Social Risk Factors and Cancer Prevention Care among Patients in Community Health Care Settings

Matthew P. Banegas, PhD, MPH, Center for Health Equity Education and Research, Department of Radiation Medicine and Applied Sciences, University of California, San Diego; La Jolla, CA, USA; 9452 Medical Center Drive, MC 0861, La Jolla, CA 92037, mbanegas@health.ucsd.edu (Corresponding author)

Jean O'Malley, MPH, OCHIN, Inc.; Portland, OR, USA, omalleyj@ochin.org

Jorge Kaufmann, ND, MS, Department of Family Medicine, Oregon Health & Science University; Portland, OR, USA, kaufmjor@ohsu.edu

Miguel Marino, PhD, Department of Family Medicine, Oregon Health & Science University; Portland, OR, USA, marinom@ohsu.edu

Laura M. Gottlieb, MD, MPH, Social Interventions Research and Evaluation Network, Department of Family and Community Medicine, University of California, San Francisco; San Francisco, CA, USA, laura.gottlieb@ucsf.edu

Nathalie Huguet, PhD, Department of Family Medicine, Oregon Health & Science University; Portland, OR, USA, huguetn@ohsu.edu

Adjoa Anyane-Yeboa, MD, MPH, Department of Gastroenterology, Massachusetts General Hospital; Boston, MA, USA, aanyane-yeboa@mgh.harvard.edu

Rachel Gold, PhD, MPH, Center for Health Research, Kaiser Permanente Northwest; OCHIN, Inc.; Portland, OR, USA, rachel.gold@kpchr.org

Precis: Patients who report social risks are less likely to be up to date with guideline-recommended cancer screening than those without social risks and may face unique barriers to receiving and/or completing cancer screening orders. Policies intended to mitigate social risks might influence the complex pathways between social risks and receipt of cancer prevention care.

Author Contributions: Matthew Banegas: conceptualization, writing–original draft preparation, and writing–review and editing; Jean O'Malley: formal analysis, data curation, writing-review and editing; Jorge Kaufmann: methodology, writing-review and editing; Miguel Marino: methodology, writing-review and editing; Laura Gottlieb: writing-review and editing; Nathalie Huguet: writing-review and editing; Adjoa Anyane-Yeboa: writing-review and editing; Rachel Gold: conceptualization, project administration, supervision, writing–original draft preparation, and writing–review and editing.

Word Limit: 3000

Word Count: 2988

ABSTRACT

Background. Social risks are negatively associated with receipt of cancer preventive care. As knowledge is lacking on the pathways underlying these associations, we investigated associations between patient-reported social risks and colorectal (CRC), cervical (CVC), and breast cancer (BC) screening order provision and screening completion.

Methods. This study included patients eligible for CRC, CVC, or BC screening at 186 community-based clinics between July 1, 2015 and February 29, 2020. Outcomes included: up-to-date status for indicated cancer screenings at baseline; percent of subsequent study months in which patients were up to date on screenings; screening order receipt; and screening completion. Independent variables were patient-reported food insecurity, transportation barriers, and housing instability. Analyses used covariate-adjusted generalized estimating equation models, stratified by social risk.

Results. Patients with documented social risks were less likely to be up-to-date on any cancer screening at baseline and in most cases had a lower rate of total study months up to date on screenings. All cancer screenings were ordered less often for food-insecure patients. CVC screening was ordered less often for transportation-insecure patients. The likelihood of completing a screening test differed significantly by select social risks: CVC and CRC screening rates were lower in food-insecure patients and CRC screening rates were lower in transportation-insecure patients. Likelihood of BC screening completion did not differ by social risk status.

Discussion. Social risks affect both the ordering and receipt of cancer screening. Research is needed on strategies to mitigate the impact of different social risks on cancer early detection services.

BACKGROUND

Timely cancer screening increases the likelihood of early detection and improves disease prognosis. Emerging research shows lower cancer screening rates among persons with social risks like food insecurity, housing instability, and transportation barriers.[1-4] However, research exploring how social risks impede receipt of cancer prevention services is limited.[4]

To help address this knowledge gap, we investigated associations between social risks and receipt of screening for cervical (CVC), colorectal (CRC), and breast (BC) cancers among patients at community-based health care organizations (CBHCOs) – e.g., community health centers and federally qualified health centers. In the United States (US), CBHCOs are a primary source of cancer screening for minoritized, low-income, rural, and immigrant populations, all of whom experience a greater burden of social risks than the general US population.[5,6]

We assessed whether CBHCO patients screened for social risks were up to date on guideline-recommended BC, CVC, or CRC screening. Among those due for a given screening, we assessed receipt and completion of screening orders. We hypothesized that the presence of social risks would not be associated with cancer screening orders but would be associated with completion of screenings, especially those that require subsequent visits (e.g., mammography and colonoscopy) or steps (FIT tests).

METHODS

Data source and study population

This study included data from adult patients seen at 186 CBHCOs from 13 states between July 1, 2015-February 29, 2020. The study was limited to CBHCOs that offered primary care services and had any electronic health record (EHR) documentation of patient-reported social risks for food, transportation, or housing

insecurity. Data on patient demographics, encounters, cancer screenings, and social risk screening were extracted from the Accelerating Data Value Across a National CHC Network (ADVANCE) Clinical Research Network, a PCORnet member,[7] which includes OCHIN (a national network of CBHCOs sharing an Epic EHR). The study period was July 2016-February 2020. The included EHR data are either patient-reported or entered by clinic staff. This study was reviewed by OCHIN Compliance and determined to be exempt of Institutional Review Board coverage needs.

Three cohorts were studied: patients due for CRC, CVC, and BC screening. Analyses were limited to patients for whom ≥1 year of observation data was available. Each patient's observation period began at their first primary care encounter ≥1 year prior to their end date or the date when they aged into their cohort, whichever occurred later (yielding a range of 1-3.7 observation years), and ended at their last primary care encounter before March 1, 2020, the date they aged out of the age criteria for their cohort, or the date they were diagnosed with a condition excluding them from the cohort, whichever occurred first. Analysis methods including patient inclusion periods and assessment of social risk screening status are based on a prior study.[8]

Inclusion criteria for each of the three cohorts were based on 2020 Uniform Data System reporting guidelines:[9] Patients due for CRC screening are 50–74 years; patients due for breast cancer screening are females ages 50–74 years; patients due for CVC screening are females ages 23-64 years. Patients with a medical history meeting a UDS exclusion criteria for any screening were excluded. Patients were considered up to date for CRC screening if they had an FOBT test within 1 year of first primary care encounter, a FIT test within 3 years, flexible sigmoidoscopy or CT colonography within 5 years, or a colonoscopy within 10 years. Patients were considered up to date for BC screening if they had received screening mammography within 2 years. Patients aged 23-29 were considered up to date for CVC screening if they had received a Papanicolaou

(Pap) test within 3 years. Patients aged 30 to 64 were considered up to date if they had received either a Pap test within 3 years or a Pap and HPV test within 5 years.

Measures

Outcomes examined for each cancer screening included: (1) up-to-date screening status at study entry; (2) the percentage of months up to date for indicated screening, measured as the number of months out of the total observation period for which a patient was in concordance with guideline recommendations for each screening test; (3) receipt of an order for screening, if indicated; (4) among persons whose screening was ordered, screening completion; and (5) the rate of primary care visits per year during observation period. We selected these outcomes to help understand receipt of guideline-recommended cancer prevention services at distinct points across the care trajectory for each cancer.

Independent variables were patient-reported food insecurity, or housing instability, and/or transportation barriers. For each social risk, patients were categorized as: not screened for social risk (i.e., no documentation of risk status); screened for social risk and documented as having risk; or screened for social risk and documented as not having risk. Individuals with no documentation of having been screened for a given risk were included to enable comparing those who were and were not screened. Of note, the diverse study sites used varying approaches to social risk screening, including different screening tools and different domains (some clinics did not screen for all risks.) Our analysis approach included screening results for a given social risk domain regardless of how screening was conducted.

Results from the entire cohort, including patients not screened for social risk, those screened who reported social risk(s), and those screened who did not report social risk(s), are shown in Supplementary Tables 1-6. Results from all patients who were screened are presented below.

Statistical analyses

Descriptive statistics of patient characteristics overall and by social risk factor were estimated and reported. Outcomes were analyzed through generalized estimating equation models stratified by risk factor (separate models for food, transportation, and housing insecurity). Binary variables used a logit link function, the count variable (months up to date for screening) used a log link, specifying a Poisson distribution and using the number of months the patients was observed as the offset. Models controlled for sex, race/ethnicity, preferred language, age and insurance status at index encounter, federal poverty level (FPL) on or after the index encounter, and the number of primary care visits per year during the individual's observation period (this variable was not included in model for primary care visit rate). Race/ethnicity was categorized into Hispanic, Non-Hispanic Black, Non-Hispanic White, Non-Hispanic Other (included American Indian or Alaskan Native, Asian, Multiple race, Native Hawaiian or Other Pacific Islander), and No data. All analyses were conducted using SAS Enterprise Guide Version 8.3.8.206, and all statistical testing was 2-sided, with a type I error set to 5%.

RESULTS

Analysis cohorts

Study sample characteristics are in Tables 1-3. In the BC screening cohort (n=83,993), 27% were Hispanic and 19% non-Hispanic Black; 84% were aged 50-64 years; 42% had Medicaid; and 54% had household incomes ≤100% of the FPL. In the CVC screening cohort (n= 202,895), 36% were Hispanic and 19% non-Hispanic Black; 45% were aged 23-39 years; 53% had Medicaid; and 56% had household incomes ≤100% of the FPL. In the CRC screening cohort (n=171,724), 24% were Hispanic and 19% non-Hispanic Black, 74% were aged 50-64 years; approximately 38% had Medicaid; and 54% had household incomes ≤100% of the FPL. In each

cohort there were some differences between those screened for a given social risk and those not screened (Supplementary Tables 1-3). These differences were adjusted for in the regression analyses in Tables 4-6.

Prevalence of social risks

In the BC screening cohort, among patients screened for a given social risk, 32% (n=3,605 of 11,213) reported food insecurity, 16% (n=1,666 of 10,590) housing instability, and 19% (n=1,689 of 9,019) transportation barriers. In the CVC screening cohort, among patients screened for a given social risk, 32% (n=8,233 of 25,864) reported food insecurity, 16% (n=3,824 of 24,612) housing instability, and 17% (n=3,461 of 20,433) transportation barriers. In the CRC screening cohort, among patients screened for a given social risk, 31% (n=4,196 of 22, 899) reported food insecurity, 16% (n=3,480 of 21.314) housing instability, and 19% (n=3,434 of 18,005) transportation barriers.

Up to date at index visit

Patients with food insecurity, housing instability, or transportation barriers were statistically significantly less likely to be up to date on BC screening at their index visit compared to those reporting not having those risks (Table 4). Specifically, those with food insecurity were 3% less likely to be up to date at index (RR: 0.97, 95% CI: 0.94-0.99); those with housing instability 6% less likely (RR: 0.94, 95% CI: 0.90-0.97); and those with transportation barriers 6% less likely (RR: 0.94, 95% CI:0.90-0.98).

The associations between having social risks and being up to date on CVC screening at the index visit were also statistically significant (Table 5). Those reporting food insecurity were 3% less likely to be up to date with CVC screening at index (RR: 0.97, 95% CI:0.95, 0.99); those with housing instability, 6% less likely (RR: 0.94, 95% CI:0.92-0.97); and those with transportation barriers, 7% less likely (RR: 0.93, 95% CI:0.89-0.96).

Persons reporting food insecurity were 6% less likely to be up to date with CRC screening at index than those reporting no food insecurity (RR: 0.94, 95% CI:0.92-0.97); those reporting housing instability, 8% less likely (RR: 0.92; 95% CI:0.88- 0.97); and those reporting transportation barriers, 13% less likely (RR: 0.87; 95% CI:0.83, 0.90; Table 6). Overall, each social risk was associated with a statistically significant lower likelihood of being up to date on cancer screenings at the index visit (Table 7).

Percent of study months up to date

Patients with food insecurity or housing instability did not have significantly different rates of study months up to date with BC screening compared to those not reporting food insecurity or housing instability (food insecurity RR: 0.99, 95% CI:0.96-1.03; housing instability RR: 0.97, 95% CI:0.93-1.02); Table 4. In all other analyses, patients with social risks had a significantly lower rate of months up to date on screenings than those without those risks. Patients with transportation barriers had a lower rate of months up to date with BC screening than those not reporting transportation barriers (RR: 0.94, 95% CI: 0.89-0.99). Those reporting food, housing, or transportation insecurity had a lower rate of study months up to date with CVC screening than those not reporting those risks (food insecurity: RR: 0.96, 95% CI:0.95-0.98; housing instability RR: 0.95, 95% CI:0.93-0.98; transportation barriers RR: 0.94, 95% CI:0.91-0.97). Those with food, housing, or transportation insecurity had a lower rate of study months up to date with CRC screening than those without those risks (food insecurity: RR: 0.91, 95% CI:0.89-0.94; housing instability RR: 0.92, 95% CI:0.88-0.95; transportation barriers RR: 0.87, 95% CI: 0.83-0.91).

Primary care visits

In all cases, patients with social risks had statistically significantly higher primary care visit rates compared to those without those risks (Tables 4-6). In the BC cohort, visit rates were higher among patients with food insecurity (RR: 1.15, 95% CI:1.10-1.20), housing instability (RR: 1.15, 95% CI:1.09-1.22), and

transportation barriers (RR: 1.13, 95% CI:1.07-1.19). In the CVC cohort, visit rates were higher among patients with food insecurity (RR: 1.16, 95% CI:1.12-1.20), housing instability (RR: 1.20, 95% CI:1.13-1.27), and transportation barriers (RR: 1.16, 95% CI:1.10-1.22). In the CRC cohort, visit rates were higher among patients with food insecurity (RR: 1.15; 95% CI:1.11-1.20), housing instability (RR: 1.17; 95% CI:1.10-1.25), and transportation barrier status (RR: 1.11; 95% CI:1.04-1.19).

Cancer screening orders

BC screening orders (RR: 0.90, 95% CI: 0.82-0.99), CVC screening orders (RR: 0.87, 95% CI:0.81-0.94), and CRC screening orders (RR: 0.91; 95% CI:0.85-0.96) were all less likely to be placed for patients with food insecurity than for patients without food insecurity. CVC screening orders were also less likely to be placed for patients with transportation barriers than for patients without (RR: 0.88, 95% CI:0.81-0.95). No other statistically significant differences in screening completion were associated with social risk status.

Completion of cancer screening

Patients with food insecurity were less likely to complete CVC screening (RR: 0.97, 95% CI:0.96-0.99) than those not reporting food insecurity. Patients with food insecurity were statistically significantly less likely to complete CRC screening (RR: 0.95; 95% CI:0.91-0.99), as were patients with transportation barriers (RR: 0.90; 95% CI:0.82-0.99), compared to those without these risks. No other statistically significant differences in screening completion were associated with social risk status.

DISCUSSION

We investigated associations between food insecurity, housing instability, and transportation barriers and cancer preventive care outcomes among CBHCO patients. We sought to identify the pathways through

which social risks impact cancer screening and early detection by studying patients with access to care and considering whether cancer screening gaps are the result of differences in primary care visits, screening orders, or screening completion rates.

Patients reporting any social risks were less likely to be up to date with cancer screenings at their index visit, aligning with prior research showing adverse associations between social risks and cancer screening receipt.[2,10-17] Patients reporting food insecurity, housing instability, or transportation barriers also had statistically significantly lower rates of total study months up to date for CVC and CRC screening compared to patients without each social risk. Those with transportation barriers also had a significantly lower rate of total months up to date for BC screening. This suggests that, compared to patients without each social risk, those reporting food insecurity, housing instability, or transportation difficulties had a lower proportion of months during their observation period during which all of the guideline-recommended screening services were complete. Interestingly, we also found that patients with social risks had higher rates of primary care visits during the study period, which aligns with prior research showing that such patients have higher chronic disease burden and healthcare utilization than those without such risks.[18] These findings suggest that differences in study months up to date for cancer screening do not reflect a lack of access to primary care in this population.

We also explored whether patients experiencing social risks receive orders for indicated cancer screenings, and / or complete screenings for which an order was received, at the same rate as patients who are not experiencing social risks. We did not find consistent associations between having a given social risk and the likelihood of cancer screening orders, with one notable exception: orders for all three cancer screenings were less likely in patients reporting food insecurity. One explanation could be that the urgency of food insecurity may shift the focus of the encounter and result in delays in routine preventive care. Research

suggests reform of primary care delivery system to include multidisciplinary teams caring for patients through multiple modalities might help to change this pattern.[19]

In contrast, housing and transportation barriers had different associations with the studied outcomes depending on the type of cancer screening. For instance, neither of these social risks was associated with BC screening. This might be because mammograms are relatively easy for patients to complete, in part because outreach programs like mobile mammography clinics support mammogram access.[20,21,22]

But other cancer screenings were associated with these social risks. For instance, patients with transportation barriers were less likely to have CVC screening orders placed or to complete CRC screening. Pap screenings (still the most common form of CVC screening) are often completed at the healthcare visit at which the screening order is issued, but it is possible that patients with transportation insecurity face barriers to staying at the clinic long enough to complete a Pap smear or may prioritize other needs during their clinical encounters. Lower rates of CRC screening orders in patients with housing instability may be because providers assume patients do not have the resources needed to prepare for colonoscopy (e.g., bathroom access), or because patients do not have a stable address to which to mail a FIT test.

Study findings underscore the need to better understand the barriers to guideline-concordant cancer screening for patients with social risks. The heterogeneous relationships between social risks, screening orders, and screening completion rates illuminate the complex pathways leading to equitable cancer care. Future research should explore patient and provider decision-making about cancer screening and the barriers social risks pose to obtaining these services.

Our findings should be interpreted in light of several study limitations. During the study period, social risk screening was not conducted by all OCHIN network clinics. Our analysis represents the 53% of OCHIN member organizations that do document social risk screening in the EHR. Results are also limited to patients with access to primary care services at these clinics; access is obviously another barrier to receipt of cancer screening. Further, we considered patients reporting food, housing, and transportation barriers. These social risks may not be the sole drivers of receipt of cancer preventive services; they also may serve as proxies for other barriers to care. Additionally, not all patients in these clinics were screened for all three of the social risks we examined. Clinic staff may have screened some patients for certain risks more than others; thus, results are generalizable to patients who have been screened. Our analysis focused on screening for breast, cervical, and colorectal cancers, which were included in the 2020 Uniform Data System (UDS) reporting requirements for health centers. Inclusion of other cancer screening services (e.g., Prostate Specific Antigen [PSA] testing for prostate cancer) is important for future research. We did not include information about patient nativity or preferred spoken language, though these also may affect cancer screening decisions and should be included in future analyses. Potential bias was addressed by including all eligible patients (including those without documented social risk screening, Supplementary Tables 4-6) and analyses adjusting for demographic, socioeconomic, and healthcare use characteristics.

CONCLUSION

Patients with social risks are less likely to be up to date with cancer screening guidelines than those without social risks; social risks are associated with both screening order and completion rates. Future research should assess both how providers make decisions about cancer preventive care and how patients prioritize cancer screening in the context of social risks. As novel strategies and policies to mitigate social risks proliferate, it will be important to assess how these programs mitigate the complex pathways between social risks and cancer early detection services.

Data Sharing Statement: The raw data underlying this article were generated from multiple health systems across the OCHIN network; restrictions apply to the availability and re-release of data under organizational agreements. Please contact the corresponding author for interest.

Funding: This work was supported by the National Cancer Institute of the National Institutes of Health (grant numbers P50CA244289). This P50 program was launched by NCI as part of the Cancer Moonshot.

Conflict of Interest Statement: The authors declare no conflicts of interest.

Acknowledgements: The funder did not play a role in the design of the study; the collection, analysis, and interpretation of the data; the writing of the manuscript; and the decision to submit the manuscript for publication.

References

1. Mendoza JA, Miller CA, Martin KJ, et al. Examining the Association of Food Insecurity and Being Up-to-Date for Breast and Colorectal Cancer Screenings. *Cancer Epidemiol Biomarkers Prev*. May 4 2022;31(5):1017-1025. doi:10.1158/1055-9965.EPI-21-1116

2. Mahmood A, Kedia S, Dillon PJ, Kim H, Arshad H, Ray M. Food security status and breast cancer screening among women in the United States: Evidence from the Health and Retirement Study and Health Care and Nutrition Study. *Cancer Causes Control*. Apr 2023;34(4):321-335. doi:10.1007/s10552-023-01667-1

3. Markus AR, Li Y, Wilder ME, Catalanotti J, McCarthy ML. The Influence of Social Determinants on Cancer Screening in a Medicaid Sample. *Am J Prev Med*. Jul 2023;65(1):92-100. doi:10.1016/j.amepre.2023.02.005

4. Korn AR, Walsh-Bailey C, Correa-Mendez M, et al. Social determinants of health and US cancer screening interventions: A systematic review. *CA Cancer J Clin*. Sep-Oct 2023;73(5):461-479. doi:10.3322/caac.21801

5. Lewis C, Getachew Y, Abrams M, Doty M. *Changes at Community Health Centers, and How Patients Are Benefiting*. August 2019. https://doi.org/10.26099/2yrd-pa13

6. Paradise J, Rosenbaum S, Markus A, et al. *Community Health Centers: Recent Growth and the Role of the ACA*. January 18, 2017. https://www.kff.org/report-section/community-health-centers-recent-growth-and-the-role-of-the-aca-executive-summary/

7. The National Patient-Centered Clinical Research Network. PCORnet. https://pcornet.org/

8. Gold R, Kaufmann J, Gottlieb LM, et al. Cross-Sectional Associations: Social Risks and Diabetes Care Quality, Outcomes. *Am J Prev Med*. Sep 2022;63(3):392-402. doi:10.1016/j.amepre.2022.03.011

9. Bureau of Primary Health Care HCP. *Uniform Data System Reporting Instructions for 2020 Health Center Data*. August 21, 2020. https://bphc.hrsa.gov/sites/default/files/bphc/funding/2020-uds-manual.pdf

10. Barrington WE, DeGroff A, Melillo S, et al. Patient navigator reported patient barriers and delivered activities in two large federally-funded cancer screening programs. *Prev Med*. Dec 2019;129S:105858. doi:10.1016/j.ypmed.2019.105858

11. Shah MM, Islam S, Braunstein MJ. Association of food insecurity with reduced cancer screening rates. *Journal of Clinical Oncology*. 2023;41(16_suppl):e18609-e18609. doi:10.1200/JCO.2023.41.16_suppl.e18609

12. Asgary R, Garland V, Jakubowski A, Sckell B. Colorectal cancer screening among the homeless population of New York City shelter-based clinics. *Am J Public Health*. Jul 2014;104(7):1307-13. doi:10.2105/AJPH.2013.301792

13. Asgary R, Garland V, Sckell B. Breast cancer screening among homeless women of New York City shelter-based clinics. *Womens Health Issues*. Sep-Oct 2014;24(5):529-34. doi:10.1016/j.whi.2014.06.002

14. May FP, Bromley EG, Reid MW, et al. Low uptake of colorectal cancer screening among African Americans in an integrated Veterans Affairs health care network. *Gastrointest Endosc*. Aug 2014;80(2):291-8. doi:10.1016/j.gie.2014.01.045

15. Castaldi M, Smiley A, Kechejian K, Butler J, Latifi R. Disparate access to breast cancer screening and treatment. *BMC Womens Health*. Jun 22 2022;22(1):249. doi:10.1186/s12905-022-01793-z

16. Jazowski SA, Sico IP, Lindquist JH, et al. Transportation as a barrier to colorectal cancer care. *BMC Health Serv Res*. Apr 13 2021;21(1):332. doi:10.1186/s12913-021-06339-x

17. Issaka RB, Bell-Brown A, Snyder C, et al. Perceptions on Barriers and Facilitators to Colonoscopy Completion After Abnormal Fecal Immunochemical Test Results in a Safety Net System. *JAMA Netw Open*. Aug 2 2021;4(8):e2120159. doi:10.1001/jamanetworkopen.2021.20159

18. Schiavoni KH, Helscel K, Vogeli C, et al. Prevalence of social risk factors and social needs in a Medicaid Accountable Care Organization (ACO). *BMC Health Serv Res*. Nov 19 2022;22(1):1375. doi:10.1186/s12913-022-08721-9

19. Fiscella K, Epstein RM. So much to do, so little time: care for the socially disadvantaged and the 15-minute visit. *Arch Intern Med*. Sep 22 2008;168(17):1843-52. doi:10.1001/archinte.168.17.1843

20. National Breast and Cervical Cancer Early Detection Program: About the Program. Centers for Disease Control and Prevention. Updated March 28, 2023. https://www.cdc.gov/cancer/nbccedp/about.htm

21. Vang S, Margolies LR, Jandorf L. Mobile Mammography Participation Among Medically Underserved Women: A Systematic Review. *Prev Chronic Dis*. Nov 15 2018;15:E140. doi:10.5888/pcd15.180291

22. Bakhai S, Ansari M, Sadeghi C, Reynolds JL. Advancing health equity in improving breast cancer screening with the use of a mobile mammography bus in marginalised population: quality improvement project. *BMJ Open Qual*. Jan 4 2024;13(1)doi:10.1136/bmjoq-2023-002482

23. *Medicaid Waiver Tracker: Approved and Pending Section 1115 Waivers by State*. January 12, 2024. https://www.kff.org/medicaid/issue-brief/medicaid-waiver-tracker-approved-and-pending-section-1115-waivers-by-state/

Table 1. Breast Cancer Screening Cohort

Characteristics	Total (Column%)	Food Insecurity		Housing Instability		Transportation Barriers	
		Need	No Need	Need	No Need	Need	No Need
Patients n	83,993 (100)	3605	7608	1,666	8,924	1,689	7,330
Female, %	83,993 (100)	100.0	100.0	100.0	100.0	100.0	100.0
Race and ethnicity[a], %							
Hispanic	23,011 (27.4)	20.3	16.6	14.7	15.7	15.4	17.1
Non-Hispanic Black	15,913 (18.9)	29.5	25.6	34.2	34.3	31.7	31.0
Non-Hispanic White	5,773 (41.8)	40.5	39.4	40.8	30.8	41.9	32.6
Non-Hispanic other	35,072 (6.9)	5.8	10.7	6.2	11.4	7.1	11.6
No data	4,224 (5.0)	3.9	7.7	4.2	7.8	3.9	7.7
Preferred language, %							
English	56,258 (67.0)	77.0	67.7	79.3	65.3	80.0	66.8
Non-English	27,735(33.0)	23.0	32.4	20.7	34.7	20.0	33.2
Age at Index visit							
Median (Range)	58 (50, 73)	57 (50, 73)	59 (50, 73)	57 (50, 73)	59 (50, 73)	57 (50, 73)	59 (50, 73)
Age Group %							
50-64	70,143 (83.5)	89.5	81.7	91.6	81.6	91.4	82.3
65-73	13,850 (16.5)	10.5	18.3	8.4	18.4	8.6	17.7
Payer at Index visit, %							
Medicaid	35,633 (42.4)	50.3	35.7	50.8	38.1	53.6	37.7
Medicare	19,543 (23.3)	26.3	21.7	23.4	22.8	25.5	22.7
Other public	4,270 (5.1)	2.1	2.8	2.1	3.0	1.7	3.0
Private	17,631 (21.0)	12.7	33.7	15.4	32.1	10.7	32.1
Uninsured	6,916 (8.2)	8.7	6.1	8.3	4.0	8.5	4.5
Federal Poverty Level, %							
<=100	45,666 (54.4)	63.8	44.0	63.4	50.2	66.6	47.5
>100-200	16,327 (19.4)	18.0	19.4	18.8	16.9	16.8	17.4
>200	8,958 (10.7)	5.2	15.0	6.2	10.6	4.1	10.6
No data	13,042 (15.5)	13.1	21.7	11.6	22.3	12.5	24.5
PC Visits in first year after index, %							
1-2 visits	17,721 21.1)	12.6	20.7	10.7	17.6	10.2	17.1
3-4 visits	28,694 (34.2)	28.9	35.7	29.3	34.7	29.8	34.4
5-6 visits	19,490(23.2)	25.7	23.4	26.1	24.7	25.9	24.8
7+ visits	18,088 (21.5)	32.8	20.3	33.9	23.0	34.0	23.7
Years of Observation[b], %							
<2	79,623 (94.8)	95.5	94.8	95.4	95.4	95.8	95.4
2-3.7	4,370 (5.2)	4.5	5.2	4.6	4.6	4.2	4.6
BC screening status at Index[c] %							
Due	23,047 (27.4)	29.3	23.1	32.5	21.2	32.7	22.4
Up-to-date	60,946 (72.6)	70.7	76.9	67.5	78.8	67.3	77.6
Ever due during observation period %							
Not due during observation	42,022 (50.0)	50.1	53.3	47.6	56.8	47.9	54.5
Due during observation	41,971 (50.0)	49.9	46.7	52.4	43.2	52.1	45.5

Notes: These data were representative of 186 clinics spanning 13 U.S. states categorized by regions Midwest (Indiana, Minnesota, Ohio, and Wisconsin), Northeast (Massachusetts), South (Georgia, North Carolina, and Texas), and West (Alaska, California,

Montana, Oregon, and Washington). SDH risk group was determined during the observation period. Pearson's chi-square tests were performed. In the regression models, FPL categories were collapsed to <=100, >200 and unknown. Race/ ethnicity categories were collapsed to: Hispanic, Non-Hispanic Black, Non-Hispanic White, Non-Hispanic other/Unknown. Comparing characteristics by the patient's SDH needs category, all tests were statistically significant at the 0.05 p-value level, except for years of observation and food Insecurity.

[a]Race/ethnicity was categorized into Hispanic, Non-Hispanic Black, Non-Hispanic White, Non-Hispanic Other (included American Indian or Alaskan Native, Asian, Multiple race, Native Hawaiian or Other Pacific Islander), and No data.

Study duration was determined at the patient level and defined by their last primary care encounter date at which they met the criteria for BC screening guidelines, and their first primary care encounter date that occurred at least 1 year before their last primary care encounter. Primary Care encounters were defined as a face-to-face visit with an MD, DO, PA or NP provider.

[b]Study followed UDS guidelines for BC screening and considered patients as meeting the criteria for screening if they had received a mammography within 2 years.

Abbreviations: BC, Breast Cancer; MD=Doctor of Medicine; NP=Nurse Practitioner; PA=Physician Assistant; PC=Primary Care.

Table 2. Cervical Cancer Screening Cohort

Characteristics	Total, Column %	Food Insecurity		Housing Instability		Transportation Barriers	
		Need	No Need	Need	No Need	Need	No Need
Patients, n	202,895 (100)	8,233	17,631	3,824	20,788	3,461	16,972
Female, %	202,895 (100)	100.0	100.0	100.0	100.0	100.0	100.0
Race and ethnicity, %							
Hispanic	72,698 (35.6)	24.4	22.0	19.4	19.0	17.7	20.8
Non-Hispanic Black	37,444 (18.5)	29.2	25.1	32.9	34.6	31.1	31.1
Non-Hispanic White	70,360 (34.8)	37.6	34.0	38.0	27.1	41.1	28.9
Non-Hispanic other	12,365 (6.1)	5.1	9.9	5.6	10.3	6.1	10.4
No data	9,758 (4.8)	3.8	8.9	4.1	9.0	3.9	8.9
Preferred language, %							
English	113,560 (65.8)	77.3	71.6	78.7	71.2	81.2	72.2
Non-English	69,315 (34.2)	22.7	28.4	21.3	28.8	18.8	27.8
Age at Index visit							
Median (Range)	42 (23, 63)	43 (23, 63)	41 (23, 63)	43 (23, 63)	41 (23, 63)	45 (23, 63)	41 (23, 63)
Age Group, %							
23-39	91,180 (44.9)	41.1	47.1	42.0	46.0	38.2	46.4
40-49	48,388 (23.8)	25.4	21.8	23.5	22.5	23.4	22.4
50-63	63,327 (31.2)	33.6	31.1	34.5	31.5	38.4	31.2
Payer at Index visit, %							
Medicaid	107,625 (53.0)	61.5	44.2	62.1	47.6	66.4	46.9
Medicare	13,210 (6.5)	10.7	5.0	10.3	6.0	11.8	5.9
Other public	109,23 (5.4)	2.9	3.6	2.6	3.9	2.2	3.9
Private	44,811 (22.1)	13.2	38.7	15.3	37.1	9.1	37.3
Uninsured	26,296 (13.0)	11.7	8.6	9.8	5.5	10.6	6.0
Federal Poverty Level, %							
<=100	114,234 (56.3)	63.1	43.1	63.8	47.9	69.0	45.5
>100-200	42,608 (21.0)	18.4	19.1	17.6	17.3	15.5	17.3
>200	19,282 (9.5)	5.8	15.5	5.3	12.1	4.1	12.2
No data	26,771 (13.2)	12.7	22.3	13.3	22.8	11.4	25.0
PC visits in first year post index, %							
1-2 visits	59,885 (29.5)	20.2	28.4	16.7	25.8	16.7	25.3
3-4 visits	67,258 (33.1)	29.7	34.7	30.2	33.9	29.5	33.9
5-6 visits	38,484 (19.0)	21.9	18.6	22.3	19.9	22.7	20.0
7+ visits	37,268 (18.4)	28.3	18.2	30.8	20.4	31.1	20.8
Years of observation[a], %							
<2 years	185,415 (91.4)	91.8	91.2	92.4	91.8	92.3	91.7
2-3.7 years	17,480 (8.6)	8.2	8.8	7.6	8.2	7.7	8.3
CVC screening status[b] at Index, %							
Due	76,710 (37.8)	36.1	31.8	38.1	31.9	38.8	29.8
Up-to-date[c]	126,185 (62.2)	63.9	68.2	61.9	68.1	61.2	70.3
Ever due for screening during observation, %							
Not due during observation	97,301 (48.0)	49.3	51.8	48.1	52.8	48.3	53.8
Due during observation	105,594 (52.0)	50.8	48.2	51.9	47.2	51.7	46.5

Notes: These data were representative of 186 clinics spanning 13 U.S. states categorized by regions Midwest (Indiana, Minnesota, Ohio, and Wisconsin), Northeast (Massachusetts), South (Georgia, North Carolina, and Texas), and West (Alaska, California, Montana, Oregon, and Washington). SDH risk group was determined during the observation period. Pearson's chi-square tests were performed. In the regression modeling, FPL categories were collapsed to <=100, >200 and unknown. Race/ ethnicity categories were collapsed to: Hispanic, Non-Hispanic Black, Non-Hispanic White, Non-Hispanic other/Unknown. Comaparing characteristics by the patient's SDH needs category, all tests were statistically significant at the 0.05 p-value level, except for years of observation and food Insecurity.

[a]Study duration was determined at the patient level and defined by their last primary care encounter date at which they met the criteria for CVC screening guidelines, and their first primary care encounter date that occurred at least 1 year before their last primary care encounter. Primary Care encounters were defined as a face-to-face visit with an MD, DO, PA or NP provider.

[b]Study followed UDS guidelines for CVC screening and considered patients as meeting the criteria for screening if they had had a Pap test within the last 3 years and were 21 or over at the time of the test or if they were over 30 and were contested for Pap and HPV within the last 5 years.

[c]Pap test or Pap/HPV co-test

Abbreviations: CVC=Cervical Cancer; MD=Doctor of Medicine; NP=Nurse Practitioner; PA=Physician Assistant; PC=Primary Care.

Table 3. Colorectal Cancer Screening Cohort

		Food Insecurity		Housing Instability		Transportation Barriers	
Characteristics	**Total, Column %**	**Need**	**No Need**	**Need**	**No Need**	**Need**	**No Need**
Patients n	171,724 (100)	7,141	15,758	3,480	17,834	3,434	14,571
Sex, %							
Female, %	95,590 (55.7)	56.8	56.5	53.3	58.4	55.9	58.3
Male, %	78,418 (44.3)	43.2	43.5	46.7	41.6	44.1	41.7
Race and ethnicity, %							
Hispanic	41,940 (24.4)	19.0	15.0	13.9	14.3	14.4	15.7
Non-Hispanic Black	31737 (18.5)	29.9	23.1	34.7	31.2	31.0	28.5
Non-Hispanic White	77,269 (45.0)	40.6	43.1	40.5	34.3	43.2	35.7
Non-Hispanic Other	11,434 (6.7)	6.1	10.5	5.7	11.7	7.3	11.9
No data	9,344 (5.4)	4.4	8.3	5.1	8.6	4.2	8.3
Preferred language, %							
English	121,173 (70.6)	78.0	69.8	80.5	66.8	81.0	68.0
Non-English	121,173 (29.4)	22.0	30.2	19.5	33.2	19.0	32.0
Age at Index visit							
Median (Range)	59 (50, 73)	58 (50, 73)	60 (50, 73)	58 (50, 73)	60 (50, 73)	58 (50, 73)	60 (50, 73)
Age Group, %							
50-64	126,825 (73.9)	79.8	69.8	82.3	69.7	80.8	70.7
65-73	44,899 (26.1)	20.2	30.2	17.7	30.3	19.2	29.4
Payer at Index visit, %							
Medicaid	65,231 (38.0)	44.5	30.7	46.8	32.7	48.9	32.4
Medicare	53,129 (31.0)	31.8	30.7	28.5	31.1	31.8	30.8
Other public	7,057 (4.1)	1.9	2.2	1.8	2.6	1.5	2.5
Private	32,689 (19.0)	11.2	30.7	13.3	30.0	8.8	30.0
Uninsured	13,588 (7.9)	10.6	5.8	9.6	3.7	9.0	4.3
Federal Poverty Level, %							
<=100	92,059 (53.6)	64.8	44.3	64.5	49.7	67.1	47.3
>100-200	33,080 (19.3)	17.4	18.8	17.0	17.2	16.4	17.5
>200	19,824 (11.5)	5.6	16.4	6.8	11.6	4.8	11.6
No data	26,761 (15.6)	12.2	20.5	11.8	21.5	11.7	23.6
PC Visits in first year after index, %							
1-2 visits	37,958 (22.1)	14.5	21.2	12.6	18.2	12.3	17.5
3-4 visits	58,848 (34.3)	28.9	35.2	28.5	34.3	29.3	33.9
5-6 visits	39001 (22.7)	24.7	23.1	25.9	24.5	24.8	24.9
7+ visits	35,917 (20.)9	31.9	20.5	33.1	23.0	33.6	23.7
Years of Observation[a], %							
<2	162,076 (94.4)	94.5	94.4	94.4	95.1	94.7	95.0
2-3.7	9,648 (5.6)	5.5	5.6	5.6	4.9	5.3	5.0
FIT/FOBT screen prior to Index							
No FIT/FOBT test prior to	96,142 (56.0)	57.9	55.7	58.0	57.2	58.4	54.8
FIT/FOBT prior to Index	75,582 (44.0)	42.0	44.3	42.0	42.8	41.6	45.2
Imaging screen prior to Index							
No	111,951 (65.2)	62.6	55.4	65.0	53.8	64.4	53.8
Yes	59,773 (34.8)	37.4	44.6	35.0	46.2	35.6	46.2
CRC screening status at Index							

Due	95,013 (56.0)	55.5	51.0	56.4	51.6	57.1	49.9
Up-to-date[b]	76,711 (44.0)	44.5	49.0	43.6	48.4	42.9	50.1
Ever due during observation period							
Not due during observation	42,494 (24.7)	26.1	28.9	24.4	28.4	24.9	29.2
Due during observation	129,230 (75.3)	73.9	71.1	75.6	71.6	75.1	70.8

Notes: These data were representative of 186 clinics spanning 13 U.S. states categorized by regions Midwest (Indiana, Minnesota, Ohio, and Wisconsin), Northeast (Massachusetts), South (Georgia, North Carolina, and Texas), and West (Alaska, California, Montana, Oregon, and Washington). SDH risk group was determined during the observation period. Pearson's chi-square tests were performed. Note that in the modeling FPL categories were collapsed to <=100. >200 and unknown. Race/ ethnicity categories were collapsed to: Hispanic, Non-Hispanic Black, Non-Hispanic White, Non-Hispanic other/Unknown.

Comparing characteristics by the patient's SDH needs category, all tests were statistically significant at the 0.05 p-value level, except for years of observation and food Insecurity.

[a]Study duration was determined at the patient level and defined by their last primary care encounter date at which they met the criteria for CRC screening guidelines, and their first primary care encounter date that occurred at least 1 year before their last primary care encounter.

[b]Study followed UDS guidelines for CRC screening and considered patients as meeting the criteria for screening if they were 50 to 74 years old with no prior history of CRC, colectomy, or referral to Hospice. UTD was defined as a completed FOBT within 1 year, FIT within 3 years, Flexible Sigmoidoscopy or colonography within 5 years or colonoscopy within 10 years.

[c]Flexible Sigmoidoscopy, Colonography or Colonoscopy

Abbreviations: CRC=Colorectal cancer; FIT=Fecal Immunochemical Test; FOBT=Fecal Occult Blood Test; MD=Doctor of Medicine; NP=Nurse Practitioner; PA=Physician Assistant; PC=Primary Care.

Table 4. Association between reported social risks and breast cancer screening

	Patient Sample	Estimated Rate or %, (95%CI)	Relative Rate or Risk, (95% CI)	p-value
Food insecurity				
Up-to-date BC status at Index[a,b]				
Food insecurity	3,805	69.5 (66.6, 72.6)	**0.97 (0.94, 0.99)**	**0.0078**
No food insecurity	7,608	72.0 (69.6, 74.5)	Reference	
Percent Months UTD[b]				
Food insecurity	3,805	61.6 (58.6, 64.7)	0.99 (0.96, 1.03)	0.6196
No food insecurity	7,608	62.1 (59.6, 64.7)	Reference	
Documented Order within 1 year of due[c]				
Food insecurity	1,150	31.7 (28.2, 35.6)	**0.90 (0.82, 0.99)**	**0.0281**
No food insecurity	2,023	35.3 (32.0, 38.8)	Reference	
Completed Mammogram[d]				
Food insecurity	417	59.9 (54.7, 65.6)	0.95 (0.88, 1.03)	0.2129
No food insecurity	808	63.0 (58.4, 67.9)	Reference	
Primary Care Visits[e] in Year after Index (Rate)				
Food insecurity	3,535	5.0 (4.8, 5.3)	**1.15 (1.10, 1.20)**	**<.0001**
No food insecurity	7,574	4.4 (4.2, 4.6)	Reference	
Housing instability				
Up-to-date BC status at Index[a,b]				
Housing instability	1,666	67.8 (64.8, 71.1)	**0.94 (0.90, 0.97)**	**0.0004**
No housing instability	8,924	72.5 (69.8, 70.3)	Reference	
Percent Months UTD[b]				
Housing instability	1,666	60.7 (57.4, 64.2)	0.97 (0.93, 1.02)	0.2043
No housing instability	8,924	62.5 (60.0, 65.2)	Reference	
Documented Order within 1 year of due[c]				
Housing instability	582	31.6 (27.6, 36.0)	0.92 (0.81, 1.03)	0.1556
No housing instability	2,100	34.5 (31.2, 38.2)	Reference	
Completed Mammogram[d]				
Housing instability	213	62.6 (56.8, 69.0)	1.04 (0.94, 1.14)	0.458
No housing instability	866	60.4 (56.3, 64.8)	Reference	
Primary Care Visits[e] in Year after Index (Rate)				
Housing instability	1,666	5.2 (4.8, 5.7)	**1.15 (1.09, 1.22)**	**<.0001**
No housing instability	8,924	4.5 (4.3, 4.7)	Reference	
Transportation barriers				
Up-to-date BC status at Index[a,b]				
Transportation barriers	1,689	67.9 (64.2, 71.7)	**0.94 (0.90, 0.98)**	**0.0040**
No transportation barriers	7,330	72.1 (69.5, 74.8)	Reference	
Percent Months UTD[b]				
Transportation barriers	1,689	59.4 (55.6, 63.4)	**0.94 (0.89, 0.99)**	**0.0301**
No transportation barriers	7,330	63.0 (60.5, 65.7)	Reference	
Documented Order within 1 year of due[c]				
Transportation barriers	589	31.9 (27.7, 36.7)	0.91 (0.80, 1.04)	0.1734
No transportation barriers	1,875	35.0 (31.8, 38.6)	Reference	
Completed Mammogram[d]				
Transportation barriers	219	60.3 (53.5, 67.9)	0.97 (0.86, 1.10)	0.6782
No transportation barriers	772	61.8 (57.3, 66.8)	Reference	
Primary Care Visits[e] in Year after Index (Rate)				

Transportation barriers	1,689	5.2 (4.8, 5.5)	**1.13 (1.07, 1.19)**	**<.0001**
No transportation barriers	7,330	4.6 (4.4, 4.8)	Reference	

Note: Boldface indicates statistical significance (p<0.05).

Estimates were derived using general estimating equations log binomial (binary outcomes) or negative binomial (rates outcome) regression models with robust sandwich variance estimation for clustering of patients within clinics. For all analyses, regression adjustment was made for race/ethnicity, preferred language, age, and insurance status at the index visit, first known federal poverty level, and yearly rate of primary care visits (except in estimating the visit rate outcome). Rates were estimated at marginal frequencies of the covariates in the model.

[a]Index visit is defined as the first primary care visit at least 1 year before their last eligible visit in the electronic health record.

[b]Study followed UDS guidelines for BC screening and considered patients as meeting the criteria for screening if they had received a mammography within 2 years.

[c]Estimates based on population of patients with 1 year of observation after first date due for mammogram, n=25,948.

[d]Estimates based on population of patients with documented order for mammogram in the 1 year of observation after first date due, n=8,955.

[e]Primary Care encounters were defined as face-to-face visits with an MD, DO, PA or NP provider.

Abbreviations: BC=Breast Cancer; DO, Doctor of Osteopathic Medicine; HPV: Human Papilloma Virus; MD, Doctor of Medicine; NP, nurse practitioner; PA, physician assistant; UTD=up-to-date.

Table 5: Association between reported social risks and cervical cancer screening

	Patient Sample (n)	Estimated Rate or %, (95%CI)	Relative Rate or Risk, (95% CI)	p-value
Food insecurity				
Up-to-date CVC status at Index[a,b]				
Food insecurity	8,233	60.3 (58.0, 62.6)	**0.97 (0.95, 0.99)**	**0.0123**
No food insecurity	17,831	61.9 (59.8, 64.1)	Reference	
Percent Months UTD[b]				
Food insecurity	8,233	63.6 (61.3, 66.0)	**0.96 (0.95, 0.98)**	**<.0001**
No food insecurity	17,831	66.0 (63.8, 68.3)	Reference	
Documented Order within 1 year of due[c]				
Food insecurity	3,210	28.8 (26.4, 31.5)	**0.87 (0.81, 0.94)**	**0.0002**
No food insecurity	6,105	33.0 (30.7, 35.4)	Reference	
Completed CVC Screen[d]				
Food insecurity	945	92.2 (89.6, 94.8)	**0.97 (0.96, 0.99)**	**0.0041**
No food insecurity	2257	94.6 (93.0, 96.3)	Reference	
Primary Care Visits[e] in Year after Index (Rate)				
Food insecurity	8,233	4.5 (4.3, 4.8)	**1.16 (1.12, 1.20)**	**<.0001**
No food insecurity	17,831	3.9 (3.7, 4.1)	Reference	
Housing instability				
Up-to-date CVC status at Index[a,b]				
Housing instability	3,824	58.5 (56.2, 60.9)	**0.94 (0.92, 0.97)**	**<.0001**
No housing instability	20,788	62.1 (59.9, 64.3)	Reference	
Percent Months UTD[b]				
Housing instability	3,824	62.6 (60.2, 65.2)	**0.95 (0.93, 0.98)**	**<.0001**
No housing instability	20,788	65.8 (63.4, 68.2)	Reference	
Documented Order within 1 year of due[c]				
Housing instability	3,210	29.9 (27.2, 33.0)	0.93 (0.85, 1.02)	0.1406
No housing instability	6,105	32.1 (29.5, 34.9)	Reference	
Completed CVC Screen[d]				
Housing instability	489	93.7 (91.4, 96.1)	0.99 (0.97, 1.02)	0.6583
No housing instability	2666	94.2 (92.2, 96.2)	Reference	
Primary Care Visits[e] in Year after Index (Rate)				
Housing instability	3,824	4.8 (4.5, 5.3)	**1.20 (1.13, 1.27)**	**<.0001**
No housing instability	20,788	4.0 (3.9, 4.2)	Reference	
Transportation barriers				
Up-to-date CVC status at Index[a,b]				
Transportation barriers	3,461	58.0 (55.4, 60.8)	**0.93 (0.89, 0.96)**	**<.0001**
No transportation barriers	16,972	62.6 (60.5, 64.8)	Reference	
Percent Months UTD[b]				
Transportation barriers	3,461	61.7 (59.0, 64.6)	**0.94 (0.91, 0.97)**	**<.0001**
No transportation barriers	16,972	65.9 (63.7, 68.3)	Reference	
Documented Order within 1 year of due[c]				
Transportation barriers	3,210	28.3 (25.6, 31.4)	**0.88 (0.81, 0.95)**	**0.0017**
No transportation barriers	6,105	32.2 (30.1, 34.5)	Reference	
Completed CVC Screen[d]				
Transportation barriers	412	92.3 (88.9, 95.8)	0.98 (0.95, 1.00)	0.0741
No transportation barriers	2099	94.6 (92.8, 96.5)	Reference	
Primary Care Visits[e] in Year after Index (Rate)				

Transportation barriers	3,461	4.7 (4.4, 5.0)	**1.16 (1.10, 1.22)**	**<.0001**
No transportation barriers	16,972	4.1 (3.9, 4.3)	Reference	

Note: Boldface indicates statistical significance ($p<0.05$).

Estimates were derived using general estimating equations log binomial (binary outcomes) or negative binomial (rates outcome) regression models with robust sandwich variance estimation for clustering of patients within clinics. For all analyses, regression adjustment was made for race/ethnicity, preferred language, age, and insurance status at the index visit, first known federal poverty level, and yearly rate of primary care visits (except in estimating the visit rate outcome). Rates were estimated at marginal frequencies of the covariates in the model.

[a]Index visit is defined as the first primary care visit at least 1 year before their last eligible visit in the electronic health record.

[b]Study followed UDS guidelines for CVC screening and considered patients as meeting the criteria for screening if they had had a Pap test within the last 3 years and were 21 or over at the time of the test or if they were over 30 and were contested for Pap and HPV within the last 5 years.

[c]Estimates based on population of patients with 1 year of observation after first date due for Pap test, n=82,145.

[d]Estimates based on population of patients with documented order for Pap test in the 1 year of observation after first date due, n=24,582.

[e]Primary Care encounters were defined as face-to-face visits with an MD, DO, PA or NP provider.

Abbreviations: CVC=Cervical Cancer; DO=Doctor of Osteopathic Medicine; HPV=Human Papilloma Virus; MD=Doctor of Medicine; NP=nurse practitioner; PA=physician assistant; Pap test=Papanicolaou test; UTD=up-to-date.

Table 6. Association between reported social risks and colorectal cancer screening

	Patient Sample (n)	Estimated Rate or %, (95%CI)	Relative Rate or Risk, (95% CI)	p-value
Food insecurity				
Up-to-date CRC status at Index[a,b]				
Food insecurity	7,141	43.4 (40.9, 46.0)	**0.94 (0.92, 0.97)**	**<.0001**
No food insecurity	15,758	46.0 (43.9, 48.2)	Reference	
Percent Months UTD[b]				
Food insecurity	7,141	44.3 (41.9, 46.9)	**0.91 (0.89, 0.94)**	**<.0001**
No food insecurity	15,758	48.6 (46.3, 50.9)	Reference	
Documented Order within 1 year of due[c]	101,724			
Food insecurity	4,196	33.3 (31.1, 35.5)	0.91 (0.85, 0.96)	0.0009
No food insecurity	8,643	36.7 (34.3, 39.3)	Reference	
Completed CRC Screen[d]	34506			
Food insecurity	1485	58.7 (54.6, 63.0)	**0.95 (0.91, 0.99)**	**0.0195**
No food insecurity	3412	61.8 (57.7, 66.2)	Reference	
Primary Care Visits[e] in Year after Index (Rate)	171,724			
Food insecurity	7141	4.9 (4.7, 5.2)	1.15 (1.11, 1.20)	<.0001
No food insecurity	15758	2.9 (2.7, 3.1)	Reference	
Housing instability				
Up-to-date CRC status at Index[a,b]	171,724			
Housing instability	3,480	42.2 (39.3, 45.2)	0.92 (0.88, 0.97)	0.001
No housing instability	17,834	45.6 (43.4, 47.9)	Reference	
Percent Months UTD[b]	171,724			
Housing instability	3,480	44.1 (41.5, 46.9)	0.92 (0.88, 0.95)	<.0001
No housing instability	17,834	48.2 (45.9, 50.6)	Reference	
Documented Order within 1 year of due[c]	101,724			
Housing instability	2,085	34.5 (32.0, 37.1)	0.96 (0.91, 1.01)	0.0852
No housing instability	9,831	36.1 (33.9, 38.5)	Reference	
Completed CRC Screen[d]	34506			
Housing instability	777	60.3 (55.5, 65.5)	0.99 (0.93, 1.05)	0.7255
No housing instability	3828	61.0 (56.9, 65.4)	Reference	
Primary Care Visits[e] in Year after Index (Rate)	171,724			
Housing instability	3,480	4.1 (3.8, 4.4)	1.17 (1.10, 1.25)	<.0001
No housing instability	17,834	3.4 (3.2, 3.6)	Reference	
Transportation barriers				
Up-to-date CRC status at Index[a,b]	171,724			
Transportation barriers	3,434	40.5 (37.8, 43.5)	**0.87 (0.83, 0.90)**	**<.0001**
No transportation barriers	14,571	46.8 (44.7, 49.1)	Reference	
Percent Months UTD[b]	171,724			
Transportation barriers	3,434	42.4 (39.5, 45.4)	**0.87 (0.83, 0.91)**	**<.0001**
No transportation barriers	14,571	48.7 (46.5, 51.0)	Reference	
Documented Order within 1 year of due[c]	101,724			
Transportation barriers	2,059	35.0 (32.5, 37.7)	0.99 (0.93, 1.05)	0.6579
No transportation barriers	7,823	35.5 (33.3, 37.8)	Reference	
Completed CRC Screen[d]	34506			
Transportation barriers	788	56.0 (50.6, 62.0)	**0.90 (0.82, 0.99)**	**0.0338**
No transportation barriers	3066	62.3 (57.8, 67.0)	Reference	
Primary Care Visits[e] in Year after Index (Rate)	171,724			

Transportation barriers	3434	3.9 (3.6, 4.4)	**1.11 (1.04, 1.19)**	**0.0027**
No transportation barriers	14571	3.5 (3.3, 3.7)	Reference	

Note: Boldface indicates statistical significance ($p<0.05$).

Estimates were derived using general estimating equations log binomial (binary outcomes) or negative binomial (rates outcome) regression models with robust sandwich variance estimation for clustering of patients within clinics. For all analyses, regression adjustment was made for race/ethnicity, preferred language, age, and insurance status at the index visit, first known federal poverty level, and yearly rate of primary care visits (except in estimating the visit rate outcome). Rates were estimated at marginal frequencies of the covariates in the model.

[a]Index visit is defined as the first primary care visit at least 1 year before their last eligible visit in the electronic health record.

[b] Study followed UDS guidelines for CRC screening and considered patients as meeting the criteria for screening if they were 50 to 74 years old with no prior history of CRC, colectomy, or referral to Hospice. UTD was defined as a completed FOBT within 1 year, FIT within 3 years, Flexible Sigmoidoscopy or colonography within 5 years or colonoscopy within 10 years.

[c]Estimates based on population of patients with 1 year of observation after first date due for test, n=101,724.

[d]Estimates based on population of patients with documented order for test in 1 year of observation after first date due, n=34,506.

[e]Primary Care encounters were defined as face-to-face visits with an MD, DO, PA or NP provider.

Abbreviations: CRC, Colorectal; DO=Doctor of Osteopathic Medicine; MD=Doctor of Medicine; NP=nurse practitioner; PA=physician assistant; UTD=up-to-date.

Table 7. Summary of the associations between breast, cervical, and colorectal cancer screenings and social risk status

Cohort	Outcome	Food insecure, compared to food secure	Housing unstable, compared to housing stable	Transportation barriers, compared to no transportation barriers
Breast Cancer screening	UTD at index	**Less likely**	**Less likely**	**Less likely**
	Months UTD	No difference	No difference	**Fewer**
	Screening order received	**Less likely**	No difference	No difference
	Screening completed	No difference	No difference	No difference
	Primary Care Visits	**More**	**More**	**More**
Cervical Cancer screening	UTD at index	**Less likely**	**Less likely**	**Less likely**
	Months UTD	**Fewer**	**Fewer**	**Fewer**
	Screening order received	**Less likely**	No difference	**Less likely**
	Screening completed	**Less likely**	No difference	No difference
	Primary Care Visits	**More**	**More**	**More**
Colorectal Cancer screening	UTD at index	**Less likely**	**Less likely**	**Less likely**
	Months UTD	**Fewer**	**Fewer**	**Fewer**
	Screening order received	**Less likely**	**Less likely**	No difference
	Screening completed	**Less likely**	No difference	**Less likely**
	Primary Care Visits	**More**	**More**	**More**

Notes. Table provides summary results based on the estimates in Tables 2-4. Bold face represents a statistically significant association with a 2-sided alpha <.05. “No difference” means that there was no statistically significant difference found at the alpha .05 level between patients with documented social risk and those without the social risk.
Abbreviations: UTD=up-to-date