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Understanding lung cancer screening behavior: Racial, gender, and geographic differences among Indiana long-term smokers

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ABSTRACT

Lung cancer screening is a relatively new screening option. Inequalities related to screening behavior have been documented in other types of cancer screening. Because stage at presentation drives mortality in lung cancer, it is critical to understand factors that influence screening behavior in lung cancer screening in order to intervene. However, we must first understand where disparities exist in lung cancer screening participation in order to effectively guide intervention efforts. Therefore, the purpose of this study was to determine the association of sociodemographic (including key disparity-related variables) and knowledge with lung cancer screening behavior. This cross-sectional, descriptive study used survey methodology to collect data from 438 screening-eligible individuals in the state of Indiana between January and February 2017 and measured sociodemographic variables and knowledge about lung cancer and screening. Key sociodemographic and health status characteristics associated with screening behavior included race, geographic area of residence, income, health insurance, and family history of lung cancer. Of the variables generally reflective of disparities, key differences were noted by race and geographic area of residence with total knowledge scores as well as screening behavior, respectively. Results indicate key differences in race and geographic area of residence that may perpetuate screening behavior disparities. We have a unique opportunity at this early implementation stage in lung cancer screening to learn what variables influence screening behavior from our target patient population. This knowledge can be used to design equitable patient outreach programs, meaningful, tailored patient engagement materials, and effective patient-clinician decision support tools.

1. Introduction

Lung cancer is the leading cause of all cancer-related deaths in the U.S. with > 158,000 people dying annually; approximately 4000 of those deaths occur among Indiana residents (American Cancer Society, 2017; Indiana Cancer Consortium, 2015). Cancer screening has the potential to save lives by identifying lung cancer early when individuals are asymptomatic and has been associated with decreased mortality rates in those at high-risk (Aberle et al., 2011). Individuals qualify for lung cancer screening if they are aged 55 to 80, are a current smoker or former smoker who has quit within the past 15 years, and have at least a 30 pack-year tobacco smoking history (Moyer, 2014). Lung cancer screening is performed with low-dose computed tomography (LDCT) of the chest and screening guidelines were issued in 2013 with a Grade B recommendation by the U. S. Preventive Services Task Force (USPSTF) (Moyer, 2014). Further, lung cancer screening is a preventive health service with a zero out-of-pocket copay under the Affordable Care Act and a covered preventive service by the Centers for Medicare and Medicaid Services (CMS) for screening-eligible beneficiaries (United States Preventive Services Task Force Lung Cancer Screening Guidelines, 2013).

Inequalities related to screening behavior have been documented in established cancer screening programs such as breast and colorectal cancer screening (Liss & Baker, 2014; Chowdhury et al., 2016; Miranda et al., 2011). Historically, the availability of a new screening test increases race and socioeconomic disparities in cancer stage at diagnosis and mortality. Once the screening test becomes standard of care and is in widespread use, disparities tend to decrease but remain (Link & Phelan, 1996; Phelan et al., 2004). This is evidenced at present by racial disparities noted in breast and colorectal cancers for which screening tests have long been available (American Cancer Society, 2017). Lung cancer screening is a relatively new screening option. Of the 6.8 million

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Americans who currently qualify for lung cancer screening, < 4% have been screened (Jemal & Fedewa, 2017). Identifying factors associated with screening behavior is important in order to proactively address screening disparities. In the National Lung Screening Trial on which the lung cancer screening guideline is based, LDCT of the chest reduced lung cancer mortality more in Black participants compared to their White counterparts (hazard ratio 0.61 vs. 0.86) respectively. (Tanner NT et al., 2015) In order for this benefit to be translated to the real world setting, effective screening interventions that target engagement of screening-eligible individuals as well as address race-relevant issues in lung cancer screening must be implemented. However, we must first understand where disparities exist in relation to lung cancer screening participation in order to guide intervention efforts. Having a baseline understanding of variables associated with lung cancer screening behavior as well as potential disparities is a critical prerequisite to proactively addressing equitable implementation of lung cancer screening.

Little is known about the relationship of sociodemographic and health status characteristics, including key variables generally reflective of disparities (i.e., race, gender, and geographic area of residence), and their association with lung cancer screening behavior. Because stage at presentation drives mortality in lung cancer (American Cancer Society, 2017), screening high-risk smokers is critical for early detection and subsequent treatment at earlier stages and has the potential to decrease mortality. Therefore, the purpose of this paper is to determine whether sociodemographic variables including key disparity-related variables (race, gender, and geographic area of residence) and knowledge are associated with lung cancer screening behavior in screening-eligible individuals in the state of Indiana. Research questions include:

1) What sociodemographic and health status characteristics (including key disparity variables) are associated with lung cancer screening behavior?
2) Does knowledge of lung cancer risk and screening differ by key disparity variables or sociodemographic characteristics?
3) Do sociodemographic and health status characteristics that are associated with lung cancer screening behavior depend on race, gender, or geographic area of residence?

2. Methods

2.1. Study design, sample, and data collection

A cross-sectional study was conducted using survey methods. Participants were recruited in the state of Indiana from January to February 2017 using two primary community-based recruitment methods, Facebook targeted advertisement and in-person recruitment efforts at four local community senior centers. Power analysis indicated that 300 participants were needed to detect an odds ratio of 2.64 or higher when analyzing categorical variables and an effect size of 0.60 or higher when analyzing continuous variables. Inclusion criteria mirrored USPSTF lung cancer screening eligibility criteria: 1) age 55 to 80 years; 2) minimum 30-pack-year tobacco smoking history; 3) current smoker or former smoker who quit within the past 15 years; and 4) not diagnosed with lung cancer.

Institutional review board approval was obtained from Indiana University prior to participant recruitment. Data were collected via a one-time, web-based survey using REDCap (**R**esearch **E**lectronic **D**ata **Cap**ture). For participants recruited in-person who did not wish to complete the survey online, a paper copy of the survey was provided (n = 52).

2.2. Measures

Guided by the Conceptual Model on Lung Cancer Screening Participation (Carter-Harris et al., 2016), data were collected using a compilation of items and scales to assess lung cancer screening behavior, sociodemographic and health status characteristics (age, gender, race, geographic area of residence, income, education, insurance status, smoking status, and family history of lung cancer), and knowledge of lung cancer and screening. Geographic area of residence was categorized using address and zip code data to classify participants as residing in urban, suburban, or rural areas.

2.3. Lung cancer screening behavior

The stage theory, Precaution Adoption Process Model (PAPM) ("The Precaution Adoption Process Model" by Neil D. Weinstein, Peter M. Sandman, and Susan J. Blalock, et al., 2008), was used to create an algorithm of questions to assess the primary outcome variable of an individuals' stage of adoption for lung screening behavior, which included intent to screen for lung cancer in the next six months. The PAPM involves seven stages ranging from Stage 1 (unaware) to Stage 7 (maintenance) ("The Precaution Adoption Process Model" by Neil D. Weinstein, Peter M. Sandman, and Susan J. Blalock, et al., 2008). "Screeners" are defined in this study as those individuals who indicated they either intended to screen for lung cancer (Stage 5), had recently completed lung cancer screening (Stage 6), or were screening annually (Stage 7).

3. Data analyses

Data were exported from REDCap into SAS version 9.4 (SAS Institute, Cary, North Carolina) and cleaned by examining frequency tables and removing invalid data. Data were evaluated for outliers and to determine if the data were normally distributed. Missing, multiple responses, "inapplicable", and "don't know" answers were recoded as missing for analytic purposes. Due to the low frequencies of non-Black and non-White races (n = 16), these were omitted in order to prevent spurious results. Two participants did not answer the PAPM and were also removed from analysis. For research question one, data were analyzed comparing screened and non-screened groups using the Pearson Chi-Square test to compare unordered categorical variables and the 1df Mantel-Haenszel Chi-Square test of trend to compare ordinal categorical variables such as education and income. For research question two, the three key disparity variables (race, gender, and geographic area of residence) were first analyzed with knowledge scores in a bivariate manner, to determine if any had a significant association. Next, a multivariable model incorporating all three of the key disparity variables was used to determine if any disparity variable was driving the association compared to others. Finally, a multivariable model that included the key disparity variables and demographic variables was analyzed to determine if sociodemographic variables would attenuate significant associations between disparity variables and total knowledge scores. For research question three, factorial ANOVA models were performed to determine if there were significant interaction effects and to determine if there was significant moderation between the disparity variables and demographic variables. Although various fields use higher p-values for interaction terms, due to the lower power to detect a significant association, we considered a p-value of 0.05 to be a significant moderating association in order to prevent inflated type I error rates. All analyses were conducted using $p < 0.05$ as the significance level.

4. Results

4.1. Sample description

A full description of participant sociodemographic and health status characteristics is shown in Table 1. Participants (N = 438) ranged in age from 55 to 79 years (mean, 62.6 [SD 5.8]), and slightly more than