

Cervical cancer screening and predictors of screening by diabetes status

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Abstract

Purpose

Women with diabetes have lower survival rates after a cervical cancer diagnosis compared to women without diabetes. Pap smears and human papilloma virus (HPV) testing are highly effective screening tests for cervical cancer, therefore, it is important to know the prevalence of guideline-concordant screening among women with diabetes and understand if their predictors of screening differ. The purpose of this analysis was to assess guideline-concordant cervical cancer screening and predictors by diabetes status.

Methods

We used the 2019 National Health Interview Survey data, limited to women aged 21-65 years without a previous diagnosis of cancer, a hysterectomy, or diagnosed with diabetes in the year prior to the survey. We considered the Pap and HPV tests together and concordance as being tested within the past 3 years as part of a routine exam. We calculated weighted, adjusted prevalence and prevalence ratios (PRs) of screening concordance comparing women with diabetes to those without.

Results

The unadjusted prevalence of concordant screening was 66.5% for women with diabetes compared to 73.3% for women without diabetes (PR=0.91 95%CI 0.84–0.98). In the model adjusting for age, race/ethnicity, education, income, marital status, employment, insurance coverage, usual source of healthcare, seeing a doctor in past year, and delaying medical care, the association was slightly attenuated and no longer statistically significant (PR=0.94 95%CI 0.88–1.02).

Conclusions

Cervical cancer screening concordance was lower in women with diabetes compared to those without overall but most barriers to screening appear to be from risk factors common to both diabetes and cervical cancer.

Background

While there is limited evidence that women with diabetes are at higher risk of cervical cancer, there is evidence of worse prognostic indicators and lower survival rates after a cervical cancer diagnosis compared to women without diabetes.[1–4] For example, in one study with approximately 5 years median follow-up, women with diabetes were approximately 1.5 times more likely to die from early stage (I-IIA) cervical cancer than women without diabetes.[3]

Pap smears and human papilloma virus (HPV) tests are highly effective screening tests in the prevention and early detection of cervical cancer.[5] Because of the increased mortality risk, it is imperative that

women with diabetes are up-to-date with cervical cancer screening guidelines. However, a number of studies have found that cervical cancer screening is lower among women with diabetes.[6–8] Many of these studies have been conducted outside the US, with different population demographics and health insurance systems, therefore, it is important to understand the relationship between diabetes and cervical cancer screening in a US population. While a recent study using state-level estimates in the US also found lower levels of cervical cancer screening among women with diabetes compared to those without, unfortunately, the data used was only able to assess if women were “ever screened” for cervical cancer with HPV testing and not if they were guideline concordant.[8]

The prevalence of diabetes continues to increase,[9] therefore, it is important to compare guideline-concordant screening by diabetes status and understand if the predictors of screening differ among women with diabetes. Using a population-based national survey, the objectives of this analysis were to assess guideline-concordant cervical cancer screening by diabetes status, compare characteristics of the women who were concordant by diabetes status, and determine predictors. Secondly, we compared reasons for not being screened by diabetes status.

Methods

Study Population

The study population for this analysis was the 2019 National Health Interview Survey (NHIS) data, limited to women aged 21–65 years. We excluded women with a previous diagnosis of cancer, a hysterectomy, or diagnosed with diabetes in the year prior to the survey. Previous cancers were excluded to help limit the study population to women under normal cancer surveillance. The diabetes exclusion was because of a noted detection bias of cancer within a year of a diabetes diagnosis.[10]

Cervical Cancer Screening

Currently, the US Preventive Services Task Force (USPSTF) recommends either a Pap smear (every 3 years) or HPV test alone (every 5 years) or a combination of the tests (every 5 years).[5] The NHIS asks women if they have ever had a test for cervical cancer and when their most recent test was. Although the NHIS asks about Pap smears and HPV testing separately, we considered the tests together because a previous study found that women may not know which test they received or if they received both.[11] For the purpose of this analysis, guideline concordant screening was defined as having either test within the past 3 years to be consistent with a previous analysis of cervical cancer screening with the NHIS.[11] Because we were interested in asymptomatic cancer screening, we excluded women who reported having a cervical test because of a problem or as a follow-up of an earlier screening test. For women who had never had a cervical cancer screening test or hadn't had one in the last 5 years, they were asked the reason why they haven't been tested.

Statistical Analysis

We calculated prevalence estimates of guideline concordant cervical cancer screening by diabetes status, which were weighted to account for non-response and selection probabilities. We used chi-squared tests to assess differences in characteristics and reasons for not getting screened by diabetes status. We calculated weighted, adjusted prevalence and prevalence ratios (PRs) of screening concordance comparing women with diabetes to those without. This method was chosen over logistic regression to provide adjusted prevalence estimates and reduce a perceived overestimation of an association with an odds ratio.[12, 13] The variables assessed as predictors of screening included age group (21–39 years, 40–49, 50–59, 60–65), race/ethnicity (Hispanic, White non-Hispanic, Black non-Hispanic, Asian non-Hispanic, Other), education level [< high school (HS), HS graduate, >HS degree], household income (<\$35K, 35–49, 50–74, ≥ 75), birthplace (US, outside US), health insurance coverage (covered, not covered), usual place for healthcare (yes, no), saw a doctor or healthcare provider in the past year (yes, no), delayed medical care due to cost in past 12 months (yes, no), region (Northwest, Midwest, South, West), urban/rural residence (Central Metro, Fringe Metro, Medium/Small Metro, Nonmetro), marital status (married/partnered, not married/partnered), current employment status (employed, not employed), self-rated health (excellent/very good/good, fair/poor), and the number of non-diabetes chronic conditions (0, 1, ≥ 2). We compared PRs for concordant screening by diabetes status between 3 models; an unadjusted model, an age-adjusted model, and a model adjusting for any variable significantly predictive of concordant screening using backwards selection. To assess whether the predictors of screening concordance differed by diabetes status, we ran separate models for diabetes and screening concordance with an interaction term for each potential predictor variable and diabetes in the fully adjusted model. Analyses were conducted in SAS 9.4 using survey procedures and SUDAAN 11.0.1 to calculate adjusted PRs.

Results

There were 11,763 women aged 21–65 years in 2019 NHIS population. After excluding women with a hysterectomy (n = 1754), previous diagnosis of cancer (n = 612), diabetes diagnosis in the past year (n = 16) or non-type I/type II diabetes (n = 20), or had a cervical test because of a problem or follow-up (n = 472) there were 8,889 women available for analysis [436 with diabetes (4.9%), 8,453 (95.1%) without].

Table 1 presents the unweighted number of participants and weighted distribution of all examined characteristics. The distribution of all characteristics was significantly different by diabetes status except for US region and birthplace. Women with diabetes were more likely to be older, Black non-Hispanic or Hispanic, live in more rural locations, have lower education and income levels, have a usual source of healthcare and have seen a doctor in the past year, rate their health as fair or poor, and have higher numbers of non-diabetes comorbid conditions.

Table 1
Distribution by diabetes status.

	No Diabetes	Diabetes	
	N (Weighted %)	N (Weighted %)	Chi-sq
Overall	8453 (95.1)	436 (4.9)	
Age			
21–39 years	4113 (51.9)	59 (14.2)	< 0.001
40–49	1746 (20.6)	90 (24.0)	
50–59	1607 (17.7)	151 (34.5)	
60–65	987 (9.8)	136 (27.2)	
Race/Ethnicity			
Hispanic	1423 (19.4)	83 (22.9)	0.001
White, non-Hispanic	5140 (57.2)	218 (48.6)	
Black, non-Hispanic	1044 (13.0)	100 (19.7)	
Asian, non-Hispanic	608 (7.5)	21 (6.1)	
Other	238 (2.9)	14 (2.6)	
Born in the US	6560 (77.7)	335 (74.5)	0.21
Married/Partnered	4922 (65.7)	198 (58.2)	0.009
Region			
Northeast	1442 (18.3)	61 (15.9)	0.22
Midwest	1833 (20.8)	97 (22.2)	
South	3033 (36.5)	186 (41.3)	
West	2145 (24.4)	92 (20.6)	
Urban/Rural			
Central Metro	2774 (33.4)	138 (30.8)	0.03
Fringe Metro	1981 (25.5)	78 (20.3)	
Medium/Small Metro	2635 (29.4)	144 (33.1)	
Nonmetro	1063 (11.6)	76 (15.8)	

^aNon-diabetes chronic conditions included hypertension, coronary heart disease, angina, myocardial infarction, stroke, COPD and asthma.

	No Diabetes	Diabetes	
Education			
<HS Grad	533 (8.9)	77 (22.2)	< 0.001
HS Grad/Some College	3096 (40.5)	193 (45.1)	
Post HS Degree	4802 (50.5)	164 (32.7)	
Income			
<\$35K	2145 (23.0)	210 (41.0)	< 0.001
35–49	992 (11.4)	60 (16.4)	
50–74	1567 (18.9)	65 (15.9)	
>=75K	3749 (46.7)	101 (26.7)	
No insurance coverage	993 (13.7)	38 (9.6)	0.047
Usual source of healthcare	7488 (88.4)	416 (95.7)	< 0.001
Saw doctor in past year	7285 (86.2)	416 (96.3)	< 0.001
Delayed care 12 months	918 (11.2)	65 (15.0)	0.03
Currently employed	6252 (75.2)	216 (53.2)	< 0.001
Self-rated health			
Excellent/Very Good/Good	7742 (91.3)	250 (56.4)	< 0.001
Fair/Poor	702 (8.7)	186 (43.6)	
Count of chronic conditions ^a			
0	6196 (73.5)	132 (32.1)	< 0.001
1	1893 (22.7)	173 (40.4)	
> 2	364 (3.7)	131 (27.5)	
^a Non-diabetes chronic conditions included hypertension, coronary heart disease, angina, myocardial infarction, stroke, COPD and asthma.			

The unadjusted prevalence of concordant screening was 66.5% for women with diabetes compared to 73.3% for women without diabetes (PR = 0.91 95%CI 0.84–0.98) (Table 2). There was little change in the adjusted PR (aPR) in the age-adjusted only model, which was borderline statistically significant (aPR = 0.92 95%CI 0.84–1.00). In the fully adjusted model, the PR moved a little closer to the null and was no longer statistically significant (aPR = 0.94 95%CI 0.88–1.02). Predictors of concordant screening in the full model included age, race/ethnicity, education, income, married/partnered, employment, insurance

coverage, usual source of healthcare, seeing a doctor in past year, and delaying medical care. Not seeing a doctor in the past year was the strongest predictor of concordant screening (aPR = 0.66 95%CI 0.61–0.71). No health insurance and no usual source of healthcare had equivalent associations with screening but were not as strong as seeing a doctor in the past year (aPR = 0.89 95%CI 0.84–0.95 for both).

Table 2

Unadjusted and adjusted models predicting concordant cervical cancer screening in past 3 years.

	Unadjusted	Model 2 – Age-Adjusted	Model 3 – Full Predictive Model^b
	% (95% CI)	% (95% CI)	% (95% CI)
Diabetes	66.5 (61.0–71.6)	67.3 (61.7–72.5)	69.5 (64.3–74.1)
No Diabetes	73.3 (72.1–74.6)	73.3 (72.1–74.6)	73.6 (72.3–74.9)
	PR (95% CI)	PR (95% CI)	PR (95% CI)
Diabetes	0.91 (0.84–0.98)	0.92 (0.84–1.00)	0.94 (0.88–1.02)
Age			
21–39 years		1.10 (1.03–1.16)	1.14 (1.07–1.20)
40–49		1.15 (1.08–1.22)	1.15 (1.08–1.22)
50–59		1.12 (1.05–1.19)	1.12 (1.05–1.19)
60–65		1.0 (Ref)	1.0 (Ref)
Race/Ethnicity			
Hispanic			0.98 (0.94–1.03)
White, non-Hispanic			1.0 (Ref)
Black, non-Hispanic			1.05 (1.01–1.10)
Asian, non-Hispanic			0.81 (0.75–0.87)
Other ^a			
Education			
<HS Grad			0.84 (0.77–0.91)
HS Grad/Some College			0.91 (0.88–0.94)
Post HS Degree			1.0 (Ref)
Household Income			
PR = prevalence ratio			
^a Results not presented because other race/ethnicity category is not meaningful.			
^b Variables dropped from model include birthplace, delayed medical care due to cost in past 12 months, region, self-rated health, and number of non-diabetes chronic conditions.			

	Unadjusted	Model 2 – Age-Adjusted	Model 3 – Full Predictive Model ^b
<\$35K			0.93 (0.89–0.98)
35–49			0.93 (0.88–0.98)
50–74			0.98 (0.94–1.03)
>=75K			1.0 (Ref)
Married/Partnered			0.90 (0.86–0.93)
Unemployed			0.94 (0.90–0.97)
No health insurance			0.89 (0.84–0.95)
No usual source of healthcare			0.89 (0.84–0.95)
No doctor in past year			0.66 (0.61–0.71)
Delayed medical care			0.95 (0.90–1.00)
PR = prevalence ratio			
^a Results not presented because other race/ethnicity category is not meaningful.			
^b Variables dropped from model include birthplace, delayed medical care due to cost in past 12 months, region, self-rated health, and number of non-diabetes chronic conditions.			

Table 3

Adjusted prevalence ratios for guideline-concordant cervical cancer screening by diabetes status and stratified by participant characteristics.

	No Diabetes		Diabetes		Interaction
	Weighted %	aPR (95% CI)	Weighted %	aPR (95% CI)	p-value
Age					
21–39 years	73.9	1.10 (1.04–1.17)	70.7	1.12 (0.89–1.42)	0.84
40–49	75.5	1.12 (1.05–1.20)	75.9	1.21 (0.98–1.48)	
50–59	73.5	1.09 (1.02–1.17)	75.2	1.19 (0.98–1.45)	
60–65	67.1	1.0 (Ref)	63.0	1.0 (Ref)	
Race/Ethnicity					
Hispanic	72.7	0.98 (0.94–1.03)	71.3	0.98 (0.83–1.17)	0.97
White, non-Hispanic	74.0	1.0 (Ref)	72.5	1.0 (Ref)	
Black, non-Hispanic	79.1	1.07 (1.02–1.12)	81.0	1.12 (0.97–1.28)	
Asian, non-Hispanic	59.9	0.81 (0.75–0.88)	57.4	0.79 (0.54–1.16)	
Region					
Northeast	72.8	1.0 (Ref)	67.9	1.0 (Ref)	0.45
Midwest	71.2	0.98 (0.93–1.03)	77.6	1.14 (0.93–1.40)	
South	74.6	1.02 (0.97–1.08)	72.3	1.06 (0.87–1.30)	
West	73.9	1.01 (0.96–1.07)	71.1	1.05 (0.85–1.30)	
Urban/Rural					
Central Metro	73.8	1.0 (Ref)	72.8	1.0 (Ref)	0.01

aPR = adjusted prevalence ratio

^aNon-diabetes chronic conditions included hypertension, coronary heart disease, angina, myocardial infarction, stroke, COPD and asthma.

	No Diabetes		Diabetes		Interaction
Fringe Metro	73.6	1.00 (0.96–1.04)	65.7	0.90 (0.73–1.11)	
Medium/Small Metro	73.3	0.99 (0.95–1.03)	69.3	0.95 (0.80–1.12)	
Nonmetro	72.1	0.98 (0.92–1.03)	86.2	1.18 (1.03–1.36)	
Education					
<HS Grad	65.3	0.84 (0.77–0.91)	65.6	0.88 (0.72–1.08)	0.75
HS Grad/Some College	70.3	0.90 (0.87–0.94)	70.6	0.95 (0.82–1.10)	
Post HS Degree	78.0	1.0 (Ref)	74.6	1.0 (Ref)	
Income					
<\$35K	69.0	0.90 (0.86–0.95)	73.8	0.96 (0.83–1.11)	0.02
35–49	70.4	0.92 (0.87–0.98)	70.2	0.91 (0.72–1.15)	
50–74	74.9	0.98 (0.94–1.02)	55.5	0.72 (0.54–0.97)	
>=75K	76.4	1.0 (Ref)	77.0	1.0 (Ref)	
Born in the US					
No	71.3	0.96 (0.92–1.01)	66.4	0.89 (0.75–1.06)	
Married/Partnered	76.1	1.0 (Ref)	75.7	1.0 (Ref)	0.84
No	68.6	0.90 (0.87–0.94)	67.0	0.88 (0.77–1.02)	
Insurance coverage					
Not Covered	60.9	0.81 (0.75–0.86)	62.9	0.85 (0.63–1.13)	
Delayed care past 12 months	67.8	0.91 (0.86–0.97)	79.3	1.12 (0.97–1.28)	0.02

aPR = adjusted prevalence ratio

^aNon-diabetes chronic conditions included hypertension, coronary heart disease, angina, myocardial infarction, stroke, COPD and asthma.

	No Diabetes		Diabetes		Interaction
No	74.2	1.0 (Ref)	71.0	1.0 (Ref)	
Currently Employed	74.7	1.0 (Ref)	71.4	1.0 (Ref)	0.29
No	70.0	0.94 (0.90–0.97)	71.9	1.01 (0.88–1.15)	
Self-rated health					
Excellent/Very Good/Good	73.7	1.0 (Ref)	70.5	1.0 (Ref)	0.31
Fair/Poor	71.4	0.97 (0.91–1.03)	73.8	1.05 (0.91–1.20)	
Count of Chronic Conditions ^a					
0	73.3	1.0 (Ref)	70.2	1.0 (Ref)	0.72
1	73.4	1.00 (0.96–1.04)	74.7	1.06 (0.90–1.26)	
> 2	75.2	1.03 (0.95–1.11)	72.4	1.03 (0.86–1.23)	
aPR = adjusted prevalence ratio					
^a Non-diabetes chronic conditions included hypertension, coronary heart disease, angina, myocardial infarction, stroke, COPD and asthma.					

Table 4
Reasons for not getting cervical screening by diabetes status.

	No Diabetes	Diabetes	Chi Sq
	N (%)	N (%)	P-value
No Reason / Never thought about it	650 (43.6)	41 (42.5)	0.94
Didn't need it / Didn't know I needed it	171 (13.2)	14 (12.1)	
Doctor didn't order it / Didn't say I needed it	172 (11.5)	18 (14.6)	
Haven't had any problems	180 (11.2)	13 (9.6)	
Other	307 (20.5)	23 (21.2)	

When comparing all potential predictors by diabetes status, urbanicity (p-value for interaction term = 0.01), household income (p = 0.01), and delaying care because of medical costs (p = 0.02) were the only predictors that were significantly different (or borderline for income) by diabetes status. There were too

few observations for seeing a doctor in the past year and usual source of healthcare to examine stratified by diabetes status so they were not included. For urbanicity, women with diabetes in a nonmetro area were significantly more likely to be concordant with screening compared to women living in a central metro area (aPR = 1.18 95%CI 1.03–1.36), while there was no association among women without diabetes (aPR = 0.98 95%CI 0.92–1.03). For delayed care, women without diabetes were less likely to be concordant if they had delayed care (aPR = 0.91 95%CI 0.86–0.97) but among women with diabetes, the association was non-significantly elevated (aPR = 1.12 95%CI 0.97–1.28). We also found a statistically significant interaction with income but women in all levels of income were less likely to be screened than the highest income regardless of diabetes status. When we compared reasons for not getting screened for cervical cancer (ever or in past 5 years), there was very little difference in the distribution of reasons ($p = 0.94$). For both groups, the major reason was “No reason / Never thought about it.”`

Discussion

In this analysis of a nationally representative sample of women in the US, we found that overall, women with diabetes were less likely to be concordant with cervical cancer screening; however once controlling for other predictors of concordant screening, the association with diabetes was attenuated towards the null and no longer statistically significant. Most predictors of concordant screening were similar for women with or without diabetes but we did see evidence of heterogeneity for urbanicity, income and delayed medical care. We also found little evidence that reasons for not being screened differed by diabetes status.

Most studies examining cervical cancer screening by diabetes status have been conducted outside of the US. Within the US, a previous analysis using the Behavioral Risk Factor Surveillance System (BRFSS) found a lower prevalence of cervical cancer screening among women with diabetes compared to those without even after adjustment for other factors, but that study was limited to HPV testing and if women had ever been tested.[8] We reported on Pap smears and HPV testing combined but unlike the BRFSS analysis, once we controlled for other participant characteristics, there was no association between diabetes status and concordant screening. In the BRFSS, there was also indication of lower rates of screening in southern states while there was no evidence of regional differences in the NHIS.

Another recent retrospective cohort study conducted in Canada found lower cervical cancer screening rates among women with prevalent (but not incident) diabetes.[7] They found women with diabetes had a 15% lower rate of concordant cervical cancer screening compared to women without diabetes. There are a number of factors that make these analyses difficult to compare. Most notably, the population demographics differ, as well as each country’s healthcare system. Since the strongest associations we found for predictors in this analysis were healthcare-related (i.e. having health insurance, a usual place for healthcare, and visiting a doctor in the past year), it is important to have data available for diabetes and cervical cancer screening in the US. In our analysis, we excluded women with incident diabetes diagnosed in the year prior to the survey because of insufficient numbers and noted detection biases.

We did not find evidence that screening concordance by race/ethnicity differed by diabetes status. This is important because the risk of being diagnosed with and dying from diabetes and cervical cancer are both higher in Hispanic and Black non-Hispanic women.[9, 14, 15] Based on this analysis, interventions targeted to increase screening in these groups would not need to consider diabetes as a modifying factor. Access to care still appears to be the biggest obstacle regardless of diabetes. This may apply to other chronic conditions also since the number of chronic conditions was not predictive of concordant screening after adjusting for other factors.

The differences we found by diabetes status for urbanicity are interesting in that women with diabetes in rural areas are more likely to be screened for cervical cancer than women in metro areas while women without diabetes in rural areas are less likely to be screened than women in metro areas. Breast and cervical cancer screening have been shown to be persistently lower in rural communities and these women face additional barriers to healthcare.[16] Perhaps having a chronic condition, such as diabetes, helps overcome some of these barriers in rural communities but acts more of a burden in metro areas. While studies have compared barriers to cervical cancer screening in urban and rural women,[17, 18] we are unaware of any that have examined the barriers by diabetes or other chronic disease status.

A major limitation of this analysis is relying on self-reported screening, which makes it less reliable to compare Pap smears and HPV tests to each other. However, for the purposes of this analysis, the focus was on any concordant screening. Because the NHIS includes such a broad questionnaire, we were able to control for and examine many potential predictors of concordant screening. However, it should be noted that we calculated a substantial number of statistical tests and did not adjust for multiple testing. It is also important that these data were collected prior to the Covid-19 pandemic, which has provided substantial disruption to cancer screening schedules and routines.[19] It is unclear how these results might differ as screenings begin to recover and it is unlikely that the recovery will be equal across groups, which could exacerbate existing disparities.

Cervical cancer screening rates have been declining since 2000.[11] Because of lower survival from cervical cancer among women with diabetes and increasing prevalence of diabetes, it is important to increase cervical cancer screening in these women. Based on the results of this study, it appears that while cervical cancer screening concordance may be lower in women with diabetes compared to those without, most barriers to screening are common to all women.

Declarations

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