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Cancer incidence trends using American Community Survey estimates are not consistent with SEER for small populations

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Abstract

Background: American Community Survey (ACS) estimates are said to be uncertain for small areas and small population groups. The Surveillance, Epidemiology and End Results (SEER) database uses a decennial census extrapolation methodology to yield population estimates used by cancer researchers across the country. We compared metropolitan Detroit cancer incidence estimates calculated using ACS data to those using SEER population estimates, which we considered to be the gold standard.

Methods: We generated age-adjusted cancer incidence rate estimates for 1-year, 3-year and 5-year time periods (2005–2010) using SEER and ACS population estimates for four racial/ethnic groups by sex and cancer type for residents in the tri-county Detroit area. We calculated incidence rate ratios (IRRs) with corresponding 95% confidence intervals (CIs), and compared trends.

Results: While the IRRs were rarely significant, there were significant differences in incidence rate estimates for Hispanic males. Additionally, interpretation of trends varied by the estimate source: the ACS-based lung cancer incidence rate estimate for Hispanic females increased from 70.59 (95% CI 44.85, 110.67) to 86.13 (95% CI 54.83, 132.44) per 100,000 women from 2007 to

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Authorship contribution

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Critical review of the manuscript for intellectual content: Kendra Schwartz, Julia Mantey, Julie Ruterbusch, Rafael Meza.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.canep.2016.06.014>.

2010, while the SEER incidence rate estimate decreased from 80.76 (95% CI 53.36, 119.24) to 73.54 (95% CI 49.24, 106.62).

Conclusions: Inconsistencies were found when comparing incidence rate estimates for small population groups using the two population estimate sources. This finding has potential implications for health disparities research.

Keywords

Cancer incidence estimates; American Community Survey; SEER

1. Introduction

The American Community Survey (ACS), administered by the U.S. Census Bureau, is a rolling survey that replaced the decennial long form census after the year 2000. It was created to eliminate the need for the long form census and to meet data users' demand for more frequent and current survey data [1]. Whereas the long form census gathered detailed information about population and housing characteristics from a subset of the population (approximately one in six households) once every decade, the ACS was implemented annually and reaches approximately one in forty households per year [2]. When cumulated to yield a five-year period estimate, the most reliable estimate available from the ACS [3], the sampling frame is approximately one in eight households. These smaller samples and procedural differences in survey follow-up³ have contributed to higher margins of error in ACS population estimates [4]. Furthermore, survey inclusion rates have been found to differ significantly between demographic groups [5]. This raises concern about the quality of the ACS population estimates.

Several studies have compared implementation issues with the ACS and long form census and their resulting population estimates [6–10]. Among the findings of these studies was the recognition that demographic estimates may differ between the two surveys [6]. However, no studies to date have considered the implications of this for the estimation of cancer incidence or other disease rates.

Due to the large population of Arab Americans in metropolitan Detroit and other urban areas in the country, the Detroit Surveillance, Epidemiology, and End Results (SEER) program has tracked the cancer burden among this population subgroup. Since Arab American is not a federally recognized racial/ethnic group, we historically have estimated population numbers based on decennial long form census responses to ancestry, country of origin, and language spoken at home [11–15]. These same questions are part of the ACS and could be used for the same purpose; however, due to the uncertainty surrounding the accuracy of the ACS data for smaller populations and geographies [16], we wanted to first assess the comparability of ACS population estimates to those from SEER using racial/ethnic data based on self-report of race/ethnicity. SEER uses population estimates from extrapolated decennial census data [17] and is considered the gold standard in this observational study.

We compared cancer incidence rate estimates for four different racial/ethnic groups calculated using ACS population estimates as population denominators to estimates of the

same rates calculated using Surveillance, Epidemiology, and End Results (SEER) population estimates. If the resulting incidence rate estimates and trends associated with those estimates were consistent between the two methods, we and others could confidently use ACS data to continue to research health disparities among minority population groups such as Arab Americans.

2. Methods

2.1. Databases

This observational study was conducted using public use databases. The SEER Program of the National Cancer Institute collects and publishes data on cancer incidence and survival in the U.S. Through population-based registries, the organization collects data on patient demographics and clinical information by primary tumor site. SEER is an authoritative source of cancer incidence information within the U.S. [18].

SEER provides a statistical software program named SEER*Stat [19] that can be used to produce incidence and survival statistics for user-defined populations [20]. SEER*Stat age-adjusted cancer incidence rate estimates are considered the gold standard in this study. We compared incidence rate estimates calculated using population estimates from the ACS to the same rates generated using SEER*Stat. Intercensal population denominator estimates used by SEER are produced by the U.S. Census Bureau's Population Estimates Program by modifying extrapolations from the 2000 Census to meet 2010 Census results [21]. The formula used produces the intercensal estimates using a method referred to as the Das Gupta method, which "assumes that the ratio of the intercensal estimate to the postcensal estimate should follow a geometric progression over the decade" [21].

The ACS is administered by the U.S. Census Bureau. Population estimates from the ACS are available in summary files from the Census Bureau website [22], and as downloadable data from the Integrated Public Use Microdata Series (IPUMS) website [23]. Estimates are available for one-year, three-year, and five-year time periods. We prepared ACS population estimates for comparison to the Detroit SEER area (Wayne, Oakland, and Macomb counties) by obtaining micro data for each period of interest from IPUMS, restricting the datasets to Wayne, Oakland, and Macomb counties, and applying population weights. We then created a new age group variable to group the data using the same 19 age categories used by SEER in calculating age-adjusted rates [13]. We generated summary data for the tri-county area from each time period by sex and for the 4 population sub-groups examined: Non-Hispanic Whites, Non-Hispanic Blacks, Non-Hispanic Asians/Pacific Islanders, and Hispanics.

Before comparing incidence rates calculated using the two different population estimates, we tested if the age distribution of population estimates varied by race, ethnicity, and sex between SEER and ACS using different ACS pooled-period estimates: one-year estimates for 2007 and 2010; three-year estimates for 2005–2007 and 2008–2010; and five-year estimates for 2005–2009 and 2006–2010. We used a 2-sample Kolmogorov-Smirnov test to determine whether the ACS and SEER age and race/ethnicity specific population estimates, as represented by distribution across the age groups, differed significantly. We conducted

this test separately for all race/ethnicities in both sexes (48 tests, in total), and found no significant differences (data not shown).

2.2. Incidence rate estimate calculations

Incidence rates were calculated using ACS and SEER population estimates stratified by race/ethnicity for cancers of lung, colon, and all cancers combined for both sexes, as well as prostate cancer in males and breast cancer in females for the metropolitan Detroit SEER area. SEER*Stat age-adjusted cancer incidence rate estimates, cancer incidence counts, and age-group population were obtained. We reproduced the age-adjusted cancer incidence rate estimates (standardized to the U.S. standard million population for 2000) using Fay and Feuer's method based on gamma intervals to compute rate estimates, variance, and confidence intervals [24]. The same calculations were repeated using ACS population estimates in place of SEER population estimates using county-level data from the IPUMS database [23]. We applied the population weights provided by the ACS to obtain the population estimates, and limited the dataset to yield only the population estimates of the four race/ethnicity groups of interest.

2.3. Statistical analysis

The two sets of age-adjusted cancer incidence rate estimates generated from the SEER and ACS population estimates were compared using incidence rate ratios (IRRs) and corresponding 95% confidence intervals (CIs). We calculated IRRs and CIs to compare each estimated cancer incidence rate within a given time period, race/ethnicity class, cancer category, and sex. We also compared the trends indicated by the incidence rates estimated with SEER and ACS population estimates within and between population groups in order to determine if the interpreted trends would differ depending on the population estimate used. All analyses were completed using SAS version 9.3.

3. Results

3.1. Overall findings

Overall, we found that cancer incidence rate estimates using SEER and ACS population estimates rarely differed significantly, with the exception of four incidence rate estimate pairs among Hispanic males. However, the comparison of trends that would be interpreted using the different population estimates shows that conclusions drawn would often change depending on the source of population estimates used to calculate incidence rate estimates.

3.2. IRR findings

In Table 1, ACS and SEER rates were similar for both non-Hispanic white and black males. There were no significant differences found between the two types of calculations for non-Hispanic Asian/Pacific Islanders; however the rate estimates varied considerably especially for the one-year time periods. Significant differences in cancer incidence rate estimates were found among Hispanic males. The ACS incidence rate estimate was significantly lower among Hispanic males for the five year time period of 2005–2009 (IRR 0.90, 95% CI 0.82, 0.99); while the ACS estimate was higher for the three year time period of 2008–2010 (IRR 1.18, 95% CI 1.04, 1.34) as well as the one year time period of 2010 (IRR 1.78, 95% CI 1.38,

2.31) (Table 1). The estimated incidence rates of prostate cancer for 2010 also differed significantly for Hispanic males (IRR 2.00, 95% CI 1.22, 3.26) (Supplementary Table 5). We found no significant differences in incidence rate estimates for all cancers among females (Table 2), nor for incidence rate estimates of specific cancer types (Supplementary Tables 2, 4, and 6).

3.3. Comparisons of trends over time

Comparison of the trends observed from one time period to the next show that different conclusions would be drawn depending on which source provided the population estimate. For instance, the lung cancer incidence rate estimates for Hispanic females calculated using SEER and ACS do not differ statistically in 2007 nor in 2010; but the ACS-based lung cancer incidence rate estimate for this group increased from 70.59 (95% CI 44.85, 110.67) per 100,000 women to 86.13 (95% CI 54.83, 132.44) per 100,000 between the two time periods, while the SEER*Stat lung cancer incidence rate estimate for the same group decreased from 80.76 (95% CI 53.36, 119.24) to 73.54 (95% CI 49.24, 106.62) per 100,000 women over the same time period (Supplementary Table 4).

3.4. Comparisons between demographic groups

Similarly, comparison between demographic groups of estimated cancer incidence rates during a specific time period frequently yields different conclusions depending on the population estimate source. Tables 3 and 4 illustrate examples of this, showing comparisons of cancer incidence rate estimates between Hispanics and non-Hispanic whites for all sites and time periods. In a number of instances, SEER and ACS-based estimates lead to opposite conclusions as to which group had the higher incidence rate. For example, using ACS estimates for male lung cancer would result in a conclusion that Non-Hispanic whites have a higher incidence than Hispanics; but using SEER estimates would conclude that Hispanics have the higher incidence rate of lung cancer.

4. Discussion

This analysis of metropolitan Detroit incidence rate estimates supports the conclusion that ACS population estimates yield comparable cancer incidence rates to those calculated by SEER, at least among more common demographic groups and cancer types. The general lack of significant results comparing incidence rate estimates suggests that SEER and ACS population estimates are not significantly different. This in turn implies that ACS population estimates could be considered usable for calculating cancer incidence rates for population subgroups for which SEER does not provide population estimates.

However, in some instances the ACS and SEER cancer incidence rate estimates demonstrated opposite trends within a population. Cancer incidence rate estimate confidence intervals were notably wider for estimates among Non-Hispanic Asian/Pacific Islanders and Hispanics, as these are small population groups in metropolitan Detroit. Although rate ratios showed most estimates do not differ significantly due to the large confidence intervals, the ACS and SEER cancer incidence rate estimates sometimes calculated opposite trends over

time, such as that for Hispanic female lung cancer incidence, with ACS estimates indicating increasing incidence and SEER estimates indicating decreasing incidence over time.

The inconsistency in the direction of rate trends may be partially attributable to differing estimated population numbers and differing amounts of estimated change in population size. In the same example, the estimated population of Hispanic females in 2007 differed by only 111 between the two sources; in 2010, the estimates differed by 495. The observed estimated change in this subpopulation between 2007 and 2010 was 6068 according to ACS estimates, while SEER estimates suggested a smaller increase of 5462 individuals. These differing amounts of change may drive the differing trends and are in part due to inherent inaccuracy related to sampling, especially sampling of small geographic areas [16].

Directional comparisons of cancer incidence rate estimates between different population groups within a given time period often resulted in opposite conclusions depending on the source of the population estimate. Since the same cancer incidence counts were used to calculate all rate estimates, and population distributions did not significantly differ, the inconsistencies are likely driven by difference in estimates of population size. Interestingly, even the 5-year estimates of ACS, which are considered more stable, often led to different conclusions than SEER 5-year estimates. Less populous minority demographic groups are likely to demonstrate more inconsistencies when using the ACS population estimates as compared to other methodologies, such as the extrapolated decennial estimates used by SEER. Similarly, low response rates in census tracts with large populations of minority groups can be expected to contribute to inaccurate population estimates, complicating the analysis of trends in health disparities.

Future studies should consider the potential role of small sample sizes yielding small population estimates for minority groups, especially in the one-year ACS population estimates, as these have the smallest sample size. However, it must be acknowledged that this study does not compare ACS estimates directly to census equivalents, due to the different sampling time frames of the two methodologies; SEER uses extrapolated decennial census data and ACS is a high-frequency survey, constantly measuring the American population using small monthly samples [16].

For our own studies of Arab American cancer trends, the inconsistencies in the trends are worrisome. In the past we relied on decennial census data regarding ancestry, country of origin and language spoken at home to calculate population estimates. These same questions are asked in the ACS but of a smaller sample. The inconsistencies between SEER and ACS demonstrated in this study among Hispanics, a demographic group close in size to the Arab American group in metropolitan Detroit, give us pause to use ACS data for estimating Arab American population numbers. Both small population groups and small geographies are known to have high margins of error in ACS [16]. Both are often studied to describe health disparities and determine if interventions to address those disparities are working. Yet it is difficult to rely on ACS data knowing these short-comings. That said, the U.S. Census Bureau has implemented multiple measures to improve the accuracy of ACS data by mitigating sources of error, including the addition of an online response option, and changes to sampling design [3].

5. Conclusions

Although SEER and ACS population estimates yield cancer incidence rate estimates that do not differ significantly, they do result in interpretation differences not detected through statistical analysis, such as differences in direction of trend between time periods and differences in comparative conclusions between population subgroups. In an applied setting, these non-statistically significant differences in population estimates can produce differing interpretation of results. Both of the observed types of inconsistencies have potential implications for the direction of cancer research and the distribution of resources. Our findings suggest that researchers should be cautious when choosing which population estimates to use, particularly in studies of small population groups. When ACS population estimates are chosen for small population groups, researchers should use the longest sampling frame available.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Comparison of Incidence Rate Estimates of All Cancers Among Males from Metropolitan Detroit at Different Time Periods Using ACS and SEER Population Estimates.

	Time Period 1				Time Period 2			
	ACS		SEER		ACS		SEER	
	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
5 year	2005–2009				2006–2010			
NHW	590.38	(584.58, 596.22)	599.40	(593.51, 605.34)	0.98	(0.97, 1.00)	601.43	(595.55, 607.35)
NHB	710.09	(697.27, 723.12)	699.79	(687.22, 712.56)	1.01	(0.99, 1.04)	705.44	(692.86, 718.23)
NHAPI	240.42	(219.00, 263.77)	263.46	(238.42, 291.26)	0.91	(0.80, 1.04)	233.32	(213.18, 255.24)
HISPANIC	525.28	(490.00, 562.77)	583.93	(544.72, 625.74)	0.90	(0.82, 0.99)	605.82	(564.09, 650.22)
3 year	2005–2007				2008–2010			
NHW	589.95	(582.43, 597.54)	603.64	(595.97, 611.38)	0.98	(0.96, 1.00)	594.51	(587.01, 602.09)
NHB	687.16	(671.08, 703.58)	695.80	(679.51, 712.44)	0.99	(0.96, 1.02)	701.47	(685.44, 717.84)
NHAPI	268.46	(235.96, 305.09)	276.16	(240.84, 316.84)	0.97	(0.81, 1.17)	258.69	(224.38, 300.36)
HISPANIC	537.42	(490.44, 588.63)	601.50	(549.10, 658.58)	0.89	(0.79, 1.01)	657.79	(599.21, 721.43)
1 year	2007				2010			
NHW	610.97	(597.75, 624.42)	621.09	(607.71, 634.70)	0.98	(0.95, 1.01)	600.76	(587.68, 614.08)
NHB	718.63	(689.859, 748.58)	712.25	(684.10, 741.44)	1.01	(0.95, 1.07)	699.92	(672.02, 728.91)
NHAPI	309.94	(241.46, 399.76)	279.09	(220.79, 353.17)	1.11	(0.80, 1.54)	231.61	(191.38, 279.59)
HISPANIC	553.15	(461.05, 662.71)	537.09	(453.00, 634.98)	1.03	(0.81, 1.31)	986.04	(817.20, 1185.12)

ACS: American Community Survey; SEER: Surveillance, Epidemiology and End Results Program. NHW: non-Hispanic white, NHB: non-Hispanic black, NHAPI: non-Hispanic Asian/Pacific Islander. All Rates are per 100,000 population. IRR: Incidence Rate Ratio.

Table 2

Comparison of Incidence Rate Estimates of All Cancers Among Females from Metropolitan Detroit at Different Time Periods Using ACS and SEER Population Estimates.

	Time Period 1				Time Period 2			
	ACS		SEER		ACS		SEER	
	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
5 year	2005–2009				2006–2010			
NHW	457.95	(453.32, 462.63)	461.71	(457.03, 466.42)	0.99	(0.98, 1.01)	458.84	(454.17, 463.56)
NHB	448.05	(439.88, 456.35)	448.36	(440.20, 456.64)	1.00	(0.97, 1.03)	444.75	(436.64, 452.98)
NHAPI	229.10	(210.31, 249.55)	230.09	(210.95, 250.95)	1.00	(0.88, 1.12)	241.85	(222.75, 262.53)
HISPANIC	485.27	(453.28, 519.31)	486.88	(455.76, 519.89)	1.00	(0.91, 1.09)	493.15	(461.03, 527.39)
3 year	2005–2007				2008–2010			
NHW	452.85	(446.94, 458.82)	461.57	(455.55, 467.66)	0.98	(0.96, 1.00)	457.87	(451.82, 463.99)
NHB	456.24	(445.43, 467.28)	448.84	(438.25, 459.64)	1.02	(0.98, 1.05)	443.13	(432.76, 453.70)
NHAPI	244.28	(216.53, 275.15)	231.09	(205.37, 259.94)	1.06	(0.90, 1.25)	238.17	(214.80, 264.11)
HISPANIC	589.50	(523.04, 666.48)	492.28	(451.03, 536.98)	1.20	(1.03, 1.39)	477.78	(438.95, 519.63)
1 year	2007				2010			
NHW	461.25	(450.90, 471.82)	467.54	(457.05, 478.25)	0.99	(0.96, 1.02)	446.94	(436.57, 457.54)
NHB	443.29	(425.15, 462.08)	443.71	(425.64, 462.40)	1.00	(0.94, 1.06)	429.88	(412.29, 448.10)
NHAPI	212.31	(173.82, 258.47)	248.44	(204.21, 301.78)	0.85	(0.65, 1.12)	265.19	(222.22, 316.56)
HISPANIC	439.53	(368.86, 523.33)	473.44	(405.47, 551.40)	0.93	(0.74, 1.16)	475.74	(404.83, 559.26)

ACS: American Community Survey; SEER: Surveillance, Epidemiology and End Results Program. NHW: non-Hispanic white, NHB: non-Hispanic black, NHAPI: non-Hispanic Asian/Pacific Islander. All Rates are per 100,000 population. IRR: Incidence Rate Ratio

Table 3

Interpretation of Comparison of Cancer Incidence Rate Estimates Between Hispanic and Non-Hispanic White Males using ACS and SEER Population Estimates.

Male	2005–2009		2006–2010		2005–2007		2008–2010		2007		2010	
	ACS	SEER	ACS	SEER	ACS	SEER	ACS	SEER	ACS	SEER	ACS	SEER
All	–	–	+	–	–	–	+	–	–	–	+	–
CRC	+	+	+	+	+	+	+	+	+	+	+	+
Lung	–	+	–	–	+	+	–	–	–	+	+	–
Prostate	–	–	+	–	–	+	+	–	+	–	+	–

ACS: American Community Survey, SEER: Surveillance, Epidemiology and End Results.

⁺Indicates that the rate is estimated to be higher among Hispanics than non-Hispanic whites.

[–]Indicates that the rate is estimated to be higher among non-Hispanic whites than Hispanics. Shaded pairs represent discordant interpretations.

Table 4

Interpretation of Comparison of Cancer Incidence Rate Estimates Between Hispanic and Non-Hispanic White Females using ACS and SEER Population Estimates.

Female	2005-2009		2006-2010		2005-2007		2008-2010		2007		2010	
	ACS	SEER	ACS	SEER	ACS	SEER	ACS	SEER	ACS	SEER	ACS	SEER
All	+	+	+	+	+	+	+	+	-	+	+	-
CRC	+	+	+	+	+	+	+	+	-	+	+	+
Lung	-	-	-	-	-	-	-	-	-	+	+	+
Breast	-	-	-	-	+	-	-	-	-	-	-	-

ACS: American Community Survey, SEER: Surveillance, Epidemiology and End Results.

⁺Indicates that the rate is estimated to be higher among Hispanics than non-Hispanic whites.

⁻Indicates that the rate is estimated to be higher among non-Hispanic whites than Hispanics. Shaded pairs represent discordant interpretations.