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Racial Disparities in Diabetes Care Among Incident Breast, Prostate, and Colorectal Cancer Survivors: A SEER Medicare Study

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Abstract

Background: Many cancer survivors with co-morbid diabetes receive less diabetes management than their non-cancer counterparts. We sought to determine if racial/ethnic disparities exist in recommended diabetes care within 12 months of an incident breast, prostate, or colorectal cancer diagnosis. Because co-morbid diabetes decreases long-term survival, identifying predictors of guideline-concordant diabetes care is important.

Methods: Using the Surveillance, Epidemiology, and End Results cancer registry linked to Medicare claims, we included beneficiaries aged 67+ years with diabetes and incident, non-metastatic breast, prostate, or colorectal cancer between 2008–2013. Primary outcomes were diabetes care services 12 months after diagnosis: 1) HbA1c test, 2) eye exam, and 3) low-density lipoprotein (LDL) test. Using modified Poisson models with robust standard errors, we examined each outcome separately.

Results: We included 34,643 Medicare beneficiaries with both diabetes and cancer. Mean age at diagnosis was 76.1 (SD 6.2), 47.2% were women; 35% had breast, 24% colorectal, and 41% prostate cancer. In the 12 months after incident cancer diagnosis, 82.4% received an HbA1c test, 55.3% received an eye exam, 77.8% had an LDL test, and 42.0% received all three tests. Compared to Non-Hispanic Whites, Blacks were 3% (95% CI 0.95–0.98) less likely to receive a HbA1c test, 10% (95% CI 0.89–0.92) less likely to receive a LDL test, and 8% (95% 0.89–0.95) less likely to receive an exam eye. Blacks and Hispanics were 16% (95% CI 0.81–0.88) and 7% (0.88–0.98) less likely to receive all three tests, after accounting for confounders. Racial/ethnic differences persisted across cancer types.

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Ethical approval: This study was deemed exempt by the Institutional Review Board at Weill Cornell Medicine.

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Conclusion: Blacks and Hispanics with breast, prostate, and colorectal cancer and diabetes received less diabetes care after cancer diagnosis compared to Non-Hispanic Whites. Differences were not explained by socio-economic factors or clinical need.

Keywords

racial disparities; diabetes; quality of care; cancer outcomes

Introduction

Employing the American Cancer Society's definition of a cancer survivor (from date of cancer diagnosis)[1] there are 17 million cancer survivors in the United States[2], 20% of whom have type 2 diabetes.[3,4] As screening and diagnosis strategies improve, we anticipate the number of cancer survivors with diabetes will increase. Survivors with cancer and diabetes have a 50% increased risk of mortality up to 10 years after a cancer diagnosis compared to non-diabetic cancer counterparts.[5,6] Potential reasons for this difference include diabetes-related cancer treatment delays[7] and receipt of less aggressive cancer treatments due to uncontrolled diabetes.[8–11] Racial/ethnic minorities with cancer are especially vulnerable because they have a greater comorbidity burden and face higher risks for poor cancer outcomes.[12–14]

A recent systematic review found that diabetes self-management (medication adherence and self-management behaviors) decline after an individual is diagnosed with cancer.[15] Similarly, a SEER-Medicare study found that diabetes care quality metrics (annual hemoglobin A1c [HbA1c] exams, low-density lipoprotein [LDL] cholesterol tests, and eye exams) declined in the year after cancer diagnosis compared to the year before cancer diagnosis.[16] This is a problem because worse glycemic control may put cancer patients with diabetes at risk for worse cancer outcomes.[17,18] To date, no studies have examined if racial/ethnic minorities with cancer and diabetes are less likely to receive recommended diabetes care than their White counterparts.

Continued diabetes management during cancer care is critical to optimizing outcomes. However, little is known about which cancer patients receive diabetes care in the year after diagnosis. Using the Surveillance, Epidemiology, and End Results cancer registry linked to Medicare fee-for-service claims (SEER-Medicare), the objective of this study was to determine if racial/ethnic disparities in receipt of diabetes processes of care (i.e., HbA1c testing, eye examination, and LDL testing) exist for breast, prostate, and colorectal cancer patients with type 2 diabetes in the 12 months after an incident cancer diagnosis. Understanding which patients are less likely to receive recommended diabetes care can inform efforts to support diabetic cancer survivors and reduce potential inequities.

Methods

Data Source:

We used SEER data (2008–2013) linked to Medicare claims from 2007 through 2015. The linked dataset includes Medicare beneficiaries 65+ years diagnosed in SEER registry

regions and contains information on cancer-related characteristics, demographics, and health services reimbursed by Medicare fee-for-service (Parts A and B).[19] SEER cancer registries capture 35% of the U.S cancer population, which assures generalizability of study findings.[20] This study was deemed exempt by the Institutional Review Board at Weill Cornell Medicine.

Cohort:

Beneficiaries aged 67+ years with incident, non-metastatic breast, prostate, or colorectal cancer who were alive 14 months after cancer diagnosis (to capture diabetes services) were included. Sixty-seven years was selected so that eligible individuals would have continuous Medicare Parts A and B enrollment for 24 months before (to identify diabetes status). As SEER provides month and year of diagnosis, we set day of diagnosis to the 15th. To define the 24-month period before diagnosis, we used claims from January 2006 to December 2007 and included individuals diagnosed with cancer after January 2008. Eligible individuals had a diabetes diagnosis in the 24 months before their cancer diagnosis date. We followed an approach validated by Miller and colleagues[21,22] using ICD-9-CM diagnoses codes 250.xx and 362.0x. A diagnosis code appeared on at least one inpatient stay or on two different outpatient claims (on two different days) in the 24-month pre-diagnosis period.[21] Outpatient claims required a face-to-face contact with a physician.[21]

Exclusion criteria:

Medicare beneficiaries: 1) diagnosed with cancer from an autopsy or death certificate (<1%), 2) with stage 4 cancer, and 3) with a prior history of cancer (Supplemental Figure 1).[21]

Defining a racial disparity:

We used the Institute of Medicine's (IOM) definition of a racial disparity as published in the report *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care.* The IOM report defined a disparity as a difference in health service use between two racial/ethnic groups that cannot be explained by health status (e.g., comorbidity burden), clinical appropriateness (e.g., cancer stage) and patient preferences.[23 24] Given that all individuals were continuously enrolled in Medicare fee-for-service, we were able to determine if disparities exist among individuals with relatively uniform health insurance coverage, which serves as a proxy for healthcare access.

Study outcomes:

Guided by the Healthcare Effectiveness Data and Information Set (HEDIS) on diabetes quality of care, we considered three diabetes care processes in the 12 months after a cancer diagnosis.[25,26] Using an approach developed by Research ANd Development (RAND)[27] and implemented in previous SEER-Medicare studies,[16,28,29] we examined claims for any of the following over the 12 months after cancer diagnosis: 1) HbA1c test, 2) eye exam, and 3) LDL test.[26] We created an overall utilization measure defined as receipt of all indicators over 12-months (i.e., "all three measures").[16] To avoid capturing routine testing for cancer diagnosis not intended for diabetes management, we implemented a 45-day "wash-out"

period after the date of cancer diagnosis (set to the 15th of each month). Beginning 45 days after the cancer diagnosis date, we examined claims over the following 12-months. Each diabetes indicator was examined as a binary outcome (any vs. no receipt).

Key Independent Variable:

Race/ethnicity was operationalized using the SEER race recode and SEER ethnicity variables. Race was categorized as White, Black, American Indian/Alaskan Native, and Asian or Pacific Islander. In SEER, ethnicity is determined using the Hispanic Identification Algorithm (NHIA).[30] This algorithm has been shown to have high sensitivity (93%) and specificity (98%).[31] We used a combination of these two variables to classify individuals as 1) Non-Hispanic White, 2) Non-Hispanic Black, 3) Hispanic, 4) Non-Hispanic Asian, and 5) Non-Hispanic Other.

Covariates:

We selected potential confounders based on Andersen's Behavioral Model of Health Services Use.[32] Covariates included: 1) predisposing characteristics (age at cancer diagnosis; gender), 2) enabling resources (census-tract level income [quartiles], Medicaid eligibility, receipt of a low-income subsidy, SEER geographic region, and urban/rural status, 3) evaluated need (comorbid conditions in the year before cancer diagnosis, presence of diabetes complications in the two years before cancer diagnosis, cancer stage [stage 1–3]), and 4) health service use. Comorbid conditions were calculated using Klabunde's version of the Charlson comorbidity index, excluding diabetes, solid tumors, leukemia, and lymphomas.[33–36] Consistent with our prior work, diabetes complications were defined by ICD-9-CM diagnosis codes 250.4x-250.9x (renal, ophthalmic, neurological, peripheral circulatory, and other specified manifestations; and unspecified complications) or 362.0x (diabetic retinopathy).[16] Diabetes without complications were defined with ICD-9-CM codes 250.0x-250.3x.[16] Health services included cancer treatments received including cancer surgery, chemotherapy, hormone therapy, and radiation within 12 months of cancer diagnosis.

Statistical Analyses:

We compared differences in characteristics by cancer type (breast, prostate, colorectal) and race/ethnicity using chi-square tests, separately. Using the Variance Inflation Factor (VIF), we assessed if socioeconomic variables (census-tract income, Medicaid eligibility, and low-income subsidy) were collinear. With and without the 45-day wash-out period, we described receipt of diabetes processes after cancer diagnosis for patients overall, by cancer type, and race/ethnicity. We examined each diabetes indicator separately and the three-measure indicator. We estimated multivariable modified Poisson models for each diabetes indicator.[37] We modeled the likelihood of receiving: 1) all three measures, 2) a HbA1c test, 3) a LDL test, and 4) an eye exam, separately. Models were run with and without the 45-day wash-out period. To examine differences by race/ethnicity, we estimated adjusted models with the IOM definition (i.e., not adjusting for socioeconomic factors), and fully-adjusted models that included socioeconomic factors as well as all other covariates described above. Adjusted risk ratios (aRR) with 95% confidence intervals (CI) were calculated. Statistical analyses were conducted in SAS Version 9.4 with two-sided statistical tests and α of 5%.

Sensitivity Analyses: To see if predictors of diabetes care varied by cancer type, we estimated models stratified by cancer type. Additionally, as HEDIS definitions are for individuals <75 years, we conducted age-stratified (<75 years and 75+ years) sensitivity analyses overall and by cancer type.

Results

Cohort Characteristics:

We included 34,643 Medicare beneficiaries with incident cancer and pre-existing diabetes (Table 1). Of these, 12,051 (35%) had breast, 8,208 (24%) had colorectal, and 14,384 (41%) had prostate cancer. Mean age at diagnosis was 76.1 years (SD 6.2). Seventy-one percent of the sample was White, 13.8% were Black, 8.5% were Hispanic, 3.8% were Asian, and 3.3% were of another race. Twenty percent were dually eligible for Medicaid, 31% had diabetes with complications, 51% had stage 1 cancer, and 41.3% had at least one comorbidity in addition to diabetes and cancer.

Unadjusted Diabetes Care Utilization:

Results with and without the 45-day wash-out period were nearly identical; results with the wash-out period are presented in detail, while results without the wash-out period are shown in Supplemental Table 2. Overall, in the year after cancer diagnosis, 82% of beneficiaries received a HbA1c test, 78% received a LDL cholesterol test, 55% received an eye exam and 42% received all three tests (Table 2). Non-Hispanic Blacks had the lowest rates of utilization compared to other racial/ethnic groups (Table 3). In crude models, Blacks were 3% (0.95–0.98) less likely to receive a HbA1c test, 10% (95%CI 0.88–0.91) less likely to receive a LDL test, 11% (95% 0.96–0.92) less likely to receive an eye exam, and 19% (95% CI 0.78–0.85) less likely to receive all three indicators compared to Non-Hispanic Whites (Table 4). Hispanics also had lower rates of utilization and were 2% (95% CI 0.95–1.00 less likely to receive a HbA1c test, 3% (95% CI 0.95–0.99) less likely to receive a LDL test, 11% (95% CI 0.85–0.93) less likely to receive an eye exam, and 13% (95% CI 0.83–0.91) less likely to receive all three indicators compared to Non-Hispanic Whites.

Adjusted Diabetes Care Utilization:

In adjusted models that did not include socioeconomic factors (i.e., income, Medicaid eligibility, and low income subsidy), compared to Non-Hispanic Whites, Blacks were 5% (95% CI 0.94–0.97) less likely to receive a HbA1c test, 11% (95% CI 0.87–0.90) less likely to receive an LDL cholesterol test, 12% (95% 0.85–0.91) less likely to receive an exam eye, and 21% (0.76–0.82) less likely to receive all three tests (Table 4). Hispanics were 3% (95% CI 0.95–0.99) less likely to receive a HbA1c test, 3% (95% CI 0.95–0.99) less likely to receive an LDL cholesterol test, 13% (95% CI 0.84–0.91) less likely to receive an exam eye, and 15% (95% CI 0.79–0.91) less likely to receive all three tests.

When socioeconomic factors were accounted for, estimates attenuated slightly but most remained statistically significant. Blacks were 3% (95% CI 0.95–0.98) less likely to receive a HbA1c test, 10% (95% CI 0.89–0.92) less likely to receive a LDL test, 8% (95% 0.89–0.95) less likely to receive an exam eye, and 16% (95% CI 0.80–0.87) less likely

to receive all three tests compared to Non-Hispanic Whites, adjusting for demographic, socioeconomic, and clinical confounders (Table 4). Compared to Non-Hispanic Whites, Hispanics were 7% (95% CI 0.89–0.96) less likely to receive an eye exam and 8% (95% CI 0.88–0.97) less likely to receive all three tests.

Sensitivity Analyses (Stratified by Cancer Type):

In unadjusted models, breast and prostate cancer patients had similar rates of testing (Table 2). Compared to breast and prostate cancer patients, colorectal cancer patients had consistently lower rates of testing, which were most pronounced for LDL cholesterol tests and receipt of all three tests. Differences in testing between Whites and Blacks were largest among men with prostate cancer. That is, 45% of Non-Hispanic White prostate cancer survivors received all three tests compared to 36% of Black prostate cancer survivors ($p<0.0001$). Similarly, among breast cancer survivors, 46% of White women received all three tests compared to 38% of Blacks and 38% of Hispanics ($p<0.0001$). When demographic, socioeconomic, and clinical confounders were accounted for, Blacks and Hispanics with prostate cancer were 5% (0.93–0.98) and 3% (0.94–1.00) less likely to receive a HbA1c test compared to Non-Hispanics Whites (Table 4). For LDL cholesterol testing, Blacks were 7–11% less likely to receive a test across prostate, breast, and colorectal cancer types. For eye exams, Blacks and Hispanics with prostate and breast cancer were less likely to receive an exam. Finally, Blacks with prostate, breast, or colorectal were 15–18% less likely to receive all three tests compared to Non-Hispanic Whites. Hispanics with prostate or breast cancer were 8% (0.86–1.00) and 15% (0.88–0.92) less likely to receive all tests, respectively.

Sensitivity Analyses (Stratified by Age):

We observed similar rates of diabetes care between individuals <75 year and 75+ years old with 42% receiving all three measures in both groups (Appendix Table 2). When each measure was examined individually, we observed that compared to adults <75 years, adults 75+ years had slightly lower rates of HbA1c tests (84% vs. 81%) and LDL cholesterol tests (80% vs 76%) but higher rates of eye exams (53% vs. 58%). When differences by race/ethnicity were examined, we observed similar patterns with Blacks and Hispanics less likely to receive all indicators for individuals <75 and those 75+ years of age.

Discussion

Only 42% of Medicare beneficiaries with diabetes and breast, prostate, or colorectal cancer received at least one HbA1c test, LDL test, and eye exam in the year after their cancer diagnosis. Blacks and Hispanics were significantly less likely to receive all three tests than Non-Hispanic Whites after adjustment for comorbidity burden and cancer clinical characteristics. Racial/ethnic differences attenuated but persisted after adjustment for socioeconomic factors. Differences by race were not fully explained by health status and clinical need suggesting that observed differences are representative of disparities, as defined by the IOM.[23,24] These disparities are concerning given that minorities are disproportionately impacted by diabetes and cancer.[12–14] A 2005 study in breast cancer survivors found that comorbidity burden measured by the Charlson Comorbidity Index

explained 50% of the all-cause survival disparity between Blacks and Whites.[12] Another study in breast cancer survivors found that comorbidities accounted for 25% of survival disparities between Blacks and Whites. Both studies concluded that improved control of comorbidities such as diabetes could help reduce survival gaps between Black and White cancer survivors.[12,38]

Racial disparities in diabetes process of care measures in our study are comparable to disparities in the same process measures seen outside of cancer.[39] A study among adults with diabetes but no cancer in the Veterans Affairs (VA) found that Blacks were significantly less likely to receive a LDL cholesterol test (72% vs. 80%) and eye exam (50% vs. 63%) compared to Whites.[40] A study of Medicaid beneficiaries in California also reported that Blacks and Hispanics had lower rates of HbA1c testing compared to Non-Hispanics Whites (66% vs. 83%) and (77% vs. 83%), respectively.[41] Similarly lower rates for Blacks and Hispanics were observed for LDL testing and eye exams. Outside of cancer, racial disparities in diabetes process measures extend to disparities in glycemic control.[39] A meta-analysis of 11 studies reported significantly higher HbA1c values among Blacks with diabetes compared to Whites.[42] Another study of 1.8 million Medicare Advantage beneficiaries found that Blacks with diabetes were 7% less likely to have controlled glucose compared to Whites.[43] Similarly, a 2019 CMS report found that among Medicare Advantage beneficiaries, Blacks with diabetes were 5% and 12% less likely to have glucose and blood pressure, respectively, controlled compared to Whites with diabetes.[44] Finally, Black VA patients with. diabetes were less likely to have controlled cholesterol and blood pressure compared to White patients.[40] Given the additional complexities of managing cancer, Blacks with diabetes and cancer may benefit from additional support to ensure they receive recommended diabetes care in the year after a cancer diagnosis, which may help to reduce existing gaps in clinical control of diabetes.

As prior studies have shown, minorities with and without cancer report poorly coordinated care[45,46] and worse patient-physician communication,[14] which may further complicate diabetes management in the year following a cancer diagnosis. A prior study among colorectal cancer survivors found that Blacks were more likely to experience problems with care coordination, access to care, and health information compared to Whites.[47] However, to date, care coordination and patient-physician communication have not yet been studied in the context of diabetes management in the year following a cancer diagnosis. Future studies should employ quantitative and qualitative strategies to identify drivers of sub-optimal diabetes care among racial/ethnic minorities with cancer. By understanding why racial/ethnic minorities receive less diabetes processes of care despite being actively engaged in the healthcare system for their cancer treatment, we can develop targeted interventions to increase the receipt of recommended diabetes care processes during the year following a cancer diagnosis. For example, a possible intervention approach could be to connect patients with pre-existing diabetes to primary care physicians upon being diagnosed with cancer to ensure that their diabetes would be considered during the acute treatment phase.

Limitations:

We included stage I-III breast, colorectal, and prostate cancer patients aged 67+ years old with continuous Part A and B Medicare enrollment for 24 months before and 14 months after diagnosis, potentially limiting generalizability. Our cohort was chosen specifically to reflect cancer patients who would benefit most from diabetes management due to a non-metastatic cancer prognosis. Those with advanced disease or other cancer types may have different diabetes management patterns and needs. This study was unable to account for unmeasured confounders of racial disparities such as institutional racism, discrimination, and mistrust.[48] Finally, our study did not capture glycemic or cholesterol control and reflects receipt of diabetes-related processes of care.

Conclusion

Racial/ethnic minorities with diabetes and breast, prostate, or colorectal cancer are less likely to receive three important processes integral to comprehensive diabetes care following their incident cancer diagnosis compared to Non-Hispanic White cancer survivors with diabetes. This observation is concerning given the high prevalence of diabetes and poor cancer outcomes among racial/ethnic minorities.[39] Prior studies found that cancer patients de-prioritize diabetes management after cancer diagnosis regardless of race/ethnicity.[15,16] However, decrements in diabetes care were larger among minorities. The next step in this line of inquiry is to determine why racial/ethnic minorities are less likely to receive comprehensive diabetes care after cancer diagnosis in order to develop targeted strategies to increase receipt of appropriate diabetes management for these vulnerable populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability:

The data that support the findings of this study are available from the National Cancer Institute.

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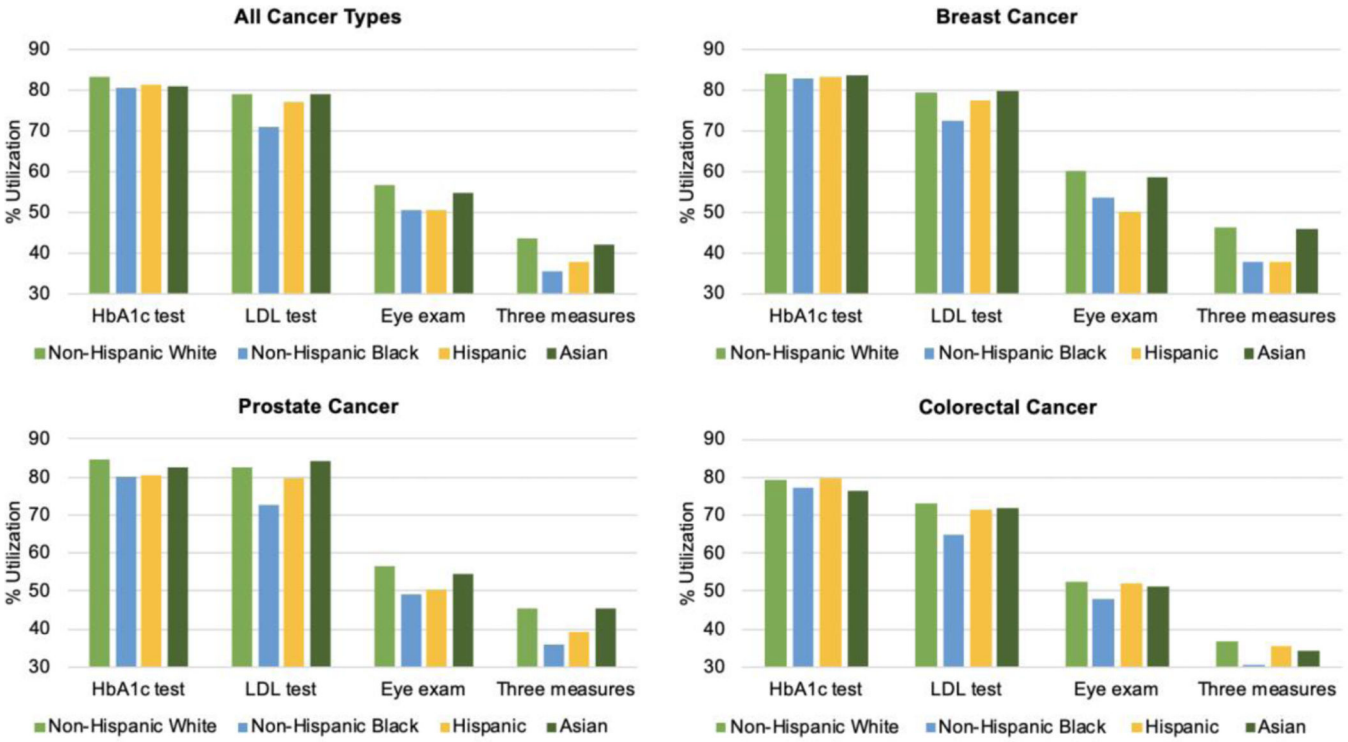

Figure 1:

Diabetes Care Management Utilization* One Year after Cancer Diagnosis, by race

Notes:

*Utilization defined as the percentage of individuals with a claim for the specific service over 12-months

Includes a 45-day wash-out period which excluded claims within 45 day after cancer diagnosis date

[a]HbA1c test: Hemoglobin A1C test

[b]LDL test: Low-density lipoprotein cholesterol test

[c]Three measures defined as receiving all three indicators (HbA1c, LDL, and eye exam)

Table 1:

Cohort Characteristics for Cancer Patients with Diabetes, Over All and by Cancer Type

	All		Cancer type						p-value
			Breast		Colorectal		Prostate		
	N	%	N	%	N	%	N	%	
All	34,643	100	12,051	100	8,208	100	14,384	100	
Age at diagnosis (years)									<.0001
67–69	6311	18.2	2050	17.0	1112	13.6	3149	21.9	
70–74	10883	31.4	3497	29.0	2156	26.3	5230	36.4	
75–79	8491	24.5	2980	24.7	1959	23.9	3552	24.7	
80–84	5602	16.2	2117	17.6	1718	20.9	1767	12.3	
85+	3356	9.7	1407	11.7	1263	15.4	686	4.8	
Gender									<.0001
Male	18285	52.8	0	0.0	3901	47.5	14384	100.0	
Female	16358	47.2	12051	100.0	4307	52.5	0	0.0	
Race									<.0001
Non-Hispanic White	24461	70.6	8585	71.2	5905	71.9	9971	69.3	
Non-Hispanic Black	4790	13.8	1694	14.1	936	11.4	2160	15.0	
Hispanic	2936	8.5	953	7.9	663	8.1	1320	9.2	
Asian	1315	3.8	436	3.6	422	5.1	457	3.2	
Other	1141	3.3	383	3.2	282	3.4	476	3.3	
Residence in a rural region	3735	10.8	1274	10.6	973	11.9	1488	10.3	0.0001
SEER geographic region									0.0015
West	13338	38.5	4676	38.8	3097	37.7	5565	38.7	
South	9476	27.4	3319	27.5	2161	26.3	3996	27.8	
Northeast	7530	21.7	2567	21.3	1929	23.5	3034	21.1	
Midwest	4299	12.4	1489	12.4	1021	12.4	1789	12.4	
Income Quartile									<.0001
Quartile 1	8669	25.0	3087	25.6	2172	26.5	3410	23.7	
Quartile 2	8662	25.0	3010	25.0	2121	25.8	3531	24.6	
Quartile 3	8662	25.0	3043	25.3	2027	24.7	3592	25.0	
Quartile 4	8650	25.0	2911	24.2	1888	23.0	3851	26.8	
Medicaid eligibility	7030	20.3	2912	24.2	2169	26.4	1949	13.6	<.0001
Low income subsidy	1027	3.0	429	3.6	280	3.4	318	2.2	<.0001
Charlson Comorbidity Index									<.0001
0	20326	58.7	7198	59.7	4180	50.9	8948	62.2	
1	6388	18.4	2294	19.0	1604	19.5	2490	17.3	
2+	7929	22.9	2559	21.2	2424	29.5	2946	20.5	
Diabetes with complications	10556	30.5	3685	30.6	2716	33.1	4155	28.9	<.0001
Cancer stage									<.0001
1	17,554	50.7	8,091	67.1	2,067	25.2	7,396	51.4	

	All		Cancer type						p-value
			Breast		Colorectal		Prostate		
	N	%	N	%	N	%	N	%	
2	9,753	28.2	2,887	24.0	1,357	16.5	5,509	38.3	
3	5,804	16.8	722	6.0	4,385	53.4	697	4.9	
Missing	1,532	4.4	351	2.9	399	4.9	782	5.4	
Cancer treatments									
Surgery	22462	64.8	11343	94.1	7266	88.5	3853	26.8	<.0001
Chemotherapy/Hormone therapy	9216	26.6	2211	18.4	1611	19.6	5394	37.5	<.0001
Radiation	15191	43.9	6542	54.3	1013	12.3	7636	53.1	<.0001

Table 2:

Diabetes Care Management Utilization * One Year after Cancer Diagnosis

	Overall	Breast	Colorectal	Prostate	p-value
# of patients	**34,643**	**12,051**	**8,208**	**14,384**	
HbA1c test [a]	82.4%	83.6%	78.9%	83.5%	<.0001
LDL test [b]	77.8%	78.2%	71.8%	80.8%	<.0001
Eye exam	55.3%	58.3%	51.7%	54.9%	<.0001
Three measures [c]	42.0%	44.3%	35.7%	43.6%	<.0001

Notes:

* Utilization defined as the percentage of individuals with a claim for the specific service over 12-months

Includes a 45-day wash-out period which excluded claims within 45 day after cancer diagnosis date

[a] HbA1c test: Hemoglobin A1C test

[b] LDL test: Low-density lipoprotein cholesterol test

[c] Three measures defined as receiving all three indicators (HbA1c, LDL, and eye exam)

Table 3:

Relative Risk Ratios Between Race/Ethnicity and Receipt of Diabetes Care Management

	HbA1c Test[a]	LDL Test[b]	Eye Exam	Three Measures[c]
Non-Hispanic Blacks				
Crude model	0.97 (0.95–0.98) *	0.90 (0.88–0.91) *	0.89 (0.86–0.92) *	0.81 (0.78–0.85) *
No SES Factors	0.95 (0.94–0.97) *	0.89 (0.87–0.90) *	0.88 (0.85–0.91) *	0.79 (0.76–0.82) *
Fully-adjusted	0.97 (0.95–0.98) *	0.90 (0.89–0.92) *	0.92 (0.89–0.95) *	0.84 (0.80–0.87) *
Hispanics/Latinos				
Crude model	0.98 (0.96–1.00) *	0.97 (0.95–0.99) *	0.89 (0.86–0.93) *	0.87 (0.83–0.91) *
No SES Factors	0.97 (0.95–0.99) *	0.97 (0.95–0.99) *	0.87 (0.84–0.91) *	0.85 (0.80–0.89) *
Fully-adjusted	0.99 (0.97–1.01)	1.00 (0.98–1.02)	0.93 (0.89–0.96) *	0.92 (0.88–0.97) *
Asians				
Crude model	0.98 (0.95–1.00)	1.00 (0.97–1.02)	0.96 (0.92–1.01)	0.96 (0.90–1.03)
No SES Factors	0.99 (0.96–1.01)	1.02 (0.99–1.06)	0.96 (0.91–1.01)	0.98 (0.92–1.05)
Fully-adjusted	1.00 (0.97–1.02)	1.05 (1.02–1.08) *	1.00 (0.95–1.06)	1.06 (0.99–1.14)
Other				
Crude model	1.00 (0.98–1.03)	0.99 (0.96–1.02)	1.01 (0.96–1.06)	1.06 (1.00–1.13) *
No SES Factors	1.00 (0.97–1.03)	1.00 (0.97–1.03)	1.01 (0.96–1.06)	1.06 (0.99–1.13)
Fully-adjusted	1.00 (0.98–1.03)	1.00 (0.97–1.03)	1.02 (0.97–1.07)	1.07 (1.01–1.14) *

Notes:

SES (Socio-economic factors). The “No SES Factors” and “Fully-adjusted” models adjust for age at diagnosis, gender, residence in a rural region, SEER geographic region, Charlson Comorbidity Index, diabetes with complications, cancer stage, and cancer treatments as described in Table 1.

SES factors include income quartile, Medicaid eligibility, and low income subsidy.

Modified Poisson models used robust standard error and implemented a 45-day wash-out period, which excluded claims within 45 day after cancer diagnosis date. Estimates indicate relative risk ratios and 95% confidence intervals.HbA1c test: Hemoglobin A1C test; LDL test: Low-density lipoprotein cholesterol test; Three measures defined as receiving all three indicators within 12-months (HbA1c, LDL, and eye exam).

* denote statistical significant $p<0.05$

[a] HbA1c test: Hemoglobin A1C test

[b] LDL test: Low-density lipoprotein cholesterol test

[c] Three measures defined as receiving all three indicators (HbA1c, LDL, and eye exam)

Table 4:

Relative Risk Ratios Between Race/Ethnicity and Receipt of Diabetes Care Management by Cancer Type

	HbA1c Test[a]			LDL Test[b]			Eye Exam			Three Measures[c]		
	Prostate	Breast	Colorectal	Prostate	Breast	Colorectal	Prostate	Breast	Colorectal	Prostate	Breast	Colorectal
NHB												
Crude model	0.94 (0.92–0.97)	0.99 (0.96–1.01)	0.97 (0.94–1.01)	0.88 (0.86–0.90)	0.91 (0.88–0.94)	0.89 (0.84–0.93)	0.87 (0.83–0.91)	0.89 (0.85–0.94)	0.91 (0.85–0.98)	0.79 (0.74–0.84)	0.81 (0.76–0.87)	0.83 (0.75–0.92)
No SES	0.93 (0.91–0.95)	0.97 (0.95–1.00)	0.97 (0.93–1.0)	0.87 (0.85–0.90)	0.91 (0.88–0.94)	0.88 (0.84–0.93)	0.86 (0.82–0.90)	0.90 (0.86–0.94)	0.91 (0.85–0.98)	0.77 (0.73–0.82)	0.81 (0.76–0.86)	0.81 (0.73–0.9)
Fully-adjusted	0.95 (0.93–0.97)	0.98 (0.96–1.01)	0.98 (0.94–1.02)	0.89 (0.87–0.92)	0.93 (0.90–0.95)	0.90 (0.86–0.95)	0.89 (0.85–0.94)	0.93 (0.89–0.98)	0.95 (0.88–1.02)	0.82 (0.77–0.87)	0.85 (0.80–0.91)	0.86 (0.78–0.96)
Hispanics/ Latinos												
Crude model	0.95 (0.93–0.98)	0.99 (0.96–1.02)	1.01 (0.97–1.05)	0.96 (0.94–0.99)	0.98 (0.94–1.01)	0.98 (0.93–1.03)	0.89 (0.84–0.94)	0.83 (0.78–0.89)	0.99 (0.92–1.07)	0.87 (0.81–0.93)	0.81 (0.75–0.88)	0.97 (0.87–1.08)
No SES	0.95 (0.92–0.97)	0.99 (0.96–1.02)	1.00 (0.96–1.04)	0.97 (0.94–1.00)	0.98 (0.94–1.02)	0.98 (0.93–1.03)	0.88 (0.83–0.93)	0.82 (0.77–0.88)	0.97 (0.89–1.05)	0.85 (0.79–0.91)	0.79 (0.73–0.86)	0.94 (0.85–1.05)
Fully-adjusted	0.97 (0.94–1.00)	1.00 (0.97–1.03)	1.01 (0.97–1.06)	0.99 (0.96–1.02)	1.00 (0.96–1.04)	1.02 (0.97–1.08)	0.93 (0.88–0.99)	0.85 (0.80–0.91)	1.03 (0.95–1.11)	0.92 (0.86–1.00)	0.85 (0.77–0.92)	1.05 (0.94–1.17)
Asians												
Crude model	0.97 (0.93–1.02)	1.00 (0.96–1.04)	0.97 (0.92–1.02)	1.02 (0.98–1.06)	1.01 (0.96–1.06)	0.98 (0.92–1.05)	0.96 (0.88–1.05)	0.98 (0.90–1.06)	0.98 (0.89–1.08)	1.00 (0.91–1.11)	0.99 (0.89–1.10)	0.93 (0.81–1.07)
No SES	0.98 (0.94–1.02)	1.01 (0.96–1.05)	0.97 (0.92–1.03)	1.04 (1.00–1.08)	1.02 (0.98–1.08)	1.00 (0.94–1.07)	0.95 (0.87–1.04)	0.96 (0.89–1.05)	0.95 (0.86–1.05)	1.01 (0.91–1.12)	0.99 (0.89–1.10)	0.92 (0.80–1.06)
Fully-adjusted	0.99 (0.94–1.03)	1.01 (0.97–1.06)	0.98 (0.93–1.04)	1.05 (1.01–1.10)	1.04 (0.99–1.10)	1.05 (0.98–1.12)	0.99 (0.90–1.08)	0.99 (0.91–1.08)	1.02 (0.92–1.13)	1.06 (0.95–1.18)	1.05 (0.94–1.17)	1.05 (0.91–1.21)
Other												
Crude model	1.00 (0.96–1.04)	0.99 (0.95–1.04)	1.03 (0.98–1.09)	1.00 (0.96–1.04)	1.00 (0.95–1.05)	0.97 (0.90–1.05)	1.08 (1.00–1.16)	0.96 (0.88–1.05)	0.95 (0.85–1.08)	1.16 (1.07–1.27)	0.99 (0.88–1.10)	0.99 (0.84–1.16)
No SES	0.99 (0.95–1.03)	0.99 (0.95–1.04)	1.03 (0.97–1.09)	1.01 (0.96–1.05)	1.00 (0.95–1.06)	0.97 (0.90–1.05)	1.09 (1.01–1.17)	0.96 (0.88–1.05)	0.96 (0.85–1.08)	1.17 (1.07–1.27)	0.99 (0.88–1.10)	0.98 (0.84–1.15)
Fully-adjusted	0.99 (0.96–1.03)	0.99 (0.95–1.04)	1.03 (0.98–1.09)	1.01 (0.96–1.05)	1.01 (0.95–1.06)	0.98 (0.91–1.06)	1.09 (1.02–1.18)	0.96 (0.88–1.05)	0.97 (0.86–1.09)	1.18 (1.08–1.28)	1.00 (0.89–1.11)	1.00 (0.86–1.18)

Notes: SES (Socio-economic factors). SES (Socio-economic factors). The “No SES Factors” and “Fully-adjusted” models adjust for age at diagnosis, gender, residence in a rural region, SEER geographic region, Charlson Comorbidity Index, diabetes with complications, cancer stage, and cancer treatments as described in Table 1. SES factors include income quartile, Medicaid eligibility, and low-income subsidy.

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* denote statistical significant p<0.05

[a] HbA1c test: Hemoglobin A1C test

[b] LDL test: Low-density lipoprotein cholesterol test

[c] Three measures defined as receiving all three indicators (HbA1c, LDL, and eye exam)