Food insecurity, social needs, and smoking status among patients in a county hospital system

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ABSTRACT

Tobacco use in the U.S. is increasingly concentrated among populations with socioeconomic disadvantages such as food insecurity. Building on prior studies showing that food insecurity increases odds of cigarette smoking, the current study sought to examine how food insecurity and other social needs, particularly financial strain, transportation barriers, and housing/utility insecurity, were associated with smoking status among adult patients seen in a county hospital system. We analyzed data from the electronic health record of patients from The MetroHealth System (Cleveland, Ohio, USA), covering a two-year period since implementation of social determinants of health assessments (2019–2021; N = 45,151 patients). Logistic regression analyses were used to examine associations with smoking status. Compared to the overall smoking prevalence (21 %), smoking was higher among patients screening for transportation barriers (41 %), financial strain (39 %), food insecurity (34 %), and housing/utility insecurity (27 %). Each of these social needs was independently associated with increased odds of current smoking (all $p < 0.05$). Smoking prevalence increased sequentially as the number of social needs increased; with each addition of a social need, there was a dose-response association with higher odds of current smoking (adjusted ORs ranged from 1.56 to 3.76, all $p < 0.001$), and current smoking specifically among ever smoking patients (adjusted ORs ranged from 1.39 to 3.01, all $p < 0.001$). There was substantial overlap among several social needs and smoking status. Alongside improving access to evidence-based cessation treatments and services, the findings raise the possibility that addressing social needs might reduce barriers to quitting and thereby reduce tobacco use disparities.

1. Introduction

There is a disproportionate concentration of tobacco use—a leading cause of preventable disease and premature mortality—among socio-economically disadvantaged populations (U.S. Department of Health and Human Services, 2014). In 2020, the overall prevalence of cigarette smoking among U.S. adults was 13 %, and significantly differed when comparing across several indicators of socioeconomic status (SES), such as annual household income (20 % smoking prevalence for those living with <$35,000 vs 6 % for those living with >$100,000) and type of health insurance coverage (23 % for those with Medicaid vs 9 % for those with private insurance) (Cornelius et al., 2022). While the overall prevalence of smoking in the general population has fallen in recent years (Babb S, Malarcher A, Asman K, Jamal A. Quitting smoking among adults — United States, 2017), disparities in smoking prevalence became larger for population groups with socioeconomic disadvantages (Leventhal et al., 2019).

Adults of lower SES who smoke have been less likely to be successful with quit attempts compared to higher SES counterparts, despite interest in quitting and attempts to quit (Babb et al., 2017; Kotz and West, 2009). Several prior studies have reported that financial strain increases the odds of smoking and reduces odds of quitting (Siahpush et al., 2003; Siahpush et al., 2007; Siahpush and Carlin, 2006). This broad concept of financial strain has been defined in previous studies as difficulty

affording food, clothing, housing, bills, leisure and other items (Kendzor et al., 2010), or the inability to pay important bills on time because of lack of money (Kalkhoran et al., 2018). Food insecurity is a specific aspect of financial strain that occurs when reliable access to adequate food is limited by a lack of money or other resources (Bickel et al., 2000; Coleman-Jensen et al., 2021). The concept of food insecurity not only encompasses the physical sensation of hunger due to the lack of money or resources for enough food, but also compensatory behaviors to avoid hunger (Seligman and Schillinger, 2010). From a health behavioral perspective, food insecurity is significant because it is independently linked with a range of poor physical and mental health outcomes (Gundersen and Ziliak, 2015), has known geographic and place-based disparities (Coleman-Jensen et al., 2021; Mayer et al., 2014), and impacts excess healthcare cost and utilization (Berkowitz et al., 2018a; Berkowitz et al., 2018b).

Findings from previous research suggest that food insecurity is an independent social determinant of smoking status and smoking cessation (Poghosyan et al., 2015; Kim-Mozeleski et al., 2019; Farrelly and Shafer, 2017). In an analysis of Behavioral Risk Factor Surveillance System data from 12 U.S. states, food insecurity was significantly associated with increased odds of current smoking, and specifically among smoking respondents, food insecurity increased the odds of having made a past-year quit attempt (Poghosyan et al., 2015). Studies have reported that individuals with food insecurity make greater quit attempts than counterparts without food insecurity, but are less successful (Poghosyan et al., 2015; Kim-Mozeleski and Tsoh, 2019). However, in a study of low-income ever smoking adults in California, those with food insecurity had lower quit ratios than those without food insecurity. (Kim-Mozeleski and Tsoh, 2019) Other population-based studies show similar patterns of findings that food insecurity is related to higher smoking rates and lower cessation rates (Kim-Mozeleski et al., 2019; Farrelly and Shafer, 2017).

An important area that has not yet been well examined in prior studies on food insecurity and smoking is the consideration of other social needs that may co-occur with food insecurity (Bahar et al., 2020). For instance, in a nationally representative study examining multiple financial stressors, 22 % of respondents reported experiencing two or more stressors related to food insecurity, financial worry, and healthcare insecurity (Tsuchiya et al., 2020). Yet much of the existing literature investigating the role of food insecurity in smoking has not examined other areas of unmet social needs, and this may limit a more contextualized understanding of the extent to which food insecurity is a social determinant of smoking status in light of other needs. It is important to examine how multiple and specific areas of unmet social needs impact smoking, to better understand and address barriers to smoking cessation in low-income populations.

This study aimed to examine how food insecurity, as well as related social needs around financial resources, transportation, and housing, were associated with smoking status among patients in a safety-net hospital system in Cleveland, Ohio. As the importance of addressing social needs is rapidly expanding in health care settings (Kreuter et al., 2021), these reflect important social needs that have been linked with smoking- and smoking cessation-related outcomes in previous research (Kalkhoran et al., 2018; Waters et al., 2019; Grafova, 2011; Flocke et al., 2019a; Bisgaier and Rhodes, 2011), and we extend previous research by examining these variables in relation to one another and cumulatively in a single study. Cleveland (located within Cuyahoga County) has a high prevalence of households living in poverty (32 % in 2019 according to the U.S. Census Bureau(U.S. Census Bureau QuickFacts, 2020), with an estimated 35 % adult smoking prevalence (Prevention Research Center for Healthy Neighborhoods, n.d.). Taken together, examining food insecurity with related areas of social needs and their associations with smoking status is important for informing smoking cessation and prevention efforts within and across healthcare systems that can more readily intervene on key social determinants.

2. Methods

2.1. Data sources

Data were drawn from The MetroHealth System, a safety-net health care system in Cleveland, Cuyahoga County, Ohio, with four hospitals, four emergency departments, and over 20 health centers throughout the county. About two-thirds of MetroHealth patients are covered by Medicaid, Medicare, or are uninsured.

In May 2019, the health system began implementing screenings to assess social determinants of health and social needs in the patient population. In general, screenings for social needs took place prior to a scheduled healthcare visit, through patient outreach telephone calls that were implemented by a team of care coordinators (prior to 2020), or through the web-based patient portal (beginning in 2020). For the first eight months (May through December 2019), screenings were conducted by telephone for patients needing care coordination and social worker involvement. In 2020, screenings were expanded to patient portals for adults who had visits for primary care, obstetrics/gynecology, or geriatrics. In 2021, some patients were screened in person during COVID-19 vaccination visits (Chagin et al., 2021). The information collected during screening became part of patients' electronic health records (EHR). For this study, we retrospectively examined EHR data of adult patients who had screening information, covering a two-year timeframe since implementing screenings (May 1, 2019-June 30, 2021), and inclusive of the onset of the COVID-19 pandemic. Referral processes following screening are described elsewhere (Chagin et al., 2021).

A total of 53,436 adult patients were screened for social needs during the study timeframe, for a 20.5 % screening rate (N = 261,066 patients eligible for screening across the study time frame). This study's analysis was restricted to patients with non-missing information on food insecurity, as the driving goal was to build on the literature on food insecurity and smoking status by also examining other areas of social needs. We used the most recent screening information for patients with multiple screens during this timeframe. This study was approved by the MetroHealth Institutional Review Board.

2.2. Measures

The dependent variable in this study was smoking status as documented in the EHR, based on information collected and entered by a provider during a healthcare visit. This information is routinely asked and updated during visits. In the EHR, smoking status is captured through the following categories: "yes" indicating current smoking, "passive" indicating intermittent smoking, "quit" indicating former smoking, "never", and "unknown". For this study, smoking status was categorized into current smoking (including "yes" and "passive"), former smoking, and never smoking status. These categories have been used in previous research on tobacco cessation support in this hospital system (Flocke et al., 2019b).

Four primary independent variables were drawn from a Social Determinants of Health Questionnaire used in this health system (Chagin et al., 2021): food insecurity, financial strain, transportation, and housing/utilities. Variables were examined dichotomously and as a count based on the number of social needs reported by patients. Food insecurity was measured by the Hunger Vital Sign (Makelarski et al., 2017; Hager et al., 2010), a validated two-item measure used to assess any food insecurity in the past 12 months (yes/no). Financial strain was measured by a single item used in prior research (Puterman et al., 2012) to assess current difficulty in paying for basics, such as food, housing, medical care, and heating. Transportation barriers were assessed by two questions from the National Association of Community Health Centers' Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences, assessing whether the lack of transportation was a barrier to medical appointments (yes/no), and whether the lack of

transportation was a barrier to daily living (yes/no). An affirmative response on either indicated any transportation barriers.

For housing/utilities, patients were screened by one of two sets of questions. The first set had three items (Billioux et al., 2017) assessing whether the patient has a steady place to live, whether there are known problems with the home (such as lack of heat, presence of mold), and whether in the past 12 months, utilities had been threatened to be shut off, or were currently shut off. The second set also had three items (Sandel et al., 2018) in reference to the last 12 months, regarding any delays in rent or mortgage payment (yes/no), the number of places lived (3 + places considered as high risk for housing instability), and whether the patient lacked a steady place to sleep or slept in a shelter, including currently (yes/no). The question sets depended on when patients were screened, associated with EHR system-related upgrades coinciding with this study period. Patients screened prior to October 2020 were given the first set, and patients screened after October 2020 were given the second set. An affirmative response to any of these items were used to determine the presence of any housing/utility insecurity.

Study covariates included sociodemographic characteristics (age, sex, race/ethnicity, and insurance type) and health comorbidities, extracted from patients' medical records using the International Classification of Disease (ICD) version 10 codes, including diabetes, hypertension, chronic obstructive pulmonary disease (COPD), coronary artery disease, and congestive heart failure. Comorbidities were used to calculate the Charlson Comorbidity Index (CCI), which uses ICD diagnosis codes to provide a clinical score to indicate disease severity (Charlson et al., 1987).

2.3. Statistical analysis

Descriptive statistics were used to examine sociodemographic and other characteristics of the study sample, and to calculate the prevalence of current, former, and never smoking. While all individuals in the study sample had non-missing data on food insecurity (per inclusion criteria), there were missing data on other social needs variables. Telephone-based screenings had larger proportions of missing data (e.g., due to time limitations). Aside from potential order effects for missing data, care coordinators used their clinical judgment to administer screening questions that were considered most relevant to the individual at the time of screening. For financial strain, transportation barriers, and housing/utility insecurity, "missing" was treated as a separate category in estimating smoking prevalence to preserve the sample size. The analytic models, however, were based on a complete case analysis to facilitate a more practical interpretation of the estimates. We conducted an additional set of descriptive statistics with the complete case analysis sample, to observe differences in sample composition.

Logistic regression analyses were used to examine how food insecurity and other areas of social needs were associated with the odds of smoking. Model 1 examined factors associated with current smoking vs current non-smoking (comprising of former smoking and never smoking), and Model 2 examined factors associated with current smoking vs former smoking, to assess continued smoking among ever smoking patients. Models controlled for sociodemographic characteristics, severity of health comorbidities, time since the COVID-19 pandemic (a binary variable indicating screening before or after March 2020), and method of screening, to estimate adjusted odds ratios (AOR) and 95 % confidence intervals (CI). A second set of logistic regression analysis examined how the number of social needs, ranging from none to all four needs, was associated with the adjusted odds of current smoking. Across all analyses, model fit was examined to identify issues related to collinearity and concordance. All analyses were conducted in 2021, using R version 4.0.3 (2020-10-10).

3. Results

3.1. Patient characteristics: Total sample and analytic sample

The total sample included 45,141 adult patients who had non-missing data on both smoking status and food insecurity screening, reflecting 85.8 % of all patients who were assessed for social needs since screenings were implemented. Table 1 displays demographic and health-related characteristics of the total sample and smoking prevalence across study variables. The majority of screenings took place after March 2020. Overall, the prevalence of current smoking was 21 %, former smoking was 30 %, and never smoking was 49 %.

As shown in Table 1, 24 % of patients screened for food insecurity, 15 % for housing/utility insecurity, 10 % for transportation barriers, and 8 % for financial strain. There was a high amount of missing information for housing/utility insecurity, and 23 % screened for housing/utility insecurity (out of N = 28,423) when excluding those with missing information. The screening rate for financial strain increased to 9 %, whereas transportation barriers remained at approximately 10 % when excluding those with missing information.

Compared to the overall sample, current smoking was higher among patients who were male, non-Hispanic Black, and had either Medicaid insurance or did not have health insurance. Patients with COPD also had higher smoking prevalence than the overall sample. Smoking prevalence was twice as high for patients with food insecurity compared to patients without food insecurity, and similar patterns in smoking prevalence were observed for patients with and without financial strain, transportation barriers, and housing/utility insecurity. There was a gradient in smoking prevalence based on the number of social needs. Patients without any social needs had the lowest smoking prevalence, which increased sequentially as the number of social needs increased (Table 1).

3.2. Factors associated with smoking status

Table 2 displays characteristics of the analytic sample, representing about half of the total sample (54.9 %). While the percentage of age and sex distribution were similar with the total sample, there were several differences, including a lower proportion of patients identifying as Hispanic and Black, and a lower proportion of patients whose primary insurance was Medicaid and Medicare.

Table 2 summarizes results from the logistic regression models in which each social need variable was examined dichotomously. Results from Model 1 showed that food insecurity was independently associated with increased odds of current smoking (AOR = 1.58; 95 % CI [1.44, 1.74]). The presence of financial strain (AOR = 1.16; 95 % CI [1.02, 1.31]), transportation barriers (AOR = 1.62; 95 % CI [1.43, 1.83]), and housing/utility insecurity (AOR = 1.25; 95 % CI [1.15, 1.37]) were also independently associated with increased odds of smoking. Furthermore, demographic characteristics related to age, sex, race/ethnicity, and insurance type were significantly related to current smoking status. Patients on Medicaid insurance as well as patients who were uninsured, compared to patients on commercial insurance, were more likely to be currently smoking. Screening method was also significant; compared to patients who were screened by telephone, patients who self-screened by the web-based patient portal and screened in-person were less likely to be currently smoking.

In Model 2 examining current smoking versus former smoking, food insecurity (AOR = 1.51; 95 % CI [1.35, 1.68]), transportation barriers (AOR = 1.63; 95 % CI [1.41, 1.89]), and housing/utility insecurity (AOR = 1.14; 95 % CI [1.03, 1.26]) were each independently associated with increased odds of current smoking among ever smokers. In this model, financial strain was not significantly associated with smoking.

Table 3 displays results from the logistic regression analysis examining associations between the count of social needs and smoking status. The odds of current smoking increased with each addition of a social need in a dose-response pattern. Compared to patients with none of the

Table 1
Patient Sociodemographic and Medical Characteristics and Smoking Prevalence (n = 45,141).

Characteristics	Total Sample Characteristics		Current Smoking (n = 9,609)	Former Smoking (n = 13,351)	Never Smoking (n = 22,181)
	N	%[a]	Prevalence of Smoking, Row Percentages (%)		
Overall	45,141	100.0	21.3	29.6	49.1
Age					
18-34	10,138	22.5	21.5	16.0	62.5
35-49	8,692	19.3	26.7	24.2	49.2
50-64	13,282	29.4	25.8	30.9	43.3
65+	12,796	28.3	12.7	42.4	44.9
Unknown	233	0.5	27.0	43.3	29.6
Sex					
Female	31,044	68.8	19.8	27.4	52.9
Male	14,097	31.2	24.6	34.5	41.0
Race/ethnicity					
Hispanic, any race	3,641	8.1	20.7	24.0	55.2
Black, non-Hispanic	15,582	34.5	25.4	29.5	45.1
White, non-Hispanic	23,875	52.9	19.4	31.1	49.4
Another race/ethnicity	1,028	2.3	8.5	16.9	74.6
Unknown	1,015	2.2	16.0	27.1	56.9
Insurance type					
Commercial	11,988	26.6	14.1	24.0	61.9
Medicaid	13,201	29.2	35.6	24.7	39.7
Medicare	14,010	31.0	16.8	41.4	41.8
Other	4,146	9.2	9.1	23.7	67.2
Uninsured/self-pay	1,796	4.0	27.2	24.2	48.6
Chronic health diagnoses					
Coronary artery disease	1,556	3.4	25.3	45.9	28.9
Congestive heart failure	2,436	5.4	23.3	44.6	32.1
COPD	3,913	8.7	43.1	46.7	10.2
Diabetes	9,530	21.1	20.2	38.0	41.8
Hypertension	19,266	42.7	20.4	36.7	42.8
Charlson Comorbidity Index					
0	11,754	26.0	16.4	20.5	63.2
1-2	17,816	39.5	21.2	29.3	49.4
3-4	7,415	16.4	22.8	38.5	38.7
5+	4,216	9.3	24.5	43.1	32.3
Unknown	3,940	8.7	29.8	26.6	43.6
Screening Method					
Telephone	14,260	31.6	31.2	31.1	37.8
Web	22,283	49.4	17.3	26.3	56.4
In-person	8,598	19.0	15.3	35.6	49.2
Screened after March 2020	41,767	92.5	20.5	29.1	50.4
Screened before March 2020	3,374	7.5	31.3	35.5	33.2
Food Insecurity					
Yes	10,636	23.6	34.3	28.8	37.0
No	34,505	76.4	17.3	29.8	52.9
Financial Strain					
Yes	3,548	7.9	38.6	28.3	33.2
No	37,984	84.1	18.7	29.9	51.4
Missing	3,609	8.0	31.7	27.5	40.8
Transportation Barriers					
Yes	4,531	10.0	40.8	27.7	31.5
No	39,224	86.9	18.9	29.8	51.3
Missing	1,386	3.1	25.3	28.2	46.5
Housing/Utility Insecurity					
Yes	6,633	14.7	27.3	28.2	44.5

Table 1 (*continued*)

Characteristics	Total Sample Characteristics		Current Smoking (n = 9,609)	Former Smoking (n = 13,351)	Never Smoking (n = 22,181)
	N	%[a]	Prevalence of Smoking, Row Percentages (%)		
No	21,790	48.3	14.7	28.6	56.7
Missing	16,718	37.0	27.5	31.4	41.1
Number of social needs from screening					
None	29,064	64.4	15.8	29.7	54.4
One	9,362	20.7	26.7	30.5	42.9
Two	4,554	10.1	34.5	28.9	36.7
Three	1,766	3.9	42.8	25.6	31.7
Four	395	0.9	49.1	22.3	28.6

Notes: [a] Not all categories may add up to 100% due to rounding; COPD, chronic obstructive pulmonary disease.

four social needs, those with all four needs were nearly-four times more likely to be currently smoking, and three times more likely to be continuing smoking (among ever smokers).

4. Discussion

Our findings leveraging EHR and social needs data from a county hospital system contribute to several emerging areas related to the study of tobacco use disparities and social determinants of health. The overall smoking prevalence found here (21 %) is higher than the U.S. general population, but similar to figures for lower-income adults (Cornelius et al., 2022). Aligned with previous epidemiological findings on food insecurity and smoking, we found that smoking prevalence was substantially higher based on the presence of food insecurity. Furthermore, the association remained significant when including financial strain, transportation barriers, and housing/utility insecurity. Each of these areas was independently associated with increased likelihood of current smoking. Three of the four areas (with the exception of financial strain) were also associated with continued smoking (i.e., current smoking among ever smokers). The odds of smoking increased successively as the number of social needs increased, suggesting a cumulative effect of social needs on current smoking and continued smoking.

A study based on the 2008–2017 National Health Interview Survey examined six areas of health and socioeconomic-related disadvantages in relation to smoking status, including unemployment, poverty, low education, disability, psychological distress, and heavy alcohol use (Leventhal et al., 2019). While these areas of disadvantages vary from the social needs assessed herein, the pattern of findings were similar in that smoking prevalence increased sequentially as the number of disadvantages increased, with a 14 % smoking prevalence among respondents with none of the disadvantages, to 58 % smoking among respondents with 5 or more disadvantages (Leventhal et al., 2019). While fundamental causes related to resources, deprivation, and stress may underlie each of the social needs assessed here (Mills et al., 2021), the pathways by which social needs influence smoking could vary across multiple levels. For instance, the research on food insecurity and smoking points to the role of nicotine in managing appetite and hunger at an individual level (Kim-Mozeleski and Pandey, 2020), while at an environmental level, tobacco marketing is particularly prevalent in retail outlets that serve people who are food insecure (Hillier et al., 2015; Rust et al., 2019). High smoking among patients with transportation barriers may speak to the severity of place-based social vulnerability with the lack of personal resources, and these are areas for further investigation.

Strategies to address unmet social needs that pose challenges to smoking cessation for low-income populations remains a research gap (McQueen et al., 2019). One area of implication is that social needs data

Table 2

Results from Logistic Regression Analyses of Factors Associated with Smoking Status.

Variable	Analytic Sample Characteristics N = 24,778	Model 1: Current smoking vs Non-smoking (former and never smoking) (N = 24,778)		Model 2: Current smoking vs Former smoking (N = 11,302)	
	%	AOR (95 % CI)	p-value	AOR (95 % CI)	p-value
Age					
< 35	23.2	Ref.		Ref.	
35 – 49	19.6	1.32 (1.19, 1.47)	<0.001	0.81 (0.71, 0.93)	0.003
50 – 64	28.0	1.21 (1.08, 1.34)	<0.001	0.67 (0.59, 0.76)	<0.001
65 +	29.2	0.46 (0.39, 0.54)	<0.001	0.26 (0.22, 0.32)	<0.001
Sex					
Female	69.0	Ref.		Ref.	
Male	31.0	1.29 (1.19, 1.39)	<0.001	1.08 (0.99, 1.18)	0.063
Race/Ethnicity					
Hispanic, any race	6.6	Ref.		Ref.	
Black, non-Hispanic	28.8	1.45 (1.25, 1.69)	<0.001	1.29 (1.08, 1.54)	0.004
White, non-Hispanic	59.3	1.53 (1.32, 1.78)	<0.001	1.18 (0.99, 1.41)	0.039
Another race/ethnicity	2.8	0.54 (0.39, 0.76)	<0.001	0.80 (0.53, 1.20)	0.274
Unknown	2.5	0.95 (0.71, 1.27)	0.7855	0.94 (0.68, 1.32)	0.780
Insurance Type					
Commercial	32.3	Ref.		Ref.	
Medicaid	22.6	2.27 (2.06, 2.50)	<0.001	1.53 (1.36, 1.72)	<0.001
Medicare	29.3	1.74 (1.51, 2.00)	<0.001	1.20 (1.03, 1.41)	0.033
Other	11.9	0.65 (0.56, 0.75)	<0.001	0.67 (0.57, 0.79)	<0.001
Uninsured/self-pay	3.9	1.73 (1.46, 2.06)	<0.001	1.47 (1.20, 1.81)	<0.001
Charlson Comorbidity Index					
0	32.3	Ref.		Ref.	
1 – 2	44.6	1.27 (1.17, 1.39)	<0.001	1.03 (0.93, 1.14)	0.658
3 – 4	15.8	1.25 (1.11, 1.40)	<0.001	0.92 (0.80, 1.05)	0.154
5+	7.3	1.48 (1.27, 1.71)	<0.001	1.05 (0.89, 1.25)	0.654
Food Insecurity^	18.2	1.58 (1.44, 1.74)	<0.001	1.51 (1.35, 1.68)	<0.001
Financial Strain^	6.8	1.16 (1.02, 1.31)	0.0236	1.05 (0.90, 1.22)	0.543
Transportation Barriers^	6.8	1.62 (1.43, 1.83)	<0.001	1.63 (1.41, 1.89)	<0.001
Housing/Utility Insecurity^	21.6	1.25 (1.15, 1.37)	<0.001	1.14 (1.03, 1.26)	0.011
Screened after March 2020	98.8	0.94 (0.72, 1.24)	0.6708	0.97 (0.70, 1.33)	0.880
Screening method					
Telephone	14.9	Ref.		Ref.	
Web	58.8	0.77 (0.70, 0.85)	<0.001	0.91 (0.81, 1.02)	0.059
In-person	26.3	0.76 (0.68, 0.85)	<0.001	0.89 (0.78, 1.02)	0.142

Notes: ^binary variables indicating presence vs absence; AOR, adjusted odds ratio; CI, confidence interval.

Table 3

Results from Logistic Regression Analyses of Association of the Number of Social Needs with Smoking Status.

	Analytic Sample Characteristics N = 24,778	Model 1: Current smoking vs Non-smoking (former and never smoking) (N = 24,778)		Model 2: Current smoking vs Former smoking (N = 11,302)	
Number of social needs from screening	%	AOR, 95 % CI	p-value	AOR, 95 % CI	p-value
None	67.1	Ref.		Ref.	
One	19.1	1.56 (1.43, 1.71)	<0.001	1.39 (1.26, 1.55)	<0.001
Two	8.4	1.88 (1.67, 2.11)	<0.001	1.62 (1.41, 1.85)	<0.001
Three	3.9	2.74 (2.36, 3.17)	<0.001	2.28 (1.90, 2.73)	<0.001
Four	1.4	3.76 (2.99, 4.73)	<0.001	3.01 (2.27, 4.01)	<0.001

Notes: Models controlled for age, sex, race/ethnicity, insurance type, comorbidities, screening date, and screening method.
AOR, adjusted odds ratio; CI, confidence interval.

captured in the EHR may be used to identify high-need patients who smoke, for proactive outreach (Flocke et al., 2019b). There are emerging examples of intervention approaches that assist low-income smokers to navigate referrals to various social services as they participate in tobacco quitline counseling (McQueen et al., 2019), and frameworks that adapt the U.S. Preventive Services Task Force's "5A's" to incorporate social needs assessments and referrals as part of promoting successful smoking cessation (Tsoh et al., 2021). The overall effectiveness of these efforts in terms of reducing smoking prevalence is not yet known, but are promising in terms of offering strategies that are better tailored to meet the various needs of populations who smoke (McQueen et al., 2019).

Whether patients were screened before or after March 2020 had no significant associations with smoking status in the analytic models, though smoking prevalence was higher among patients screened before March 2020. This may be related to screening procedures that were primarily telephone-based prior to 2020, with screening efforts focusing on those with care coordination needs. Across the total sample (Table 1) and the analytic sample (Table 2), there was a reduction in the proportion of patients who were screened by telephone, along with changes in demographic composition. There are likely several explanations for missing social needs data for racial/ethnic minority and low-income patients, such as disparities in digital connectivity and technology access, and care coordinators dealing with increasingly complex cases in the midst of the COVID-19 pandemic. Smoking prevalence was lower

among those who were screened in-person during visits for COVID-19 vaccinations, which may also correspond to age, as older individuals (who have lower prevalence of smoking than the general population Cornelius et al., 2022) had prioritized access to vaccines in early 2021.

There were several limitations to this study, which foremost cannot infer causality in its cross-sectional associations. By relying on a complete case analysis, nearly half of the overall sample was excluded in the analytic models. Therefore, it will be important to further investigate the key reasons for non-screening (e.g., patient refusal, lack of time) to better understand potential bias of the current findings in relying on a complete case analysis, and in recognizing that only one-fifth of patients who were presumably eligible for social needs screening were actually screened. The self-reported nature of the screening variables, and relying on EHR documentation of smoking status are also potential limitations, as we relied on the assumption that EHR-documented smoking status is up-to-date and would correspond to when screening information was collected. Current smoking included those considered "passive" smokers, and disentangling smoking intensity was not possible through the available data.

A related limitation was the high proportion of missing data on housing/utility insecurity, partly related to changes in the screening questions during the study period. Due to the healthcare system's screening and coding metrics, our analysis grouped utility insecurity (only assessed prior to EHR upgrades) with housing insecurity. We recognize that these are different aspects of insecurity. That housing/utility insecurity was significant in both models might therefore suggest the relevance of *any* general unmet needs related to housing, including poor housing quality Nevertheless, the current study was able to identify missing data considerations arising from real-world implementation of screening for social needs that can be pursued in future research (e.g., advantages and drawbacks of using telephone-based screening). By documenting social needs across the first two years since implementation, we provide baseline estimates across the current patient population, while also recognizing missing data considerations that result from the real-world challenges of collecting screening information during a period that coincided with the beginning of the COVID-19 pandemic. Because we focused on one health system, the findings may not generalize to patients at non-safety-net health systems or other geographic regions.

Tobacco use continues to exert an enormous burden on healthcare and public health systems. There is recognition of the growing concentration of socioeconomic and health-related disadvantages among population groups who continue to smoke (Leventhal et al., 2019), and that social determinants impact health status and health outcomes beyond provision of quality clinical care. The current study's findings underscore the need for comprehensive strategies to reduce tobacco-related health disparities that involves strategic and coordinated investments in addressing social needs and social determinants of health.

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.

Data availability

The data that has been used is confidential.

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