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A cross-sectional analysis of factors associated with cervical cancer screening in a large midwest primary care setting



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Abstract

Background Lower cervical cancer screening (CCS) rates have been reported among non-White populations, older women, rural populations, and populations with low socioeconomic status (SES). We evaluate associations between CCS status and individual, healthcare, and SES variables in a large primary care setting in southeast Minnesota.

Methods We identified participants assigned female sex at birth, aged 21–65 years, without hysterectomy, and eligible for CCS via cross-sectional analysis of the electronic health record. Subjects were categorized as having up-to-date CCS or not. Logistic regression was used to model CCS status, with odds ratios (OR) and respective confidence intervals (95% CI) calculated for single predictor models for demographic factors, co-morbidities, and healthcare utilization.

Results Approximately 78% (30,670 subjects) were current with CCS (total *N*=39,433). Individuals who were Hispanic [OR (95% CI): 0.69 (0.62, 0.76)], non-White [0.53 (0.5, 0.56)], foreign-born [0.49 (0.46, 0.52)], and/or had limited English proficiency [0.44 (0.40, 0.49)] had lower odds of up-to-date CCS compared to Non-Hispanic, White, US-born, and/ or English-speaking individuals. Older age, higher comorbidity burden, greater healthcare utilization, and having a female primary care provider were associated with higher odds of up-to-date CCS, while an inactive online patient portal account had lower odds of up-to-date CCS. Individuals with lower SES had lower odds of up-to-date CCS compared to those with higher SES.

Conclusions In our sample, disparities in CCS status were associated with specific individual, healthcare, and SES factors/characteristics. Our results identify populations that may benefit from targeted interventions to address CCS uptake.

Keywords Cervical cancer prevention, Cervical cancer screening barriers, Immigrant women, Limited English Proficiency, Women's health, Population with health disparities

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Introduction

Cervical cancer screening (CCS) followed by treatment of pre-cancerous lesions is an effective secondary prevention strategy. It has been associated with a reduction of more than 50% in cervical cancer incidence and mortality in the United States (US) from the mid- 1970 s to the mid- 2000 s [1]. From 2001 to 2018, the United States Cancer Statistics program reported an annual decrease



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of 1.59% for local-stage cancers but increased advanced (stage IV) cervical cancer at a rate of 1.3% annually [2]. Despite screening efficacy, the American Cancer Society estimates 13,360 new diagnoses and 4,320 deaths from cervical cancer in the US in 2025 [3].

Cervical cancer incidence and mortality is greater among Hispanics (incidence: 9.8 and mortality: 2.4 per 100,000 persons, respectively), American Indian (incidence: 11.9 and mortality: 3.6 per 100,000, respectively), and non-Hispanic Black women (incidence: 8.5 per and mortality: 3.2 per 100,000 persons, respectively) compared to non-Hispanic White women in the US (incidence 7.1 and mortality: 2.1 per 100,000 persons, respectively). In comparison, Asian women have lower incidence and mortality compared to non-Hispanic White women (incidence: 6.1 and mortality 1.6 per 100,000 persons, respectively) [3, 4]. The disparity in cervical cancer burden widens even further between non-Hispanic White women versus Hispanic women and non-Hispanic Black women when accounting for hysterectomy status [5, 6]. About 50% of newly diagnosed cervical cancer are in individuals with inadequate past screening, and approximately 25% of those eligible for screening in the US are under screened [6]. There are disparities in CCS uptake, with lower screening rates in Hispanic and Asian women compared to non-Hispanic White and Black women [7, 8]. Additionally, immigration status, length of residency in the US, language barriers, and cultural differences have been linked to a lower likelihood of up-to-date CCS [7, 9, 10]. Foreign-born women are twice as likely to have not received the recommended screenings compared to their counterparts in the US [9, 11] and contribute to this group, often presenting with more advanced stages of cervical cancer [12]. Socioeconomic status (SES) and geographical factors have been linked with cancer screening and prevention behaviors. Lower rates of CCS are seen among individuals who are uninsured [13, 14], have lower educational attainment [15, 16], and lower annual household income [14–16]. With respect to geography, lower rates of CCS are seen among eligible individuals living in rural areas and the southern states in the US [7, 17, 18]. Rural areas have lower rates of preventative cancer screenings as they often experience higher rates of poverty, have a greater burden of chronic health conditions with less health care access, transportation issues and face greater social vulnerability [18].

The current body of research reveals that barriers to CCS are multifactorial and result from complex interactions between the social determinants of health at the systems, area, and individual levels. These findings emphasize the critical need for targeted outreach, education, and improved healthcare accessibility to ensure timely detection and intervention among these vulnerable groups. It is important to understand the systems-, area-, and individual-level barriers to CCS that are at play within the many unique primary care catchment areas in different US regions to implement relevant community and patient-centered interventions to improve screening.

Aims

In this study, we aim to analyze individual, healthcare, and SES-level factors that differ between individuals who are eligible and up to date on CCS versus those who are eligible and not up to date on CCS in a primary care setting in southeast Minnesota via electronic health record (EHR) review.

Methods

This study is a cross-sectional analysis that evaluates individuals eligible for CCS from a large primary care setting at a tertiary care academic institution in southeast Minnesota. Individuals eligible for CCS were identified via EHR review in October 2023. Individuals were eligible for CCS if they were between 21–65 years of age, female sex, and without prior hysterectomy. Individuals were categorized as up to date on CCS if they had completed a Pap test (cervical cytology) in the previous 3 years, primary human papillomavirus (HPV) screening in the previous 5 years, or cytology/HPV co-testing within the previous 5 years per United States Preventative Services Task Force (USPSTF) guidelines [19] as documented per last collection within our EHR or by self-report of collection at an outside health system within the appropriate screening interval during a provider visit.

The EHR was reviewed to collect data on individual demographics with the following continuous and categorical variables (age, race, ethnicity, country of origin, primary language, marital status), co-morbidities (assessed via the Deyo Age-Weighted Charlson Comorbidity Index) [20], and healthcare utilization (defined by number of years where the individual had at least one office visit limited to the preceding 5 years before crosssectional analysis, and evidence of active online patient portal status). The Devo Age-Weighted Charlson Comorbidity Index was calculated by using diagnoses in the prior 3 years that were binned into 17 different disease categories based on ICD 9 & 10 codes. Each category was given a weight, and those weights were summed for an individual if a diagnosis in a category was present. An additional point is given for each decade of age 50 or older for age weighting. Scores were then categorized into healthy, mild, moderate, and severe with a score of 0, 1-2, 3-4, and 5 + respectively [20].

To assess individual socioeconomic status, we utilized the HOUsing-based index of SocioEconomic Status

(HOUSES) index-a previously validated measure that utilizes individual housing characteristics to estimate SES [21]. The HOUSES index is a composite score derived from four real property feature variables: housing value, square footage of housing unit, number of bedrooms and number of bathrooms. To calculate an individual's HOUSES index, the individual's address is matched to real property data available from the local government assessors' office. Each of the four features from this property data are then compared to all other properties within the same county and standardized into a z-score. This z-score can be compared to all other available properties within the county and converted to guartiles with guartile 1 (Q1) denoting lowest estimated SES and quartile 4 (Q4) denoting highest estimated SES [22]. The HOUSES index has been used as a measure to estimate individual SES in other studies examining health outcomes in adult patient populations [23-25]. We also assessed associations between CCS status and the Area Deprivation Index (ADI). The ADI is a composite score to estimate SES at the census block level derived from 17 census measures including education, employment, housingquality, and poverty measure from the American Community Survey data. ADI scores are also categorized into quartiles with quartile 1 (Q1) denoting lowest deprivation or highest estimated SES and quartile 4 (Q4) denoting highest deprivation or lowest estimated SES. The ADI scores were provided within the HOUSES software, but data to generate ADI score was sourced from neighborhood atlas v3.2 [26, 27].

Logistic regression was used to model CCS status, with odds ratios and respective Wald 95% confidence intervals calculated for single predictor models, which included: demographic factors, co-morbidities, and healthcare utilization. This study was reviewed and approved by our institutional review board, and participant consent was waived for this study (reference ID: 23–004802). All analyses were completed using Rstudio production software v4.4.1 and SAS v9.4 statistical software.

Results

Within our primary care setting, we identified a total of 39,433 individuals who were eligible for CCS. Within this group, 30,670 (77.8%) were up to date on CCS and 8763 (22.2%) were not. In the up-to-date CCS group, 64.7% had undergone co-testing with cytology and primary HPV screening, 29.2% were up-to-date via cytology alone, and 4.0% were up to date via primary HPV screening alone. Approximately, 2.2% of our sample was characterized as up –to-date on CCS via self-report by a provider as the type of screening was not readily available in our electronic review at the time of analysis. Table 1 outlines the number of individuals with up-to-date CCS

versus not up-to-date CCS by individual level sociodemographics, comorbidity burden calculated by Charlson co-morbidity index, SES estimates, healthcare utilization patterns, online patient portal status, and primary care provider gender.

With respect to individual-level factors, we found lower odds of up-to-date CCS status in individuals who were Hispanic [odds ratio, OR (confidence interval, CI): 0.69 (0.62, 0.76), non-White race [OR (95% CI): 0.53 (0.5, 0.56)], foreign-born [Somalia, OR (95% CI): 0.32 (0.27, 0.37); India, OR (95% CI): 0.44 (0.36, 0.54); China, OR (95% CI): 0.69 (0.55, 0.88); Mexico, OR (95% CI): 0.51 (0.4, 0.64), and/or had limited English proficiency [preferred languages: Arabic, OR (95% CI) 0.48, (0.35, 0.66); Somali, OR (95% CI) 0.3, (0.25, 0.36); Spanish, OR (95% CI) 0.46 (0.37, 0.57)] compared to Non-Hispanic, White, US-born, and English-speaking individuals (see Fig. 1). Additionally, at the individual level, individuals who were older or had a higher comorbidity index had higher odds of up-to-date CCS (see Fig. 1) compared to their counterparts.

At the healthcare level, individuals with inactive/ other online patient portal account status had lower odds of up-to-date CCS [OR (95% CI): 0.23 (0.21, 0.26)] compared to those with an active online patient portal. Additionally, individuals assigned to female primary care providers had higher odds of up-to-date CCS compared to individuals assigned to male primary care providers [Female primary care provider, OR (95% CI): 1.19 (1.13, 1.26)]. Lastly, individuals demonstrating higher healthcare utilization, as evidenced by those who had at least one office visit in each of the last 5 years prior to the analvsis, had the highest odds of up-to-date CCS compared to those with lower healthcare utilization [Years with a visit, last 5, OR (95% CI): 50.37 (36.92, 70.48)]. This trend remained significant even after adjusting for age, race, country of origin, preferred language, and co-morbidity burden (Years with a visit, last 5, OR (95% CI): 43.95 (32.04, 61.76)]. See Fig. 2 for additional details.

Lastly, with respect to SES, individuals estimated to have lower SES via the HOUSES index had a lower likelihood of up-to-date CCS compared to those estimated to have higher SES via the HOUSES index. For example, individuals estimated to be the first quartile (Q1, lowest SES category in the HOUSES index) were estimated to have 41% lower odds of having an up-to-date CCS compared to the fourth or highest SES quartile [Q1 OR (95% CI): 0.59, (0.55, 0.63)]. This trend was also consistent when estimating SES using census block level data via the area deprivation index (ADI), where individuals in the fourth quartile (Q4, lowest SES category in the ADI) had 51% lower odds of having up-to-date CCS compared to those in the first quartile (Q1, highest SES category)

Table 1 Baseline demographics of empaneled individuals eligible for CCS

	Unscreened (<i>N</i> = 8763, 22.2%)	Screened (<i>N</i> = 30,670, 77.8%)	Total (N = 39,433)
Age			
21–29	2383 (30.1%)	5524 (69.9%)	7907 (100.0%)
30–39	2762 (22.3%)	9609 (77.7%)	12,371 (100.0%)
40–49	1658 (18.8%)	7163 (81.2%)	8821 (100.0%)
50–59	1247 (18.9%)	5357 (81.1%)	6604 (100.0%)
60–65	713 (19.1%)	3017 (80.9%)	3730 (100.0%)
Race			
White	6533 (20.0%)	26,126 (80.0%)	32,659 (100.0%)
Black or African American	852 (36.6%)	1478 (63.4%)	2330 (100.0%)
Asian	794 (29.1%)	1936 (70.9%)	2730 (100.0%)
American Indian/Alaskan Native	32 (21.1%)	120 (78.9%)	152 (100.0%)
Native Hawaii/Pacific Islander	14 (29.8%)	33 (70.2%)	47 (100.0%)
Unknown	199 (30.7%)	449 (69.3%)	648 (100.0%)
N-Missing	339	528	867
Ethnicity			
Hispanic	539 (28.5%)	1349 (71.5%)	1888 (100.0%)
Non-Hispanic	7917 (21.6%)	28,792 (78.4%)	36,709 (100.0%)
Unknown	307 (36.7%)	529 (63.3%)	836 (100.0%)
Preferred language			
English	8103 (21.5%)	29,600 (78.5%)	37,703 (100.0%)
Arabic	64 (36.4%)	112 (63.6%)	176 (100.0%)
Chinese (Mandarin)	35 (28.9%)	86 (71.1%)	121 (100.0%)
Other	160 (34.4%)	305 (65.6%)	465 (100.0%)
Somali	233 (47.4%)	259 (52.6%)	492 (100.0%)
Spanish	130 (37.5%)	217 (62.5%)	347 (100.0%)
Vietnamese	23 (22.3%)	80 (77.7%)	103 (100.0%)
Unknown	15 (57.7%)	11 (42.3%)	26 (100.0%)
Country of Origin			
USA	6968 (20.4%)	27,236 (79.6%)	34,204 (100.0%)
Somalia	291 (44.6%)	362 (55.4%)	653 (100.0%)
India	149 (36.8%)	256 (63.2%)	405 (100.0%)
China	97 (27.0%)	262 (73.0%)	359 (100.0%)
Mexico	110 (33.5%)	218 (66.5%)	328 (100.0%)
Other	1010 (30.8%)	2266 (69.2%)	3276 (100.0%)
Unknown	138 (66.3%)	70 (33.7%)	208 (100.0%)
Provider gender			
Male	2331 (24.6%)	7142 (75.4%)	9473 (100.0%)
Female	6432 (21.5%)	23,528 (78.5%)	29,960 (100.0%)
Marital status			
N-Missing	61	81	142
Married	4123 (17.6%)	19,292 (82.4%)	23,415 (100.0%)
Single	3860 (31.1%)	8536 (68.9%)	12,396 (100.0%)
Divorced/separated/widowed	642 (20.7%)	2464 (79.3%)	3106 (100.0%)
Life Partnership	77 (20.6%)	297 (79.4%)	374 (100.0%)
HOUSES quartile			
Q4	2097 (18.0%)	9561 (82.0%)	11,658 (100.0%)
Q3	1906 (20.3%)	7483 (79.7%)	9389 (100.0%)
Q2	1882 (23.6%)	6096 (76.4%)	7978 (100.0%)
Q1	2347 (27.2%)	6289 (72.8%)	8636 (100.0%)

Table 1 (continued)

missing	531 (30.0%)	531 (30.0%) 1241 (70.0%)		
ADI quartile				
Q1	963 (18.0%)	963 (18.0%) 4375 (82.0%)		
Q2	4339 (21.0%)	16,338 (79.0%)	20,677 (100.0%)	
Q3	2575 (24.6%)	7884 (75.4%)	10,459 (100.0%)	
Q4	324 (31.0%)	720 (69.0%)	1044 (100.0%)	
missing	562 (29.3%)	1353 (70.7%)	1915 (100.0%)	
Charlson index (age weighted-Deyo)				
healthy (0)	5618 (24.8%)	17,032 (75.2%)	22,650 (100.0%)	
mild (1–2)	2459 (19.0%)	10,497 (81.0%)	12,956 (100.0%)	
moderate (3–4)	425 (16.9%)	2086 (83.1%)	2511 (100.0%)	
severe (5 +)	261 (19.8%)	1055 (80.2%)	1316 (100.0%)	
Years with visit (last 5)				
0	297 (87.4%)	43 (12.6%)	340 (100.0%)	
1	1243 (52.9%)	1108 (47.1%)	2351 (100.0%)	
2	1496 (40.2%)	2228 (59.8%)	3724 (100.0%)	
3	1568 (32.5%)		4819 (100.0%)	
4	1608 (22.8%)	.2.8%) 5435 (77.2%)		
5	2551 (12.1%)	18,605 (87.9%)	21,156 (100.0%)	
MyChart status				
UNKNOWN STATUS	15 (100.0%)	0 (0.0%)	15 (100.0%)	
ACTIVATED	8048 (21.1%)	30,056 (78.9%)	38,104 (100.0%)	
INACTIVATED	253 (51.1%)	242 (48.9%)	495 (100.0%)	
NON-STANDARD MYCHART STATUS	20 (90.9%)	2 (9.1%)	22 (100.0%)	
PATIENT DECLINED	19 (31.7%)	41 (68.3%)	60 (100.0%)	
PENDING ACTIVATION	408 (55.4%)	329 (44.6%)	737 (100.0%)	

[Q4 OR (95% CI): 0.49 (0.42, 0.57)]. See Fig. 3 for additional details.

Discussion

We found that despite overall rates of CCS in our large Midwest primary care practice almost meeting the Healthy People 2030 target of 79.2% screened [28], there were lower odds of up-to-date screening status among individuals from non-White populations who were foreign-born, with limited English proficiency, and/or estimated to be of lower SES. At the healthcare level, greater healthcare utilization and having a female primary care provider were associated with greater odds of up-to-date CCS status, whereas having an inactive portal status was associated with lower odds of up-to-date CCS.

Our findings regarding lower screening rates in non-White populations, foreign-born individuals, those with limited English proficiency, and those of lower SES are well established in the literature [9, 14, 29]. Datta and colleagues evaluated responses from the US Behavioral and Risk Factor Surveillance Survey on CCS and found that women belonging to non-White populations were more likely to have never been screened compared to Non-Hispanic White women across all minority groups even after adjusting for co-variates such as age, primary care provider access, health insurance coverage, income, marital status, and educational attainment [30]. Their study also found that a greater proportion of women who reported having never undergone CCS were unmarried, uninsured, reported no access to primary care, lower educational attainment, and lower household income.

Foreign-born women living in the U.S. have a considerably lower chance of receiving CCS, as seen by our data and the literature, when compared to women born in the U.S. [31, 32]. Under screening in foreign-born women may contribute to the greater cervical cancer mortality in older foreign-born women and women born in Mexico compared to US-born women, as previously reported [33]. Among immigrant populations, lack of knowledge on the importance of CCS, language barriers, lack of insurance, lack of easily accessible screening services in proximity to immigrant communities, and patientprovider cultural and gender discordance have been identified as barriers to CCS [34–37]. In addition, fear of

Variables	Odds Ratio (95%	Confidence	Interval)			
	,		Less Likely	More Likely		
Age						
21-29	Reference			•		
30-39	1.5 (1.41, 1.6)			—		
40-49	1.86 (1.73, 2)		l	_	•	
50-59	1.85 (1.71, 2)				—	
60-65	1.83 (1.66, 2.01)		1		+	
Race			I			
White	Reference		•	•		
White vs. Non-White	0.53 (0.5, 0.56)		+			
Black or African American	0.43 (0.4, 0.47)		◆			
Asian	0.61 (0.56, 0.67)		-			
American Indian/Alaskan	0.94 (0.64, 1.41)		+			
Native Hawaii/Pacific Islander	0.59 (0.32, 1.14)	-	•			
Unknown	0.56 (0.48, 0.67)		—			
Ethnicity			1			
Non-Hispanic	Reference			•		
Hispanic	0.69 (0.62, 0.76)		—			
Unknown	0.47 (0.41, 0.55)					
Country of Origin			1			
USA	Reference			•		
USA vs. All other countries	0.49 (0.46, 0.52)		•			
Somalia	0.32 (0.27, 0.37)	-	- i			
India	0.44 (0.36, 0.54)					
China	0.69 (0.55, 0.88)					
Mexico	0.51 (0.4, 0.64)		<u> </u>			
Other country	0.57 (0.53, 0.62)		+			
Unknown	0.13 (0.1, 0.17)	+				
Preferred language			 			
English	Reference			•		
English vs. All other languages	0.44 (0.4, 0.49)		+			
Arabic	0.48 (0.35, 0.66)					
Chinese (Mandarin)	0.67 (0.46, 1.01)					
Somali	0.3 (0.25, 0.36)	+	- 1			
Spanish	0.46 (0.37, 0.57)		—			
Vietnamese	0.95 (0.61, 1.55)					
Other language	0.52(0.43, 0.63)		<u> </u>			
Unknown	0.2(0.09, 0.43)	-	-			
Dovo Ago Waightod Charles -	omorbidite ladas					
	Defense					
Healthy (U)	Keterence		1			
IVIIId disease (score 1-2)	1.41 (1.34, 1.49)					
ivioderate disease (score 3-4)	1.62 (1.45, 1.81)				-	
Severe disease (score 5+)	1.33 (1.16, 1.53)					
		0	0.5 1	1.5	2	2.5

Fig. 1 Individual level variables and odds of up-to-date CCS, cross-sectional analysis, October 3, 2023

Variables	Odds Ratio (95% Confidence Interval)		
Healthcare util	ization (years with visit, last 5 years)		
Unadjusted		Mara Likaly	
	Less Likely		
0	Reference		
1	6.16 (4.48, 8.67)	-	
2	10.29 (7.51, 14.44)	↓ → → →	
3	14.32 (10.46, 20.09)	—	
4	23.35 (17.07, 32.73)		
5	50.37 (36.92, 70.48)		•
Healthcare util Adjusted for age, rac	zation (years with visit, last 5 years) e, preferred language, country of origin, comorbidities		
0	Reference	•	
1	5.7 (4.13, 8.05)	-	
2	9.63 (7, 13.57)	—	
3	13.03 (9.48, 18.34)	—	
4	20.7 (15.07, 29.13)		
5	43.95 (32.04, 61.76)	· · · · · ·	
	0	5 10 15 20 25 30 35 40 48	5 50 55 60 65 70 75
Online portal s	tatus	Less Likely	More Likely
Active	Reference		•
Inactive/other	0.23 (0.21, 0.26)		1
Primary care p	rovider gender		I
Male	Reference		
Female	1.19 (1.13, 1.26)		

0

0.5

1

1.5

Fig. 2 Healthcare level variables and odds of up-to-date CCS, cross-sectional analysis, October 3, 2023

Variables	Odds Ratio (95% Confi	dence Interva	al)			
HOUsing-base	d index of SocioEconomic	Status (HOU	SES) Index		Less Likely	More Likely
Q4	Reference (Highest SE	S)				•
Q3	0.86 (0.8, 0.92)					- 1 1
Q2	0.71 (0.66, 0.76)			_		
Q1	0.59 (0.55, 0.63)					
missing	0.51 (0.46, 0.57)					
Area Deprivatio	on Index (ADI)					
Q1	Reference (Highest SE	S)				♦
Q2	0.83 (0.77, 0.9)					
Q3	0.67 (0.62, 0.73)			-+		
Q4	0.49 (0.42, 0.57)		•	<u> </u>		
missing	0.53 (0.47, 0.6)		_	•		
	0	0.2	0.4	0.6	0.8	1 1.2

Fig. 3 Surrogate markers of socioeconomic status and odds of up-to-date CCS, cross-sectional analysis, October 3, 2023

healthcare navigation, receiving bad news, and the cost of receiving care have been reported as barriers to completing CCS in a scoping review on barriers to breast and cervical cancer screening uptake among migrant Latinx farmworkers [38].

Other individual level barriers previously identified include: previous negative pelvic exam experiences, lack of time for a clinic appointment due to work, household or childcare responsibilities, poor social support, availability of only male providers, concerns for safety, perceived risk, and psychological factors [7, 39]. Psychologic factors that negatively affect CCS completion can include fear, anxiety, embarrassment, pain, and/or a history of trauma or prior sexual abuse [40].

Contrary to prior studies, we found that older individuals and those with greater co-morbidities had higher odds of having up-to-date CCS compared to compared to younger, healthier individuals. Current data suggests that older women are less likely to have received adequate screening prior to cessation of screening at age 65 as currently recommended by USPSTF screening guidelines [41].

We utilized surrogate markers of healthcare utilization (number of years with visits in the last 5 years and active MyChart status) and found that a greater number of years with visits and having an active MyChart account was strongly associated with higher odds of being up to date on CCS even after adjusting for age, race, language, country of origin, and comorbidities. This is consistent with National Health Interview Survey data showing greater odds of CCS (OR 1.11, 95% CI 1.02-1.20) among women who had engaged in patient portal communication with their healthcare team [42]. Our results align with findings from a large integrated healthcare system, Kaiser Permanente Washington. Inactive patient portal status was associated with higher odds of being under screened (OR 2.6, 95% CI 2.4-2.8), as was a lack of a visit in the prior 12 months with their assigned primary care provider (OR 2.9, 95% CI 2.6–3.1) [43].

Individuals of lower SES have been shown to have lower rates of participation in preventative screening [14]. Our findings using the HOUSES index are consistent with what others have reported using surrogate SES scores at the census tract and block level [44–46]. Geographic analysis at the census tract and county level using the Area Deprivation Index (ADI) [45], the Social Vulnerability Index (SVI) [44], and the Index of Concentration of Extremes (ICE) [46] have found that areas experiencing high deprivation, social vulnerability, and less privilege have lower uptake of cervical, breast, and colon cancer screenings. In these analyses, rural counties comprised a greater proportion of the counties experiencing higher deprivation, social vulnerability, and less privilege [44–46]. However, in these studies, analysis is limited to the census tract or county level, which may miss nuances regarding screening behaviors and socioeconomic status at the individual level. Our use of the HOUSES index offers a more precise understanding of the association between individual SES and CCS status via an objective surrogate SES measure, rather than at the census tract or county level or through self-reported SES measures. The HOUSES index may be applied to assess associations with SES and other individual level screening behaviors and health outcomes in patient populations when individual SES measures are not readily available.

Evaluation of the relationship between insurance status and cancer screenings among US adults has found that women with employer-based insurance or Medicare were more likely to receive CCS compared to other types of insurance [13]. Studies evaluating the racial inequities in the stage of cervical cancer diagnoses have found that health insurance status was a mediator for greater than 50% of advanced-stage cervical cancer diagnoses for non-White women in comparison to Non-Hispanic White Women [47]. Thus, access to preventative care services and insurance coverage continues to be a major barrier among non-White women seeking CCS.

Limitations

Our cross-sectional analysis included a sample of majority non-Hispanic White, English-speaking, US-born individuals from the Midwest, which is representative of our catchment area but may not be generalizable to primary care populations in different regions of the US. While we can establish correlation, we are unable to determine causality from the data presented. With respect to healthcare utilization, we could not determine how many of these visits were within primary care versus with another medical or surgical subspecialty, which limits our interpretation of these results. Lastly, while we were able to identify individuals with an active online patient portal account, we are unable to draw conclusions about how often individuals utilized or accessed their MyChart accounts.

Future directions

Our current analysis allows us to engage community stakeholders from the specific under screened subpopulations within our empaneled primary care population. Based on our data, there is a need to engage communitybased stakeholders in the Hispanic and Somali communities to gain a more nuanced understanding of the barriers to CCS uptake in these communities—as they comprised most of our non-White under screened population. Community-based engagement is crucial to understand the specific barriers to completing CCS [35, 48, 49]. As next steps, we have actively engaged women from these affected communities through a community-based participatory research approach and are completing a mixed methods evaluation of barriers and facilitators to CCS uptake. The ongoing community-based outreach has provided the foundation for intervention work, which is currently in development.

Prior studies have suggested that increasing community outreach and the use of patient navigators can help improve cancer screening in minority communities experiencing limited English proficiency [50]. The use of Community Health Workers (CHWs) to improve CCS is recommended by the Community Preventive Services Task Force and supported by a 12.8% median increase in screening observed in a systematic review of 33 CHWbased interventional studies across diverse populations [50].

Additionally, self-collection of a vaginal sample for human papillomavirus (HPV) testing in a healthcare setting was approved by the U.S. Food and Drug Administration (FDA) in May of 2024 [51, 52] and has not been widely implemented yet in the US but has the potential to address screening barriers, including discomfort and embarrassment with pelvic exams [53], and if homebased self-collection is ultimately approved, this will address barriers of cost, transportation, and limited clinic hours [54]. Reassuringly, high acceptability of self-collection for CCS was reported in a systematic review of 72 studies including just over 52,000 women, with no significant differences by factors such as income or age [55].

The use of the HOUSES index in this analysis also allows us to pinpoint areas in our catchment with greater numbers of under screened individuals where we can implement further targeted efforts to increase screening.

Conclusion

Our findings warrant further exploration to identify barriers to cervical cancer screening among specific communities which will guide future intervention strategies. The newly FDA approved option for vaginal HPV self-collection [51, 52] has great promise to address screening barriers and may be a more patient-centered tool to complete CCS.

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Authors' contributions

JC was involved in study conceptualization, data abstraction, analysis, and visualization, original draft preparation, and subsequent revision. KM and JN provided oversight on study design and execution, mentorship to core team, provision of funding support for data analysis, and manuscript drafting/ revision. GJ contributed to methodology design, data curation, analysis, and visualization, and manuscript drafting/revision. BS, DO, and JS contributed to study conceptualization and manuscript drafting/revision. All authors reviewed the manuscript.

Page 9 of 10

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available in order to protect patient confidentiality but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was reviewed and approved by the Mayo Clinic Institutional Review Board, and participant consent was waived for this study (reference ID: 23–004802). Electronic health record data analysis performed in this study was done in accordance with the Minnesota Research Authorization process as outlined by the State of Minnesota Legislature: https://www.revisor.mn.gov/ statutes/cite/144.295.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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