Cancer Epidemiology 45 (2016) 112–118

Contents lists available at ScienceDirect

Cancer Epidemiology

The International Journal of Cancer Epidemiology, Detection, and Prevention

journal homepage: www.cancerepidemiology.net

Racial/ethnicity disparities in invasive breast cancer among younger and older women: An analysis using multiple measures of population health

Mei-Chuan Hung, PhD, MS, RN, Donatus U. Ekwueme, PhD, MS*, Sun Hee Rim, PhD, MPH, Arica White, PhD, MPH

Division of Cancer Prevention and Control, US Centers for Disease Control and Prevention, Atlanta, Georgia

ARTICLE INFO

Article history:
Received 6 May 2016
Received in revised form 29 September 2016
Accepted 18 October 2016
Available online 25 October 2016

Keywords:
Breast cancer
Racial health disparity
Incidence and mortality
Survival
Life expectancy
and expected years of life lost

ABSTRACT

Introduction: Few studies have examined age and racial/ethnic disparities in invasive breast cancer among younger (age 15–44 years) vs. older (age 45–64 years) women. This study estimates disparities in breast cancer among younger compared with older women by race/ethnicity using five measures of population health: life expectancy (LE), expected years of life lost (EYLL), cumulative incidence rate (CIR), and incidence and mortality rate ratios (IRR and MRR).

Methods: Using Surveillance, Epidemiology, and End Results data, LE and EYLL were estimated from a cohort of 15–44 and 45–64 years, non-Hispanic black (NHB), non-Hispanic white (NHW), and Hispanic women diagnosed with breast cancer, 2000–2013. Survival function was obtained from the study years and then extrapolated to lifetime using the Monte Carlo method. The CIR, IRR and MRR were calculated using 2009–2013 breast cancer incidence and mortality rates from the Centers for Disease Control and Prevention's National Program of Cancer Registries.

Results: The estimated LE ranged from 32.12 to 7.42 years for localized to distant stages among younger NHB women compared to 33.05 to 9.95 years for younger NHW women. The estimated EYLL was 12.78 years for younger women, and 4.99 for older women. By race/ethnicity, it was 15.53 years for NHB, 14.23 years for Hispanic and 11.87 years for NHW ($P < 0.00025$). The CIR for age-group 15–44 years (CIR_{15-44}) indicated a 1 in 86 probability for NHB compared to a 1 in 87 probability for NHW being diagnosed with breast cancer by age 45. The estimated age-adjusted incidence rate for NHB-to-NHW women was IRR = 1.10 (95%, CI = 1.08–1.11) and the corresponding mortality rate was MRR = 2.02 (95%, CI = 1.94–2.11).

Conclusions: The breast cancer disparities between younger NHB compared to NHW women highlight the need for expanded efforts to address these disparities through primary prevention and to improve access to quality healthcare to minority women with breast cancer.

Published by Elsevier Ltd.

1. Introduction

Breast cancer is the most common malignant tumor among U.S. women, accounting for 30% of incident cancers [1]. Despite the benefits of advances in treatment and early detection that have contributed to the decline in breast cancer deaths [2], not all age and racial/ethnic groups have benefited equally and disparities in incidence and mortality still exist [3]. Further, several studies have examined age disparities in breast cancer outcomes [4–9]. These studies have reported substantially lower health-related quality of life resulting from breast cancer treatment in younger (i.e., aged 15–44 years) compared with older (i.e., aged 45–64 years) women. Similarly, studies have reported racial/ethnic disparities in breast cancer outcomes [10–13]. These studies found that black women are more likely than white women to have late-stage breast cancer at diagnosis and have less favorable outcomes, including higher mortality rates [10,11]. In addition, other studies have also found that both younger and older black women have higher mortality rates than any other racial/ethnic group [12,13].

In recent years, there has been public health initiative in breast cancer among younger women. More specifically, the Education and Awareness Requires Learning Young (EARLY) Act, Section 10413 of the Affordable Care Act [Public Law 111–148]) [14] has renewed interest in how the risk of breast cancer impacts

* Corresponding author at: Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, 4770, Buford Highway, MS F-76, Atlanta, GA, 30341, Georgia.
E-mail address: donatus.ekwueme@cdc.hhs.gov (D.U. Ekwueme).

http://dx.doi.org/10.1016/j.canep.2016.10.013
1877-7821/Published by Elsevier Ltd.

younger women. Currently, no studies have examined age (younger versus (vs) older) and racial/ethnic disparities (that is, non-Hispanic black (NHB), non-Hispanic white (NHW), and Hispanic women) using multiple measures of population health, which includes life expectancy (LE), expected years of life lost (EYLL), cumulative incidence rates for women ages 15–44 and 45–64 years ($CIR_{15\text{-}44,45\text{-}64}$), and age-adjusted incidence and mortality rate ratios (IRR and MRR). However, the impact of breast cancer disparities have been quantified using other population-based measures developed to evaluate cancer progress in national health objectives [15–17].

In this paper, we utilized multiple measures of population health (i.e., LE, EYLL, CIR, IRR, and MRR), to determine 1) whether breast cancer burden was greater for younger vs older women; 2) to estimate the magnitude of racial/ethnic disparities in invasive breast cancer among younger NHB vs NHW women, and younger Hispanic vs NHW women; and 3) to examine whether racial/ethnic disparities in incidence and mortality of breast cancer among younger women are worse in breast cancer than in all other female cancers. Each of these measures contributes differently in providing information to patients, clinicians, and health policy-makers on the burden of breast cancer disparities in age-and racial/ethnic-groups. We hope that the use of these measures may provide useful data for outcome assessment and resource allocation of health services and development of prevention strategies for age- and racial/ethnic-groups that are disproportionately more likely to develop breast cancer in their lifetime.

2. Methods

2.1. Data sources and study population

Data from the National Cancer Institute (NCI)'s 2000–2013 Surveillance, Epidemiology, and End Results (SEER-18) registries [18], which covers 28% of the US population, were used to estimate LE and EYLL. The SEER-18 registries were used because it contains survival information needed to estimate these measures [18]. A cohort of 88,406 women aged 15–44 and 345,025 women aged 45–64 with invasive breast cancer were identified from SEER. In addition, the combined dataset from the Centers for Disease Control and Prevention (CDC)'s National Program of Cancer Registries (NPCR) and the NCI's SEER registries [1], which covers the entire U.S. population, were used to estimate CIRs, incidence, and mortality rates for a separate cohort of 113,328 women aged 15–44 and 512,511 women aged 45–64 diagnosed (2009–2013) with invasive breast cancer. These population-based cancer registries collect detailed information on patient's sex, race/ethnicity, year of diagnosis, age of diagnosis, cancer site, stage, survival months, and vital status [18]. In both datasets, invasive breast cancer was defined by the standards in the International Classification of Diseases for Oncology, 3rd Edition [19]. To minimize confounding of survival times for the primary cancer, patients with a prior breast cancer diagnosis and those diagnosed based on death certificate or autopsy only were excluded ($< 1\%$). Death was defined as all-cause mortality; all breast cancer patients were followed until death or through the end of follow-up (December 31, 2013).

2.2. Measures of population health

The LE and EYLL incorporate data on the US life tables to estimate the burden of breast cancer in the population [20]. The estimation of LE from the date of diagnosis until death was used to generate lifetime survival in different racial/ethnic groups (NHB, NHW, and Hispanic) that may be relevant to clinicians in treating breast cancer patients. In estimating LE, we did not include racial/ethnic groups of Asian/Pacific Islander and American Indian/Alaska Native women because of a lack of life tables for these populations.

On the other hand, the estimation of EYLL, which is a measure of the overall burden of disease was used to determine the lifetime health impact of breast cancer in age-and racial/ethnic-groups. These two measures were used to examine the extent to which a younger NHB vs NHW, and younger Hispanic vs NHW woman's life span was likely to be reduced by breast cancer after diagnosis. The third measure ($CIR_{15\text{-}44,45\text{-}64}$) estimated age, and racial/ethnic disparities in the cumulative risk of being diagnosed with breast cancer over a time period and age interval [21] in the population. The last two measures, IRR and MRR, were used to further explore whether racial/ethnic disparity in incidence and mortality of breast cancer among younger women are worse in breast cancer than in all other female cancers [22].

2.3. Calculation of life expectancy (LE)

The Kaplan-Meier method [23] was used to estimate survival function for each cohort of breast cancer patients with 14 years of follow-up. Using a semi-parametric method [24], the estimated survival functions were further extrapolated up to 720 months (60 years) to derive LE after breast cancer diagnosis. The method uses relevant external information to aid the survival extrapolation. Its technical details have been described elsewhere [25]. Briefly, for a breast cancer cohort, the US life tables [26] were used to generate survival times for an age-, sex- and race/ethnicity-matched reference population using a Monte Carlo method. Thesurvival times are then used for estimating survival function of the reference population. Second, with the assumption of excess constant hazard, logit transformation of the survival ratios between the cohort and the reference population will approach a straight line [27]. Hence, a linear regression was fitted to the logit transformed survival ratios during some time period near the end of follow-up. Finally, the estimated regression line and the survival function of the reference population beyond the follow-up limit were used to extrapolate the lifetime survival function of the cohort. The standard errors of the estimated LE were obtained using a bootstrap method.

2.4. Calculation of expected years of life lost (EYLL) per breast cancer patient

EYLL was defined as the reduced LE due to breast cancer in younger vs older women, younger NHB vs NHW women and younger Hispanic vs NHW women from that of the age- sex- and race/ethnicity-matched reference population. It was calculated by taking the difference in the areas under the long-term survival curves between the breast cancer cohort and the reference population as shown in Fig. 1a, b, and c.

2.5. Calculation of cumulative incidence rates ($CIR_{15\text{-}44,45\text{-}64}$)

The $CIR_{15\text{-}44,45\text{-}64}$ was calculated using the most recent five years of data (2009–2013) on breast cancer incidence rates among younger vs older women, younger NHB vs NHW women, and younger Hispanic vs NHW women from the NPCR/SEER registries [1]. The calculation of $CIR_{15\text{-}44,45\text{-}64}$ was as follows: $CIR_{15\text{-}44,45\text{-}64} = 1 - \exp[-S_i(IR_i) * (\Delta t_i)]$; where IR_i represents the age-specific incidence rate and Δt_i indicates the range of each age stratum.

2.6. Calculation of breast cancer incidence and mortality rate ratios (IRRs and MRRs)

Using the age-adjusted breast cancer incidence and mortality rates obtained from the 2009–2013 NPCR-SEER registries [1], IRRs