



# Differences in up-to-date colorectal and cervical cancer screening rates by ethnicity and preferred language: An analysis across patient-, clinic-, and area-level data sources

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## ABSTRACT

**Research objective:** There is interest in using clinic- and area-level data to inform cancer control, but it is unclear what value these sources may add in combination with patient-level data sources. This study aimed to investigate associations of up-to-date colorectal and cervical cancer screenings at community health centers (CHCs) with ethnicity and language variables at patient-, clinic-, and area-levels, while exploring whether patient-level associations differed based on clinic-level patient language and ethnicity distributions.

**Study design:** This was a cross-sectional study using data from multiple sources, including electronic health records, clinic patient panel data, and area-level demographic data. The study sample included English-preferring Hispanic, Spanish-preferring Hispanic, English-preferring non-Hispanic, and non-English-preferring non-Hispanic patients eligible for either colorectal cancer (N = 98,985) or cervical cancer (N = 129,611) screenings in 2019 from 130 CHCs in the OCHIN network in CA, OR, and WA.

**Population studied:** The study population consisted of adults aged 45+ eligible for colorectal cancer screening and adults with a cervix aged 25–65 eligible for cervical cancer screening.

**Principal findings:** Spanish-preferring Hispanic patients were significantly more likely to be up-to-date with colorectal and cervical cancer screenings than other groups. Patients seen at clinics with higher concentrations of Spanish-preferring Hispanics were significantly more likely to be up-to-date, as were individuals residing in areas with higher percentages of Spanish-speaking residents. Differential associations between patient ethnicity and language and up-to-date colorectal cancer screenings were greater among patients seen at clinics with higher concentrations of Spanish-preferring Hispanics.

**Conclusions:** The findings highlight that Spanish-speaking Hispanics seen in CHCs have higher rates of up-to-date cervical and colorectal cancer screenings than other groups and that this relationship is stronger at clinics with higher percentages of Spanish-preferring Hispanic patients. Our findings suggest area-level variables are not good substitutions for patient-level data, but variables at the clinic patient panel-level are more informative.

## 1. Introduction

Despite ongoing technological advances in cancer detection and treatment, cancer continues to be a major public health concern in the US with significant impacts on individuals and healthcare systems (Siegel et al., 2022). Keeping up-to-date with recommended cancer screenings has been shown to decrease cancer morbidity and mortality (Meester et al., 2015; Plevritis et al., 2018; Siegel et al., 2020). While the overall cancer death rate in the US has declined in recent years, socio-economic disparities in mortality have grown, especially in cancers (e.g.,

cervical cancer) in which early detection and treatment yields the most potential benefits (Siegel et al., 2022). A strong commitment to health equity—that is, prioritizing the needs of those most at risk in society—is therefore key to improving cancer-related outcomes (Alcaraz et al., 2020). For patients, barriers leading to inequitable access and utilization include discomfort, stigma, or fear around screenings, lack of awareness of the benefits, cost concerns, and other challenges such as lack of time off, transportation availability, and dependent care (Fuzzell et al., 2021; Muthukrishnan et al., 2019; Nagelhout et al., 2017). Factors associated with lower rates of cancer screening among age-eligible adults include

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no usual source of healthcare, uninsured or underinsured status, recent immigrant status, less than high school education, low income, younger age, American Indian/Alaska Native, Asian, Black, or Hispanic race/ethnicity, and residence in a rural or remote area (Berkowitz et al., 2018; T. Nuño et al., 2012; Sabatino et al., 2021).

Contemporary cancer control research emphasizes the importance of addressing social determinants of health (SDH), which are the non-medical factors that influence health outcomes, defined by the World Health Organization (WHO) as the conditions in which people are born, live, learn, work, and play that affect their health and quality of life (WHO, 2023). SDH are shaped by global, national, and local distributions of money, power, and resources (Alderwick & Gottlieb, 2019), and origins of the concept trace back to Link and Phelan's foundational theory of fundamental causes, which posits that health disparities persist despite continual medical advances because disadvantaged communities lack key resources that affect both their health behaviors and their access to healthcare (Link & Phelan, 1995; Phelan & Link, 2015). As long as these root causes remain unaddressed, it is likely that efforts to improve health equity will have limited effectiveness (Alcaraz et al., 2020). Consequently, leading health entities in the US—such as the Department of Health and Human Services, which includes the Centers for Disease Control and Prevention and the National Institutes of Health—have increasingly recognized the role of SDH in shaping population health, along with the need for government entities and healthcare institutions to address health disparities through targeted interventions and policy change (US Department of Health and Human Services, 2023).

SDH-based frameworks for promoting health equity emphasize the insights that (1) individual factors on their own are insufficient in explaining socioeconomic disparities in cancer and (2) individual-level analyses, while providing information on *which* populations are in need, provide limited guidance regarding *how* to intervene with at-risk populations (Alcaraz et al., 2020). There is growing acknowledgement that, to develop effective strategies for addressing disparities in cancer-related outcomes, SDH must be conceptualized within a multi-level framework (Alcaraz et al., 2020). Individual-level characteristics (such as gender, race and ethnicity; social class and markers of socioeconomic status such as education, income, occupation, and employment status; and language use, disability status, and social capital) interact with broader social-structural factors, affecting both healthcare behaviors and healthcare access (Singh et al., 2017). Socioeconomic disadvantage, for example, often results in people living in under-resourced areas that make it more difficult for them to prioritize their health and to access necessary screenings and treatments—research based on six decades of data show that residents of lower-income neighborhoods experience higher cancer incidence and mortality relative to people who live in more affluent areas (Singh & Jemal, 2017).

At the healthcare system level, SDH may be addressed through expansion of the availability and accessibility of cancer screening and treatment (Han et al., 2018), interventions that promote equitable patient access to health information technology (Lyles et al., 2015), and improvement in the cultural competency of healthcare providers or the quality of care provided (Henderson et al., 2018). At the area or community level, SDH include systemic factors broadly affecting healthcare access and outcomes, such as educational opportunities, the availability of affordable housing, access to healthy foods, transportation infrastructure, physical and built environments, racial and ethnic population composition, medically underserved areas, and funding for public safety and social services (Singh et al., 2017). A recent study found that, relative to individuals living in the 20 % least deprived census block groups, those living in the 20 % most socially deprived groups were almost half as likely to receive recommended breast, cervical, and colorectal cancer screenings (Kurani et al., 2020).

Operationalizing SDH at multiple levels requires diverse data sources. At the individual level, data may be collected through surveys,

interviews, electronic health records, or administrative data. At the clinic level, data may be collected through clinic patient panel registries. And at the area level, data may be collected through census data (Kurani et al., 2020; Oates et al., 2017), geographic information systems (GIS) (Angier et al., 2014; Bazemore et al., 2010), or other area-level sources of data. Clear standards regarding how to implement social risk screenings in clinical settings, however, are lacking, and some have questioned the benefits of adding additional data collection requirements to already-burdened primary care practice workflows (Solberg, 2016; Tong et al., 2018). Research shows that many clinicians are aware of the importance of SDH but are uncertain how to ask about individuals' needs and lack the resources to address those needs (Eder et al., 2021; Tong et al., 2018).

There is interest in leveraging these area-level measures within population health research investigating at-risk populations; in a risk prediction context, SDH are increasingly viewed as critical to the identification of upstream drivers of poor outcomes and higher costs (Chen et al., 2020; Daniel et al., 2018). Reliance on area-level data alone to inform patient-level interventions, however, can lead to making incorrect assumptions about individuals based on aggregate information—a type of error known as the ecological fallacy (Diez-Roux, 1998; Robinson, 1950). A recent study by Cottrell et al. (2020) demonstrated a lack of equivalence between social risk assessments using patient- and area-level sources, suggesting that the use of area-level data alone may lead to a failure to identify all patients who could benefit from an intervention. More research is needed to understand how to effectively incorporate information about SDH at multiple levels in exploring factors associated with differences in health-related outcomes. It is unclear what value clinic- and area-level data sources may add, either *in combination with* individual-level sources or *instead of* patient variables when such data are unavailable.

Cervical and colorectal cancers are the source of significant health burdens in the US, and screenings that detect these cancers at early stages—paving the way for timely treatment—are particularly important for adults of Hispanic ethnicity, who often have underlying risk factors such as un- or under-insurance and higher levels of comorbidities (Miller et al., 2021). After non-Hispanic Black women, Hispanic women have the second-highest rate of dying from cervical cancer (CDC, 2023). Evidence shows cancer preventive service uptake among Hispanic adults varies depending on ethnic subgroup and region, English language proficiency, undocumented status, insured status, and healthcare setting (Alba et al., 2004; Echeverria & Carrasquillo, 2006; Jerant et al., 2008; Miller et al., 2021; Ortega et al., 2007). Further, many studies are limited due to the response bias inherent to the survey-based methods they use (Heintzman et al., 2018). A recent study found that, although Hispanic adults had a lower average use of cancer preventive services—due primarily to being less likely to have a usual source of care—after adjustment for this and other relevant variables, cancer screening rates among this population were comparable to those of non-Hispanic whites (Hall et al., 2022). Another recent study of a sample of women with low-income seeking care at community health centers (CHCs) shows minimal racial/ethnic differences in cervical cancer prevention services (Heintzman et al., 2018).

Hispanic patients often seek care at CHCs, as they can access services regardless of insurance status, with Hispanic patients accounting for more than 35 % of CHC patients nationally (Ortega et al., 2015). Within this setting also, Hispanic patients are not a homogenous group—in particular, studies show linguistically different sub-populations vary in their receipt of recommended cancer screenings. One recent study of patients from a multistate network of CHCs in the US showed that Spanish-preferring Hispanic adults over age 50, relative to their non-Hispanic white counterparts, were more likely to have been screened for colorectal cancer (Heintzman et al., 2023). It is unknown, however, whether this observed association between language preference and cancer screening rate may vary depending on individual clinic-level factors (e.g. targeted outreach to Spanish-speaking

populations or higher cultural competence among providers). To address the gap in the research, this study aimed to investigate the associations of up-to-date colorectal and cervical cancer screenings at CHCs with ethnicity and preferred language at patient-, clinic-, and area-levels and assessed the impact of clinic-level panel distribution on the relationship between ethnicity/language and colorectal and cervical cancer screenings.

## 2. Material and methods

### 2.1. Data source

We used electronic health record (EHR) data from OCHIN (not an acronym) Inc., a network of CHCs from across the US consisting of a single instance of Epic® EHR record (DeVoe and Sears 2013). To allow for the effects of geographic variation on SDH, we restricted our analysis to the three states (WA, OR, and CA) with a greater number of clinics represented in our dataset, allowing for better geographic diversity. Our study period was the year 2019: we analyzed patients who were eligible for either cervical or colorectal cancer screening that year.

We used data from multiple sources, including patient electronic health records, aggregated patient panel data from these clinics, and area-level demographic data linked to patient addresses. The patient-level demographic and clinic-level data were extracted from the Accelerating Data Value Across a National Community Health Center (ADVANCE) clinic research network (CRN) of PCORnet®. Demographic data from all patients seen at an office or telehealth visit during the study period were summarized to create the OCHIN clinic-level patient panel data and we linked this information to patients through identification of their most frequented facility. Finally, we linked patient-level EHR data with area-level data summarized at the census tract level from the Community Vital Signs dataset obtained from HealthLandscape, based on the address noted in the patient's EHR with the longest period of overlap with the study period (Bazemore et al., 2016).

We excluded patients we were not able to link to the area-level data (29.7 % of the initial sample for colorectal cancer and 26.0 % for cervical cancer). Patients who identified as Hispanic but preferred a language other than English or Spanish or who were missing information on either ethnicity or language preference variables were grouped into an "Other/Unknown" category (5.4 % of the final sample for colorectal cancer and 4.9 % of the final sample for cervical cancer). For the colorectal cancer screening analyses, the study sample included 98,895 Spanish-prefering Hispanic, English-prefering Hispanic, English-prefering non-Hispanic, non-English-prefering non-Hispanic, or Other/Unknown adults aged 50+ who were eligible for colorectal cancer screenings in 2019. For the cervical cancer screening analyses, the study sample included 129,611 Spanish-prefering Hispanic, English-prefering Hispanic, English-prefering non-Hispanic, non-English-prefering non-Hispanic, or Other/Unknown adults with a cervix aged 25 to <65 who were eligible for cervical cancer screening in 2019.

## 2.2. Variables

### 2.2.1. Dependent variables

For all analyses, the outcome measure was a binary variable denoting whether the patient was up-to-date with the screening of interest (colorectal cancer or cervical cancer) during any month in 2019. To generate the monthly up-to-date screening variables, the denominator for the cervical cancer screening rate was measured using monthly percentages of eligible patients up-to-date for cervical cancer screenings, while the denominator for the colorectal cancer screening rate was measured using monthly percentages of eligible patients up-to-date for colorectal cancer screening, which considers colonoscopy, flexible sigmoidoscopy and fecal immunochemical test (FIT)/fecal occult blood test (FOBT) records among eligible patients. The up-to-date variables were generated initially at the monthly level, then rolled up to yearly

outcome measures: a patient was considered up-to-date in 2019 if they were up-to-date in *any* month that year.

### 2.2.2. Independent variables

**Patient-level:** For the models leveraging patient-level information, the independent variable of interest was a categorical variable with four levels, combining ethnicity and language preference: English-prefering Hispanic, Spanish-prefering Hispanic, English-prefering non-Hispanic, non-English preferring non-Hispanic, and other/unknown. CHCs are required to collect and report many patient-level data elements for the US Health Resources and Services Administration (HRSA), so these data are captured consistently for all CHC patients.

**Clinic patient panel-level:** For the models leveraging clinic-level patient panel information, the independent variables of interest were continuous: % English-prefering Hispanic, % Spanish-prefering Hispanic, % English-prefering non-Hispanic, and % non-English-prefering non-Hispanic.

**Area-level:** For the models leveraging area-level information, the independent variables of interest were continuous: % English-prefering Hispanic and % Spanish-prefering Hispanic. These were constructed variables derived as follows: as a proxy for % Spanish-prefering Hispanic, we used the variable from the American Community Survey at the census tract level representing the percent of the population age five and over that speak Spanish at home. For % English-prefering Hispanic, this Spanish-prefering % was subtracted from the tract-level % Hispanic to approximate the percentage of Hispanics that prefer English.

### 2.2.3. Covariates

For models leveraging patient-level information, we adjusted for a variety of additional demographic and utilization-related characteristics, including sex (only for the colorectal cancer models), age, race (White, Black, Asian, and other), insurance status, household income as a percent of the federal poverty level percentage (FPL), Charlson comorbidity level, primary care provider assignment, ambulatory (AV) visits per year in 2019, and whether they had a pre-2019 AV visit.

For models leveraging clinic-level information, we adjusted for clinic state (CA, OR, or WA), in addition to available characteristics corresponding to the selected patient-level variables, including percentages by sex (only for the colorectal cancer models), age groups, race categories (White, Black, and Asian), insurance status, income as % of FPL, Charlson comorbidity level, and primary care provider assignment.

For models leveraging area-level information, we adjusted for percentages by race categories (White, Black, and Asian), insurance status, and people living in poverty, as well as the age dependency ratio (65+), where higher values indicate a greater level of old-age-related dependency in the population.

### 2.2.4. Moderating variable

We constructed a clinic-level categorical variable with five levels: 1) <5 % Spanish-prefering Hispanic; 2) 5 to <10 % Spanish-prefering Hispanic; 3) 10 to <25 % Spanish-prefering Hispanic; 4) 25 to <50 % Spanish-prefering Hispanic; and 5) ≥50 % Spanish-prefering Hispanic. The cutoffs for this classification were based on the quintiles of the patient-level operationalization of this clinic-level variable—that is, with a roughly equal proportion of patients in our sample linked to a clinic (based on their most-frequented facility) in each of these five categories. We were interested in investigating whether the association between patient-level ethnicity/language preference and up-to-date cancer screening varied depending on the concentration of Spanish-prefering patients on the clinic patient panel. Specifically, we investigated whether, in clinics with higher concentrations of Spanish-prefering Hispanics, up-to-date cancer screening rates were *more* different across language/ethnicity groups than in clinics with lower concentrations of Spanish-prefering Hispanics. We hypothesized this might be the case because if a clinic did a significant amount of outreach to Spanish speaking patients (or perhaps, relatedly, had a high number

**Table 1**  
Patient-, clinic-, and area-levels characteristics, colorectal and cervical cancer screening samples.

Patient- and Clinic-Levels Variables <sup>a</sup>	n = 130 clinics			
	Colorectal cancer screening sample, N = 98,895			
	Patient-level, %	Clinic-level %, mean (SD)	Area-Level Variables	Area-level %, mean (SD)
<b>Ethnicity and preferred language</b>				
Spanish-preferring Hispanic	28.1	25.9 (21.3)	Spanish-preferring <sup>b</sup> Hispanic	23.7 (24.6)
English-preferring Hispanic	6.1	14.5 (8.1)	English-preferring Hispanic	6.4 (5.4)
English-preferring non-Hispanic	55.9	49.5 (26.4)	–	–
Non-English-preferring non-Hispanic	4.6	3.4 (6.0)	–	–
<b>Sex</b>				
Female	55.7	56.6 (5.1)	–	–
<b>Age</b>				
50-64	76.2	21.2 (5.9)	–	–
65+	23.8	10.4 (5.2)	Dependency ratio <sup>c</sup>	24.5 (14.2)
<b>Race</b>				
White	78.0	75.5 (16.2)	White	70.4 (21.1)
Black	5.0	4.8 (6.3)	Black	4.1 (6.9)
Asian	5.1	4.0 (4.7)	Asian	6.7 (9.3)
Other	2.4	3.0 (2.0)	–	–
<b>Insurance status</b>				
Uninsured	11.7	9.5 (7.6)	Uninsured	9.10 (5.6)
Always insured	75.5	–	–	–
Mixed	12.8	–	–	–
<b>Income as % of federal poverty level (FPL)</b>				
< 138 % FPL	56.8	63.2 (22.8)	< 100 % FPL	17.0 (9.4)
≥ 138 % FPL	20.1	19.9 (12.8)	–	–
<b>Charlson score</b>				
0-1	60.1	56.8 (11.0)	–	–
2-4	32.7	25.1 (3.7)	–	–
5-6	4.7	8.1 (3.0)	–	–
7+	2.5	9.9 (5.9)	–	–
<b>Primary care provider assigned</b>	90.9	40.0 (11.7)	–	–
<b>Ambulatory visits per year</b>				
1-3	13.7	–	–	–
4-6	14.8	–	–	–
7-10	18.3	–	–	–
>10	53.2	–	–	–
<b>At least 1 ambulatory visit pre-2019</b>	86.2	–	–	–
Patient- and Clinic-Levels Variables <sup>a</sup>	Cervical cancer screening sample, N=129,611			
	Patient-level, N ( %)	Clinic-level %, mean (SD)	Area-Level Variables	Area-level %, mean (SD)
<b>Ethnicity and preferred language</b>				
Spanish-preferring Hispanic	33.8	28.0 (20.9)	Spanish-preferring <sup>b</sup> Hispanic	25.7 (25.6)
English-preferring Hispanic	11.6	15.6 (8.4)	English-preferring Hispanic	6.6 (5.4)
English-preferring non-Hispanic	46.1	46.2 (25.7)	–	–
Non-English-preferring non-Hispanic	3.6	3.5 (5.9)	–	–
<b>Age</b>				
< 30	15.0	18.7 (6.6)	–	–
30-49	52.2	31.7 (6.0)	–	–
50-64	32.9	19.7 (6.6)	–	–
			Dependency ratio <sup>c</sup>	22.7 (12.7)
<b>Race</b>				
White	76.1	74.1 (16.6)	White	69.0 (21.2)
Black	4.6	5.1 (6.5)	Black	4.1 (6.7)
Asian	3.9	4.1 (4.7)	Asian	6.9 (9.3)
Other	3.0	3.0 (2.2)	–	–
<b>Insurance status</b>				
Uninsured	16.9	10.5 (8.9)	Uninsured	9.4 (5.8)
Always insured	68.3	–	–	–
Mixed	14.9	–	–	–
<b>Income as % of federal poverty level (FPL)</b>				
< 138 % FPL	58.3	64.6 (22.4)	< 100 % FPL	17.1 (9.4)
≥ 138 % FPL	20.7	19.8 (12.5)	–	–
<b>Charlson score</b>				
0-1	81.5	59.2 (11.6)	–	–
2-4	16.3	24.2 (4.3)	–	–
5-6	1.6	7.5 (3.0)	–	–
7+	0.6	9.0 (5.6)	–	–
<b>Primary care provider assigned</b>	87.6	38.9 (13.1)	–	–
<b>Ambulatory visits per year</b>				
1-3	22.8	–	–	–
4-6	19.1	–	–	–
7-10	18.3	–	–	–
>10	39.8	–	–	–
<b>At least 1 ambulatory visit pre-2019</b>	87.6	–	–	–

<sup>a</sup> Percentages do not always add up to 100, due to (omitted) unknown/missing category.

<sup>b</sup> Estimated the Spanish-preferring Hispanics as the % Spanish-preferring population and the English-preferring Hispanics as the Hispanic population minus the % Spanish-preferring population.

<sup>c</sup> Calculated as (The number of dependents aged >64/The population aged 15–64) x 100.

of culturally competent or Spanish-speaking providers), then the association between Spanish language preference and higher screening rates might be stronger at these clinics. A differential association between these variables at different levels of Spanish-language-preference concentration at a clinic, then, might provide some (very preliminary) evidence for this hypothesis.

### 2.3. Statistical analysis

First, we conducted descriptive analyses to characterize the two samples (those eligible for colorectal cancer screenings and those eligible for cervical cancer screenings), comparing results for main independent variables and covariates across data sources (patient-level, clinic-level, and area-level). Second, we performed a descriptive analysis to characterize the characteristics of clinics categorized by the percentage of Spanish-preferring patients on their panel.

Next, we ran three initial sets of logistic models for each sample, structured as follows: (1) patient-level measures only, (2) clinic-level measures only, and (3) area-level measures only. The first investigated the association between patient-level ethnicity/language preference and up-to-date screening, adjusting for other patient-level covariates. The second investigated the association between clinic-level ethnicity/language preference at the patient's 'home' (most frequented) clinic and up-to-date cancer screening, adjusting for clinic-level covariates. The third investigated the association between area-level ethnicity/language preference in the patient's tract and up-to-date cancer screening, adjusting for area-level covariates.

With our final set of models, we performed a moderation analysis investigating whether the association between ethnicity/language preference and up-to-date screening varies by the Spanish-preferring Hispanic concentration at a clinic. After grouping clinics into the categories (described above), we tested an interaction term between this clinic-level variable and the patient-level ethnicity/language preference variable, adjusting for clinic state along with patient-level covariates. After finding that the interaction was significant for both screening types, we ran adjusted models stratified by clinic-level Spanish-preferring Hispanic concentration to show how the association between patient level ethnicity/language preferences and up-to-date cancer screening rates differed by clinic group.

All estimates, in the form of odds ratios and 95 % confidence intervals, were produced via logistic mixed effects models with random intercepts to account for correlations between patients receiving care at the same facility, based on the patient's 'home' (most frequented) clinic. Statistical analyses were performed in R (version 4.2.0). This study was approved by the Oregon Health & Science University Institutional Review Board.

## 3. Results

### 3.1. Up-to-date colorectal and cervical cancer screening rates by patient-, clinic-, area-level characteristics

About a third of the colorectal cancer screening sample of adults aged 50+ was Hispanic (34.2 %; 28.1 % Spanish- and 6.1 % English-preferring), similar to the mean proportion of Hispanics (40.4 %; 25.9 % Spanish- and 14.5 % English-preferring) at these patients' home clinics as well as within the area they live in (30.1 %; 23.7 % Spanish- and 6.4 % English-preferring). The colorectal cancer screening sample was predominantly White (78 %), slightly higher than clinic- (75.5 %) and area-(70.4 %) level proportions. Levels of uninsured were similar across patient- (11.7 %), clinic- (9.5 %), and area- (9.1 %) levels, and the

majority of individuals at both patient- (56.7 %) and clinic- (63.2 %) levels had incomes under 138 % of the Federal Poverty Level (FPL) (Table 1).

Among the cervical cancer screening patient sample of adults with a cervix aged 25 to <65, more than a third were Hispanic (40.4 %; 33.8 % Spanish-preferring and 11.6 % English-preferring), similar to the mean proportion of Hispanics (43.6 %; 28.0 % Spanish-preferring and 15.6 % English-preferring) at these patients' home clinics as well as within the area they lived in (32.3 %; 25.7 % Spanish-preferring and 6.6 % English-preferring). The cervical cancer screening sample was predominantly White (76.1 %), slightly higher than clinic- (74.1 %) and area- (69.0 %) level proportions. The uninsured percentage for the cervical cancer screening sample was somewhat higher at the patient- (16.7 %), compared to clinic- (10.5 %), and area- (9.4 %) levels. The majority of individuals at both the patient- (58.3 %) and clinic- (64.6 %) levels had incomes under 138 % of the Federal Poverty Level (FPL) (Table 1).

### 3.2. Characteristics of clinics categorized by the percentage of Spanish-preferring patients on their panel

Clinics with higher percentages of Spanish-preferring Hispanic patients were more likely to be in CA (vs. OR or WA), to be located in urban areas (vs. urban clusters, small towns, or rural areas), and to have seen a higher volume of patients in 2019. Patient panels at clinics with higher percentages of Spanish-preferring patients tended to be younger, with a higher proportion with income <138 % of the FPL, and to have fewer comorbidities. Insurance status exhibited a different pattern, with clinics with both the *highest* (50 %+ ) and the *lowest* (<10 %) concentrations of Spanish-preferring Hispanics characterized by lower proportions of uninsured patients compared with clinics in the middle (10 to <50 %) of the Spanish-preferring Hispanic distribution. These clinics in the middle also had higher percentages of nonwhite patients compared with those on either extreme of the distribution (Table 2).

### 3.3. Colorectal and cervical cancer screenings by ethnicity/language preference by data level

In terms of unadjusted proportions, among the colorectal cancer screening sample, Spanish-preferring Hispanics (65.7 %) and non-English-preferring non-Hispanics (66.3 %) were most likely to be up-to-date with the recommended screening, followed by English-preferring non-Hispanic (56.5 %) and English-preferring Hispanic (50.3 %), with the other/unknown category lowest (45.9 %). Among the cervical cancer screening sample of adults with a cervix aged 25 to <65, Spanish-preferring Hispanics (58.4 %) and non-English-preferring non-Hispanics (53.8 %) were most likely to be up-to-date with recommended cancer screenings, followed by English-preferring non-Hispanic (45.6 %) and English-preferring Hispanic (48.9 %), with the other/unknown category lowest (39.9 %) (Table 3).

Among the colorectal cancer screening sample, relative to non-Hispanic whites, Spanish-preferring Hispanics were more likely to be up-to-date with the recommended screening (OR 1.722, 95 % CI 1.649–1.799), as were non-English-preferring non-Hispanics (OR 1.398, 95 % CI 1.293, 1.511). Patients receiving care at clinics with higher percentages of Spanish-preferring Hispanics were significantly more likely to be up-to-date, with each additional percentage associated with a 2.5 % increase in the odds (OR 1.025, 95 % CI 1.020, 1.030). Patients living in areas with higher percentages of Spanish-preferring Hispanics were statistically more likely to be up-to-date, although the effect size was smaller, with each additional percentage associated with a 0.4 % increase in the odds (OR 1.004, 95 % CI 1.002, 1.005) (Table 4).

**Table 2**  
Clinic characteristics by Spanish-prefering percentage on the clinic patient panel.

Percentage of Spanish-prefering patients at the clinic:	n = 130 clinics				
	<5 % N = 33	5 to <10 % N = 20	10 to <25 % N = 33	25 to <50 % N = 28	50 %+ N = 16
<b>Clinic Location and Size</b>	N (%)				
<b>State</b>					
CA	7 (21.2)	8 (40.0)	6 (18.2)	16 (57.1)	12 (75.0)
OR	21 (63.6)	10 (50.0)	22 (66.7)	11 (39.3)	4 (25.0)
WA	5 (15.2)	2 (10.0)	5 (15.2)	1 (3.6)	0 (0.0)
<b>Urbanicity<sup>b</sup></b>					
Urban area	13 (39.4)	13 (65.0)	27 (81.8)	24 (85.7)	16 (100.0)
Urban cluster	8 (24.2)	6 (30.0)	3 (9.1)	2 (7.1)	0 (0.0)
Small town	3 (9.1)	0 (0.0)	3 (9.1)	1 (3.6)	0 (0.0)
Rural area	9 (27.3)	1 (5.0)	0 (0.0)	1 (3.6)	0 (0.0)
<b>Clinic size</b>					
<i>Number of patients seen in 2019</i>					
150 to <1000	16 (48.5)	6 (30.0)	6 (18.2)	2 (7.1)	2 (12.5)
1000 to <2500	9 (27.3)	2 (10.0)	10 (30.3)	9 (32.1)	2 (12.5)
2500 to <4500	2 (6.1)	4 (20.0)	14 (42.4)	8 (28.6)	3 (18.8)
4500 to 10,500	6 (18.2)	8 (40.0)	3 (9.1)	9 (32.1)	9 (56.2)
<b>Clinic Patient Panel Variables<sup>a</sup></b>	Mean (SD)				
<b>Sex</b>					
% Female	58.2 (11.5)	56.2 (13.6)	59.0 (10.9)	60.2 (10.0)	59.8 (7.8)
<b>Age</b>					
% <18	13.9 (9.9)	9.8 (7.6)	19.9 (19.7)	19.1 (13.4)	30.1 (11.0)
% 18 to 29	23.0 (19.5)	21.6 (10.5)	22.7 (11.8)	20.1 (5.9)	16.7 (5.6)
% 30 to 49	29.2 (9.0)	34.5 (5.8)	32.2 (9.2)	34.2 (6.7)	29.0 (4.7)
% 50 to 64	19.5 (9.0)	22.9 (9.5)	17.7 (8.3)	19.7 (7.2)	17.0 (7.8)
% 65+	14.4 (10.5)	11.1 (6.9)	7.5 (4.8)	6.8 (3.4)	7.3 (3.5)
<b>Race</b>					
% White	83.0 (9.2)	81.5 (12.9)	68.4 (19.5)	65.7 (13.4)	79.9 (17.2)
% Blac	2.2 (3.8)	3.6 (5.4)	7.1 (8.5)	5.6 (5.3)	2.0 (2.2)
% Asian	2.0 (3.5)	2.1 (2.4)	4.2 (4.9)	5.0 (4.9)	2.1 (2.6)
% Other	4.5 (2.5)	4.1 (1.7)	5.2 (2.3)	2.5 (1.7)	0.9 (0.5)
<b>Insurance status</b>					
Uninsured	8.4 (11.9)	9.8 (10.6)	16.2 (11.7)	13.2 (10.5)	9.1 (6.6)
<b>Income as % of federal poverty level (FPL)</b>					
<138 % FPL	50.7 (23.7)	59.3 (21.7)	67.4 (18.6)	62.6 (28.3)	71.3 (19.0)
≥138 % FPL	24.7 (10.9)	24.3 (15.6)	21.2 (12.0)	15.9 (9.3)	20.4 (18.1)
<b>Charlson score</b>					
0-1	51.0 (18.6)	46.8 (12.4)	59.2 (15.2)	64.5 (8.6)	68.8 (7.1)
2-4	25.5 (6.8)	27.3 (4.9)	22.6 (5.7)	23.6 (4.2)	22.1 (4.2)
5-6	9.8 (4.4)	11.1 (3.2)	7.9 (3.9)	6.1 (2.2)	4.9 (1.3)
7+	13.5 (8.1)	14.8 (6.2)	10.1 (6.3)	5.8 (3.1)	4.1 (2.2)

**Table 2 (continued)**

Percentage of Spanish-prefering patients at the clinic:	n = 130 clinics				
	<5 % N = 33	5 to <10 % N = 20	10 to <25 % N = 33	25 to <50 % N = 28	50 %+ N = 16
<b>Clinic Location and Size</b>	N (%)				
<b>Primary care provider assigned</b>	38.1 (19.6)	33.3 (16.2)	31.7 (17.2)	38.7 (17.9)	40.5 (11.2)

<sup>a</sup> Percentages do not always add up to 100, due to (omitted) unknown/missing category.

<sup>b</sup> Categories based on 2010 Census Rural-Urban Commuting Area (RUCA) codes.

Among the cervical cancer screening sample, relative to non-Hispanic whites, all other language/ethnicity groups were significantly more likely to be up-to-date with the recommended screening, with rates for Spanish-prefering Hispanics highest (OR 1.535, 95 % CI 1.482, 1.591), followed by non-English-prefering non-Hispanics (OR 1.226, 95 % CI 1.144, 1.314), then English-prefering Hispanics (OR 1.141, 95 % CI 1.094, 1.189). Patients receiving care at clinics with higher percentages of Spanish-prefering Hispanics were significantly more likely to be up-to-date (OR 1.020, 95 % CI 1.017, 1.023). Patients living in areas with higher percentages of Spanish-prefering Hispanics were statistically more likely to be up-to-date, although the effect size was smaller (OR 1.004, 95 % CI 1.002, 1.005) (Table 4).

The association between patient-level ethnicity/language and up-to-date colorectal cancer screening differed significantly by the percentage of Spanish-speaking Hispanics at the clinic level. That is, as the percent of Spanish-speaking Hispanics at the clinic level increased, the stronger the association was between language/ethnicity and up-to-date colorectal cancer screening. Among patients seen at clinics, for example, with at least 50 % Spanish-speaking Hispanics, Spanish-prefering Hispanics were significantly more likely than English-prefering non-Hispanics to be up-to-date (OR 1.704, 95 % CI 1.544, 1.880), while among patients seen at clinics with <5 % of Spanish-prefering Hispanics, Spanish-prefering Hispanic patients did not have significantly different rates of being up-to-date compared to English-prefering non-Hispanics, and English-prefering Hispanics had significantly lower rates (Table 4).

The association between patient-level ethnicity/language and up-to-date cervical cancer screening also differed by the percentage of Spanish-speaking Hispanics at the clinic level, but this trend was less straightforward, with up-to-date rates in all groups tending to increase as the Spanish-speaking Hispanic clinic concentration increased (Figs. 1 and 2).

#### 4. Discussion

Some studies have shown that Spanish-prefering Hispanic adults

**Table 3**  
Percent up-to-date with colorectal and cervical cancer screenings, unadjusted means.

Ethnicity and language preference	% up-to-date with colorectal cancer screening	% up-to-date with cervical cancer screening
Spanish-prefering Hispanic	65.7 %	58.4 %
English-prefering Hispanic	50.3 %	48.9 %
English-prefering non-Hispanic	56.5 %	45.6 %
Non-English-prefering non-Hispanic	66.3 %	53.8 %
Other or unknown language and/or ethnicity	45.9 %	39.9 %

**Table 4**  
Adjusted odds Ratios<sup>a</sup>, comparison of ethnicity/language results by data Source (s).

Model	OR [95 % Confidence Interval]	
	Up-to-date colorectal cancer screening	Up-to-date cervical cancer screening
<b>Model 1: Patient-level information only</b>		
<u>Reference: English-preferring non-Hispanic:</u>		
Spanish-preferring Hispanic	1.722 (1.649, 1.799)***	1.535 (1.482, 1.591)***
English-preferring Hispanic	1.033 (0.972, 1.099)	1.141 (1.094, 1.189)***
Non-English-preferring non-Hispanic	1.398 (1.293, 1.511)***	1.226 (1.144, 1.314)***
<b>Model 2: Clinic-level information only</b>		
<u>Omitted: % English-preferring non-Hispanic</u>		
% Spanish-preferring Hispanic	1.025 (1.020, 1.030)***	1.020 (1.017, 1.023)***
% English-preferring Hispanic	0.950 (0.944, 0.956)***	0.976 (0.973, 0.980)***
% non-English-preferring non-Hispanic	1.009 (1.000, 1.018)	0.986 (0.982, 0.990)***
<b>Model 3: Area-level information only</b>		
<u>Omitted: % non-Hispanic</u>		
% Spanish-preferring Hispanic	1.004 (1.002, 1.005)***	1.004 (1.002, 1.005)***
% English-preferring Hispanic	0.997 (0.994, 1.001)	1.002 (0.999, 1.005)
<b>Model 4a-e. Patient-level, stratified by clinic patient panel distribution</b>		
<u>Reference: English-preferring non-Hispanic</u>		
<b>a) &lt; 5 % clinic-level Spanish-preferring Hispanic</b>		
% Spanish-preferring Hispanic	1.068 (0.818, 1.394)	1.411 (1.154, 1.725)***
% English-preferring Hispanic	0.817 (0.674, 0.990)*	0.995 (0.871, 1.138)
% non-English-preferring non-Hispanic	1.062 (0.756, 1.490)	1.038 (0.776, 1.389)
<b>b) 5 to &lt;10 % clinic-level Spanish-preferring Hispanic</b>		
% Spanish-preferring Hispanic	1.486 (1.291, 1.711)***	1.686 (1.495, 1.902)***
% English-preferring Hispanic	1.055 (0.911, 1.222)	1.029 (0.921, 1.151)
% non-English-preferring non-Hispanic	1.276 (0.988, 1.647)	1.024 (0.806, 1.302)
<b>c) 10 to &lt;25 % clinic-level Spanish-preferring Hispanic</b>		
% Spanish-preferring Hispanic	1.684 (1.531, 1.851)***	1.691 (1.572, 1.820)***
% English-preferring Hispanic	1.093 (0.941, 1.269)	1.221 (1.121, 1.330)***
% non-English-preferring non-Hispanic	1.458 (1.269, 1.674)***	1.223 (1.089, 1.373)***
<b>d) 25 to &lt;50 % clinic-level Spanish-preferring Hispanic</b>		
% Spanish-preferring Hispanic	1.779 (1.652, 1.914)***	1.518 (1.428, 1.612)***
% English-preferring Hispanic	1.099 (0.986, 1.225)	1.099 (1.021, 1.184)*
% non-English-preferring non-Hispanic	1.409 (1.236, 1.605)***	1.223 (1.086, 1.376)***
<b>e) 50 %+ clinic-level Spanish-preferring Hispanic</b>		
% Spanish-preferring Hispanic	1.704 (1.544, 1.880)***	1.412 (1.296, 1.539)***
% English-preferring Hispanic	1.025 (0.892, 1.177)	1.199 (1.081, 1.329)***
% non-English-preferring non-Hispanic	1.349 (1.096, 1.662)**	1.475 (1.207, 1.802)***

\*p < 0.050, \*\*p < 0.010, \*\*\*p < 0.001.

<sup>a</sup>Logistic mixed effects models incorporate random intercepts to account for correlations between patients seen at the same facility. *Model 1* adjusts for patient-level race, sex, age, insurance, income as % of federal poverty level (FPL), comorbidities, primary care provider assignment, ambulatory visits per year, and any pre-study ambulatory visit (AV). *Model 2* adjusts for clinic state and clinic-level race, sex, age, insurance, income as % of FPL, comorbidity, and primary care provider distributions. *Model 3* adjusts for area-level race distributions, the dependency ratio, % living in poverty, and % uninsured. *Model 4* stratifies by clinic-level Spanish-preferring Hispanic % and adjusts for clinic state and patient-level race, sex, age, insurance, income as % of FPL,

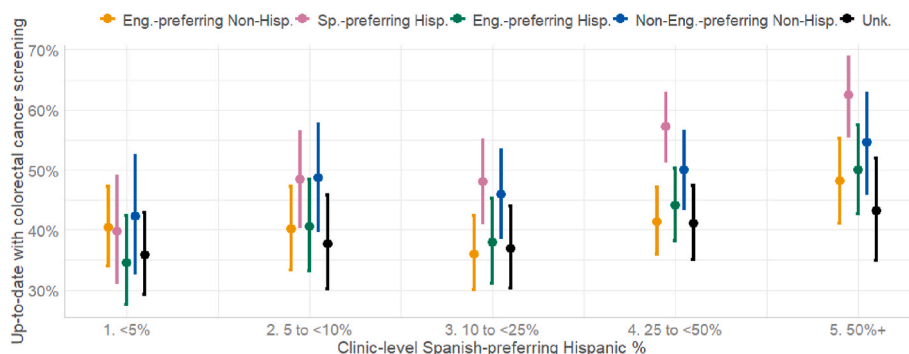
comorbidities, primary care provider assignment, ambulatory visits per year, and any pre-study AV.

have lower rates of recommended cancer screenings relative to both non-Hispanic and English-preferring Hispanic adults (Diaz et al., 2008), but these studies do not examine outcomes at CHCs in particular. Consistent with recent studies examining cancer preventive care utilization at CHCs (Heintzman et al., 2023; Huguet et al., 2019), our data show that, relative to other ethnicity and language groups, Spanish-preferring Hispanic patients seeking care at CHCs in WA, OR, and CA had higher rates of up-to-date colorectal and cervical cancer screenings.

This may be explained by the fact that CHCs offer care to everyone, removing financial and insurance-related barriers to access, in addition to offering a variety of services beyond healthcare provision. For example, CHCs often employ insurance eligibility specialists who can help individuals gain insurance whether or not they are active patients (Huguet et al., 2021). Alongside providing comprehensive healthcare services, CHCs emphasize culturally competent care, building relationships with underserved communities to reduce various social barriers to healthcare access (Yamanis et al., 2020). Undocumented immigrants, for example, experience hardships affecting their healthcare access that include language barriers, isolation/depression, barriers to health care access, unhealthy living conditions, racism, and fears due to their legal status (L. E. Nuño et al., 2022; Yamanis et al., 2020). By providing safe spaces, support groups, referrals to legal service providers, health promoter training, and interpreters, CHCs contribute to community resilience among this population (Yamanis et al., 2020).

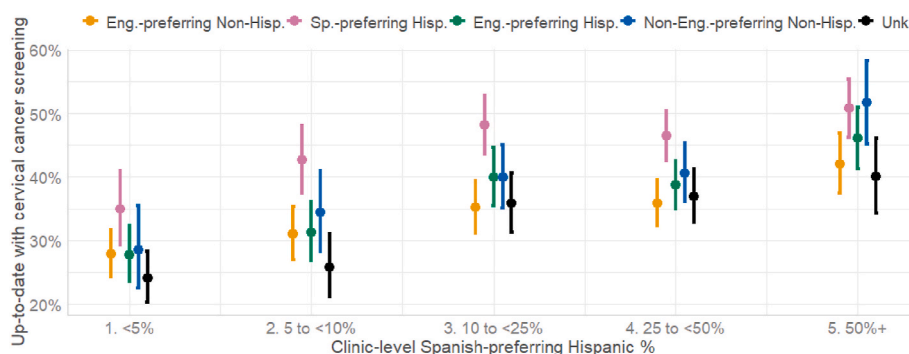
When these barriers to access are diminished, evidence suggests Hispanic patients may experience greater improvement in health outcomes relative to non-Hispanic whites (Marino et al., 2020). The fact that racial and ethnic health disparities appear to be attenuated in CHCs compared to other healthcare settings (Appel et al., 2006; Heintzman, Bailey, DeVoe, et al., 2017; Heintzman, Bailey, Muench, et al., 2017; Heintzman et al., 2018) underscores the importance of understanding the strategies CHCs have developed to deliver equitable care. And even within a CHC setting, results across clinics with different demographics vary: our data show that at clinics with the highest percentages of Spanish-preferring Hispanics, the association between language and ethnicity group and up-to-date colorectal screening was strongest. It is unclear, however, whether the relatively high cancer screening rates among Spanish-preferring Hispanic patients seen at CHCs, particularly in this subset of our sample, is due to patient comfort with the setting, resources for targeted outreach to these populations, or both.

Additionally, our results (for cervical cancer screening particularly) show that in clinics with higher proportions of Spanish-speaking Hispanics, all groups had higher screening rates, not only Spanish-speaking Hispanics. This suggests that these clinics are different; it is possible that their efforts to care for their diverse patient populations have translated to higher rates of up-to-date screenings overall. Our clinic-level descriptive results show that the clinics with higher proportions of Spanish-preferring Hispanics tended to be larger clinics in California, located in metropolitan areas—due to location, these clinics may have access to community health workers (CHWs) and other resources that clinics in other areas lacked. CHWs are individuals who not only possess close knowledge of community needs and resources, but also share life experiences with the community served (Malcarney et al., 2017). As lay (nonclinical) members of the community, CHWs help bridge the gap between the patient and the healthcare system by offering interpretation and translation services, providing culturally appropriate health education and information, giving informal guidance, and advocating for the needs of individuals and the community. CHWs may be an important contributing factor both to high cancer screening rates among this population and to the differential associations by clinic type. The results also showed that clinics with lower proportions of Spanish-preferring Hispanics were more likely to be smaller clinics in rural areas, small



**Fig. 1.** Adjusted\* Predicted Probabilities for Up-to-Date Colorectal Cancer Screenings with 95 % CI, Comparison of Language-Ethnicity Results by Spanish-prefering Hispanic Concentration of Patient Panel at Home Clinic

\*Adjusted predictions for up-to-date colorectal cancer screening with clinic state fixed (Oregon) and patient-level covariate levels fixed for race (White), sex (male), age (50–64), insurance (always insured), income as a % of federal poverty level ( $\geq 138$  %), ambulatory visits in 2019 (4–6), comorbidities (0 or 1), primary care provider assignment (yes), and whether the patient had an ambulatory visit before the study period (no).



**Fig. 2.** Adjusted\* Predicted Probabilities for Up-to-Date Cervical Cancer Screenings with 95 % CI, Comparison of Language-Ethnicity Results by Spanish-prefering Hispanic Concentration of Patient Panel at Home Clinic

\*Adjusted predictions for up-to-date cervical cancer screening with clinic state fixed (Oregon) and patient-level covariate levels fixed for race (White), age (30–49), insurance (always insured), income as a % of federal poverty level ( $\geq 138$  %), ambulatory visits in 2019 (4–6), comorbidities (0 or 1), primary care provider assignment (yes), and whether the patient had an ambulatory visit before the study period (no).

towns, or urban clusters in Oregon or Washington—these clinics may have less resources for targeted outreach to Spanish-speaking populations. More research is needed to investigate the factors that may underlie the higher baseline up-to-date rates at these clinics, along with the observed differences by language and ethnicity.

Our results indicate that area-level ethnicity and language variables would be a poor substitute or supplement for patient-level variables. The fact that area-level operationalizations of language and ethnicity variables, relative to patient- and clinic-level versions of these variables, showed highly attenuated (although still present) associations may reflect several complicating factors. Previous studies have shown that social needs data from patients is a better predictor of health than neighborhood data (Cottrell et al., 2020). Our results confirm this finding and show, additionally, that clinic patient panel context information is important and should be considered, particularly when assessing outcomes among Hispanic patients. While area-level data may not be suitable for use in supplementing missing demographic information, in community health care settings, at least, clinic-level information may be more useful.

4.1. Limitations

Our study has several limitations. These are predominantly patients with low-income seeking care at CHCs; results are not generalizable to Hispanic patients in other healthcare settings. This analysis was limited to the association of language/ethnicity variables with up-to-date screening rates across data sources, and while we adjusted for a

number of patient-level demographic and healthcare utilization variables, we did not examine the effects of any of these in-depth—other area-level measures impacting healthcare access and utilization might show stronger associations and could be explored in future studies. Finally, while the associations between language/ethnicity and up-to-date colorectal and cervical cancer screenings differ by Spanish-prefering clinic concentration, our data cannot explain *why* this is or what these clinics are doing differently. A follow-up study is needed to investigate what these clinics are doing differently (e.g. deploying more community health workers).

5. Conclusion

The findings highlight the importance of clinic patient panel distributions in understanding the relationship between patient-level demographic data and quality care metrics, and follow-up studies are recommended to better understand differences between clinics. The findings also demonstrated that area-level variables are not good substitutions for patient-level data, but variables at the clinic-level are more informative.

Ethical statement

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1018762-01-HOPS from the American Cancer Society. The funding source had no role in design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### CRediT authorship contribution statement

**Rachel Springer:** Writing – original draft, Visualization, Methodology, Formal analysis, Data curation. **Jeremy Erroba:** Writing – review & editing, Project administration, Conceptualization. **Jean P. O'Malley:** Writing – review & editing, Resources, Data curation, Conceptualization. **Nathalie Huguet:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

### Data availability

The data that has been used is confidential.

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