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Non-communicable chronic diseases and timely breast cancer screening among women of the Eastern Caribbean Health Outcomes Research Network (ECHORN) Cohort Study

KH Wang^{1,*}, TA Thompson¹, D Galusha¹, H Friedman¹, CM Nazario², M Nunez³, RG Maharaj⁴, OP Adams⁵, and M Nunez-Smith¹ on behalf of ECHORN Writing Group

¹Equity Research and Innovation Center, Yale School of Medicine, USA ²School of Public Health, University of Puerto Rico, Puerto Rico ³School of Nursing, University of the Virgin Islands, US Virgin Islands ⁴Faculty of Medical Sciences, University of the West Indies at St. Augustine, Trinidad and Tobago ⁵Faculty of Medical Sciences, University of the West Indies at Cave Hill, Barbados

Abstract

Purpose: The Caribbean population faces a growing burden of multiple non-communicable chronic diseases (NCDs). Breast cancer is the leading cause of cancer death for women in the Caribbean. Given the substantial burden of NCDs across the region, cancer prevention and control strategies may need to be specifically tailored for people with multiple co-morbidities. Preventive screening, such as timely mammography, is essential but may be either facilitated or hampered by chronic disease control. The main objective of this study is to examine the relationship between a chronic disease and timely breast cancer screening.

Methods: We conducted a cross-sectional data analysis using baseline data from the Eastern Caribbean Health Outcomes Research Network (ECHORN) Cohort Study–ECS. Our independent variables were presence of chronic diseases (hypertension or diabetes), defined as having been told by a clinical provider. Our dependent variable was timely screening mammography, as defined by receipt of mammography within the past two years. We examined bivariate and multivariate associations of covariates and timely screening mammography.

Results: In our sample (n=841), 52% reported timely screening mammography. Among those with timely screening, 50.8% reported having hypertension, and 22.3% reported having diabetes. In our bivariate analyses, both diabetes and hypertension were associated with timely screening mammography. In partially adjusted models, we found that women with diabetes were significantly more likely to report timely screening mammography than women without diabetes. In our fully adjusted models, the association was no longer significant. Having a usual source of healthcare and a woman's island of residence was significantly associated with timely screening mammography (p<0.05).

Conclusions: We found that half of eligible women received timely screening mammography. Diabetes and hypertension, though common, are not associated with timely screening

*Corresponding Author: karen.wang@yale.edu, tel #203-785-5440, fax # 203-737-3306.

mammography. Usual source of care remains an important factor to timely breast cancer screening.

Keywords

Caribbean; non-communicable chronic diseases; screening mammography; social determinants of health

Background

Among developing regions, the Caribbean is facing a disproportionate burden of non-communicable chronic diseases (NCDs), such as cancer, diabetes, and cardiovascular disease and their associated risk factors. For a majority of Caribbean countries, cancer is the second leading cause of mortality, after cardiovascular and related diseases. Among women, breast cancer is the most common cause of cancer-related deaths [1, 2]. Rates of breast cancer mortality can be improved by early detection and treatment [3, 4]. From previous studies, African-descent and Spanish-speaking Caribbean immigrant populations in Canada, the United Kingdom, and the United States have lower rates of initial breast cancer screening and have delayed follow-up as compared with European/American whites [4–7].

Barriers to timely breast cancer screening have been attributed to determinants of health such as lower levels of education and less access to healthcare [1, 4–8]. These determinants are likely to influence cancer-related morbidity and mortality in the Caribbean itself. In addition to the influence of social determinants of health, research findings suggest that chronic diseases also influence the likelihood of timely cancer screening, however the results are equivocal as to whether having a chronic disease facilitates or hinders timely screening. [9–11]. Some studies demonstrate that individuals with existing co-morbidities, such as diabetes, have lower cancer screening rates than those without co-morbidities [12–14]; and in some cases, those with diabetes have lower screening rates despite having more visits to healthcare providers [9, 15–17]. A proposed reason for this under-screening includes competing priorities, i.e. more focus on controlling the chronic disease rather than on cancer screening during office visits [16, 18, 19]. Other studies have found no association between having a chronic disease and timely breast cancer screening [9, 11, 20]. However, a few studies have demonstrated that those with chronic disease are more likely to have screening mammography than those without [21–23].

Prior research suggests that cancer prevention and control may be challenging in limited resources settings, such as the Caribbean, especially in the context of caring for populations with multiple chronic conditions. It is therefore important to understand how having a chronic disease in concert with other determinants of health may affect timeliness of cancer screening. The Eastern Caribbean Health Outcome Research Network (ECHORN) Cohort Study (ECS)—a population-based cohort study of community-dwelling adults in Barbados, Trinidad and Tobago, Puerto Rico, and the U.S. Virgin Islands—provides the ideal opportunity to better understand breast cancer screening among women with chronic diseases. Our primary objective is to examine the association between having a chronic

disease and timely breast cancer screening. Our secondary objective is to identify other factors that hinder or facilitate timely breast cancer screening in this geographic context.

Methods

Data Source and sample:

We used data from the ECS, a study of community-dwelling adults 40 years and older who identify as permanent or semi-permanent residents of one of the following islands: Barbados, Puerto Rico, Trinidad and Tobago, and the U.S. Virgin Islands (USVI). Semi-permanent residence is defined as having not been away from the island for a period longer than six months within the prior five years. In application, semi-permanent residents are typically individuals who spend part of any 12-month period on island and part of the year elsewhere.

ECS used a multistage area probability sampling frame for all islands to empanel the baseline cohort in three of the four sites. ECHORN:USVI, unlike the other three sites, implemented a simple random sampling design; each member of the population had an equal probability of being in the study. The sampling frame for smaller islands (ECHORN:USVI and ECHORN:Barbados) was the entire island population, while the larger island sites of ECHORN:Puerto Rico and ECHORN:Trinidad restricted sampling to a select number of communities/municipalities. Selected communities/municipalities had similar distributions of age, race/ethnicity, sex, and educational levels to the general island population.

Baseline ECS participants, enrolled between 2013–2016, completed a questionnaire to capture self-reported data on socio-demographics, health behaviors, healthcare utilization, medical history, and other domains. Questionnaire items were administered using audio computer-assisted self-interview to maximize validity, providing a private and confidential venue for responding to sensitive questions. Clinical and laboratory data were also collected on each participant. Our sample of interest was all women in the cohort who were eligible for breast cancer screening with complete data.

Measures:

Dependent variable of interest: Timely screening mammography.—We operationalize timely breast cancer screening by measuring timely screening mammography. ECS participants were asked to report the year of their most recent mammography, based on a question adapted from the U.S. National Health Interview Survey [24]. We used the U.S. Preventive Services Task Force (USPSTF) for guidelines to operationalize timely screening mammography [25, 26]. We used the screening guidelines in place at the start of data collection in 2013. As USPSTF recommends the most conservative breast cancer screening guideline, we excluded the age groups in which USPSTF recommends against the service or in which its recommendations were inconclusive. Therefore, any woman age 40–74 who reported receiving a mammography within two years of their baseline survey was categorized as having had timely screening mammography [27].

Independent Variable of Interest: Diabetes or Hypertension Status.—ECS participants who reported ever being told by a clinical provider that they had diabetes or pre-

diabetes were categorized as having diabetes. ECS participants who reported ever being told by a clinical provider that they had hypertension or prehypertension were categorized as having hypertension.

As a sub-analysis, we further categorized women with diabetes or hypertension as having controlled or uncontrolled disease to test the idea that competing interests during a clinical visit may affect the likelihood of cancer screening. Among those with diabetes, we defined controlled diabetes as having hemoglobin A1c values ≤ 6.5 , based on literature that suggests that fewer micro and macrovascular complications at these lower values [28]. Among those with hypertension or pre-hypertension, we defined controlled hypertension as having systolic blood pressure <140 and diastolic blood pressure <90 from one measured blood pressure during the clinical assessment, based on literature that suggests that fewer cardiovascular complications occur below these values [29].

Other covariates of interest: We included several variables based upon prior studies examining factors associated with screening mammography and risk for breast cancer: age (40–49; 50–59; 60–74); race/ethnicity/nationality; marital status (unmarried, married, divorced/separated; or widowed); self-perception of social-economic status based on the Cantril self-anchoring scaling method (bottom 25%, middle 50%, and highest 25%) [30]; education (less than high school, high school, some of college, and college and above); employment status (full employed, part-employed, and unemployed; retired); number of biological children (0, 1–4, and 5 or more); and a history of living off-island (ever lived outside of the island vs. never). For race/ethnicity/nationality, ECS participants had the option to self-identify using any/all of the items listed within a set of categories. From this selection, we categorized the groups as Black or African, Caribbean, Mixed/Multiracial (who selected the mixed category or selected more than one “race” category), Hispanic, White, or East Indian.

We also included other covariates such as family history of cancer; general mental health status as measured by the PROMIS 10 that asks participants to self-rate their mental health (excellent, very good, good, fair and poor) [31]; alcohol use (ever drink alcohol vs never); usual source of care; and the use of hormone replacement therapy. We included the island residence of the participants.

Analytic strategy

We used chi-square tests to describe the characteristics of our sample population of women, comparing those with timely screening mammography to those with delayed screening; comparing those with diabetes or without, and comparing those with hypertension/prehypertension or without. We used logistic regression analyses to model the association between timely screening mammography and our independent variable of interests (diabetes or hypertension) and other covariates. We generated several multivariate logistic models to examine the relationship between diabetes or hypertension and timely screening mammography. In our first model, we adjusted for socio-demographic characteristics: age, race/ethnicity, education, marital status, perceived economic status. In our second model, we added health-related characteristics: history of living off-island, family history of cancer,

biological children, mental health, usual source of care, ever drink alcohol, and hormone replacement therapy. In the last model, we included the woman's island of residence (Barbados, Puerto Rico, Trinidad and Tobago, USVI). We then performed backward stepwise logistic regression to determine the covariates that were independently associated with timely mammography. For our sub-analyses, we restricted our sample to those with disease, i.e. diabetes or hypertension categorized as controlled or uncontrolled. We used chi-square tests to describe the characteristics of those with controlled disease compared to those with uncontrolled disease. We then generated multivariate logistic models to examine the relationship between disease control and timely screening mammography. Among each sample of women with diabetes or hypertension, we then performed backward stepwise logistic regression to determine the covariates that were independently associated with timely mammography. Results with a p value of 0.05 or less were considered statistically significant. We calculated an area under the receiver operator characteristic (ROC) curve for the multivariate model to evaluate its discriminating power [32]. All analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA). This study was reviewed and approved by the institutional ethics review boards at the Ministry of Health in Trinidad and Tobago, University of Puerto Rico, University of the Virgin Islands, University of West Indies at Cave Hill, and Yale University School of Medicine.

Results

Our sample included 841 women eligible for breast cancer screening during their baseline interview (34.7% Barbados [N=292], 30% Puerto Rico [N=252], 22.6.1% Trinidad and Tobago [N=190], and 12.7% US Virgin Islands [N=107]). Approximately 16.4% [N=164] reported diabetes; and approximately 46.5% [N=391] had hypertension (Table 1). Half of our sample, 52.2% (N=439), reported receiving timely screening mammography. Women in the older age groups were more likely to report timely screening mammography. Among the older age groups, approximately 59% of those aged 50–59 and 60–74 reported timely screening mammography compared to 37.9% of women aged 40–49. Women in Puerto Rico were the most likely to report timely screening mammography as compared to women in the other island locations, with the lowest proportion in Trinidad and Tobago.

In bivariate analyses (Table 2), those with diabetes were older, more likely to self-identify as White or Hispanic, more educated, married or divorced/separated, and have a usual source of care; and those with hypertension were more likely to be older, divorced/separated or widowed, and have usual source of care. Residents of Puerto Rico and the US Virgin Islands were more likely to report diabetes and hypertension.

In our unadjusted model, we found that women with diabetes or hypertension were more likely to have timely screening than those without disease (diabetes: Odds ratio (OR) 2.60, confidence interval (CI) 1.75–3.87, $p<0.001$; hypertension: OR 1.44, CI 1.09–2.89, $p=0.009$). With adjustment for socio-demographics and health-related characteristics, the association between diabetes and timely screening mammography was attenuated, but significant ($p<0.01$). The association between hypertension and timely screening mammography was no longer significant when the model was adjusted for socio-demographic characteristics (OR 1.21, CI 0.87–1.66). In our full model, women who had

diabetes or hypertension were as likely as those without disease to have timely screening mammography (Table 3).

We found several covariates that were independently associated with timely mammography screening (Table 4): age, marital status, race/ethnicity, a usual source of care, hormone replacement therapy, and woman's island of residence. Women in the older age groups (ref: Age 40–49; Age 50–59 OR 1.98, CI 1.37–2.87; Age 60–69 OR 1.81, CI 1.17–2.78) had greater odds of having timely screening mammography compared to younger age groups. Similarly, being married or divorced/separated was associated with greater odds of timely screening mammography (ref: not married; married OR 1.99, CI 1.39–2.85; divorced/separated OR 1.81, CI 1.07–3.07); whereas being East Indian was associated with less timely screening mammography (ref: black; OR 0.31, CI 0.13–0.71). Women were more likely to have received timely screening mammography if they had a usual source of care (OR 1.65, CI 1.13–2.40) or had a history of hormone replacement therapy (OR 1.79, CI 1.00–3.19). Residents of both Puerto Rico and USVI were more likely to have timely screening than those from Trinidad and Tobago. We found a positive association between a higher level of education and timely screening mammography that did not reach statistical significance (ref: less than high school; OR 1.63, CI 0.99–2.67). The full multivariate model showed good discriminative ability with an area under the ROC curve of 0.791.

Results of sub-analyses: controlled versus uncontrolled disease (diabetes or hypertension) (Supplemental tables).

Diabetes.—In the sample of women with diabetes (n=138), approximately 48% had controlled diabetes. In bivariate analyses, we found that those with controlled diabetes as compared to uncontrolled diabetes were more likely to have a higher level of education, be divorced or separated, or be residents of Puerto Rico (Supplemental Table 1). In unadjusted and adjusted analyses, we found that women with controlled diabetes were as likely to have timely screening as those with uncontrolled diabetes (Supplemental Table 2). In adjusted analyses, we found that having more than a college education, perception of economic status as middle income, and those with a family history of cancer were independently associated with timely screening mammography (data not shown).

Hypertension.—In the sample of women with hypertension (n=203), approximately 52% had controlled hypertension. In bivariate analyses, we found fewer differences among those with controlled and uncontrolled hypertension. Residents of Barbados and Puerto Rico were more likely to have controlled hypertension compared to residents of other island-sites (Supplemental Table 1). In unadjusted analyses, we found that women with controlled hypertension as compared to uncontrolled were more likely to have timely screening mammography, but the associations were no longer significant in the adjusted models (Supplemental Table 3). In adjusted analyses, we found that marital status and residence in Puerto Rico and USVI were independently associated with timely screening mammography (data not shown).

Discussion

Given the high burden of noncommunicable diseases in the Caribbean, this study adds to our current understanding about the influence of chronic disease status on the receipt of cancer screening services. In our ECS sample of women, more than half had timely screening mammography. Almost 16% and 47% of the sample had been told by a provider that they had diabetes or hypertension, respectively, prior to joining the study. We found that having either diabetes or hypertension was not associated with receipt of timely screening mammography. Factors such as having a usual source of care and a woman's island of residence were independently associated with timely screening mammography.

Similar to a few prior studies, we found that women with diabetes or hypertension were as likely as those without disease to have timely screening mammography when all individual and societal factors were considered. However, the partially adjusted analyses suggest that differences exist between those with diabetes compared to those without diabetes. In our partially adjusted models, those with diabetes compared to those without were more likely to have timely screening mammography even after adjustment of socio-demographic and health-related characteristics. We hypothesize that social determinants of health may have greater influence on likelihood of screening in less-resourced settings. We found that several characteristics that are traditionally associated with having more resources, such as higher level of education, were independently associated with timely screening mammography. This finding was even more striking when analyses were restricted to only women with chronic disease. Irrespective of diabetes control status, women with higher levels of education had increased odds of receiving timely screening mammography. In limited resource settings, individuals with more resources through education, for example, are more likely to access and have interactions with healthcare providers and thereby have more opportunities to be offered counseling about and referrals to cancer screening [33–35]. Though neither having diabetes nor hypertension was independently associated with timely screening mammography, there is suggestion of an association between chronic disease and timely screening mammography. Studies with larger sample sizes focused on examining healthcare utilization patterns may provide further insight in this area. Moreover, those with diabetes or hypertension most likely have more contact with healthcare providers, therefore these interactions should be further leveraged to offer counseling and referrals regarding cancer screening [16, 18, 19].

Importantly, we found a strong association between contextual determinants of health, such as island of residence and having a usual source of care, and timely screening mammography. Women residing in the US territories were more likely to have timely screening. Differences in each of the islands' affordability, availability and accessibility of mammography, and health promotion practices, such as the presence and goals of national breast cancer screening programs, likely influence timely screening mammography [1]. A Pan-American Health Organization (PAHO) report stated that the Caribbean region mostly has opportunistic breast cancer screening programs, which requires self- or healthcare provider-referral to obtain a mammography. Having a relationship with a healthcare provider would then most likely increase the likelihood of obtaining a screening mammography [1]. In countries with opportunistic breast cancer screening programs, having a usual source of

care may be leveraged to improve cancer screening. Having a usual source of care increases the likelihood of preventive health education about the importance of obtaining cancer screening, such as provider counseling and recommendations about mammography screening [33–35]. Previous studies have documented the role of clinical providers in chronic disease prevention and control [36]; therefore, these providers would be important targets for improving screening mammography uptake among their patients. Future work should aim to examine accessibility and availability of mammography services, identify strategies that increase having a usual source of care among women, and examine the role and practices of providers as a mechanism to increase rates of screening mammography.

Understanding and improving specific island-level strategies for screening mammography will also be important to improve screening rates among all eligible women. Studies of Caribbean women living in other countries have described values and beliefs that affect timely screening [37, 38]. For example, women who identified as East Indian, mostly residing in Trinidad and Tobago, are the least likely to obtain timely screening. This finding could be related to individual and contextual factors as seen in other East Indian immigrant communities, such as beliefs around cancer and challenges with access to healthcare services [39, 40]. Moreover, in Trinidad and Tobago, the use of mammography services is primarily for diagnostics purposes [41, 42]. A study conducted in Barbados demonstrated that women have negative perceptions about mammography, and this may lower screening rates in spite of the accessibility and availability [43]. Future research will need to examine each island context to elucidate factors that may contribute to women's receipt of timely screening mammography.

Our study is not without limitations. One important limitation is that we used the USPSTF guideline to operationalize timeliness of screening mammography. The USPSTF guideline, one of several guidelines used in the United States, is the most conservative of the guidelines; and like other U.S. guidelines, is based solely on synthesis of evidence from the U.S. and so may not be applicable in other settings or in more diverse populations. Per the USPSTF guidelines, we did not include other forms of breast cancer screening, such as self- and provider-breast examinations, although they are recommended screening practices in resource limited areas [26, 44–48]. There may be self-report bias in determining eligibility as there could be individuals who are undiagnosed with diabetes or hypertension at baseline. Further, the inclusion of pre-diabetes and pre-hypertension in our independent variable may have affected our results. We would hypothesize that healthy individuals would be less likely to see healthcare providers and therefore would push the results towards the null. The timeframe for measuring “receipt of screening mammography within the last two years” may have overestimated the number of women with timely screening. For example, women who completed baseline surveys in the latter half of the year would have had more time to receive screening. We did not include a measure for health insurance because of collinearity with the island-site variable. Both Barbados and Trinidad have national health insurance programs, whereas Puerto Rico and the U.S. Virgin Islands do not. For our sub-analysis, we set diabetes control at a hemoglobin A1c value of less than 6.5, though tighter control has been associated with worse outcomes for older populations. Lastly, as a cross-sectional study, causation cannot be inferred from our results.

On track with PAHO's Non-Communicable Disease plan of action's goal to have 50% of women aged 50–69 receive cancer screenings, overall approximately 59% of women aged 50–69 in our sample reported timely screening mammography [1, 44]. This study serves as a starting point for exploring some of the socio-demographic, health-related, and contextual characteristics that affect timely screening mammography in the Caribbean region to improve screening rates in the other 41% [49–51]. The proportion of women with chronic diseases, such as diabetes and hypertension, is high, and the region will need to concurrently manage the burden of NCDs while implementing and strengthening cancer surveillance programs. Future ECS studies can prospectively study the effect of chronic disease control and management and timely cancer screening. ECS, along with other in-region collaboratives such as the African-Caribbean Cancer Consortium, can contribute to this growing body of research on factors that have implications for surveillance programs to improve early cancer detection and control for the Caribbean basin mammography and to affect change through education, advocacy, and health system enhancement [41, 49, 51–56].

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Women's Cancer and Comprehensive Care in the Caribbean: Situation and Challenges. 2016, World Health Organization, Pan American Health Organization
2. Razzaghi H, et al., Leading Causes of Cancer Mortality--Caribbean Region, 2003–2013, in Morbidity and Mortality Weekly Report. 2016, Center for Disease Control and Prevention.
3. Armstrong H, Breast and Cervical Cancers in Barbados: a Situational Analysis. Barbados Ministry of Health.
4. Wells KJ and Roetzheim RG, Health disparities in receipt of screening mammography in Latinas: a critical review of recent literature. *Cancer Control*, 2007 14(4): p. 369. [PubMed: 17914337]
5. Consedine NS, et al., Beyond the black box: a systematic review of breast, prostate, colorectal, and cervical screening among native and immigrant African-descent Caribbean populations. *J Immigr Minor Health*, 2015 17(3): p. 905–24. [PubMed: 24522436]
6. Aldridge ML, Daniels JL, and Jukic AM, Mammograms and Healthcare Access Among US Hispanic and Non-Hispanic Women 40 Years and Older. *Family & Community Health*, 2006 29(2): p. 80–88. [PubMed: 16552286]
7. Reyes-Ortiz CA, et al., The impact of education and literacy levels on cancer screening among older Latin American and Caribbean adults. *Cancer Control*, 2007 14(4): p. 388–95. [PubMed: 17914339]
8. Banegas MP and Li CI, Breast cancer characteristics and outcomes among Hispanic Black and Hispanic White women. *Breast Cancer Research and Treatment*, 2012 134(3): p. 1297–1304. [PubMed: 22772379]
9. Constantinou P, Dray-Spira R, and Menvielle G, Cervical and breast cancer screening participation for women with chronic conditions in France: results from a national health survey. *BMC Cancer*, 2016 16(1): p. 255. [PubMed: 27029643]
10. Beckman TJ, et al., Screening mammogram utilization in women with diabetes. *Diabetes Care*, 2001 24(12): p. 2049–53. [PubMed: 11723081]

11. Diaz A, et al., Association between comorbidity and participation in breast and cervical cancer screening: A systematic review and meta-analysis. *Cancer epidemiology*, 2017 47: p. 7–19. [PubMed: 28086199]
12. Kiefe CI, et al., Chronic disease as a barrier to breast and cervical cancer screening. *J Gen Intern Med*, 1998 13.
13. Beckman TJ, et al., Screening mammogram utilization in women with diabetes. *Diabetes care*, 2001 24(12): p. 2049–2053. [PubMed: 11723081]
14. Chan W, et al., Impact of socio-economic status on breast cancer screening in women with diabetes: a population-based study. *Diabet Med*, 2014 31(7): p. 806–12. [PubMed: 24588332]
15. Lafata JE, et al., Provider type and the receipt of general and diabetes-related preventive health services among patients with diabetes. *Med Care*, 2001 39.
16. Martinez-Huedo MA, et al., Adherence to breast and cervical cancer screening in Spanish women with diabetes: Associated factors and trend between 2006 and 2010. *Diabetes Metab*, 2012 38.
17. Lipscombe LL, Hux JE, and Booth GL, Reduced screening mammography among women with diabetes. *Arch Intern Med*, 2005 165(18): p. 2090–5. [PubMed: 16216998]
18. Tabaei BP, et al., Does diabetes care compete with the provision of women's preventive care services? *Diabetes Care*, 2005 28.
19. Sarfati D, Koczwara B, and Jackson C, The impact of comorbidity on cancer and its treatment. *CA: A Cancer Journal for Clinicians*, 2016 66(4): p. 337–350. [PubMed: 26891458]
20. López-de-Andrés A, et al., Predictors of breast and cervical cancer screening in a Spanish metropolitan area. *Journal of Women's Health*, 2010 19(9): p. 1675–1681.
21. Guo F, Hirth JM, and Berenson AB, Effects of Cardiovascular Disease on Compliance with Cervical and Breast Cancer Screening Recommendations Among Adult Women. *J Womens Health (Larchmt)*, 2015 24(8): p. 641–7. [PubMed: 26263281]
22. Bostick RM, et al., Predictors of cancer prevention attitudes and participation in cancer screening examinations. *Prev Med*, 1994 23(6): p. 816–26. [PubMed: 7855115]
23. Kiefe CI, et al., Chronic disease as a barrier to breast and cervical cancer screening. *Journal of general internal medicine*, 1998 13(6): p. 357–365. [PubMed: 9669564]
24. Center for Disease Control, U.S. National Health Interview Survey. 2016: Washington, D.C.
25. Smith RA, et al., Cancer screening in the United States, 2010: a review of current American Cancer Society guidelines and issues in cancer screening. *CA Cancer J Clin*, 2010 60(2): p. 99–119. [PubMed: 20228384]
26. WHO Guidelines Approved by the Guidelines Review Committee, in WHO Position Paper on Mammography Screening. 2014, World Health Organization Copyright (c) World Health Organization 2014: Geneva.
27. Final Recommendation Statement: Breast Cancer: Screening. 2014, U.S. Preventive Services Task Force.
28. Wang CCL, et al., Clinical Update: Cardiovascular Disease in Diabetes Mellitus. *Circulation*, 2016 133(24): p. 2459–2502. [PubMed: 27297342]
29. James PA, et al., 2014 Evidence-based Guideline for the Management of High Blood Pressure in Adults: Report from the Panel Members Appointed to the Eighth Joint National Committee (JNC 8). *Jama*, 2014 311(5): p. 507–520. [PubMed: 24352797]
30. Kilpatrick FP and Cantril H, Self-anchoring scaling: A measure of individuals' unique reality worlds. *Journal of Individual Psychology*, 1960 16(2): p. 158.
31. Ahmad F, et al., Single item measures of self-rated mental health: a scoping review. *BMC health services research*, 2014 14(1): p. 398. [PubMed: 25231576]
32. Hosmer DW, Lemeshow S, and Klar J, Goodness-of-Fit Testing for the Logistic Regression Model when the Estimated Probabilities are Small. *Biometrical Journal*, 1988 30(8): p. 911–924.
33. Corbie-Smith G, et al., Influence of usual source of care on differences by race/ethnicity in receipt of preventive services. *Journal of General Internal Medicine*, 2002 17(6): p. 458–464. [PubMed: 12133161]

34. Martínez-Donate A, et al., Prevalence and Correlates of Breast and Cervical Cancer Screening Among a Midwest Community Sample of Low-Acculturated Latinas. *J Health Care Poor Underserved*, 2013 24(4): p. 1717–38. [PubMed: 24185166]
35. Martínez-Donate AP, et al., Healthcare access among circular and undocumented Mexican migrants: results from a pilot survey on the Mexico-US border. *International Journal of Migration and Border Studies* 5, 2014 1(1): p. 57–108.
36. Grady KE, et al., The importance of physician encouragement in breast cancer screening of older women. *Preventive Medicine*, 1992 21(6): p. 766–780. [PubMed: 1438121]
37. Vrinten C, Wardle J, and Marlow LA, Cancer fear and fatalism among ethnic minority women in the United Kingdom. *British journal of cancer*, 2016 114(5): p. 597. [PubMed: 26867159]
38. Consedine NS, Magai C, and Neugut AI, The contribution of emotional characteristics to breast cancer screening among women from six ethnic groups. *Preventive medicine*, 2004 38(1): p. 64–77. [PubMed: 14672643]
39. Ahmad F, Cameron J, and Stewart DE, A tailored intervention to promote breast cancer screening among South Asian immigrant women. 2005.
40. Boxwala FI, et al., Factors associated with breast cancer screening in Asian Indian women in metro-Detroit. *Journal of immigrant and minority health*, 2010 12(4): p. 534–543. [PubMed: 19629691]
41. Camacho-Rivera M, et al., Breast cancer clinical characteristics and outcomes in Trinidad and Tobago. *Journal of immigrant and minority health*, 2015 17(3): p. 765–772. [PubMed: 24146313]
42. Joseph MD, et al., Breast cancer diagnosis from screening in Trinidad and Tobago: opportunities for cancer prevention. *Journal of Immigrant and Minority Health*, 2014 16(3): p. 409–415. [PubMed: 23315045]
43. Granado MN, et al., Exploring breast cancer screening barriers among Barbadian women: a focus group study of mammography in a resource-constrained setting. *Critical Public Health*, 2014 24(4): p. 429–444.
44. Plan of Action for the Prevention and Control of Noncommunicable diseases in the Americas 2013–2019. 2014, Pan American Health Organization, World Health Organization
45. Granado MN, et al., Exploring breast cancer screening barriers among Barbadian women: a focus group study of mammography in a resource-constrained setting. *Critical Public Health*, 2014 24(4): p. 429–444.
46. Hiatt RA, et al., Community-based cancer screening for underserved women: design and baseline findings from the Breast and Cervical Cancer Intervention Study. *Preventive medicine*, 2001 33(3): p. 190–203. [PubMed: 11522160]
47. Goss PE, et al., Planning cancer control in Latin America and the Caribbean. *The Lancet Oncology*, 2013 14(5): p. 391–436. [PubMed: 23628188]
48. Champion VL, et al., Comparison of three interventions to increase mammography screening in low income African American women. *Cancer detection and prevention*, 2006 30(6): p. 535–544. [PubMed: 17110056]
49. Taioli E, et al., Breast cancer survival in women of African descent living in the US and in the Caribbean: effect of place of birth. *Breast Cancer Res Treat*, 2010 122(2): p. 515–20. [PubMed: 20052539]
50. Colón-Ramos U, et al., Transnational Mortality Comparisons Between Archipelago and Mainland Puerto Ricans. *Journal of Immigrant and Minority Health*, 2016: p. 1–9. [PubMed: 25576178]
51. Mutetwa B, et al., Prostate cancer characteristics and survival in males of African Ancestry according to place of birth: data from Brooklyn—New York, Guyana, Tobago and Trinidad. *The Prostate*, 2010 70(10): p. 1102–1109. [PubMed: 20503395]
52. Felix A, et al., Cancer screening and cancer mortality in Nevis, West Indies: *Pesquisaje de cáncer y mortalidad por cáncer en Nevis, West Indies*. *West Indian Medical Journal*, 2009 58(4): p. 311–318. [PubMed: 20099770]
53. Nemesure B, et al., Risk factors for breast cancer in a black population—The Barbados National Cancer Study. *International journal of cancer*, 2009 124(1): p. 174–179. [PubMed: 18814239]
54. United Nations Development Programme, Overcoming barriers: Human mobility and development. 2009, United Nations Development Programme.

55. Allison MA, et al., Prevalence of and risk factors for subclinical cardiovascular disease in selected US Hispanic ethnic groups: the Multi-Ethnic Study of Atherosclerosis. *Am J Epidemiol*, 2008 167(8): p. 962–9. [PubMed: 18283034]
56. Ragin CC, et al., African-Caribbean cancer consortium for the study of viral, genetic and environmental cancer risk factors. *Infect Agent Cancer*, 2007 2: p. 17. [PubMed: 17892589]

Table 1.

Characteristics of women with timely versus delayed screening mammography

Characteristic	Total (N=841)		Delayed Mammography (n=402)		Timely Mammography (n=439)		p-value
	n	%	n	%	n	%	
Age screened							<.001
40–49	282	33.5	175	43.5	107	24.4	
50–59	345	41.0	140	34.8	205	46.7	
60–74	214	25.5	87	21.6	127	28.9	
Race/ethnicity/nationality							<.001
Black	405	48.2	211	52.5	194	44.2	
Caribbean	136	16.2	54	13.4	82	18.7	
Mixed	97	11.5	59	14.7	38	8.7	
Hispanic	89	10.6	20	5.0	69	15.7	
White	61	7.3	15	3.7	46	10.5	
East Indian	53	6.3	43	10.7	10	2.3	
Education							<.001
Less than high school	248	29.5	146	36.3	102	23.2	
High school	234	27.8	133	33.1	101	23.0	
Some college	181	21.5	77	19.2	104	23.7	
College+	178	21.2	46	11.4	132	30.1	
Marital Status							<.001
Not married	371	44.1	210	52.2	161	36.7	
Married	293	34.8	124	30.9	169	38.5	
Divorced/Separated	105	12.5	34	8.5	71	16.2	
Widowed	72	8.6	34	8.5	38	8.7	
Perceived Economic Status							0.982
Bottom 25%	187	22.2	89	22.1	98	22.3	
Middle	422	50.2	201	50.0	221	50.3	
Top 25%	232	27.6	112	27.9	120	27.3	
Family history of cancer	435	51.7	203	50.5	232	52.9	0.476
Lived off island	198	23.5	77	19.2	121	27.6	0.003
Biological Children							0.004
0	107	12.7	52	12.9	55	12.5	
1–4	658	78.2	300	74.6	358	81.6	
>=5	76	9.0	50	12.4	26	5.9	
Mental Health (1 (poor) - 5 (excellent)) - mean,sd	3.43	0.96	3.38	0.93	3.48	0.99	0.137
Usual Source of Care	629	74.8	268	66.7	361	82.2	<.001
Ever Drink Alcohol	599	71.2	305	75.9	294	67.0	0.004
Hormone Replacement Therapy	89	10.6	23	5.7	66	15.0	<.001

Characteristic	Total (N=841)		Delayed Mammography (n=402)		Timely Mammography (n=439)		p-value
	n	%	n	%	n	%	
Location							<.0001
Barbados	292	34.7	170	42.3	122	27.8	
Puerto Rico	252	30.0	49	12.2	203	46.2	
US Virgin Islands	107	12.7	41	10.2	66	15.0	
Trinidad and Tobago	190	22.6	142	35.3	48	10.9	
Hypertension							0.009
No	450	53.5	234	58.2	216	49.2	
Yes	391	46.5	168	41.8	223	50.8	
Diabetes							<.001
No	703	83.6	362	90.1	341	77.7	
Yes	138	16.4	40	10.0	98	22.3	

Table 2.

Characteristics of Women with Diabetes or Hypertension (N=841)

Characteristic	Total		Diabetes				Hypertension			
			No Diabetes		Diabetes		No Hypertension		Hypertension	
	N	%	n	%	n	%	n	%	n	%
Age screened										p-value
40–49	282	33.5	258	36.7	24	17.4	194	43.1	88	22.5
50–59	345	41.0	287	40.8	58	42.0	175	38.9	170	43.5
60–74	214	25.5	158	22.5	56	40.6	81	18	133	34.0
Race/ethnicity/nationality										0.208
Black	405	48.2	353	50.2	52	37.7	204	45.3	201	51.4
Caribbean	136	16.2	113	16.1	23	16.7	77	17.1	59	15.1
Mixed	97	11.5	86	12.2	11	8.0	56	12.4	41	10.5
Hispanic	89	10.6	66	9.4	23	16.7	51	11.3	38	9.7
White	61	7.3	40	5.7	21	15.2	28	6.2	33	8.4
East Indian	53	6.3	45	6.4	8	5.8	34	7.6	19	4.9
Education										0.1696
Less than high school	248	29.5	211	30.0	37	26.8	123	27.3	125	32.0
High school	234	27.8	207	29.5	27	19.6	127	28.2	107	27.4
Some college	181	21.5	144	20.5	37	26.8	93	20.7	88	22.5
College+	178	21.2	141	20.1	37	26.8	107	23.8	71	18.2
Marital Status										0.039
Not married	371	44.1	323	46.0	48	34.8	209	46.4	162	41.4
Married	293	34.8	242	34.4	51	37.0	163	36.2	130	33.3
Divorced/Separated	105	12.5	79	11.2	26	18.8	48	10.7	57	14.6
Widowed	72	8.6	59	8.4	13	9.4	30	6.7	42	10.7
Perceived Economic Status										0.771
Bottom 25%	187	22.2	159	22.6	28	20.3	98	21.8	89	22.8
Middle	422	50.2	349	49.6	73	52.9	231	51.3	191	48.9
Top 25%	232	27.6	195	27.7	37	26.8	121	26.9	111	28.4

Characteristic	Diabetes						Hypertension						
	Total		No Diabetes		Diabetes		p-value		No Hypertension		Hypertension		p-value
	N	%	n	%	n	%	n	%	n	%	n	%	
Family history of cancer	435	51.7	358	50.9	77	55.8	0.295	228	50.7	207	52.9	0.510	
Lived off island	198	23.5	166	23.6	32	23.2	0.914	103	22.9	95	24.3	0.631	
Biological Children							0.463					0.978	
0	107	12.7	85	12.1	22	15.9		58	12.9	49	12.5		
1-4	658	78.2	554	78.8	104	75.4		352	78.2	306	78.3		
>=5	76	9.0	64	9.1	12	8.7		40	8.9	36	9.2		
Mental Health (1 (poor) - 5 (excellent)) - mean, sd	3.43	1.0	3.5	1.0	3.4	1.0	0.335	3.5	1.0	3.4	1.0	0.032	
Usual Source of Care	629	74.8	508	72.3	121	87.7	0.001	310	68.9	319	81.6	0.000	
Ever Drink Alcohol	599	71.2	499	71.0	100	72.5	0.725	334	74.2	265	67.8	0.039	
Hormone Replacement Therapy	89	10.6	67	9.5	22	15.9	0.025	40	8.9	49	12.5	0.087	
Location							<.001					0.008	
Barbados	292	34.7	264	37.6	28	20.3		151	33.6	141	36.1		
Puerto Rico	252	30.0	179	25.5	73	52.9		130	28.9	122	31.2		
US Virgin Islands	107	12.7	85	12.1	22	15.9		48	10.7	59	15.1		
Trinidad and Tobago	190	22.6	175	24.9	15	10.9		121	26.9	69	17.7		

Table 3.

Association between Diabetes and Hypertension and Timely Screening Mammography

Effect	Unadjusted				Model 1 [†]				Model 2 ^{††}				Model 3 ^{†††}			
	OR	95% CI	p-value		OR	95% CI	p-value		OR	95% CI	p-value		OR	95% CI	p-value	
Hypertension																
No				reference				reference				reference				
Yes	1.438	1.095	1.889	0.009	1.214	0.886	1.663	0.227	1.125	0.814	1.553	0.476	1.116	0.8	1.558	0.517
Diabetes																
No				reference				reference				reference				
Yes	2.60	1.75	3.87	<.001	1.85	1.19	2.88	0.007	1.80	1.14	2.84	0.011	1.39	0.86	2.23	0.179
								ROC = 0.745				ROC = 0.761				ROC = 0.790

[†]Model 1: adjusted for socio-demographic characteristics: age, race/ethnicity, education, marital status, perceived economic status^{††}Model 2: model 1 plus history of living off-island, family history of cancer, biological children, mental health, usual source of care, and ever drink alcohol, and hormone replacement therapy^{†††}Model 3: model 2 plus residence of participants (Barbados, Puerto Rico, Trinidad and Tobago, USVI)

Abbreviations: OR-odds ratio, CI-confidence interval, ROC-receiver operator characteristic

Table 4.

Covariates independently associated with timely screening mammography

Effect	Adjusted covariates		
	AOR	95% CI	p-value
Age screened			
40–49		reference	
50–59	1.98	1.37 2.87	<.001
60–74	1.81	1.17 2.78	0.007
Race/ethnicity/nationality			
Black		Reference	
Caribbean	0.81	0.51 1.30	0.384
Mixed	0.64	0.36 1.16	0.145
Hispanic	0.75	0.38 1.50	0.421
White	0.68	0.32 1.45	0.321
East Indian	0.31	0.13 0.71	0.006
Education			
Less than high school		Reference	
High school	0.89	0.59 1.35	0.587
Some college	1.28	0.81 2.00	0.286
College+	1.63	0.99 2.67	0.053
Marital Status			
Not married		Reference	
Married	1.99	1.39 2.85	<.001
Divorced/Separated	1.81	1.07 3.07	0.026
Widowed	1.24	0.68 2.28	0.474
Usual Source of Care	1.65	1.13 2.40	0.009
Hormone Replacement Therapy	1.79	1.00 3.19	0.049
Location			
BB	1.42	0.85 2.37	0.182
PR	6.86	3.72 12.6	<.001

Effect	Adjusted covariates			
	AOR	95% CI	p-value	
	Reference			
TT	2.92	1.61	5.31	<.001
USVI				