FSM (rate ratios ranging from 0.17 to 0.19). Incidence rates among women in

the USAPI were also significantly lower than rates among Asian and Pacific Islander women in the US (rate ratio: 0.51) and Hawaii (rate ratio: 0.36) (Appendix Table S2).

The stage-specific distribution of breast cancer cases is presented in Figure 1 and Appendix Table S3 and Figure S1. Among cases with a known stage at diagnosis, the proportion diagnosed with late-stage cancer was significantly higher in the USAPI (48.7%) than the US (34.0%), particularly in the freely associated states of FSM (78.7%), Palau (73.1%), and RMI (67.6%). Compared to the US (5.8%), the proportion of cases diagnosed at distant stage was significantly higher in FSM (46.7%) followed by American Samoa (19.1%) and RMI (16.2%).

4. Discussion

In this study examining 14 years of population-based registry data, women in the USAPI had a lower reported incidence of breast cancer compared to women in the US and Asian and Pacific Islander women in the US and Hawaii. However, almost half of the cancer cases in the USAPI were diagnosed at a late stage of disease when prognosis is comparatively poorer and treatment options are more limited. Breast cancer burden within the USAPI varied, with Guam having considerably higher incidence rates than other territories and freely associated states.

Variations in incidence rates within the USAPI and compared to the US and the Asian and Pacific Islander population in the US and Hawaii could reflect differences in patterns of risk factors, possible underreporting, and the availability of and access to early detection and timely treatment. Although breast cancer screening is recommended among eligible adults [13, 14], mammography screening services are limited or even unavailable in some USAPI. For example, mammography is only offered in two of the four states of FSM and only in the capital of RMI [22]. Even in USAPI that provide mammography, screening coverage is low. Approximately 30% of women in Palau, 25% in American Samoa, and 22% in RMI were up to date with mammography screening [23] compared to an estimated 75% in Guam [24]. Lower uptake of mammography is associated with higher rates of late-stage breast cancers [25]. In this study, most cases in the USAPI (excluding Guam) were diagnosed at an advanced cancer stage, especially in FSM, Palau, and RMI. Relative survival for breast cancer decreases with increasing stage at diagnosis [6]. From 2008 to 2013, incidence-based mortality from female breast cancer was the leading cause of cancer death in American Samoa and FSM [18], and mortality from female breast cancer ranked second in Guam, third in RMI, and fourth in CNMI [18].

In a recent review, several factors were associated with low screening participation and late presentation of cancer among women in the Pacific Islands [15]. These included limited health resources and facilities, lack of awareness, and low socioeconomic status [15]. Access to screening is hindered by geographical challenges unique to USAPI, where some islands are dispersed across vast distances, remote, and isolated. These geographical barriers are further exacerbated by limited and inadequate transportation options across islands. Some of these screening-related barriers likely contribute to an underdiagnosis of cancer cases, which could underestimate incidence rates. In addition, women without health care coverage

had one of the lowest proportions of breast cancer screening in Guam compared to those with coverage (41.8 vs 78.8%) [24]. Improving coverage could increase access to cancer screenings and improve test receipt. All USAPI, except FSM, receive support from the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) to provide breast cancer screening services to women who have low incomes and are uninsured or underinsured. During the 2017 to 2022 program years, approximately 6,300 women in the USAPI received breast cancer screenings or diagnostic procedures through the NBCCEDP [26]. Furthermore, federally qualified health centers (FQHC) provide access to breast cancer screening services for underserved and low-income populations in the USAPI. In 2022, approximately 1,200 mammograms were ordered through or by an FQHC in the USAPI [27]. Resource-appropriate screening approaches, such as clinical breast examination, could potentially be suitable in areas where mammography is not widely available [13]. Approximately 24% of women in RMI, 25% in Kosrae state in FSM, and 34% in American Samoa reported receiving a clinical breast exam [23]. In the US, treatment for stage I to III and metastatic breast cancers reduced mortality by approximately 47% and 29%, respectively [12]. However, cancer care varies across USAPI, with some patients receiving no treatment, restrictive treatment, or treatment abroad when resources allow [28]. On-islands treatment options such as chemotherapy and radiotherapy are not available in some USAPI [29].

Due to several challenges in cancer surveillance, limited healthcare infrastructure, lack of trained personnel, and geographical and socioeconomical barriers to screening and healthcare access in the USAPI [18], there is a potential for underreporting, delay in reporting, or lack of complete reporting of cancer cases. For instance, breast cancer cases were underreported in RMI during 2017 and 2018 and in one of the largest states in FSM, Chuuk state, during the study period. Such underreporting could underestimate breast cancer incidence rates and suggest that the true incidence rate in the USAPI is likely higher than the rate reported in this study.

Genetic, familial, reproductive, lifestyle, and age-related factors can influence the risk of breast cancer [30, 31]. The risk factors for breast cancer are not well studied among Pacific Islander populations. In the only case-control study of breast cancer risk factors among women in CNMI and Guam, older age at first live birth and higher waist circumference were associated with an increased risk [32]. In the same study, sedentary behavior was also suggested to be a risk factor for breast cancer in this population [32]. Economic growth, globalization, and dependence on foreign imports have fueled a shift from traditional dietary patterns in the region [33]. This transformation in the food environment, coupled with the rise in a sedentary lifestyle, have contributed to the obesity epidemic in some USAPI. Programs to promote access to local food options and support a transition to traditional diets may reduce the burden of overweight and obesity. For example, reversion to a traditional Hawaiian diet was associated with short- and long-term weight loss among Native Hawaiian adults who were obese [34]. The age at diagnosis of breast cancer was relatively younger in the USAPI. This younger age at diagnosis could correspond with higher breast cancer mortality rates among younger Native Hawaiian and Pacific Islander women compared to other race groups in the US [35].

The findings in this study are subject to at least three limitations. First, underreporting of cancer cases could underestimate breast cancer incidence in some USAPI. Second, the small number of cases in some USAPI prevented us from analyzing temporal trends and resulted in wide confidence intervals for incidence rate estimates. Third, due to challenges with accurate death registration, certification, and reporting highlighted previously [18], mortality rates were not analyzed and presented in this study. Despite these limitations with PRCCR data, it remains a vital source for cancer surveillance in the USAPI. Strengthening and expanding central cancer registries across the USAPI and the Pacific region is crucial to estimating disease burden, informing locally relevant priorities and policies, and evaluating cancer prevention and control interventions.

While breast cancer incidence rate was lower in the USAPI than the US, the proportion of cases diagnosed at later stages was considerably higher. Improving and expanding access to timely breast cancer screening and treatment may decrease the proportion of late-stage cancer and increase the proportion of localized cases, thereby improving survival. Increasing cancer screening coverage is a priority for the USAPI. The Community Preventive Services Task Force recommends multicomponent interventions to improve screening for breast cancer, including increasing community demand and reducing barriers to access [36]. National comprehensive cancer control plans in the USAPI propose strategic initiatives such as one-on-one and group education sessions and media campaigns to increase community screening demand and participation [37–39]. These plans also outline the implementation of patient navigation services to reduce structural barriers to screening. Women are more likely to get cancer screening when they can enroll easily. During the SARS-CoV-2 pandemic, Guam BCCEDP made enrollment in their program easier, resulting in more women screened [40]. Furthermore, increasing the availability of and access to mammography machines and services may improve screening coverage.

Culturally appropriate interventions addressing modifiable risk factors and promoting healthy behaviors could reduce the incidence of breast cancer in the USAPI. A comprehensive systems approach to develop a coordinated breast cancer surveillance, prevention, diagnosis, and treatment program would likely improve early detection and survival. Some of this work is ongoing in the USAPI through partnerships across comprehensive cancer control [41], noncommunicable disease [28], and the Racial and Ethnic Approaches to Community Health programs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data Availability Statement:

Investigators can request cancer incidence data for the USAPI by submitting a data request to the Pacific Regional Central Cancer Registry.

Abbreviations:

CNMI	Commonwealth of the Northern Mariana Islands
SEER	Surveillance, Epidemiology, and End Results Program
FSM	Federated States of Micronesia
ICD-O-3	International Classification of Diseases for Oncology, Third Edition
NBCCEDP	National Breast and Cervical Cancer Early Detection Program
NPCR	National Program of Cancer Registries
PRCCR	Pacific Regional Central Cancer Registry
RMI	Republic of the Marshall Islands
USAPI	US-Affiliated Pacific Islands
USPSTF	US Preventive Services Task Force

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Highlights:

- Breast cancer incidence was lower in the USAPI than in the US.
- Incidence varied within the USAPI, with Guam having a higher incidence rate.
- The proportion of late-stage diagnoses was higher in the USAPI than in the US.
- Almost half of the breast cancer cases in the USAPI were late-stage diagnoses.

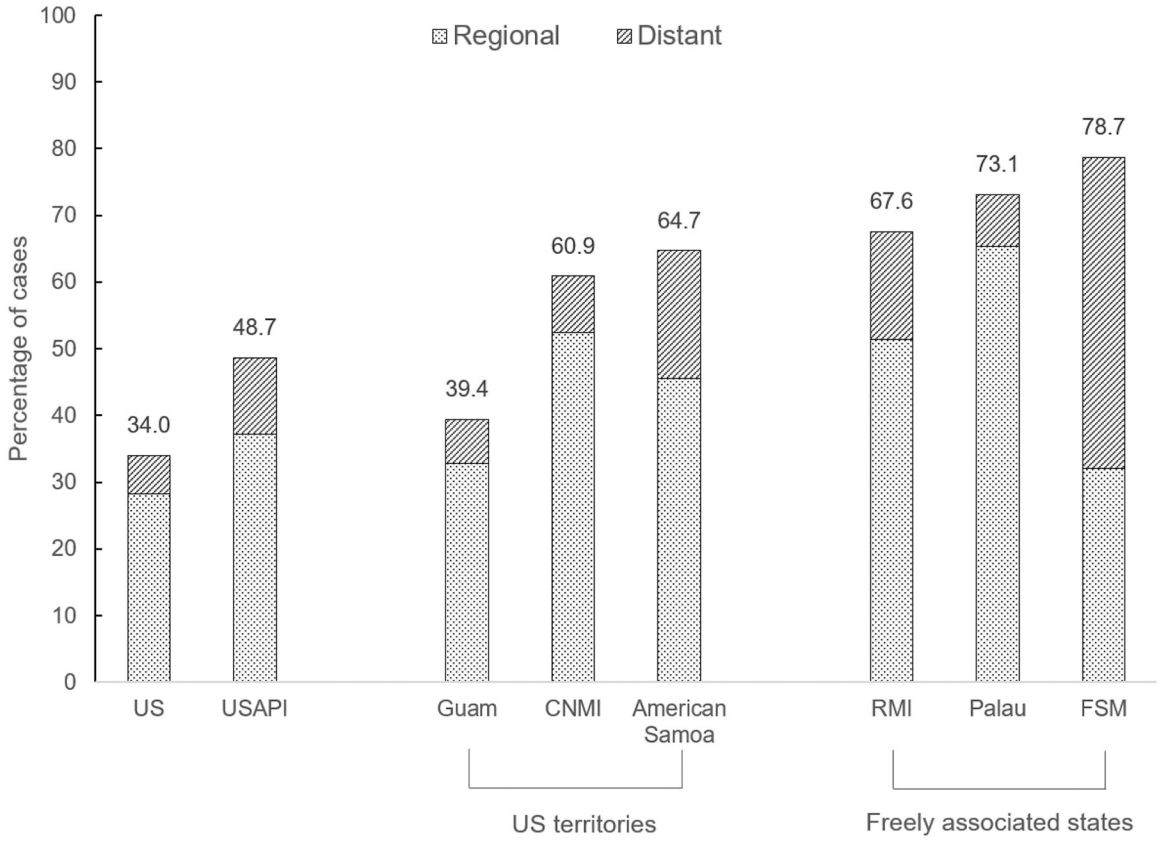

Figure 1.

Distribution of late-stage[a,b] breast cancer in the US-Affiliated Pacific Islands and US,[c,d] 2007–2020.

Abbreviations: CNMI, Commonwealth of the Northern Mariana Islands; FSM, Federated States of Micronesia; RMI, Republic of the Marshall Islands.

[a] Stage at diagnosis was created by combining Surveillance, Epidemiology, and End Results (SEER) Summary Stage 2000, Derived SEER Summary Stage 2000, and Summary Stage 2018.

[b] Localized stage is not shown, but the proportion of the localized can be calculated by subtracting the percentage of late-stage diagnosis from 100% (e.g., proportion of localized stage in the USAPI is 51.3% [100.0%−48.7%]).

[c] Does not include unstaged or unknown stage.

[d] All comparisons of late-stage cancers in the USAPI to the US were significant (p<0.05).

Table 1.

Age-standardized[a] incidence rates of invasive breast cancer in the US-Affiliated Pacific Islands, 2007–2020.

	No. (%)	Incidence rate[b] (95% CI)	Incidence rate[c] (95% CI)	Incidence rate[d] (95% CI)
USAPI				
All USAPI	1,118 (100.0)	68.6 (64.5, 72.8)	68.7 (64.6, 72.9)	66.4 (62.5, 70.5)
US territories				
American Samoa	95 (8.5)	51.7 (41.6, 63.6)	52.5 (42.1, 64.5)	48.4 (39.0, 59.4)
CNMI	99 (8.9)	46.9 (37.3, 58.1)	44.7 (35.7, 55.4)	41.2 (32.9, 51.0)
Guam	741 (66.3)	110.5 (102.7, 118.8)	103.1 (95.8, 110.8)	101.1 (94.0, 108.7)
Freely associated states				
FSM	100 (8.9)	32.6 (26.2, 40.0)	30.5 (24.6, 37.3)	31.8 (25.6, 38.9)
Palau	37 (3.3)	37.1 (26.1, 51.3)	45.8 (32.1, 63.3)	41.6 (29.2, 57.4)
RMI	46 (4.1)	24.6 (17.7, 33.1)	37.1 (26.2, 50.9)	33.7 (24.2, 45.6)

Abbreviations: CI, confidence interval; CNMI, Commonwealth of the Northern Mariana Islands; FSM, Federated States of Micronesia; RMI, Republic of the Marshall Islands; USAPI, US-Affiliated Pacific Islands.

[a] Rates were age-standardized to 2000 US standard population and expressed per 100,000 women.

[b] Population estimates from the US Census Bureau's International Database.

[c] Population estimates from the United Nations Population Division.

[d] Population estimates from the Pacific Data Hub.

Table 2.

Comparison of age-standardized[a] incidence rates of invasive breast cancer between the US-Affiliated Pacific Islands and the US, 2007–2020.

	USAPI[b]:US	USAPI[c]:US	USAPI[d]:US
	Rate ratio (95% CI)	**Rate ratio (95% CI)**	**Rate ratio (95% CI)**
USAPI			
All USAPI	0.39 (0.37, 0.41)	0.39 (0.37, 0.42)	0.38 (0.36, 0.40)
US territories			
American Samoa	0.29 (0.24, 0.36)	0.30 (0.24, 0.37)	0.28 (0.22, 0.34)
CNMI	0.27 (0.21, 0.33)	0.25 (0.20, 0.32)	0.23 (0.19, 0.29)
Guam	0.63 (0.58, 0.68)	0.59 (0.55, 0.63)	0.58 (0.54, 0.62)
Freely associated states			
FSM	0.19 (0.15, 0.23)	0.17 (0.14, 0.21)	0.18 (0.15, 0.22)
Palau	0.21 (0.15, 0.29)	0.26 (0.18, 0.36)	0.24 (0.17, 0.33)
RMI	0.14 (0.10, 0.19)	0.21 (0.15, 0.29)	0.19 (0.14, 0.26)

Abbreviations: CI, confidence interval; CNMI, Commonwealth of the Northern Mariana Islands; FSM, Federated States of Micronesia; RMI, Republic of the Marshall Islands; USAPI, US-Affiliated Pacific Islands.

Note: The age-standardized female breast cancer incidence rate was 175.5 per 100,000 women in the United States.

[a]Rates were age-standardized to 2000 US standard population and expressed per 100,000 women.

[b]Population estimates from the US Census Bureau's International Database.

[c]Population estimates from the United Nations Population Division.

[d]Population estimates from the Pacific Data Hub.