Neighborhood-Level Socioeconomic Predictors of Nonadherence to Mammography Screening Guidelines

Amy B. Dailey,[1] Stanislav V. Kasl,[2] Theodore R. Holford,[2] Lisa Calvocoressi,[2] and Beth A. Jones[2]

[1]Department of Epidemiology and Biostatistics, University of Florida College of Public Health and Health Professions, Gainesville, Florida and [2]Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, Connecticut

Abstract

As neighborhood context is increasingly recognized as an important predictor of health outcomes and health behaviors, this analysis sought to determine the relationship between neighborhood-level socioeconomic status (SES) and regular mammography screening behavior. One thousand four hundred fifty-one women ages 40 to 79 years who obtained an ''index'' screening mammogram at one of five urban hospitals in Connecticut between October 1996 and January 1998 were enrolled in this prospective study. The logistic regression analysis includes the 1,229 women [484 African-American (39%) and 745 White (61%)] who completed telephone interviews at baseline and follow-up (average 29.4 months later) and for whom the study outcome, nonadherence to age-specific mammography screening guidelines, was ascertained. Neighborhood-level SES was determined using 1990 census tract information. Neighborhood-level SES variables (quartiles) were associated with nonadherence for African-American women [neighborhood-level education and composite socioeconomic position index (SEP Index)] and White women (neighborhood-level crowding and neighborhood-level assets). Using race-specific categorizations reflective of individual-level SES distributions, the SEP Index and neighborhood-level education were associated with nonadherence to mammography screening guidelines for African-American women (marginally significant for White women), independent of individual-level SES and other known predictors of mammography screening use [African-American women: SEP Index odds ratio (OR), 3.55; 95% confidence interval (95% CI), 1.33-9.51; neighborhood-level education OR, 3.21; 95% CI, 1.25-8.26; White women: SEP Index OR, 2.13; 95% CI, 0.97-4.67; neighborhood-level education OR, 2.31; 95% CI, 0.93-5.76]. The results of this analysis underscore the importance of examining neighborhood social context as well as individual factors in the study of mammography screening behavior. (Cancer Epidemiol Biomarkers Prev 2007;16(11):2293–303)

Introduction

There is ample evidence showing that persons of higher socioeconomic status (SES) do better on most measures of health status (1). Traditionally, SES has been measured on an individual level, taking into account measures such as income, education level, and occupational ranking. Although individual-level variables are of particular importance in health disparities research, interest in neighborhood- or community-level SES has increased markedly (2, 3). Numerous studies have reported independent neighborhood effects on health outcomes, including all-cause mortality, chronic and infectious disease outcomes, and some health-damaging behaviors (4).

Despite the increasing volume in studies reporting area-level effects on health outcomes, a limited number of published studies have examined the influence of neighborhood effects on mammography screening use. In 2002, Coughlin et al. (5) found that women living in rural areas were less likely to have received a mammogram in the previous 2 years compared with women living in metropolitan areas. A Canadian study by Kothari and Birch (6) found that a regional-level variable (percent high school graduates in provinces' public health agency boundaries) had a significant effect on mammography use (measured as ever/never had a mammogram) independent of individual-level education. Conversely, in a study of African-American women enrolled in the Black Women's Health Study, Rosenberg et al. (7) reported that neighborhood-level socioeconomic characteristics were not associated with regular mammography use, measured at three 2-year follow-up periods. Most recently, Schootman et al. (8) found that area-level poverty was associated with never having a mammogram and Litaker and Tomolo (9) reported that the number of primary care physicians per capita and proportion of female-headed households were independently associated with breast cancer screening. In the health services literature, studies have shown that mammography screening has been associated with area-level health maintenance organization market share and other system-level factors (10-12). Although several novel studies have considered neighborhood-level

Received 12/20/06; revised 8/1/07; accepted 8/14/07.

Grant support: National Cancer Institute grant RO1-CA-CA70731 (B.A. Jones), Agency for Healthcare Research and Quality grant R36 HS 015686-01 (A.B. Dailey), and National Institute of Mental Health grant 5T32-MH-14235 (A.B. Dailey).

The costs of publication of this article were defrayed in part by the payment of page charges. This article must therefore be hereby marked *advertisement* in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.

Requests for reprints: Amy B. Dailey, Department of Epidemiology and Biostatistics, University of Florida School of Public Health and Health Professions, P. O. Box 100231, Gainesville, FL 32610. Phone: 352-273-5934; Fax: 352-273-5365. E-mail: abdailey@phhp.ufl.edu

doi:10.1158/1055-9965.EPI-06-1076

predictors of mammography use, there is significant variability in the neighborhood-level indicators examined and the evidence remains inconclusive.

The aim of this study was to build on this relatively new area of research by determining if neighborhood-level SES was an independent predictor of nonadherence to mammography screening guidelines in a cohort of African-American and White women, ages 40 to 79, living in Connecticut who participated in the Race Differences in the Screening Mammography Process Study. The purpose of this prospective study was to better understand race differences in maintenance of mammography screening and related outcomes by examining a host of individual-level biomedical and psychosocial factors. This study was expanded to include neighborhood-level SES variables to potentially further explain racial/ethnic and socioeconomic disparities in adherence to mammography screening guidelines.

Materials and Methods

Study Population, Procedures, and Participation. As previously reported (13-16), women who presented for a screening mammogram (hereafter referred to as the ''index mammogram'') between October 1996 and January 1998, at five hospital-based mammography facilities in the Connecticut cities with the largest African-American populations, were recruited for enrollment. As African-Americans compose only 9.1% of the Connecticut population (17), we used 1990 U.S. Census data (18) and our own (1994) survey of mammography facilities in Connecticut (19) to identify where African-Americans lived as well as the mammography facilities that were most likely to provide their screening mammograms. As in most of the Northeast, the African-American population in Connecticut is largely urban (20). Thus, study subjects were recruited from hospital-based facilities in the five Connecticut cities with the largest African-American populations (ranged from 16% to 38% of total population); furthermore, four of these five cities were among the five most populous cities in Connecticut. The state-wide survey of all facilities in Connecticut showed that, with one exception, only hospital-based facilities met our enrollment criteria of reporting a high monthly volume of screening mammograms and ≥20% African-American patient population. The five hospital-based sites were located in New Haven, New London, Bridgeport, Hartford, and Waterbury. As expected from a community-based sample, the race-specific sociodemographic profiles in the final study population are similar to those of the general population in Connecticut (21-26).

All eligible African-American women who obtained index mammograms at these five facilities during the study period were invited to participate. White women were selected by a computer-generated random selection process and frequency matched to the African-American women on facility and date of mammogram. Asymptomatic women ages 40 to 79, who self-identified as African-American or White, with no previous history of breast malignancy, cyst aspiration, or biopsy were eligible for participation. In accordance with age recommendations for regular mammography screening in the general population (27, 28), women younger than age 40 were not included. Women over the age 79 were also excluded because of a lack of consensus with regard to screening recommendations for older women (29, 30). Approvals of the institutional review boards of Yale University School of Medicine and each participating hospital were maintained throughout the study period.

Initially, 2,359 women were identified for participation; 1,451 were interviewed after excluding ineligible women (n = 171), those who could not be contacted (n = 206), and women who declined participation (n = 531). Participation differed across race group (African-American, 69%; White, 77%; $P < 0.001$) and marginally by age (ages 40-49, 76%; age ≥50, 72%; $P = 0.052$). Two interviews were conducted in this study: (a) a structured 45-min baseline telephone interview conducted ~1 month after the index screening mammogram so as to allow time for receipt of mammography results (mean time to baseline interview, 1.5 months; SD, ±0.85 month; range, 1-6 months) and (b) a follow-up interview arranged at a minimum of 26 months after the index screening. The time interval between baseline and follow-up interview averaged 29.4 months (SD, ± 1.42 months), with a range of 27 to 41 months. Of the 1,451 women who participated in the baseline interviews, 1,249 (86%) completed follow-up interviews. Twenty women were excluded either due to a cancer diagnosis associated with the exam or in the time interval between interviews (n = 11) or due to inadequate information to determine adherence to mammography screening guidelines (n = 9). Women included in the analysis differed significantly from those excluded or lost to follow-up by race (African-American, 78%; White, 93%; $P < 0.001$) but not by age.

Measures

Nonadherence to Screening Mammography Guidelines. The American Cancer Society screening guidelines in effect at the onset of the data collection period (1996) of this study (30) were used to determine the main outcome, nonadherence to screening mammography guidelines. Women ages 40 to 49 were considered nonadherent if they did not obtain at least one mammogram within 2 years (+2 months) of the index exam. Women ages ≥50 were considered nonadherent if they did not obtain at least two screenings within 2 years (+2 months) of the index exam. The ''+2 months'' allowed for reasonable delays in scheduling appointments.

For 1,126 respondents (92%), the outcome was determined by self-report. The remaining 103 women (8%) did not provide sufficient self-reported information to ascertain the outcome (i.e., could not recall the month or year of at least one mammogram) but did consent to a review of their mammography records. For these women, we relied on radiology records to determine outcome status. These 103 women did not differ from women with self-reported data by recruitment site or family breast cancer history, but they were more likely to be African-American than White (55% versus 38%, respectively; $P < 0.001$) and to be age ≥ 50 [78% versus 63% (age < 50); $P < 0.003$].

Neighborhood-Level Socioeconomic Factors. Baseline residential addresses (97.8%; n = 1,420) were successfully geocoded to obtain 1990 census tracts. Census tract-level variables were downloaded from the U.S. Census (31)

and then linked to the individual-level study data. Because the health effects of neighborhood are thought to be related in large part to factors associated with socioeconomic position (2, 32), six conceptual domains of SES that are relevant to neighborhood socioeconomic position were evaluated. These domains and corresponding census indicators are as follows: (*a*) occupational class (percentage of adults in working class positions and percentage of adults unemployed), (*b*) income (median household income), (*c*) poverty (percentage of persons with households below the U.S. poverty line), (*d*) wealth (high assets defined as percentage of owner-occupied homes valued at $300,000 or more), (*e*) education (percentage of adults without a high school education), and (*f*) crowding (percentage of persons living in crowded conditions defined as more than one person per room). Additional variables that were considered in preliminary analyses were percentage of households without a car, percentage of housing units rented, percentage of housing units boarded, and racial

Table 1. Characteristics of the study population by race/ethnicity (*n* = 1,229), Connecticut, 1996-2000

Domain	Variables	African-American (*n* = 484)		White (*n* = 745)		OR (95% CI)
		No.*	%	No.*	%	
Sociodemographic factors	Age					
	40-49	168	34.7	275	36.9	0.91 (0.71-1.16)
	50+	316	65.3	470	63.1	1.00
	Marital status					
	Married/living as married	161	33.5	536	72.2	1.00
	Single	319	66.5	206	27.8	5.16 (4.02-6.61)
	Education (y)					
	>12	158	32.9	524	70.6	1.00
	12	176	36.7	184	24.8	3.17 (2.39-4.21)
	<12	146	30.4	34	4.6	14.24 (9.25-22.02)
	Annual family income					
	$50,000+	73	16.6	416	59.0	1.00
	$30,000-$49,999	71	16.1	148	21.0	2.73 (1.84-4.05)
	$15,000-$29,999	91	20.6	79	11.2	6.56 (4.36-9.89)
	<$15,000	206	46.7	62	8.8	18.93 (12.77-28.15)
	Occupational status †					
	Quartile 1 (low)	202	41.7	54	7.2	17.86 (11.37-28.15)
	Quartile 2	121	25.0	196	26.3	2.95 (1.98-4.40)
	Quartile 3	45	9.3	216	29.0	0.99 (0.62-1.59)
	Quartile 4 (high)	49	10.1	234	31.4	1.00
	Missing	67	13.8	45	6.0	7.11 (4.25-11.94)
	Neighborhood SEP Index					
	Quartile 1	27	5.7	268	36.8	1.00
	Quartile 2	45	9.6	253	35.0	1.77 (1.03-3.02)
	Quartile 3	140	29.8	161	22.3	8.63 (5.35-13.99)
	Quartile 4 (most disadvantaged)	258	54.9	42	5.8	60.97 (35.48-105.57)
Access to medical care	Mammography insurance (full, annual coverage)					
	Yes	325	67.7	513	69.0	1.00
	No	155	32.3	231	31.1	1.06 (0.85-1.35)
	Usual healthcare provider					
	Yes	424	88.3	676	91.4	1.00
	No	56	11.7	64	8.6	1.40 (0.95-2.04)
Mammography-related factors	Knowledge of screening mammography guidelines ‡					
	Correct	275	59.4	507	69.7	1.00
	Incorrect	188	40.6	220	30.3	1.58 (1.23-2.00)
	Family history of breast cancer§					
	No	378	78.4	491	66.2	1.00
	Yes	104	21.6	251	33.8	0.54 (0.41-0.70)
	Healthcare provider recommended a mammogram					
	Yes	349	72.3	541	72.9	1.00
	No	134	27.7	201	27.1	1.03 (0.80-1.33)
	History of nonadherence to mammography screening guidelines‖					
	Nonadherent	143	29.8	93	12.5	2.96 (2.21-3.97)
	Adherent	337	70.2	649	87.5	1.00
	Adherence to mammography screening guidelines¶					
	Nonadherent	260	53.7	327	43.9	1.48 (1.18-1.87)
	Adherent	224	46.3	418	56.1	1.00

*Numbers may not sum to total because of some missing data.

†Combined spouse pair score, adapted from the Ducan Socioeconomic Index (37, 38); missing data included nonrespondents as well as women who reported no occupation for either themselves or a partner.

‡Correct identification of the age-specific mammography screening guidelines.

§Breast cancer in first- or second-degree relative.

‖Previous history of nonadherence to guidelines was calculated based on the respondent's age and available data on the number of lifetime mammography screenings she reported (0, 1, 2, 3, 4, or 5+). Women ages 40 to 49 y were considered nonadherent if they did not obtain at least one screening every 2 y. Women ages ≥50 y were considered nonadherent if they did not obtain at least five screenings.

¶Prospectively collected study outcome (nonadherence to mammography screening guidelines).

Table 2. Adjusted race-specific associations of neighborhood measures of SES and nonadherence to screening mammography guidelines using multivariable logistic regression, Connecticut, 1996-2000

Domain and indicators	Quartile	African-American women			
		Adjusted for age (n = 474), OR (95% CI)	Additional adjustment for all three individual measures of SES* (n = 432), OR (95% CI)	Additional adjustment for mammography-related covariables† (n = 422), OR (95% CI)	Additional adjustment for percentage of non-Whites in census tract (n = 422), OR (95% CI)
Occupation					
Percentage of adults in working class jobs‡	1 (low)	1.00	1.00	1.00	1.00
	2	1.32 (0.78-2.23)	1.29 (0.72-2.31)	1.23 (0.66-2.28)	1.39 (0.74-2.62)
	3	2.52 (1.46-4.34)	2.77 (1.50-5.12)	2.18 (1.14-4.18)	2.34 (1.11-4.94)
	4 (high)	1.50 (0.88-2.55)	1.39 (0.76-2.53)	0.98 (0.52-1.87)	1.44 (0.62-3.32)
Unemployment					
Percentage of adults unemployed	1 (low)	1.00	1.00	1.00	1.00
	2	1.18 (0.70-2.00)	0.99 (0.56-1.77)	0.98 (0.53-1.82)	0.87 (0.42-1.82)
	3	1.52 (0.89-2.59)	1.39 (0.77-2.49)	1.24 (0.66-2.32)	1.69 (0.71-4.02)
	4 (high)	2.11 (1.22-3.64)	1.93 (1.02-3.62)	1.67 (0.86-3.26)	2.27 (0.87-5.92)
Income					
Median income	1 (low)	2.06 (1.20-3.54)	1.76 (0.95-3.27)	1.72 (0.90-3.31)	1.86 (0.83-4.17)
	2	1.92 (1.14-3.22)	1.72 (0.95-3.12)	1.46 (0.78-2.75)	1.70 (0.79-3.64)
	3	1.83 (1.08-3.08)	1.72 (0.97-3.06)	1.62 (0.89-2.97)	1.49 (0.78-2.83)
	4 (high)	1.00	1.00	1.00	1.00
Poverty					
Percentage of persons below poverty	1 (low)	1.00	1.00	1.00	1.00
	2	1.22 (0.72-2.06)	1.12 (0.63-2.00)	0.99 (0.54-1.83)	1.06 (0.52-2.15)
	3	2.59 (1.40-4.78)	2.34 (1.18-4.61)	2.18 (1.07-4.42)	2.02 (0.77-5.28)
	4 (high)	1.71 (1.04-2.81)	1.41 (0.79-2.53)	1.27 (0.69-2.32)	1.72 (0.60-4.93)
Assets					
Percentage of houses valued ≥$300,000	0-10%	1.39 (0.76-2.55)	1.26 (0.65-2.45)	1.00 (0.50-2.03)	1.13 (0.54-2.37)
	>10%	1.00	1.00	1.00	1.00
Education					
Percent of adults without a high school education	1 (low)	1.00	1.00	1.00	1.00
	2	1.70 (1.00-2.87)	1.67 (0.93-3.01)	1.52 (0.82-2.85)	1.44 (0.76-2.73)
	3	2.52 (1.43-4.45)	2.96 (1.56-5.62)	2.59 (1.32-5.08)	2.70 (1.26-5.77)
	4 (high)	2.39 (1.43-3.99)	2.12 (1.16-3.86)	1.67 (0.90-3.10)	3.56 (1.34-9.47)
Crowding					
Percentage of households with high school education	1 (low)	1.00	1.00	1.00	1.00
	2	1.33 (0.78-2.27)	1.13 (0.61-2.06)	1.07 (0.57-2.01)	0.92 (0.40-2.08)
	3	1.60 (0.91-2.81)	1.35 (0.71-2.59)	1.25 (0.64-2.46)	1.17 (0.41-3.32)
	4 (high)	1.65 (0.97-2.82)	1.40 (0.75-2.62)	1.18 (0.61-2.26)	1.06 (0.37-3.02)
Additional variables					
Percentage of households without a car	1 (low)	1.00	1.00	1.00	1.00
	2	1.59 (0.94-2.69)	1.42 (0.79-2.55)	1.31 (0.70-2.43)	1.27 (0.62-2.60)
	3	2.98 (1.70-5.23)	2.48 (1.30-4.70)	2.30 (1.17-4.53)	2.07 (0.87-4.93)
	4 (high)	1.61 (0.95-2.73)	1.30 (0.70-2.41)	1.25 (0.66-2.37)	1.56 (0.55-4.41)
Percentage of housing units boarded up	1 (low)	1.00	1.00	1.00	1.00
	2	1.07 (0.63-1.81)	1.25 (0.70-2.22)	1.12 (0.61-2.08)	0.96 (0.50-1.84)
	3	1.78 (1.02-3.11)	1.73 (0.94-3.21)	1.45 (0.75-2.78)	1.30 (0.62-2.72)
	4 (high)	1.39 (0.81-2.40)	1.27 (0.68-2.35)	1.14 (0.59-2.18)	0.98 (0.42-2.24)
Composite measure					
SEP Index quartiles§	1 (low)	1.00	1.00	1.00	1.00
	2	1.24 (0.74-2.11)	1.10 (0.61-1.99)	1.10 (0.58-2.07)	1.17 (0.59-2.32)
	3	1.91 (1.07-3.41)	1.91 (1.00-3.65)	1.83 (0.91-3.67)	2.01 (0.87-4.63)
	4 (high)	1.98 (1.18-3.32)	1.66 (0.90-3.05)	1.42 (0.74-2.72)	3.13 (1.01-9.70)

NOTE: Each neighborhood SES measure reported was modeled separately due to multicollinearity if entered in the same model. All variables are categorized using race-specific quartiles.

*Income (<$15,000, $15,000-$29,999, $30,000-$49,999, ≥$50,000), education (<12 y, 12 y, >12 y), occupation [combined spouse pair score, adapted from the Duncan Socioeconomic Index (37, 38), categorized as quartiles plus a missing data category that included nonrespondents as well as women who reported no occupation for either themselves or a partner].

†Marital status, mammography insurance, having a usual care provider, history of adherence to mammography screening guidelines, perceived susceptibility to getting breast cancer, perceived usefulness of mammography, embarrassment associated with the mammography process, receipt of a mammogram reminder notice (since index exam), and receipt of a provider recommendation (since index exam).

‡The 8 of 13 occupational categorizations consisting primarily of nonsupervisory employees (32).

§Composite SEP Index (33) consisting of a standardized z score combining data on percentage working class, unemployment, percentage below the U.S. poverty line, percentage low education (less than high school), percentage expensive homes (≥$300,000), and median household income. Greater score signifies greater disadvantage.

Table 2. Adjusted race-specific associations of neighborhood measures of SES and nonadherence to screening mammography guidelines using multivariable logistic regression, Connecticut, 1996-2000 (Cont'd)

Domain and indicators	Quartile	White women			
		Adjusted for age (n = 724)	Additional adjustment for all three individual measures of SES* (n = 686)	Additional adjustment for mammography-related covariables† (n = 663)	Additional adjustment for percentage of non-Whites in census tract (n = 663)
Occupation					
Percentage of adults in working class jobs‡	1 (low)	1.00	1.00	1.00	1.00
	2	1.04 (0.68-1.60)	1.01 (0.64-1.59)	1.07 (0.66-1.73)	1.07 (0.66-1.75)
	3	1.40 (0.92-2.15)	1.31 (0.83-2.07)	1.32 (0.81-2.14)	1.32 (0.81-2.16)
	4 (high)	1.30 (0.85-2.00)	1.04 (0.64-1.71)	1.15 (0.69-1.93)	1.17 (0.70-1.98)
Unemployment					
Percentage of adults unemployed	1 (low)	1.00	1.00	1.00	1.00
	2	1.17 (0.76-1.80)	1.17 (0.74-1.84)	1.03 (0.63-1.67)	1.05 (0.64-1.72)
	3	1.10 (0.72-1.69)	1.15 (0.73-1.80)	1.00 (0.62-1.61)	1.01 (0.62-1.64)
	4 (high)	1.63 (1.06-2.49)	1.50 (0.95-2.39)	1.31 (0.80-2.14)	1.43 (0.84-2.44)
Income					
Median income	1 (low)	1.53 (1.00-2.34)	1.39 (0.86-2.26)	1.22 (0.73-2.03)	1.49 (0.80-2.78)
	2	1.11 (0.72-1.69)	1.05 (0.67-1.66)	1.02 (0.63-1.67)	1.04 (0.63-1.69)
	3	1.16 (0.76-1.78)	1.14 (0.73-1.79)	1.06 (0.65-1.72)	1.04 (0.64-1.70)
	4 (high)	1.00	1.00	1.00	1.00
Poverty					
Percentage of persons below poverty	1 (low)	1.00	1.00	1.00	1.00
	2	0.72 (0.47-1.11)	0.71 (0.45-1.12)	0.65 (0.40-1.05)	0.64 (0.40-1.04)
	3	0.97 (0.63-1.48)	0.91 (0.58-1.41)	0.81 (0.50-1.30)	0.81 (0.50-1.33)
	4 (high)	1.09 (0.71-1.66)	0.98 (0.62-1.55)	0.77 (0.47-1.25)	0.79 (0.45-1.38)
Assets					
Percentage of houses valued ≥$300,000	0-10%	1.43 (1.05-1.93)	1.37 (0.97-1.93)	1.41 (0.98-2.03)	1.46 (1.00-2.12)
	>10%	1.00	1.00	1.00	1.00
Education					
Percent of adults without a high school education	1 (low)	1.00	1.00	1.00	1.00
	2	1.11 (0.72-1.70)	1.14 (0.73-1.79)	1.09 (0.67-1.77)	1.15 (0.69-1.91)
	3	1.10 (0.71-1.69)	1.09 (0.69-1.73)	1.10 (0.68-1.79)	1.13 (0.69-1.85)
	4 (high)	1.61 (1.05-2.46)	1.36 (0.82-2.24)	1.29 (0.76-2.17)	1.38 (0.79-2.41)
Crowding					
Percentage of households with high school education	1 (low)	1.00	1.00	1.00	1.00
	2	1.09 (0.75-1.58)	1.14 (0.78-1.69)	1.05 (0.69-1.58)	1.08 (0.71-1.64)
	3	1.82 (1.26-2.63)	1.65 (1.10-2.48)	1.54 (1.00-2.38)	1.72 (1.07-2.74)
	4 (high)				
Additional variables					
Percentage of households without a car	1 (low)	1.00	1.00	1.00	1.00
	2	1.15 (0.75-1.76)	1.12 (0.71-1.75)	1.26 (0.77-2.05)	1.26 (0.77-2.05)
	3	1.02 (0.66-1.56)	1.02 (0.65-1.60)	0.96 (0.58-1.56)	1.00 (0.60-1.67)
	4 (high)	1.60 (1.05-2.46)	1.32 (0.82-2.13)	1.26 (0.75-2.13)	1.36 (0.75-2.44)
Percentage of housing units boarded up	1 (low)	1.00	1.00	1.00	1.00
	2	1.19 (0.82-1.73)	1.27 (0.86-1.88)	1.24 (0.82-1.89)	1.22 (0.80-1.87)
	3	1.40 (0.97-2.02)	1.30 (0.88-1.92)	1.25 (0.83-1.89)	1.26 (0.83-1.91)
	4 (high)				
Composite measure					
SEP Index quartiles§	1 (low)	1.00	1.00	1.00	1.00
	2	1.05 (0.68-1.62)	1.03 (0.66-1.61)	0.91 (0.56-1.48)	0.93 (0.57-1.53)
	3	1.14 (0.75-1.75)	1.07 (0.68-1.70)	0.99 (0.60-1.63)	1.02 (0.62-1.69)
	4 (high)	1.51 (0.99-2.30)	1.24 (0.76-2.04)	1.12 (0.66-1.90)	1.18 (0.67-2.09)

composition (percentage non-Whites). A composite neighborhood socioeconomic index (SEP Index) was also created, following the example of Krieger et al. (33), using a standardized z score combining data on percentage working class, percentage unemployed, percentage below the U.S. poverty line, percentage without a high school education, percentage of expensive homes, and median household income; a higher score indicates a higher degree of deprivation.

Categorization of each of the neighborhood SES measures addressed specific analytic objectives. (*a*) In the absence of a priori category considerations, quartiles of the neighborhood measures were used for initial analyses. (*b*) Because of major differences in SES distributions by race, resulting in insufficient racial/ethnic overlap in categories, race-specific quartiles were created to examine race-specific relationships, a strategy used by Diez Roux et al. and Borrell et al. (34-36). (*c*) In

addition, following the example of Diez Roux et al. (34) and Borrell et al. (35), categories of the SEP Index and the neighborhood-level education variables were created to have the same relative positions within these distributions as their respective positions within the race-specific individual-level income distributions and individual-level education distributions. This approach allowed a meaningful comparison of the effect of neighborhood-level SES and individual-level SES within each race group. Thus, the neighborhood SEP categories were created based on the four-category individual-level income distribution. Likewise, categories of neighborhood-level education mimic the three-category individual-level education distribution.

Individual-Level Socioeconomic Measures. Three measures of individual-level SES were collected: (*a*) annual family income (<$14,999, $15,000-$29,999, $30,000-$49,999, ≥$50,000), (*b*) education level (<12 years, 12 years, >12 years), and (*c*) occupation [combined spouse pair score, adapted from the Duncan Socioeconomic Index (37, 38), categorized as quartiles plus a missing data category that included nonrespondents as well as women who reported no occupation for either themselves or a partner].

Statistical Analyses. Bivariate associations were examined between the neighborhood SES measures, the outcome (nonadherence to screening mammography guidelines), race, individual-level SES, and additional covariates that were hypothesized to influence mammography screening. Statistical significance was determined by the χ^2 test ($P < 0.05$). Linear trend was tested using the Mantel-Haenszel χ^2 test ($P < 0.05$).

Multivariable logistic regression was used to determine the adjusted association between neighborhood SES and nonadherence to screening mammography guidelines; adjusted odds ratios (OR) with 95% confidence intervals (95% CI) are reported. To account for possible within-area correlations, models were analyzed using Monte Carlo Markov Chain methods in MLwiN (39), software specifically designed for multilevel data. However, the estimated variance of the neighborhood random effects was negligible and not statistically significant in any models (final model random effects variance variable estimate, 0.032; SE, 0.030). Thus, models without the random effects essentially remained unchanged from models with random effects included. Therefore, only fixed effects for neighborhood SES from logistic regression modeling using Statistical Analysis System 9.1 are presented. Likelihood ratio tests were calculated to identify variables that contributed significantly to the fit of the model (40). A wide range of potential confounders and variables with known associations with screening mammography or SES, as well as variables known to vary significantly by race/ethnicity, was considered for inclusion in the multivariable models. These included sociodemographic factors, variables that were specific to the experience of undergoing mammography screening, health status and behaviors, logistical barriers, interaction with provider and provider characteristics, psychosocial factors, and known breast cancer risk factors. In addition to variables that were independently associated with the outcome, covariates that changed the estimate of the relationship between neighborhood variables and nonadherence by ≥10% were retained in the final models. Multicollinearity between the multiple neighborhood-level measures of SES was assessed by examining variance inflation factors in regression models with two or more neighborhood-level SES measures included simultaneously. A variance inflation factor of <2.5 was considered acceptable (41). Because the variance inflation factors exceeded this criterion, multiple measures of neighborhood-level SES were not included in the same model (except when included as a one-variable composite index). All two-level interactions were tested, including race interactions. Due to the significant racial/ethnic variation in neighborhood-level SES distributions, resulting in insufficient racial/ethnic overlap in categories, race-specific models, using race-specific quartiles and categories, were also examined. All reported analyses were done with Statistical Analysis System software, version 9.1 (42).

Results

Characteristics of the study population by race/ethnicity are presented in Table 1. More than 60% of the respondents were age ≥50, with no significant difference by race/ethnicity. African-American women were significantly more likely than White women to be single than married/living as married, to have lower annual family incomes, to have <12 years of education, and to be in the lowest occupational status quartiles. Considering the main predictor, African-American women were disproportionately represented in the most disadvantaged neighborhoods as measured by the SEP Index. Over two thirds of all participants reported having complete coverage for annual screening mammography, and the majority of women reported having a usual healthcare provider and received a recommendation from their provider to get a mammogram in the 2 years after the index screening (with no significant differences by race/ethnicity). African-American women were significantly less likely than White women to correctly identify age-appropriate screening mammography guidelines and less likely to report a family history of breast cancer (any first- or second-degree relative). African-American women were also more likely to report a history of nonadherence to mammography screening guidelines. With respect to the study outcome, 47.8% of the total study population was nonadherent to screening mammography guidelines. African-American women were more likely than White women to be nonadherent (African-American, 53.7%; White, 43.9%; OR, 1.48; 95% CI, 1.18-1.87).

The unadjusted associations between individual-level SES and individual neighborhood-level SES variables (i.e., the components of the SEP index) and nonadherence to mammography screening guidelines are not shown in tables but are briefly described. All three individual-level SES measures (income, education, and occupation) were statistically significantly associated with nonadherence to guidelines (with statistically significant linear trend). Further, all neighborhood-level SES measures (i.e., occupation, unemployment, income, poverty, assets, education, crowding, percent of households without a car, and percent of housing units boarded up) examined were significantly associated with nonadherence (comparing

participants living in the most disadvantaged neighborhoods with the least disadvantaged neighborhoods). A significant linear trend was observed for all measures of neighborhood SES. In unadjusted analyses, SEP Index [OR (quartile 4 versus quartile 1), 2.26; 95% CI, 1.60-3.18] and percentage of adults without a high school education [OR (quartile 4 compared with quartile 1), 2.43; 95% CI, 1.73-3.42] were significantly associated with nonadherence.

Multivariable Models. Although multivariable logistic regression models were initially tested using the total study population (data not shown), the significantly different distributions of SES for African-Americans and Whites resulted in lack of racial/ethnic overlap in categories. As such, we present race-specific multivariable models with sequential multivariable adjustment (first for age, then adding individual-level measures of SES, next adding other known predictors of mammography screening, and finally adjusting for neighborhood racial composition). Table 2 shows results using race-specific quartiles for all of the neighborhood-level SES measures examined, and Table 3 shows results using categories based on race-specific individual-level income distributions for the composite neighborhood SEP Index and neighborhood-level education, with the corresponding individual-level SES results.

Table 2 shows that, for African-American women, neighborhood-level unemployment, neighborhood-level median household income, neighborhood-level poverty, neighborhood-level education, and the SEP Index (all presented in separate models due to multicollinearity) were significantly associated with nonadherence to mammography screening guidelines after adjustment for age (highest quartiles versus lowest quartiles). After further adjustment for individual-level SES and mammography-related covariables, neighborhood unemployment and neighborhood median household income and neighborhood-level poverty, were no longer significantly associated with nonadherence. The results for neighborhood education and the SEP index were attenuated after adjustment for individual-level measures of SES but remained statistically significant. These associations were further attenuated with adjustment for mammography-related covariables and were no longer statistically significant. However, when the models were further adjusted for neighborhood racial composition, both neighborhood education and the overall SEP Index were significantly independently associated with nonadherence [neighborhood-level education: OR (4th quartile versus 1st quartile), 3.56; 95% CI, 1.34-9.47; neighborhood-level SEP Index: OR (4th quartile versus 1st quartile), 3.13; 95% CI, 1.01-9.70]. Conversely, for White women, neighborhood-level unemployment, neighborhood-level assets, neighborhood-level education, neighborhood-level crowding, neighborhood-level car ownership, and the SEP Index were all predictive of nonadherence to mammography screening guidelines after adjustment for age (highest quartiles versus lowest quartiles). However, only neighborhood-level crowding was significantly associated with nonadherence after adjustment for individual-level SES and mammography-related covariables. After further adjustment for neighborhood racial composition, neighborhood-level crowding and neighborhood-level assets (marginally significant) were associated with nonadherence to mammography screening guidelines for White women [neighborhood-level crowding: OR (4th quartile versus 1st quartile), 3.56; 95% CI, 1.34-9.47; neighborhood-level assets: OR (4th quartile versus 1st quartile), 1.72 (1.07-2.74); 1.46 (1.00-2.12)].

The following results (Table 3) are based on models using neighborhood SEP variables categorized to mirror the race-specific individual-level SES distributions. For African-American women, neighborhood-level SES (SEP Index) was associated with nonadherence to mammography screening guidelines after each step of sequential adjustment (first for age, next for individual-level SES, then for mammography-related covariables, and finally for neighborhood racial composition). The OR for African-Americans living in the most disadvantaged neighborhoods (SEP Index) compared with those living in the least disadvantaged neighborhoods was 3.55 (95% CI, 1.33-9.51) in the fully adjusted model. Sequential adjustment for a model including neighborhood-level education (categorized based on African-American individual-level education distributions) was also undertaken with similar results. Neighborhood-level education was significantly associated with nonadherence in the fully adjusted model [OR, 3.21; 95% CI, 1.25-8.26 (category 3 versus category 1)]. The results for individual-level SES (individual-level income and individual-level education, respectively) are also shown for each model. For African-American women, neither individual-level income nor individual-level education significantly predicted nonadherence with the selected neighborhood-level SES variable in the model.

For White women (with categorization of the neighborhood SEP Index and neighborhood-level education reflective of individual-level income and education, respectively), both neighborhood SEP (SEP Index) and neighborhood-level education were associated with nonadherence after adjustment for age. However, with further sequential adjustment for individual-level measures of SES, mammography-related variables, and neighborhood racial composition, the associations remained only marginally significant [OR, 2.13; 95% CI, 0.97-4.67 (quartile 4 versus quartile 1)] and neighborhood-level education [OR, 2.31; 95% CI, 0.93-5.76 (category 3 versus category 1)] once finally adjusted for racial composition. Neither individual-level income nor individual-level education was independently associated with nonadherence in White women in their respective models. Please note that these race-specific models are not directly comparable with each other or with total study population models, as race-specific distributions were used for categorization, resulting in different categorizations of neighborhood-level SES for each race-specific model.

Discussion

Using data from the Race Differences in the Screening Mammography Process Study, we have shown that measures of neighborhood SES were associated with regular mammography screening independent of individual-level SES and other predictors of regular mammography screening behavior for both African-American and White women. However, the specific neighborhood

Table 3. Race-specific multivariable logistic regression models of the associations between neighborhood-level SES, individual-level SES, and nonadherence to mammography screening guidelines using race-specific categorizations of the neighborhood-level SES (SEP Index and education) reflective of individual-level income and education distributions (n = 1,229), Connecticut, 1996-2000

Study population	Model	Indicator		Adjusted for age, OR (95% CI)	Addition of three individual measures of SES,* OR (95% CI)	Additional adjustment for mammography-related covariables,† OR (95% CI)	Additional adjustment for percentage of non-Whites in census tract, OR (95% CI)
				n = 470	n = 428	n = 420	n = 420
African-American women	Model 1	SEP Index‡	Category 1	1.00	1.00	1.00	1.00
			Category 2	1.47 (0.76-2.87)	1.24 (0.58-2.66)	1.31 (0.58-2.96)	1.55 (0.65-3.73)
			Category 3	1.55 (0.84-2.86)	1.36 (0.68-2.71)	1.31 (0.62-2.76)	1.52 (0.64-3.59)
			Category 4	2.51 (1.45-4.34)	2.20 (1.14-4.22)	2.07 (1.02-4.20)	3.55 (1.33-9.51)
		Individual income	$50,000+		1.00	1.00	1.00
			$30,000-$49,999		1.10 (0.54-2.24)	1.02 (0.47-2.21)	0.90 (0.41-1.98)
			$15,000-$29,999		0.83 (0.40-1.70)	0.69 (0.30-1.58)	0.62 (0.27-1.43)
			<$15,000		1.40 (0.70-2.81)	1.20 (0.53-2.72)	1.06 (0.46-2.44)
	Model 2	Neighborhood education§	Category 1	1.00	1.00	1.00	1.00
			Category 2	2.10 (1.34-3.30)	2.24 (1.35-3.70)	2.14 (1.25-3.65)	2.02 (1.15-3.53)
			Category 3	2.25 (1.39-3.65)	1.99 (1.14-3.47)	1.64 (0.92-2.95)	3.21 (1.25-8.26)
		Individual education	More than high school		1.00	1.00	1.00
			High school graduate		1.39 (0.81-2.39)	1.44 (0.85-2.44)	1.52 (0.88-2.62)
			Less than high school		1.34 (0.70-2.57)	1.43 (0.75-2.72)	1.43 (0.75-2.76)
				(n = 722)	(n = 684)	(n = 661)	(n = 661)
White women	Model 1	SEP Index‡	Category 1	1.00	1.00	1.00	1.00
			Category 2	0.86 (0.58-1.27)	0.80 (0.53-1.21)	0.78 (0.50-1.22)	0.79 (0.50-1.25)
			Category 3	1.36 (0.84-2.22)	1.34 (0.79-2.29)	1.20 (0.68-2.11)	1.30 (0.73-2.33)
			Category 4	2.30 (1.32-4.01)	1.79 (0.92-3.48)	1.76 (0.86-3.62)	2.13 (0.97-4.67)
		Individual income	$50,000+		1.00	1.00	1.00
			$30,000-$49,999		1.50 (0.97-2.31)	1.32 (0.82-2.13)	1.32 (0.82-2.12)
			$15,000-$29,999		1.22 (0.69-2.15)	1.01 (0.52-1.95)	1.01 (0.52-1.96)
			<$15,000		1.70 (0.84-3.46)	1.44 (0.64-3.25)	1.41 (0.62-3.20)
	Model 2	Neighborhood education§	Category 1	1.00	1.00	1.00	1.00
			Category 2	1.33 (0.94-1.90)	1.14 (0.76-1.70)	1.12 (0.73-1.70)	1.15 (0.75-1.77)
			Category 3	2.48 (1.17-5.23)	1.95 (0.84-4.54)	2.06 (0.86-4.94)	2.31 (0.93-5.76)
		Individual education	More than high school		1.00	1.00	1.00
			High school graduate		0.93 (0.62-1.39)	0.94 (0.62-1.41)	0.94 (0.62-1.42)
			Less than high school		2.38 (0.94-6.01)	2.01 (0.75-5.40)	2.08 (0.77-5.62)

*Income (<$15,000, $15,000-$29,999, $30,000-$49,999, ≥$50,000), education (<12 y, 12 y, >12 y), occupation [combined spouse pair score, adapted from the Duncan Socioeconomic Index (37, 38), categorized as quartiles plus a missing data category that included nonrespondents as well as women who reported no occupation for either themselves or a partner].

†Marital status, mammography insurance, having a usual care provider, history of adherence to mammography screening guidelines, perceived susceptibility to getting breast cancer, perceived usefulness of mammography, embarrassment associated with the mammography process, receipt of a mammogram reminder notice (since index exam), and receipt of a provider recommendation (since index exam).

‡Higher category signifies greater disadvantage. Categories mirror individual SES distribution (household income for SEP Index, personal education for neighborhood education). African-American SEP categories: SEP category 1, 16% living in least disadvantaged, corresponding to the distribution of individuals in the highest individual income category. Likewise, category 2 represents the next 15%, category 3 represents the next 21%, and category 4 represents the 46% living in the most disadvantaged neighborhoods. Respective White SEP categories: category 1 comprised 59% (least disadvantaged), category 2 represents the next 21%, category 3 represents the next 11%, and category 4 represents the 9% living in the most disadvantaged neighborhoods.

§Neighborhood-level education categories mirror individual education distribution. African-American neighborhood-level education percentile cutoffs: category 1, 33% (most educated); category 2, the next 25%; and category 3, the next 30% (least educated). White neighborhood-level education percentile cutoffs: category 1, 71% (most educated); category 2, 25%; and category 3, 5% (least educated).

measures that significantly predicted nonadherence differed for each race. For African-American women, neighborhood-level education and the overall neighborhood SEP Index predicted nonadherence, whereas neighborhood-level crowding and neighborhood-level assets were significant predictors of nonadherence for White women. When examining models with the neighborhood measures categorized to allow for comparison with individual-level SES, the neighborhood-level SES effects were larger in magnitude than individual-level measures of SES for all women irrespective of race. Furthermore, after adjustment for percentage non-Whites in the census tract, the magnitude of the associations for neighborhood-level SES measures became larger due to

negative confounding (i.e., racial composition was masking a stronger effect of neighborhood-level SES). This suggests that there is an aspect of neighborhood socioeconomic deprivation that influences adherence to mammography screening (health behavior) independent of racial composition.

Although there are many potential mechanisms by which neighborhood SES influences regular mammography screening, hypothesized pathways relate to access to material or social resources or exposure to stressors or harmful environmental conditions. Because social norms and attitudes are believed to differ by residential areas (43) and may influence individual health behavior, we examined several mammography-specific psychosocial variables (with a theoretical basis in the Health Belief Model and other health behavior models) that may be correlated with social norms and attitudes. These included perceived susceptibility to getting breast cancer, perceived usefulness of mammography, barriers to screening, and cues to action. Even after adjustment for these psychosocial variables, neighborhood-level SES remained significantly associated with nonadherence. Additionally, low-SES neighborhoods may offer limited resources in support of good health and health behaviors (6). Although not measured directly here, specific conditions of one's environment may influence one's ability to develop supportive relationships (44), as literature suggests that neighborhoods shape neighboring and social interaction patterns (45). Moreover, social resources such as social capital, social cohesion, or collective efficacy, which are associated with poor health outcomes (44, 46-55), may be lower in more deprived neighborhoods. Thus, although we were able to control for a range of covariates that were theoretically based on the major health behavior models, there is the possibility of confounding due to unmeasured factors.

A limited number of studies have examined the association between neighborhood SES and mammography use, with varying conclusions. Whereas some of the studies showed a significant, independent effect of area-level factors on mammography screening, one notable study, using data from the Black Women's Health Study, did not find an association between neighborhood SES and regular mammography use (7). However because that study was composed of relatively affluent, well-educated Black women (97% had graduated high school) with high rates of regular screening (~80%), that study population is not likely to be representative of African-American women in the general U.S. population. With only two neighborhood characteristics used in that study, and because the women were generally of high SES, the variation in the types of neighborhoods in which they resided may have been limited. Comparatively, our study offers several important methodologic advantages. (*a*) Because of the socioeconomic variability of the study participants' individual characteristics (e.g., ~70% of African-American women graduated from high school and ~47% had annual household incomes of ≤$15,000) and of the neighborhoods in which they lived, we have sufficient variation and numbers in the SES strata to detect significant associations. In addition, this socioeconomic variation in our study population is comparable with the general Connecticut and U.S. populations (e.g., U.S. African-American high school graduation percentage, 72%; Connecticut African-American high school graduation percentage, 74%; refs. 21-26). (*b*) Nonadherence to mammography screening guidelines was measured prospectively, with predictors collected at baseline, allowing for correct temporal sequencing. (*c*) The outcome addressed regular mammography screening behavior rather than one-time or recent use, an outcome more closely related to receiving the full benefit of mammography (56). (*d*) In addition to the benefit of having a large sample size of both African-American and White women, extensive data on many aspects of the mammography process were collected, including mammography-specific variables and factors relevant to health disparities that may confound, mediate, or moderate the relationships between neighborhood-level SES and nonadherence to mammography screening guidelines.

A limitation that many studies of neighborhood effects share is the use of administrative census data as a proxy for neighborhood. It is unlikely that census boundaries directly coincide with any meaningful definition of ''neighborhood'' as defined by residents. However, there are several advantages to using census data, such as the systematic collection of data for the entire population and its accessibility. Another measurement issue in our study, potentially leading to some misclassification, stems from linking geocoded address information provided at baseline (1996-1998) to 1990 census tract characteristics. The 1990 census information was chosen over 2000 census information to maintain the correct temporal sequence, but we cannot rule out changes in neighborhood characteristics between the 1990 census and the study enrollment period. However, as neighborhoods generally do not change significantly over short times (57), this is unlikely to have had a significant effect on reported findings. As a check, models using 2000 census tract median income (as an example of a neighborhood-level SES measure) were examined and produced results that were consistent with those using the 1990 census data.

The outcome, adherence to mammography screening guidelines, measured after an index screening, is a more detailed assessment of mammography use than that which is generally reported from retrospective studies of mammography screening and national surveys. However, if women who were lost to follow-up (and were also nonadherent) or never presented for a mammogram (not assessed in this study) were more likely to have lived in even more disadvantaged neighborhoods than those represented in the study sample, it is possible that we underestimated the effect of neighborhood-level SES on mammography screening behavior. However, because all facilities chosen were situated in urban areas [where ~98% of the African-American population in Connecticut live (20)], and due to the relatively high levels of residential segregation in Connecticut (58, 59), it is likely that African-American women who have never had a mammography screening live among women who have had at least one mammogram. Thus, it is possible that the neighborhood-level barriers are similar for both groups. However, because some (mostly White women) also receive mammograms in smaller, private facilities, limiting our comparison with larger, hospital-based facilities may have attenuated differences across race groups. That said, as in the general U.S. and Connecticut populations, we observed the usual racial/ethnic differences in SES variables (21-26). Finally, with only 15.9% of eligible

women reporting that they had never had a mammogram in national survey data (2002; ref. 60), the findings of this study may be applicable to the majority of women for whom maintenance of this screening behavior is relevant.

Conclusion

These results underscore the importance of examining social context as well as individual factors in health outcomes, as shown in this analysis of neighborhood-level SES and mammography screening behavior. In this study, living in disadvantaged neighborhoods was associated with nonadherence to mammography screening guidelines. Neighborhood disadvantage is increasingly recognized as a determinant of health outcomes, and our findings suggest that the effect of neighborhood disadvantage may extend to health prevention behaviors.

Although some aspects of neighborhood conditions may be amenable to intervention efforts, further research is needed to fully understand the mechanisms involved to develop appropriate interventions that are likely to influence change in health prevention behaviors, such as adherence to mammography screening guidelines. Meanwhile, building up both economic and social resources in disadvantaged communities may contribute to the adoption of better health behaviors and eventually lead to the reduction of racial/ethnic and socioeconomic disparities in selected health outcomes.

Acknowledgments

We thank the hospitals in Connecticut that allowed access to their patients and medical records (Bridgeport Hospital, Lawrence and Memorial Hospital, St. Francis Hospital and Medical Center, Waterbury Hospital, and Yale-New Haven Hospital) and our project coordinator, Lisa Schlenk, for her assistance with data collection and management.

References

1. Lynch J, Kaplan GA. Socioeconomic position. In: Berkman L, Kawachi I, editors. Social epidemiology. New York (NY): Oxford University Press; 2000. p. 13–35.
2. Krieger N, Williams DR, Moss NE. Measuring social class in US public health research: concepts, methodologies, and guidelines. Annu Rev Public Health 1997;18:341–78.
3. Diez Roux AV. Investigating neighborhood and area effects on health. Am J Public Health 2001;91:1783–9.
4. Kawachi I, Berkman L. Neighborhoods and health. New York (NY): Oxford University Press; 2003.
5. Coughlin SS, Thompson TD, Hall HI, Logan P, Uhler RJ. Breast and cervical carcinoma screening practices among women in rural and nonrural areas of the United States, 1998-1999. Cancer 2002;94:2801–12.
6. Kothari AR, Birch S. Individual and regional determinants of mammography uptake. Can J Public Health 2004;95:290–4.
7. Rosenberg L, Wise LA, Palmer JR, Horton NJ, Adams-Campbell LL. A multilevel study of socioeconomic predictors of regular mammography use among African-American women. Cancer Epidemiol Biomarkers Prev 2005;14:2628–33.
8. Schootman M, Jeffe DB, Baker EA, Walker MS. Effect of area poverty rate on cancer screening across US communities. J Epidemiol Community Health 2006;60:202–7.
9. Litaker D, Tomolo A. Association of contextual factors and breast cancer screening: finding new targets to promote early detection. J Womens Health (Larchmt) 2007;16:36–45.
10. Baker LC, Phillips KA, Haas JS, Liang SY, Sonneborn D. The effect of area HMO market share on cancer screening. Health Serv Res 2004;39:1751–72.
11. Phillips KA, Kerlikowske K, Baker LC, Chang SW, Brown ML. Factors associated with women's adherence to mammography screening guidelines. Health Serv Res 1998;33:29–53.
12. Zenk SN, Tarlov E, Sun J. Spatial equity in facilities providing low- or no-fee screening mammography in Chicago neighborhoods. J Urban Health 2006;83:195–210.
13. Jones BA, Dailey A, Calvocoressi L, et al. Inadequate follow-up of abnormal screening mammograms: findings from the race differences in screening mammography process study (United States). Cancer Causes Control 2005;16:809–21.
14. Calvocoressi L, Stolar M, Kasl SV, Claus EB, Jones BA. Applying recursive partitioning to a prospective study of factors associated with adherence to mammography screening guidelines. Am J Epidemiol 2005;162:1215–24.
15. Calvocoressi L, Kasl SV, Lee CH, Stolar M, Claus EB, Jones BA. A prospective study of perceived susceptibility to breast cancer and nonadherence to mammography screening guidelines in African American and White women ages 40 to 79 years. Cancer Epidemiol Biomarkers Prev 2004;13:2096–105.
16. Jones BA, Reams K, Calvocoressi L, Dailey A, Kasl SV, Liston NM. Adequacy of communicating results from screening mammograms to African American and White women. Am J Public Health 2007;97:531–8.
17. U.S. Census Bureau. American fact finder [cited October 2005]. Available from: http://factfinder.census.gov/servlet/BasicFactsTable?_lang=en&_vt_name=DEC_2000_PL_U_GCTPL_ST7&_geo_id=04000US09.
18. State of Connecticut Department of Economic and Community Development. Connecticut population information [cited October 12]. Available from: http://www.ct.gov/ecd/cwp/view.asp?a=1106&q=250666, 1990.
19. Jones BA, Culler CS, Kasl SV, Calvocoressi L. Is variation in quality of mammographic services race linked? J Health Care Poor Underserved 2001;12:113–26.
20. U.S. Census Bureau. American fact finder [cited July 2007]. Available from: http://factfinder.census.gov/servlet/GCTTable?_bm=y&-context=gct&-ds_name=DEC_2000_SF1_U&-CONTEXT=gct&-mt_name=DEC_2000_SF1_U_GCTP6_ST1&-tree_id=4001&-redoLog=false&-geo_id=04000US09&-format=ST-1&-_lang=en.
21. U.S. Census Bureau. American fact finder, US populations data (Blacks) [cited July 2007]. Available from: http://factfinder.census.gov/servlet/SAFFIteratedFacts?_event=&geo_id=01000US&_geoContext=01000US&_street=&_county=&_cityTown=&_state=&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=010&_submenuId=factsheet_2&ds_name=DEC_2000_SAFF&_ci_nbr=002&qr_name=DEC_2000_SAFF_R1010&reg=DEC_2000_SAFF_R1010%3A002&_keyword=&_industry=.
22. U.S. Census Bureau. American fact finder, US population data (Whites) [cited July 2007]. Available from: http://factfinder.census.gov/servlet/SAFFIteratedFacts?_event=&geo_id=01000US&_geoContext=01000US&_street=&_county=&_cityTown=&_state=&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=010&_submenuId=factsheet_2&ds_name=DEC_2000_SAFF&_ci_nbr=004&qr_name=DEC_2000_SAFF_R1010&reg=DEC_2000_SAFF_R1010%3A004&_keyword=&_industry=.
23. U.S. Census Bureau. American fact finder, CT population data (Whites) [cited July 2007]. Available from: http://factfinder.census.gov/servlet/SAFFIteratedFacts?_event=&geo_id=04000US09&_geoContext=01000US%7C04000US09&_street=&_county=&_cityTown=&_state=04000US09&_zip=&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pctxt=fph&pgsl=040&_submenuId=factsheet_2&ds_name=DEC_2000_SAFF&_ci_nbr=002&qr_name=DEC_2000_SAFF_R1040&reg=DEC_2000_SAFF_R1040%3A002&_keyword=&_industry=.
24. U.S. Census Bureau. American fact finder, CT population data (Blacks) [cited July 2007]. Available from: http://factfinder.census.gov/servlet/SAFFIteratedFacts?_event=&geo_id=04000US09&_geoContext=01000US%7C04000US09&_street=&_county=&_cityTown=&_state=04000US09&_zip=&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pctxt=fph&pgsl=040&_submenuId=factsheet_2&ds_name=DEC_2000_SAFF&_ci_nbr=004&qr_name=DEC_2000_SAFF_R1040&reg=DEC_2000_SAFF_R1040%3A004&_keyword=&_industry=.
25. U.S. Census Bureau. Profile of selected economic characteristics: 2000, Census 2000 Summary File 4 (SF 4) Sample Data, Connecticut. [cited July 2007]. Available from: http://factfinder.census.gov/servlet/QTTable?_bm=y&-geo_id=04000US09&-qr_name=DEC_2000_SF4_U_DP3&-reg=DEC_2000_SF4_U_DP3:002|004&-ds_name=DEC_2000_SF4_U&-_lang=en&-redoLog=false&-CONTEXT=qt.
26. U.S. Census Bureau. Profile of selected economic characteristics: 2000, Census 2000 Summary File 4 (SF 4) Sample Data, United States

[cited July 2007]. Available from: http://factfinder.census.gov/servlet/QTTable?_bm=y&-geo_id=01000US&-qr_name=DEC_2000_SF4_U_DP3&-ds_name=DEC_2000_SF4_U&-reg=DEC_2000_SF4_U_DP3:002|004&-_lang=en&-redoLog=false&-CONTEXT=qt.
27. Smith RA, Cokkinides V, Eyre HJ. American Cancer Society guidelines for the early detection of cancer, 2003. CA Cancer J Clin 2003;53:27–43.
28. Leitch AM, Dodd GD, Costanza M, et al. American Cancer Society guidelines for the early detection of breast cancer: update 1997. CA Cancer J Clin 1997;47:150–3.
29. Smith RA, Saslow D, Sawyer KA, et al. American Cancer Society guidelines for breast cancer screening: update 2003. CA Cancer J Clin 2003;53:141–69.
30. Leitch AM. Controversies in breast cancer screening. Cancer 1995;76:2064–9.
31. U.S. Census Bureau. [cited February 2007]. Available from: http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC2&_submenuId=datasets_1&_lang=en&_ts=162475383517.
32. Krieger N, Zierler S, Hogan JW, et al. Geocoding and measurement of neighborhood socioeconomic position: a US perspective. In: Kawachi I, Berkman L, editors. Neighborhoods and health. New York (NY): Oxford University Press; 2003. p. 147–78.
33. Krieger N, Chen JT, Waterman PD, Soobader MJ, Subramanian SV, Carson R. Geocoding and monitoring of US socioeconomic inequalities in mortality and cancer incidence: does the choice of area-based measure and geographic level matter?: the Public Health Disparities Geocoding Project. Am J Epidemiol 2002;156:471–82.
34. Diez Roux AV, Merkin SS, Hannan P, Jacobs DR, Kiefe CI. Area characteristics, individual-level socioeconomic indicators, and smoking in young adults: the coronary artery disease risk development in young adults study. Am J Epidemiol 2003;157:315–26.
35. Borrell LN, Diez Roux AV, Rose K, Catellier D, Clark BL. Neighbourhood characteristics and mortality in the Atherosclerosis Risk in Communities Study. Int J Epidemiol 2004;33:398–407.
36. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. N Engl J Med 2001;345:99–106.
37. Duncan OD. A socioeconomic index for all occupations. In: Reiss A Jr, editor. Occupations and social class. New York: Free Press; 1961. p. 109–38.
38. Stevens GF. A revised socioeconomic index of occupational status. Soc Sci Res 1981;10:364–95.
39. Centre for Multilevel Modelling. MLwiN. London (United Kingdom): Institute of Education; 2004.
40. Holford T. Multivariate methods in epidemiology. New York (NY): Oxford University Press; 2002.
41. Allison PD. Logistic regression using the SAS system: theory and Application. Cary (NC): SAS Institute, Inc.; 1999.
42. The SAS System for Windows. Version 9.1. Cary (NC): SAS Institute Inc.; copyright 2002-2003.
43. Curry SJ, Wagner EH, Cheadle A, et al. Assessment of community-level influences on individuals' attitudes about cigarette smoking, alcohol use, and consumption of dietary fat. Am J Prev Med 1993;9:78–84.
44. Cohen DA, Farley TA, Mason K. Why is poverty unhealthy? Social and physical mediators. Soc Sci Med 2003;57:1631–41.
45. Skjaeveland O, Garling T. Effects of interactional space on neighbouring. J Environ Psychol 1997;17:181–98.
46. Sampson R. Neighborhood-level context and health: lessons from sociology. In: Kawachi I, Berkman L, editors. Neighborhoods and health. New York City (NY): Oxford University Press; 2003. p. 132–46.
47. Kawachi I, Kennedy BP, Glass R. Social capital and self-rated health: a contextual analysis. Am J Public Health 1999;89:1187–93.
48. Lindstrom M, Merlo J, Ostergren PO. Individual and neighbourhood determinants of social participation and social capital: a multilevel analysis of the city of Malmo, Sweden. Soc Sci Med 2002;54:1779–91.
49. Lindstrom M, Merlo J, Ostergren PO. Social capital and sense of insecurity in the neighbourhood: a population-based multilevel analysis in Malmo, Sweden. Soc Sci Med 2003;56:1111–20.
50. Steptoe A, Feldman PJ. Neighborhood problems as sources of chronic stress: development of a measure of neighborhood problems, and associations with socioeconomic status and health. Ann Behav Med 2001;23:177–85.
51. Subramanian SV, Kim DJ, Kawachi I. Social trust and self-rated health in US communities: a multilevel analysis. J Urban Health 2002;79:S21–34.
52. Subramanian SV, Lochner KA, Kawachi I. Neighborhood differences in social capital: a compositional artifact or a contextual construct? Health Place 2003;9:33–44.
53. Duncan SC, Duncan TE, Strycker LA. A multilevel analysis of neighborhood context and youth alcohol and drug problems. Prev Sci 2002;3:125–33.
54. Duncan TE, Duncan SC, Okut H, Strycker LA, Hix-Small H. A multilevel contextual model of neighborhood collective efficacy: a multilevel analysis of neighborhood context and youth alcohol and drug problems. Am J Community Psychol 2003;32:245–52.
55. Browning CR, Cagney KA. Neighborhood structural disadvantage, collective efficacy, and self-rated physical health in an urban setting. J Health Soc Behav 2002;43:383–99.
56. Jones B, Patterson EA, Calvocoressi L. Mammography screening in African American women: evaluating the research. Cancer 2003;97:258–72.
57. Geronimus AT, Bound J. Use of census-based aggregate variables to proxy for socioeconomic group: evidence from national samples. Am J Epidemiol 1998;148:475–86.
58. U.S. Census Bureau. [cited July 2007]. Available from: http://factfinder.census.gov/servlet/BasicFactsTable?_lang=en&_vt_name=DEC_2000_PL_U_GCTPL_ST7&_geo_id=04000US09.
59. State of Connecticut. Connecticut population information [cited July 2007]. Available from: http://www.ct.gov/ecd/cwp/view.asp?a=1106&q=250666.
60. Centers for Disease Control and Prevention (CDC). Behavioral risk factor surveillance system survey data [cited May 2006]. Available from: http://apps.nccd.cdc.gov/brfss/Trends/trendchart.asp?qkey=10050&state=US.