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Comparing cancer screening estimates: Behavioral Risk Factor Surveillance System and National Health Interview Survey

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ABSTRACT

Cancer screening prevalence from the Behavioral Risk Factor Surveillance System (BRFSS), designed to provide state-level estimates, and the National Health Interview Survey (NHIS), designed to provide national estimates, are used to measure progress in cancer control. A detailed description of the extent to which recent cancer screening estimates vary by key demographic characteristics has not been previously described. We examined national prevalence estimates for recommended breast, cervical, and colorectal cancer screening using data from the 2012 and 2014 BRFSS and the 2010 and 2013 NHIS. Treating the NHIS estimates as the reference, direct differences (DD) were calculated by subtracting NHIS estimates from BRFSS estimates. Relative differences were computed by dividing the DD by the NHIS estimates. Two-sample *t*-tests (2-tails), were performed to test for statistically significant differences. BRFSS screening estimates were higher than those from NHIS for breast (78.4% versus 72.5%; DD = 5.9%, $p < 0.0001$); colorectal (65.5% versus 57.6%; DD = 7.9%, $p < 0.0001$); and cervical (83.4% versus 81.8%; DD = 1.6%, $p < 0.0001$) cancers. DDs were generally higher in racial/ethnic minorities than whites, in the least educated than most educated persons, and in uninsured than insured persons. For example, the colorectal cancer screening DD for whites was 7.3% compared to ≥ 8.9% for blacks and Hispanics. Despite higher prevalence estimates in BRFSS compared to NHIS, each survey has a unique and important role in providing information to track cancer screening utilization among various populations. Awareness of these differences and their potential causes is important when comparing the surveys and determining the best application for each data source.

1. Introduction

Cancer screening is an important element of cancer early detection and prevention (for colorectal and cervical cancers) (Smith et al., 2017). Cancer screening metrics are included in the Healthy People 2020 goals (US Department of Health and Human Services and Office of Disease Prevention and Health Promotion, 2014), and the National Colorectal Cancer Roundtable (NCCRT) aims to increase colorectal cancer (CRC) screening prevalence to 80% by 2018 (National Colorectal Cancer Roundtable, 2014). Furthermore, state and county-level cancer screening prevalence estimates are included in the National Cancer Institute's (NCI) State Cancer Profiles, a tool used for cancer control planning (US Department of Health and Human Services et al., 2017). The Behavioral Risk Factor Surveillance System (BRFSS) is designed to provide reliable state and sub-state level data and the National Health Interview Survey (NHIS) is designed to provide reliable national and regional level data to measure progress toward these goals. The BRFSS is an annual cross-sectional state-based telephone survey facilitated by the Centers for Disease Control and Prevention's (CDC) National Center for Chronic Disease Prevention and Health Promotion since 1984. Due to the rapidly increasing cellular telephone-only households in the US, in 2011, the BRFSS methodology changed to include those cellular telephone-only households in the sampling frame and also improved the method of statistical weighting. NHIS is an annual cross-sectional in-person interview survey conducted by CDC's National Center for Health Statistics since 1957. Given the differences in design and methodology between the two surveys, it is unsurprising that differences in prevalence estimates of smoking and obesity (Nelson et al., 2003) as well as cancer screening (Centers for Disease Control and Prevention, 2013; Davis et al., 2010; Sabatino et al., 2015) have been reported previously. Yet, a detailed description of the extent to which the estimates vary by key demographic characteristics has not been previously described. Additionally, no detailed comparison of cancer screening estimates from the two surveys has been published since the 2011 methodologic change in BRFSS. The purpose of the current study is to examine differences in the prevalence estimates for

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breast, cervical, and colorectal cancer screening test use based on recent BRFSS and NHIS data. Our aim is not to downplay the importance or accuracy of one survey over the other, but instead to identify and provide possible explanations for observed differences.

2. Materials and methods

2.1. Data sources

We used the 2012 and 2014 BRFSS and the 2010 and 2013 NHIS data based on availability of cancer screening data. The BRFSS is a state-based telephone survey, with a target population of non-institutionalized adults ≥ 18 years, designed to produce state-level estimates of chronic conditions, and preventive care behaviors based on self-reports (Centers for Disease Control and Prevention et al., 2014). Cancer screening questions are included every two years. The 2012 and 2014 public use data files were combined for this study to improve the precision of estimates. All states implemented computer-assisted telephone interview systems. The sampling frame included cellular telephone-only households and households with landlines. Cellular telephone numbers were randomly selected from banks of 1000 numbers from the cellular telephone databases (Centers for Disease Control and Prevention, 2015b). A disproportionate stratified sample design was used for the sampling of landline telephone numbers. The median state response rate in 2012 was 42.5% (range: California = 27.7%, South Dakota = 60.4%) and 47.0% in 2014 (range: California = 25.1%, South Dakota = 60.1%). Each BRFSS participant was weighted to account for non-equal probability of selection, number of residential phone numbers and adults ≥ 18 years in his/her household. Sample weights were further adjusted to the state population through a raking process by age, gender, race and ethnicity, education level, marital status, and geographic region within each state to reduce potential non-response bias and improve representativeness (Centers for Disease Control and Prevention, 2012). BRFSS estimates included aggregated data from all 50 states and the District of Columbia.

The NHIS is an in-person interview survey, with a target population of non-institutionalized people residing in the US, designed to produce national estimates of sociodemographic and health-related topics based on self-reports (Centers for Disease Control and Prevention, 2015a). Cancer screening questions are included every 2–3 years as part of the Cancer Control Supplement. The public use data files for 2010 and 2013 were combined for this study to ensure sufficient sample sizes in subgroups of interest. The NHIS questionnaires were administered using computer-assisted personal interview software (National Center for Health Statistics, 2013). NHIS participants were selected based on a multistage area probability sample of households (National Center for Health Statistics, 2013). The 2010 and 2013 final sample adult response rates were 60.8% and 61.2%, respectively. Household- and person-level base weights for the NHIS data, a reflection of the probability of selection at each sampling stage, were adjusted for non-response and were ratio-adjusted to create final sampling weights. The final person-level weights were also post-stratified to US population estimates produced by the Census Bureau, using classes of age, sex, and race/ethnicity to mitigate non-response bias.

2.2. Primary outcomes

Primary outcomes included self-reports of breast, cervical, and colorectal cancer screening derived from responses to the relevant survey questions (Fig. 1). The US Preventive Services Task Force (USPSTF) cancer screening recommendations were used as the basis for defining our primary outcomes (Moyer, 2012; Siu, 2016; U.S. Preventive Services Task Force, 2008). Breast cancer screening was defined as having had a mammogram within the past two years among women age 50–74 years (BRFSS n = 263,010; NHIS n = 11,881). The specified age group and frequency for recommended breast cancer screening differs by organization, including USPSTF (Siu, 2016) and the American Cancer Society (Smith et al., 2017); thus, annual mammography among women age 50–74 years was also assessed. Due to the inconsistency in screening guidelines for women age 40–49 years by organization and to align with the most recent USPSTF guidelines, we excluded this age group in this study. Cervical cancer screening was defined as having had a Pap test within the past three years among women age 21–65 years who had not reported ever having a hysterectomy (BRFSS n = 255,774; NHIS n = 20,856). Data were not available to assess human papillomavirus co-testing as a means of cervical cancer screening. Three CRC screening measures were considered among men and women age 50–75 years: home fecal occult blood test (FOBT) within the past year (BRFSS n = 449,461; NHIS n = 21,937), colonoscopy within the past 10 years (BRFSS n = 438,467; NHIS n = 22,024), and a summary measure according to USPSTF screening recommendations (FOBT within the past year or sigmoidoscopy in the past five years with FOBT within the past three years or colonoscopy within the past 10 years) (BRFSS n = 441,073; NHIS n = 22,113).

The BRFSS data are limited with respect to details about whether the test/procedure was conducted for screening or diagnostic purposes, precluding exclusion of participants tested for diagnostic purposes (Becker et al., 2015). Thus, our analyses of both the BRFSS and NHIS data defined “screening” as having the recommended screening tests for any reason, consistent with the approach used for the Heathy People 2020.

2.3. Statistical analysis

Descriptive statistics were used to summarize self-reported screening prevalence overall and by the following sociodemographic characteristics: age, sex (CRC screening), race/ethnicity (non-Hispanic white [NHW], non-Hispanic black [NHB], Hispanic, and other), educational attainment (< high school [HS], HS/GED, some college/associate's degree, college graduate), health insurance status at the time of the survey (insured, uninsured), and geographic region (U.S. Census Bureau, 2016) (Northeast, Midwest, South, West). To calculate nationally representative estimates, sample weights and the complex survey design were incorporated in all analyses. Results are presented as weighted estimates and Taylor Series linearization method was used to estimate variances. Weighted estimates were also age-standardized to the 2000 US standard population (Klein et al., 2002). All analyses were conducted using SAS 9.3 Software (SAS Institute, Cary, NC) and SAS-callable SUDAAN (release 11.0.1) (RTI International, 2016).

The NHIS estimates were treated as the reference since NHIS has higher response rates and better coverage of no-phone households. Direct (DDs) and relative differences (RDs) between the two surveys were calculated as both can be useful in monitoring inequities (King et al., 2012). DDs were defined as the BRFSS estimates minus the NHIS estimates. RDs were defined as the DD divided by the NHIS estimate. Two-sample t-tests (2-tails) were performed to test the significance of the differences between the two surveys. T-tests were preferred over z-tests to account for the degrees of freedom in NHIS (df = 300). Bonferroni correction was applied to account for multiple simultaneous comparisons. Statistical significance was ascertained using a threshold of $p <$ alpha-value of 0.05 divided by number of groups to be compared.

3. Results

3.1. Breast cancer screening

Demographic characteristics of women age 50–74 years were similar between the two surveys (Supplemental Table 1) where nearly one-half of women were 50–59 years of age (DD = − 1.3%, RD = − 2.5%). The most common racial/ethnic group was NHW (DD = − 0.8%, RD = − 1.0%) followed by NHB (DD = − 0.2%,

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