

Racial and Socioeconomic Disparities in Cancer-Related Knowledge, Beliefs, and Behaviors in Indiana



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Abstract

Background: This statewide survey examined differences in cancer-related knowledge, beliefs, and behaviors between racial and socioeconomic groups in select counties in Indiana.

Methods: A stratified random sample of 7,979 people aged 18–75 who lived in one of 34 Indiana counties with higher cancer mortality rates than the state average, and were seen at least once in the past year in a statewide health system were mailed surveys.

Results: Completed surveys were returned by 970 participants, yielding a 12% response rate. Black respondents were less likely to perceive they were at risk for cancer and less worried about getting cancer. Individuals most likely to perceive that they were unlikely to get cancer were more often black, with low incomes (less than \$20,000) or high incomes

(\$50,000 or more), or less than a high school degree. Black women were greater than six times more likely to be adherent to cervical cancer screening. Higher income was associated with receiving a sigmoidoscopy in the last 5 years and a lung scan in the past year. Those with the highest incomes were more likely to engage in physical activity. Both income and education were inversely related to smoking.

Conclusions: Socioeconomic and racial disparities were observed in health behaviors and receipt of cancer screening. Black individuals had less worry about cancer.

Impact: Understanding populations for whom cancer disparities exist and geographic areas where the cancer burden is disproportionately high is essential to decision-making about research priorities and the use of public health resources.

Introduction

The burden of illnesses such as cancer, disability, and premature death disproportionately affects vulnerable populations in the United States. Residents in minority communities generally have lower socioeconomic status (SES), limited access to health care, and greater risks for disease than the general population living in the same area (1). Disparities in cancer outcomes have been identified in numerous populations, including racial and ethnic minorities and patients of lower SES (2). Evidence suggests that disparities have increased in recent years with some groups experiencing a decline in life expectancy (3).

Substantial evidence exists regarding disparities in cancer incidence and mortality among blacks both nationally and within the state of Indiana. In the United States, blacks have the highest cancer-related death rates of any racial group for all cancers combined (4, 5). The latest Indiana data show that mortality rates from all cancers, in all groups, was 11.2% higher compared

with the national average (6). Furthermore, from 2011 to 2015, the Indiana cancer mortality rate was 17% higher among blacks compared with whites (209.4 vs. 178.8 per 100,000, respectively). While differences in cancer incidence rates between blacks and whites decreased from 5.1% during 2006–2010 to 1.6% from 2011 to 2015, disparities in cancer mortality rates between black and white Indiana residents decreased only slightly in the same timeframe, from 19.9% in 2006–2010 to 17.1% in 2011–2015 (6).

Cancer disparities are the result of several complex factors including socioeconomic factors; inequalities in access to health care including preventive services, screening, or treatment; risk factor profiles and health behaviors/habits; cultural perceptions; biological differences; and genetic predisposition (2). People living in poverty, who lack health insurance, and have limited access to high-quality health care suffer greater cancer burdens than the general population. In Indiana, data from 2016 showed that higher education and income levels were associated with greater likelihood that: women ages 21–65 years had a Pap test within the past three years; women ages 50–74 had a mammogram within the past two years; and adults ages 50–75 were up-to-date with colorectal cancer screening (6). Limited income and education, cultural values or beliefs about health and healthcare, discrimination, and social inequalities that contribute to poor patient–provider communication were shown to promote disparities (6).

The National Cancer Institute (NCI) requires Designated Cancer Centers to define and describe their catchment areas, highlight community outreach and engagement activities within their catchment areas, and identify how research they conduct is relevant to their catchment areas. For all cancer centers,

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understanding the problem areas within their catchment area where the cancer burden is high or where cancer disparities exist is essential to making decisions about the use of resources, outreach efforts, and research priorities. While local data on cancer incidence, mortality, and clinical trial enrollments are available, data on cancer-relevant social and behavioral factors are not routinely collected. To enhance cancer prevention and control efforts, NCI funded the Indiana University Melvin and Bren Simon Cancer Center and 14 other cancer centers in 2016 to enhance our abilities to define and describe our catchment areas and needs (ref. 7; <https://cancercontrol.cancer.gov/brp/hcirb/catchment-areas.html>).

With support from that supplement, this study was undertaken to examine differences in cancer-related knowledge, beliefs, and behaviors (cancer screening, physical activity, tobacco use) between racial and socioeconomic groups among Indiana residents in counties with high cancer mortality rates who were seen at least once in a statewide health system during the prior year.

Materials and Methods

Sample

The sampling frame was designed to represent patients who lived in the 34 Indiana counties with higher cancer mortality rates than the state average and who had been seen at least once in the past year at one of 178 Indiana University Health (IUH) system facilities, were between 18 and 75 years old, and either white/Caucasian or black/African American. IUH is a statewide integrated health care system with 19 hospitals across Indiana. The Indiana University Melvin and Bren Simon Cancer Center is an NCI-Designated Clinical Cancer Center that is part of the IUH network. A list of patients who were seen at least once in the past 12 months at an IUH facility was generated that included names, addresses, race, and age. From the original list of 284,062 patients, a random, stratified sample of 8,000 individuals was drawn to survey. Stratification was based on race (black or white), geographic location (urban or rural), age (18–49 or 50–75), and sex (male or female). The study was approved by the Indiana University–Purdue University Institutional Review Board.

Eligibility criteria. Health care providers were notified of the intent to survey their patients and 21 declined to have their patients invited; therefore, the final sample who were mailed surveys was 7,979. Adult patients aged 21–75 years who were identified as white or black in their electronic medical record, who resided in one of 34 counties with higher than average cancer mortality rates, were mailed survey packets and invited to participate in the study.

We included a broad age range to obtain a generational perspective on the constructs of interest. Sampling young adults provided data on cervical cancer prevention, HPV vaccination rates, and healthy behaviors among men and women. We set the upper age limit of our sample at 75 years because, after that age, most types of cancer screening (breast, cervical, colon) are not recommended. We oversampled blacks to have adequate power to test for racial differences in knowledge, beliefs, and behaviors. To identify potential participants, race data were obtained from the electronic medical record and then confirmed by self-report in the survey. While the intention was to sample 2,000 participants from each combination of location and race (urban white, urban black, rural white, and rural

black), there were only 524 people in the rural black category, so all 524 were sampled with the remainder of the 2,000 taken from the rural white category, to ensure 4,000 total rural and 4,000 urban participants to sample.

Data collection

In January and February 2018, the Indiana University Center for Survey Research (CSR) mailed survey packets to 7,979 individuals. Following the tailored design method (8), the first mailing included a cover letter introducing the study, a study information sheet, the survey instrument, a written consent form, a HIPAA authorization form to allow access to medical records, a postage-paid, preaddressed envelope to return the completed survey and signed authorization form, and a one-time \$1 bill as a small token of appreciation. Two weeks later, a postcard reminder was sent; 1 month later, a second copy of the survey and other documents were mailed to nonrespondents.

Respondents returned paper surveys and authorization forms directly to the CSR, where staff reviewed the returned surveys and entered serial numbers and dispositions into a tracking database. CSR created a codebook with all survey items, variable names, and response options for scanning programming and conducted quality control tests to verify scanning precision and data accuracy. CSR staff examined completed surveys for illegible marks and corrected them when necessary to enhance data capture, counted and compiled the surveys into groups of 50, and digitally scanned them.

Following guidelines provided by CSR, our scanning partner implemented data handling rules during the data verification process. The data reflected what was entered by the respondent and were not edited or cleaned. Responses that did not follow survey instructions, such as selecting more than one option for a "Mark only ONE" item, were entered as missing data. Poor handwriting and faint marks or corrections may have affected the ability to capture respondent data accurately. After data verification was complete, staff conducted a final quality check and compiled the data in a comma-separated value file for secure transfer to CSR.

Measures. To facilitate harmonization of data collected, data sharing, and the ability to merge datasets across cancer centers, project leaders worked closely with NCI staff to determine specific items to be included in the final survey. Together with investigators from 15 other cancer centers, the group evaluated and agreed upon a core set of survey items to assess: individual and sociodemographic characteristics (13 items); cancer knowledge and beliefs (10 items); health information-seeking behavior (7 items); health-promoting/cancer prevention behaviors including tobacco use, screening, vaccines (9 items); and access to health care (3 items). Relevant items were identified from the Health Information National Trends Survey (HINTS), the Behavioral Risk Factor Surveillance System (BRFSS) survey, and the National Health Interview Survey (NHIS). See commentary included with this special issue for a description and complete list of all core items (9).

Individual and sociodemographic characteristics. Individual sociodemographic data collected included age, gender, race, ethnicity, education, marital status, income, financial security, home ownership, occupational status, and place of birth (United States or not).

Cancer knowledge and beliefs. Using the U.S. Preventive Task Force guidelines, knowledge of the appropriate ages to start breast, colon, and lung cancer screening were assessed separately with three single items consistent with those used in the HINTS. Beliefs about personal risk of getting cancer were assessed with a single item: "compared with people your same age, how likely are you to get cancer in your lifetime? Cancer worry was assessed with a single item: "how worried are you about getting cancer?" Five items assessed level of agreement with the following statements: "it seems everything causes cancer;" "there are so many different recommendations about preventing cancer, it's hard to know which ones to follow;" "when I think about cancer, I automatically think about death;" "there's not much you can do to lower your chances of getting cancer;" and "I'd rather not know my chance of getting cancer."

Health promotion/cancer prevention behaviors. Physical activity was assessed using a single item asking days per week of moderate physical activity/exercise. Tobacco use was assessed with two items: "have you ever smoked at least 100 cigarettes in your entire life?" and "do you now smoke cigarettes. . .every day?, some days?, or not at all?". Four items assessed participants' access to, and use, of health care services: "do you have health care coverage/insurance?," "is there a usual place you go when you are sick?," "what kind of place do you go to most often?," and "was there a time in the past 12 months when you could not see a doctor because of cost?". Fourteen items from the BRFSS were used to evaluate adherence to the US Preventive Task Force recommended cancer screenings (e.g., mammograms, Pap tests, HPV tests, stool blood tests, sigmoidoscopy, and colonoscopy).

Statistical analyses

Data cleaning was performed to prepare the data for statistical analysis. Demographic data (age, education, income, marital status, employment, and home ownership) were regrouped to provide at least five observations in the combination of each variable with race, and preferably 25 where possible. Income was also further collapsed into three categories for logistic regression analysis to prevent small cell counts with outcome measures. Physical activity reported as days per week was grouped into three levels (None/0, 1–2, or 3–7). For tobacco use, respondents who reported never smoking more than 100 cigarettes were grouped with those who are currently not smoking. Descriptive statistics were performed on demographics and cancer-related knowledge, beliefs, and behaviors (cancer screening, physical activity, tobacco use). Survey weights were created to account for the stratified sample and oversampling of minorities and used to calculate weighted estimates and SEs for the population. Descriptive statistics were performed overall as well as separately by race (black, white) and SES (education, income).

To examine differences in cancer-related knowledge, beliefs, and health promotion/cancer prevention behaviors, the proportions for each response were compared between racial groups using Pearson χ^2 tests. The SurveyFreq procedure in the SAS System for Windows version 9.4 was then used to also estimate the frequencies and percentages of each response in the population of all eligible patients. Multiple logistic regression models were performed on each outcome with predictor variables for race, geographic location (urban/rural), sex, age group (18–49, 50–75), income, and education. The SurveyLogistic procedure was used to account for survey weights and the stratified sampling

design, which projects data from the sample to estimate rates in the larger population. Survey weights for analysis were calculated according to the American Association for Public Opinion Research, based on response rates in each strata. Adjusted ORs from the logistic models are reported for race, income, and education. *P* values were considered significant at $P < 0.05$, and *P* values were not adjusted for multiple testing due to the descriptive nature of the study.

Results

Of the 7,979 surveys mailed, 970 were returned completed, yielding a 12% response rate. Figure 1 illustrates the Indiana counties sampled, surveys mailed in each county, and completed surveys returned. Overall, 54 refused directly, 28 refused implicitly (blank survey returned), 27 were deceased or physically/mentally unable to participate, two were determined out of sample, and 586 were returned undeliverable. Response rates were lower for black compared with white (8% vs. 14% respectively, $P < 0.001$) people and young (18–49 years) compared with old (50–75 years) respondents (6% vs. 15% respectively, $P < 0.001$). Response rates were also higher in rural areas compared with urban (13% vs. 11%, respectively, $P = 0.009$), and for females compared with males (13% vs. 11%, respectively, $P = 0.024$).

As shown in Table 1, compared with whites, black respondents had a lower proportion in the youngest age group and a higher proportion aged 50–64 years ($P = 0.008$). Lower proportions of blacks were married or living with a partner ($P < 0.001$), owned their own home ($P < 0.001$), and were living comfortably ($P < 0.001$). Higher proportions of black respondents reported low incomes ($P < 0.001$) and had not seen a doctor in the last 12 months because of cost ($P < 0.001$). These patterns were consistent with estimates of the population, after adjusting for survey weights. However, there were significant differences between black and white subgroups of the population in the estimated distributions of sex and education. There was a significantly higher percentage of females estimated in the white population than the black population ($P < 0.001$), while more of the black population are estimated to have lower levels of education ($P = 0.019$).

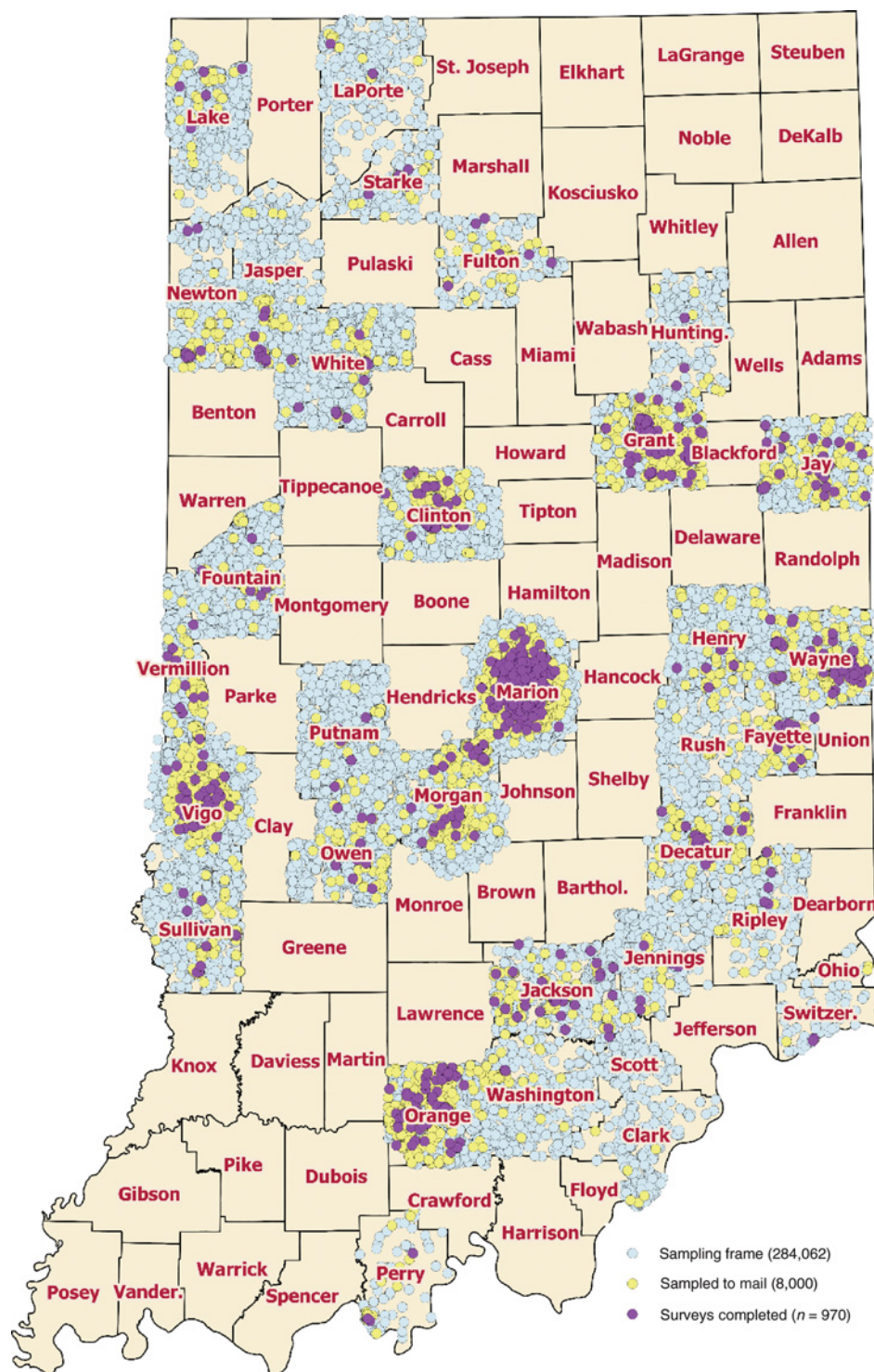
Differences in cancer-related knowledge and beliefs

Bivariate analyses in Table 2A showed that the percentage of white participants who responded with the correct age to start colorectal screening was significantly higher than black respondents (60.3% vs. 46.3%, respectively; $P = 0.002$). Yet no significant differences by race on knowledge of the correct ages to start having mammograms or lung cancer screening were observed. For cancer beliefs, White respondents reported more worry about cancer (moderately or extremely worried) than blacks (22.6% vs. 15.2%, respectively; $P = 0.029$). More black respondents reported their personal lifetime risk of cancer as "very unlikely," compared with whites who more often reported their risk of getting cancer as "likely" or "very likely" ($P < 0.001$). These significant differences in cancer-related knowledge and beliefs by race were also significant in the population estimates using survey weights. There were no other significant differences in cancer beliefs by race.

While differences in knowledge about the age to start colorectal screening was significant by race in bivariate analyses, race was not significant in the logistic regression models that included sex, age

Figure 1.

Sampling frame, mailed surveys, and complete responses. Figure 1 illustrates Indiana counties and numbers included in the sampling frame (light blue), those sampled to receive mailed surveys (yellow), and completed surveys returned (purple).



group, location, income, and education variables and adjusted for survey weights (see Table 2B). There were no other significant effects for screening knowledge.

For cancer beliefs, black respondents had significantly lower odds of reporting being "likely" or "very likely" to get cancer in their lifetime ($OR = 0.26, P < 0.01$), and lower odds of reporting "neither likely or unlikely" compared with whites ($OR = 0.38, P <$

0.05). People with incomes from \$20,000 to \$49,999 had five times higher odds of reporting their lifetime cancer risk as "neither likely or unlikely" compared with those with incomes of more than \$50,000 ($OR = 5.47, P < 0.001$) and three times higher odds of reporting "likely" or "very likely" ($OR = 3.16, P < 0.05$). Respondents who completed high school were more than three times more likely to report their cancer risk as "neither likely or

Table 1. Sample demographics by race

Variable	Black (192), n (%)	White (743), n (%)	<i>P</i> ^a	Black (44,084) Weighted n (%)	White (248,047) Weighted n (%)	<i>P</i> ^a
Age group						
18–34	12 (6.3%)	86 (11.6%)	0.008	6,443 (14.6%)	74,619 (30.1%)	0.015
35–49	28 (14.6%)	98 (13.2%)		15,432 (35.0%)	55,739 (22.5%)	
50–64	93 (48.4%)	274 (36.9%)		13,593 (30.8%)	65,569 (26.4%)	
65+	59 (30.7%)	285 (38.4%)		8,616 (19.5%)	52,120 (21.0%)	
Sex						
Female	105 (54.7%)	400 (53.8%)	0.830	23,781 (53.9%)	158,158 (63.8%)	< 0.001
Male	87 (45.3%)	343 (46.2%)		20,303 (46.1%)	89,889 (36.2%)	
Education						
<High school	19 (10.8%)	49 (6.9%)	0.154	3,859 (9.4%)	12,002 (5.1%)	0.019
High school graduate	54 (30.7%)	198 (28.1%)		10,857 (26.3%)	46,648 (19.7%)	
Some college or vocational school	50 (28.4%)	194 (27.5%)		12,568 (30.5%)	53,844 (22.7%)	
College grad or higher	53 (30.1%)	265 (37.5%)		13,959 (33.8%)	124,286 (52.5%)	
Marital status						
Not partnered	108 (59.3%)	244 (33.8%)	< 0.001	26,271 (61.4%)	97,141 (40.1%)	< 0.001
Partnered	74 (40.7%)	479 (66.3%)		16,494 (38.6%)	145,197 (59.9%)	
Employed						
Yes	77 (44.5%)	284 (41.0%)	0.162	22,509 (58.1%)	131,997 (56.6%)	0.886
No	48 (27.8%)	164 (23.7%)		8,871 (22.9%)	58,731 (25.2%)	
Retired	48 (27.8%)	244 (35.3%)		7,375 (19.0%)	42,454 (18.2%)	
Own home						
Yes	82 (45.6%)	534 (74.4%)	< 0.001	16,270 (38.3%)	150,194 (62.9%)	< 0.001
No	98 (54.4%)	184 (25.6%)		26,186 (61.7%)	88,757 (37.1%)	
Income						
\$0–19,999	51 (31.1%)	115 (17.2%)	< 0.001	12,313 (30.3%)	41,954 (18.3%)	< 0.001
\$20,000–49,999	59 (36.0%)	196 (29.4%)		15,245 (37.5%)	45,262 (19.7%)	
\$50,000–99,999	41 (25.0%)	228 (34.2%)		9,483 (23.3%)	68,777 (30.0%)	
\$100,000+	13 (7.9%)	128 (19.2%)		3,639 (8.9%)	73,201 (31.9%)	
Financial security						
Living comfortably	42 (23.7%)	295 (41.9%)	< 0.001	10,460 (24.9%)	114,220 (48.2%)	< 0.001
Getting by	73 (41.2%)	245 (34.8%)		15,241 (36.3%)	72,345 (30.5%)	
Finding it difficult	38 (21.5%)	113 (16.1%)		10,663 (25.4%)	29,920 (12.6%)	
Finding it very difficult	24 (13.6%)	51 (7.2%)		5,675 (13.5%)	20,705 (8.7%)	
Health insurance						
Yes	175 (94.1%)	681 (94.3%)	0.902	39,497 (91.5%)	228,387 (94.3%)	0.427
No	11 (5.9%)	41 (5.7%)		3,666 (8.5%)	13,792 (5.7%)	
Unable to see doctor due to cost in last 12 months						
Yes	43 (23.5%)	92 (12.7%)	< 0.001	12,923 (30.6%)	33,589 (13.9%)	0.002
No	140 (76.5%)	630 (87.3%)		29,346 (69.4%)	208,589 (86.1%)	
Born in United States						
Yes	179 (96.8%)	710 (98.2%)	0.220	41,577 (96.3%)	234,814 (97.7%)	0.545
No	6 (3.2%)	13 (1.8%)		1,581 (3.7%)	5,519 (2.3%)	

^a*P* values are from Pearson χ^2 tests.

unlikely" compared with those with less than a high school education (OR = 3.29, $P < 0.05$). Those who completed college were more than seven times more likely to consider their cancer risk to be "neither likely nor unlikely" (OR = 7.48, $P < 0.01$) compared with people with less than a high school education. Participants with some college (OR = 4.30, $P < 0.05$) or a college degree (OR = 5.83, $P < 0.01$) were also more likely to report their lifetime cancer risk as "likely" or "very likely" compared with those with less than a high school education. These results indicate that people most likely to perceive that they are "likely" to get cancer are more often white, with middle incomes (\$20,000 to \$49,999), and some college education.

Participants with lower income levels (less than \$20,000, or \$20,000 to \$49,999) were more likely to agree that there is "not much you can do to lower your chances of cancer" (OR = 2.37 and OR = 2.00, respectively, $P < 0.05$). Similarly, respondents with middle incomes (\$20,000–\$49,999) were more likely to report that they would "rather not know my chances of getting cancer" (OR = 1.92, $P < 0.05$) than people with higher incomes (\$50,000

or more), and black respondents were significantly less likely to report being worried about getting cancer (OR = 0.41, $P < 0.05$).

Differences in cancer screening and health behaviors

Table 3A reports the frequencies of cancer screening and health promotion behaviors by race with no differences in cancer screening behaviors by race using Pearson χ^2 tests. There was a significant difference between races on tobacco use ($P = 0.006$) with higher proportions of white participants reporting they did not currently smoke compared with blacks (84.4% vs. 77.6%, $P = 0.002$). No difference in physical activity was observed. In weighted estimates of the population, tobacco use by race was still significant ($P = 0.028$). Additional significant effects were identified in the population for colon and cervical cancer screening; whites were more likely ($P = 0.043$) to have had a colonoscopy in the past 10 years and black women were more likely to have had a Pap test in the last 3 years than whites ($P = 0.043$).

Table 3B shows the results of the logistic regression models on cancer screening and behaviors. Respondents with incomes of

Table 2A. Cancer-related knowledge and beliefs by race

	Black (192) n (%)	White (743) n (%)	P ^a	Black (44,084) Weighted n (%)	White (248,047) Weighted n (%)	P ^a
Knowledge						
Start mammograms at age 40 or 50 (% correct)	76 (48.4%)	322 (51.2%)	0.532	76 (48.4%)	322 (51.2%)	0.532
Start CRC screening at age 50 (% correct)	69 (46.3%)	378 (60.3%)	0.002	14,540 (39.9%)	124,231 (57.8%)	0.005
Smokers start lung screening at age 55 (% correct)	2 (1.4%)	11 (2.0%)	0.662	387 (1.1%)	2,920 (1.5%)	0.679
Cancer beliefs						
Everything causes cancer (% agree)	122 (66.0%)	475 (65.9%)	0.987	27,620 (64.0%)	170,578 (71.2%)	0.167
So many recommendations, hard to know what to do (% agree)	157 (85.3%)	606 (83.7%)	0.591	37,299 (86.8%)	198,428 (82.5%)	0.307
Think about cancer, think about death (% agree)	118 (63.4%)	438 (60.5%)	0.463	27,499 (63.4%)	149,919 (62.2%)	0.840
Not much you can do to lower chances of cancer (% agree)	72 (39.1%)	239 (32.9%)	0.110	13,751 (32.3%)	83,845 (34.8%)	0.652
Rather not know my chances of getting cancer (% agree)	64 (34.4%)	283 (39.4%)	0.216	14,566 (33.6%)	91,163 (37.9%)	0.459
Cancer worry (% moderately and extremely worried)	28 (15.2%)	162 (22.6%)	0.029	6,479 (15.0%)	68,819 (28.7%)	0.004
Comparative lifetime cancer risk						
Very unlikely	21 (11.9%)	26 (3.7%)	<0.001	6,490 (15.8%)	6,502 (2.8%)	0.003
Unlikely	17 (9.7%)	74 (10.4%)		2,987 (7.3%)	20,805 (8.8%)	
Neither likely nor unlikely	90 (51.1%)	341 (48.0%)		21,934 (53.3%)	121,531 (51.5%)	
Likely	40 (22.7%)	186 (26.2%)		8,285 (20.1%)	61,397 (26.0%)	
Very likely	8 (4.6%)	84 (11.8%)		1,484 (3.6%)	25,801 (10.9%)	

Abbreviation: CRC, colorectal cancer.

^aP values are from Pearson χ^2 tests.

\$20,000 to \$49,999 were less likely to have had a sigmoidoscopy within the past 5 years (OR = 0.06, $P < 0.01$) compared with those with higher incomes. Adherence to colorectal cancer screening guidelines with any test was not associated with race, education, or income. Participants with incomes less than \$20,000 or \$20,000 to \$49,000 were less likely to have had a lung scan in the past year (OR = 0.05, $P < 0.05$, and OR = 0.07, $P < 0.01$, respectively); those with some college or a college degree were also less likely than their counterparts to have had this test (OR = 0.02, $P < 0.01$ and OR = 0.04, $P < 0.05$, respectively). However, these results are sensitive due to small numbers reporting a lung scan in the past year ($n = 16$, in Table 3A). The odds of having had a Pap test in the past 3 years, or the past 5 years with an HPV test, was more than six times higher among black women compared with white (OR = 6.69, $P < 0.01$). While black and white women had similar cervical screening rates in the sample overall, the survey

logistic model revealed that the rates of cervical cancer screening in our population of black women was estimated to be higher than whites after adjusting for income and education, and using survey weights from the urban/rural strata.

For health promotion/cancer risk behaviors, people with lower incomes (less than \$20,000 or \$20,000–\$49,999) had about one-third the odds of reporting engaging in physical activity 1 to 3 times per week (OR = 0.28, $P < 0.05$ and OR = 0.39, $P < 0.05$, respectively). People with income levels less than \$20,000 had three times the odds of smoking every day (OR = 3.10, $P < 0.05$), whereas those with a college degree had one-fifth the odds of smoking every day (OR = 0.22, $P < 0.05$).

Discussion

The intersection between race and SES is well documented and further examination of the minority poverty hypothesis—that

Table 2B. ORs from logistic regression on cancer-related knowledge and beliefs

	Black vs. White	<\$20,000 vs. \$50,000+	\$20–\$49,999 vs. \$50,000+	High school vs. <HS	Some college vs. <HS	College grad vs. <HS
Knowledge						
Start mammograms at age 40 or 50	0.78	0.68	0.56	0.94	1.21	1.01
Start CRC screening at age 50	0.62	0.67	0.40	0.71	1.06	1.30
Smokers start lung screening at age 55	1.09	0.39	0.16	NA	NA	NA
Cancer beliefs						
Everything causes cancer	0.69	0.93	1.06	1.48	1.49	1.13
So many recommendations, hard to know what to do	1.33	1.11	1.26	0.79	0.82	0.80
Think about cancer, think about death	1.11	1.75	0.90	0.67	0.75	0.95
Not much you can do to lower chances of cancer	0.62	2.37^a	2.00^a	0.72	0.73	0.57
Rather not know my chances of getting cancer	0.63	1.68	1.92^a	0.72	0.62	0.52
Cancer worry (% moderately/extremely worried)	0.41^a	2.32	0.96	1.39	2.76	2.36
Comparative cancer risk						
(Ref = unlikely/very unlikely)						
Neither likely nor unlikely	0.38^a	1.78	5.47^b	3.29^a	2.95	7.48^c
Likely/very likely	0.26^c	1.80	3.16^a	2.63	4.30^a	5.83^c

NOTE: ORs are from logistic regression models with race, age group, sex, location, income, and education, including survey weights. Results for sex and location not shown. Stable estimates for ORs are unavailable for education on lung screening knowledge due to small cell counts, where only one person with less than a high school degree had a correct response for lung scan age.

Abbreviations: CRC, colorectal cancer; HS, high school; NA, not available.

^a $P < 0.05$.^b $P < 0.001$.^c $P < 0.01$.

Table 3A. Cancer screening and health promotion behaviors by race

	Black (192) n (%)	White (743) n (%)	P ^a	Black (44,084) Weighted n (%)	White (248,047) Weighted n (%)	P ^a
Cancer screening						
Stool test in past year						
Yes	10 (7.0%)	27 (5.0%)	0.344	2,270 (10.9%)	7,697 (6.8%)	0.350
No	132 (93.0%)	511 (95.0%)		18,485 (89.1%)	106,176 (93.2%)	
Sigmoidoscopy in past 5 years						
Yes	4 (2.8%)	8 (1.5%)	0.309	533 (2.5%)	1,590 (1.4%)	0.490
No	141 (97.2%)	525 (98.5%)		20,614 (97.5%)	110,749 (98.6%)	
Colonoscopy in past 10 years						
Yes	105 (72.9%)	413 (77.6%)	0.236	14,814 (70.6%)	92,110 (82.3%)	0.043
No	39 (27.1%)	119 (22.4%)		6,166 (29.4%)	19,787 (17.7%)	
Adherent to any CRC screening						
Yes	111 (78.2%)	427 (80.3%)	0.581	16,147 (77.6%)	95,182 (84.7%)	0.134
No	31 (21.8%)	105 (19.7%)		4,660 (22.4%)	17,152 (15.3%)	
Lung scan in past year						
Yes	2 (12.5%)	14 (15.7%)	0.741	172 (8.9%)	1,821 (11.8%)	0.767
No	14 (87.5%)	75 (84.3%)		1,774 (91.2%)	13,588 (88.2%)	
Mammogram in past 2 years						
Yes	65 (81.3%)	217 (80.4%)	0.861	10,136 (82.5%)	54,906 (84.5%)	0.750
No	15 (18.8%)	53 (19.6%)		2,151 (17.5%)	10,096 (15.5%)	
Pap test in past 3 years (or past 5 years with HPV test)						
Yes	39 (78.0%)	137 (75.7%)	0.734	13,304 (90.6%)	77,573 (78.4%)	0.043
No	11 (22.0%)	44 (24.3%)		1,377 (9.4%)	21,420 (21.6%)	
Health promotion/risk behaviors						
Physical activity						
None/0 days per week	53 (28.7%)	193 (27.0%)	0.696	10,687 (25.5%)	52,541 (22.0%)	0.770
1-2 days per week	45 (24.3%)	196 (27.4%)		10,525 (25.2%)	62,741 (26.3%)	
3-7 days per week	87 (47.0%)	327 (45.7%)		20,628 (49.3%)	123,575 (51.7%)	
Tobacco use						
Not at all	142 (77.6%)	605 (84.4%)	0.006	32,855 (77.1%)	210,596 (87.7%)	0.028
Some days	19 (10.4%)	25 (3.5%)		3,678 (8.6%)	5,492 (2.3%)	
Everyday	22 (12.2%)	87 (12.1%)		6,102 (14.3%)	23,990 (10.0%)	

NOTE: Eligibility for stool test, sigmoidoscopy, colonoscopy, and any CRCS includes ages 50–75. Lung scan is for ages 55 to 80 with more than 30 pack-years. Mammogram is ages 50–75, and Pap test is ages 21 to 65 without a hysterectomy.

^aP values are from Pearson χ^2 tests.

Table 3B. ORs from logistic regression on cancer screening and health promotion/risk behaviors

	Race Black vs. white	Income		Education		
		<\$20,000 vs. \$50,000+	\$20–\$49,000 vs. \$50,000+	High school vs. <HS	Some college vs. <HS	College grad vs. <HS
Cancer screening						
Stool test in past year	1.48	0.69	1.33	0.73	0.17	0.55
Sigmoidoscopy in past 5 years	1.43	1.79	0.06^a	5.48	1.98	1.41
Colonoscopy in past 10 years	0.63	0.48	0.65	0.49	1.34	1.68
Adherent to any CRC screening	0.72	0.45	0.53	0.46	0.92	1.16
Lung scan in past year	2.84	0.05^b	0.07^a	0.25	0.02^a	0.04^b
Mammogram in past 2 years	1.09	1.54	0.75	1.24	3.65	1.98
Pap test in past 3 years (or past 5 years with HPV test)	6.69^a	0.76	0.85	0.37	1.72	4.29
Health promotion/risk behaviors						
Physical activity (Ref = 0 days per week)						
1-3 days per week	1.52	0.28^b	0.39^b	0.70	0.45	0.82
3-7 days per week	1.25	0.76	0.53	0.50	0.78	0.96
Tobacco use (Ref = Not at all)						
Some days	2.45	4.35	1.13	0.45	0.43	0.16
Every day	1.05	3.10^b	0.74	0.93	0.39	0.22^b

NOTE: ORs are from logistic regression models with race, sex, age group, location, income, and education, including survey weights. Results for sex and location not shown. Eligibility for stool test, sigmoidoscopy, colonoscopy, and any CRCS includes ages 50–75. Lung scan is for ages 55 to 80 with more than 30 pack-years. Mammogram is ages 50–75, and Pap test is ages 21–65 without a hysterectomy.

Abbreviations: CRC, colorectal cancer; HS, high school.

^aP < 0.05.

^bP < 0.01.

disparities are concentrated in minority groups with low SES—can be used to guide strategies to reduce disparities (10, 11). An intersectional approach emphasizes the importance of intersecting inequalities, multiple vulnerabilities, and the need to examine how multiple dimensions of social status (race, income, education) combine to facilitate or restrict exposure and response to risk factors and resources relevant for a disease and its treatment (Schulz and Mullings 2006; Weber and Fore 2007). Intersectional theory proposes that multiple social statuses are experienced simultaneously and dynamic interdependent processes arise when race, ethnicity, SES, and other social status factors combine to affect patterns of risks and resources, privilege, and disadvantage that can affect health (12).

Our results support the relevance of intersectional theory and methods to evaluate cancer disparities (13) with important differences in cancer-related knowledge, beliefs, and behaviors (cancer screening, physical activity, tobacco use) between racial and socioeconomic groups observed in selected counties in the state of Indiana. Our results confirmed the relationship between race and SES with fewer black respondents having higher incomes, living comfortably on their current income, and owning their own home.

Despite including only people who had been seen at least once in an Indiana University Health facility in the past year, a significantly greater proportion of black respondents reported being unable to see a doctor in the last 12 months due to cost. Having a single health care encounter does not guarantee that, when other health care needs arise, people are not constrained from seeing a doctor by costs. Financial burden can be driven by inadequate insurance, co-payments, and high out-of-pocket costs relative to income.

When controlling for SES, sex, age, and geographic location of residence (urban/rural), Black respondents were less likely to perceive that they were at risk for getting cancer during their lifetime and less worried about getting cancer. Surprisingly, black women were greater than six times more likely to be adherent to cervical cancer screening in Indiana.

Knowledge about appropriate ages to start screening for breast, colorectal, and lung cancer did not differ by race or SES. The percentages of respondents overall who answered those questions correctly was low, often near 50%. Frequent changes made to cancer screening guidelines has been shown to be a source of confusion for both the public and health care providers and likely contributed to these results (14–16). The need to increase awareness about when to initiate screening is clear, and ongoing campaigns for providers and the public may narrow this knowledge gap in the future. The low levels of perceived risk of developing cancer among black residents is another opportunity for education and outreach. Current cervical cancer screening rates in Indiana are at 75%, indicating the need to implement effective strategies to increase rates, particularly among white women (<https://statecancerprofiles.cancer.gov/quick-profiles/index.php?statername=indiana#t=2>).

Two socioeconomic factors, income and education, were associated with cancer-related beliefs and health promotion behaviors, but not knowledge of cancer screening. Perceptions of comparative lifetime cancer risk differed by both income and education groups. People with incomes from \$20,000–\$49,999 and those with a high school education or higher were more likely to report that they were neither likely nor unlikely to get cancer in their lifetime compared with those with lower incomes or less

education. People with higher incomes (\$50,000 or higher) were less likely to have a fatalistic attitude about cancer believing there is not much one can do to lower their chance of getting cancer. Those with higher incomes have the resources to access preventive services such as cancer screening—in fact having had a lung scan in the past year was associated with income. People with the highest incomes were more likely to engage in physical activity and less likely to smoke. These behaviors all reduce one's risk of getting cancer and are consistent with the belief that one can do something to lower your chances of getting cancer.

Comparing our results with available statewide and national data yielded some interesting and conflicting findings (<https://statecancerprofiles.cancer.gov/quick-profiles/index.php?statername=indiana#t=1>). On several measures, our sample engaged in more health-promoting behaviors than the rest of the state of Indiana. For example, our sample had higher rates of having had a mammogram in the past 2 years than both the Indiana and US averages (80.6% vs. 72.5% vs. 78.3%, respectively). For colorectal cancer screening, an impressive 79.8% of our sample was up-to-date compared with 64.6% statewide and 67.7% nationally. The higher screening rates were not surprising given this sample was comprised of people who had access to health care services.

On other parameters, our sample reported comparable or less healthy behaviors than the rest of the state. Almost half of our sample reported ever having smoked at least 100 cigarettes (45.7%) which exactly matched the Indiana state rate (45.7%) but was higher than the national rate of 40.9%. Regarding current smoking, 83% of our sample reported no cigarette smoking, while 17.0% smoke every day (12.1%) or on some days (4.9%). Comparatively, the cigarette smoking rate is higher in Indiana (21%) and 16.4% nationally. In our sample, 27.3% reported no leisure time physical activity, which was comparable with the state at 26.8%, but higher than the national rate of 24.2%.

These health behaviors are less related to access to healthcare and more closely reflect statewide rates. Clearly, there is work to be done to improve the health, and reduce the risk of cancer, for the people of Indiana.

This study was funded by an administrative supplement from the National Cancer Institute (P30 CA082709-17S6) that was issued to "support infrastructure development at Designated Cancer Centers to enable state-of-the-art local data collection, and to pilot the fielding of local population health assessments." Funded sites worked with NCI staff to collect data at local catchment area levels that complements national survey data and will enable local versus national comparisons on common data elements. Therefore, one of the strengths of this study lies in our future ability to compare results from our catchment area to data collected by 14 other funded cancer centers. Combining these datasets that used a common set of core measures will enable comparisons on self-reported data from diverse populations across the country that previously has not been available. Because measures were derived from the HINTS, NHIS, and BRFSS, additional comparisons with national data will be possible. Another unique strength of this study is our ability to link self-reported survey data to medical record data for the 743 Indiana respondents who returned signed authorizations forms. These respondents granted our research team access to their medical records for the next 10 years, allowing prospective studies to be conducted in the future.

These results must be interpreted in light of several limitations. First, our sampling frame included only residents who were

engaged with a single health system in Indiana; nonetheless, IUH is the largest integrated health system in Indiana and has locations serving patients throughout the state. Second, this study did not collect data from residents who had no interactions with any health care facility in the past year. Our sample by definition demonstrates at least some health-seeking behavior and so likely has worse health status than the general population. Access to health services and completion of cancer screenings, thus, may be over-estimated in this sample. Third, our response rate was low, despite use of established methods for survey research. Comparisons between responders and nonresponders showed that those who chose to complete the survey were more often white, older, and residents in rural areas. Therefore, these results may not be generalizable to younger, black, urban Indiana residents. Future studies are needed that specifically focus on these populations. Other data collection methods, including in-person or telephone interviews, might have increased our participation rate. However, we did receive completed surveys from every county sampled (See Fig. 1).

Study results have established a baseline to enable investigators to conduct future research future to: (i) further examine and monitor patterns of knowledge, beliefs, and screening behaviors of residents in our catchment area; (ii) identify factors that contribute to cancer disparities in Indiana; and (iii) test community and health system-based interventions to reduce cancer incidence, mortality, and disparities in Indiana.

The survey data will be linked with electronic medical record (EMR) data for 743 (77% of total) respondents who signed authorization forms granting the researchers permission to access their EMR data. EMR data are available from the Indiana Network for Patient Care, a federated database populated with clinical data from hospital systems throughout Indiana, enabling the measurement of care received across health care settings. With EMR

data, respondents can be better characterized in terms of health status, including medical comorbidities, blood pressure, and body mass index. Furthermore, patients can be followed longitudinally for up to 10 years regarding health care utilization behavior, including cancer screening, preventive care, diagnoses, treatments, and relevant disease outcomes. This infrastructure will enable testing of temporal associations between relevant survey domains (health information-seeking behavior, health behaviors) and health care utilization.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: S.M. Rawl, D.A. Haggstrom, J.L. Lee
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Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): S.M. Rawl, D.A. Haggstrom, E. Teal, L.B. Baker
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): S.M. Rawl, D.A. Haggstrom, S. Dickinson, S. Kianersi
Writing, review, and/or revision of the manuscript: S.M. Rawl, D.A. Haggstrom, S. Dickinson, J.L. Lee, J.L. Roberts, L.B. Baker, S. Kianersi
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): J.L. Roberts, L.B. Baker
Study supervision: S.M. Rawl, D.A. Haggstrom, L.B. Baker

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