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Food Insecurity and Clinical Outcomes in Surgical Trauma Patients

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IMPORTANCE Food insecurity, which is the lack of consistent access to sufficient and nutritious food, impacts over 1.3 billion individuals worldwide. The impact of food insecurity on primary care and medical subspecialties is recognized, but its influence on surgical outcomes remains underexplored.

OBJECTIVE To investigate the association between food insecurity and postoperative clinical outcomes in adult surgical trauma patients.

DESIGN, SETTING, AND PARTICIPANTS This prospective longitudinal cohort study was conducted from October 2021 to June 2023 and surveyed patients at admission and at 1 and 3 months postoperatively. This multicenter study was conducted across 3 public and private tertiary care centers in India. Adult patients who underwent inpatient operative intervention for traumatic injury were included through consecutive sampling.

EXPOSURES Food insecurity, which was identified using the validated Hunger Vital Sign tool. This was determined at admission as preoperative food insecurity. Also assessed was a subset of participants who were food secure at admission but then became food insecure during the follow-up period.

MAIN OUTCOMES AND MEASURES Postoperative complications and length of stay. These outcomes were tracked during hospitalization and also at 1 month and 3 months after discharge to compare between time points.

RESULTS A total of 848 patients (median [IQR] age, 32 [24-45] years; 692 male [82%]) were included in this analysis. Of the total cohort, 174 participants (21%) reported experiencing food insecurity in the year before admission. Patients with food insecurity had significantly higher rates of postoperative complications compared with those without food insecurity (41.4% [72 of 174] vs 12.5% [84 of 671]; odds ratio [OR], 3.68; 95% CI, 2.24-6.05). Additionally, patients with food insecurity had a longer median (IQR) length of stay (13 [6-28] days vs 5 [3-9] days; incidence rate ratio, 1.51; 95% CI, 1.31-1.74). Furthermore, new-onset food insecurity at 1 month postoperatively was associated with an increased risk of new complications at 3 months postoperatively (OR, 5.06; 95% CI, 2.21-11.13).

CONCLUSIONS AND RELEVANCE Results demonstrate that food insecurity was significantly associated with increased postoperative complications and longer hospital stays in surgical trauma patients. Routine screening for food insecurity and targeted interventions like medically tailored meals, food prescription programs, and philanthropic food resources may mitigate the detrimental impact of food insecurity on surgical outcomes.

Invited Commentary

Supplemental content

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More than 1.3 billion people are food insecure.[1] Food insecurity (FI) is defined as the lack of consistent access to sufficient, safe, and nutritious food.[2] Although many studies have established the detrimental impact of malnutrition on health outcomes, FI is an important additional concept to study. FI is a broader concept than malnutrition as it reflects access, affordability, and economic factors that affect the ability to obtain proper nutrition. In medical populations, FI has been linked to increased hospital readmissions, higher health care expenditures, and elevated risks of premature mortality and reduced life expectancy.[3-5]

Despite increased awareness of the impact of FI on patients in primary care and the medical subspecialties, surgeons have been less involved in identifying and treating FI in their patients compared with other specialties.[6] One reason for this may be that the impact of FI on health-related outcomes after surgery remains unclear. The importance of proper nutrition in preventing surgical complications is well known, and organizations such as the American College of Surgeons have recognized the importance of good nutritional status in improving postoperative recovery, wound healing, and long-term outcomes.[7,8] However, the role of food security as a factor that enables optimal nutrition has been underemphasized in the surgical literature. Given the interlinked nature of FI, nutrition, and other social determinants of health, FI could be particularly harmful to surgical patients. Surgical cohorts, especially those requiring emergent care, are at high risk for FI due to the impact of disability, medical debt, and mental health conditions on their ability to obtain, use, and afford proper nutrition.[9-12] However, without clear evidence linking FI to clinical outcomes, surgeons may find it challenging to justify the administrative burden of screening for and treating FI, even though there are FI interventions that have been demonstrated to be feasible and effective in complex health care settings.[13,14]

Therefore, the goal of our study was to use primary, prospective patient data to evaluate the association between FI and clinical outcomes. We examined this in the context of 2 different time points at which FI can manifest. First, we examined the association of FI that was present before hospitalization. Then, we examined the association of incident FI that began after hospitalization during the perioperative period. With interventions to address FI increasingly becoming part of clinical care, demonstrating the association between FI and poor outcomes in surgical patients has the potential to move the needle toward incorporating such interventions into surgical care.

Key Points

Question What is the association between food insecurity at admission and postoperative clinical complications in surgical patients?

Findings In this multicenter cohort study of 848 surgical trauma patients, patients with food insecurity experienced postoperative complications 41% of the time compared with 12% of patients without food insecurity, a significant difference.

Meaning Results suggest that addressing food insecurity in surgical patients may reduce the risk of postoperative complications and improve clinical outcomes.

Methods

Ethical Approval

This study was approved by the institutional review board and ethics committees of Harvard Medical School (protocol number 2021P000750), and the ethics boards of All India Institute of Medical Sciences, Saveetha Institute of Medical and Technical Sciences, and Ganga Hospital. Informed consent was obtained from all participants. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Study Design and Setting

A prospective, multicenter, longitudinal cohort study was conducted in 3 tertiary care public and private hospitals in India to evaluate the association between FI and complications after surgical trauma. These institutions are internationally recognized, high-quality, tertiary care facilities. The public hospital, recognized as India's premier government health care institution, was selected as the national criterion standard to ensure consistency in clinical management strategies and resource availability. Two leading private hospitals, representing diverse care models, were included to capture variability in private sector care delivery. These institutions were chosen for their national rankings, geographic distribution across northern and southern India, and high trauma caseloads, with annual volumes exceeding 20 000 patients at the highest-volume center and operative trauma procedures ranging from 5 to 20 daily across all 3 sites.[15-17] This ensures generalizability to other institutions including those in high-income countries given the high standard of clinical care offered. The high volume of trauma cases and the higher prevalence of FI in India allowed us to achieve a suitable sample size to study the association between these 2 concepts while maintaining high standards of care. Moreover, using data from the selected institutions in India enhanced the global relevance of our study compared with data from high-income countries.

Data collection occurred from October 2021 through June 2023. Adult patients 18 years of age or older who underwent inpatient operative intervention for traumatic injury were eligible for inclusion. Patients who declined to provide consent were excluded from the study. Consent was obtained in local languages of Hindi, Tamil, and Malayalam, and occasionally English, by investigators who were native speakers of these languages. The reasons for nonconsent included concerns about privacy, hesitance to disclose financial information, challenges in maintaining functional contact for follow-up, reluctance to attend follow-up visits, and anxiety regarding their health status. Surveys were administered at admission to capture preinjury food security status. Patients were followed up for 3 months postoperatively. Follow-up surveys were administered telephonically or at clinic follow-up visits at 1-month

and 3-month intervals to capture postdischarge complications (eAppendixes 1 and 2 in Supplement 1). All surveys were translated into Hindi, Tamil, and Malayalam by a third party and then back translated in a review meeting to ensure translation accuracy. Information about participant race and ethnicity was not gathered as the study was conducted in India, and this information is not readily available or utilized in this context. The national census of India does not recognize racial or ethnic groups within India.

Data were obtained through a combination of medical records and direct patient reports by trained investigators. Based on the prevalence of FI reported in existing literature and anticipated loss to follow-up, we initially planned to recruit at least 450 patients to ensure adequate statistical power for our analyses. Ultimately, our final sample size far exceeded this minimum requirement, providing robust power to detect meaningful outcomes.

Demographic Variables

Patient demographic factors collected at baseline included age, sex, marital status, presence and number of children, number of people in the household, highest level of education achieved, employment status, status of current receipt of welfare, health insurance status, and total household income. Clinical covariates included Injury Severity Score (ISS), injury cause, and operation type. Surgical cases were classified into minor or major procedures using the US Department of Veteran Affairs procedure complexity designation requirements.[18] Social determinants of health included housing status and transportation access. The collection of these variables was based on prior studies.[5,19,20]

Measurement of Exposure

The main exposure of this study was preinjury FI status for the 12 months before hospitalization. This was determined on admission. FI status since time of discharge was asked at follow-up. FI was assessed using the validated Hunger Vital Sign screening tool.[21,22]

Measurement of Outcomes

The primary outcome of this study was the development of postoperative complications within 3 months after surgery (ie, at any point from surgical intervention to the end of follow-up). The second outcome of this study was length of stay (LOS) of the initial hospitalization, measured in days.

Commonly documented surgical complications including wound dehiscence, surgical site infection, deep vein thrombosis, pulmonary embolism, and any other clinically significant issues diagnosed by the primary surgical team were evaluated.[23] To further investigate the association between postoperative complications and FI and address potential confounding factors related to baseline FI present on admission, we assessed another subset of FI, namely new FI. In this subset, we analyzed data from patients who were food secure at admission but then became food insecure during the follow-up period. We compared new complications reported at 3 months postdischarge in this cohort to a cohort of patients who remained food secure throughout these time points.

Statistical Analysis

Descriptive statistics were performed using *t* tests for continuous variables, χ^2 tests for categorical variables, and Fisher exact tests for categorical variables with small, predicted frequencies. A multivariable logistic regression model was developed to evaluate the association between preinjury FI and the development of a complication within 3 months postoperatively, adjusted for age, sex, total household income, ISS, and injury cause. Covariates for all multivariable models were selected through a priori background knowledge.[24] Univariate and bivariate logistic regression models were used to evaluate the secondary complication outcome.

We used a multivariable negative binomial regression model to evaluate the association between FI and LOS of the primary hospitalization.[25] In this model we adjusted for age, sex, total household income, total number of people in household, education status, employment status, ISS, and injury cause. Because age may have a curvilinear relationship with LOS, an age-squared term was also included.[26]

We used complete-case analysis and excluded any missing data points. Statistical analysis was conducted with the use of R, version 4.3.1 (R Core Team).

Results

Patients

A total of 894 patients were enrolled, of which 848 (median [IQR] age, 32 [24-45] years; 156 female [18%]; 692 male [82%]) were included in the analysis; the remaining patients were excluded due to incomplete data. Of the 848 patients, 674 (79%) reported food security and 174 (21%) reported FI during the 12 months before admission. The cohort size at follow-up was 769 at 1 month (91% retention) and 708 at 3 months (83% retention).

The characteristics of this population are presented in **Table 1**. The median (IQR) age of individuals with food security was 32 (24-45) years, whereas the median (IQR) age of individuals with FI was 31 (24-42) years. Patients with FI had significantly larger households (eg, ≥6 people, 62 of 174 [35.6%] vs 122 of 673 [18.1%]; $P < .001$), lower educational attainment (eg, no education to first to eight standard education, 72 of 174 [41.4%] vs 119 of 674 [17.7%]; $P < .001$), and lower incomes (eg, earning <$318 total annual income, 100 of 171 [58.5%] vs 159 of 667 [23.8%]; $P < .001$). They experienced longer hospital stays (eg, >20 days, 58 of 172 [33.7%] vs 60 of 672 [8.9%]; $P < .001$), higher injury severity (eg, ISS 50-75, 19 of 156 [12.2%] vs 12 of 644 [1.9%]; $P < .001$), and underwent more major surgeries (116 of 168 [69.0%] vs 352 of 666 [52.9%]; $P < .001$). FI was also significantly associated with poorer social determinants of health, including higher rates of housing insecurity (eg, no housing and housing insecure, 36 of 174 [20.7%] vs 74 of 673 [11.0%]; $P < .001$) and transportation difficulties (54 of 174 [31.0%] vs 15 of 674 [2.2%]; $P < .001$). Notably, public hospitals reported higher FI than private hospitals (110 of 174 [63.2%] vs 64 of 174 [36.8%]; $P < .001$).

Among individuals with food security, 56 (8%) experienced a complication during the initial hospitalization, 40 (6%)

Table 1. Demographics at Admission[a]

Characteristic	Baseline food, No. (%)		P value
	Security (n = 674 [79.5%])	Insecurity (n = 174 [20.5%])	
Age, median (IQR), y	32 (24-45)	31 (24-42)	.04
Sex			
Female	121 (18.0)	33 (19.0)	.86
Male	551 (82.0)	141 (81.0)	
Marital status			
Single	274 (40.7)	70 (4.2)	.99
Married	400 (59.3)	104 (59.8)	
Children			
None	340 (50.4)	69 (39.7)	.01
≥1	334 (49.6)	105 (6.3)	
People in household, No.			
0-3	243 (36.1)	25 (14.4)	<.001
4-5	308 (45.8)	87 (5.0)	
≥6	122 (18.1)	62 (35.6)	
Highest level of education achieved			
None	40 (5.9)	24 (13.8)	<.001
1st to 8th Standard	79 (11.7)	48 (27.6)	
9th to 12th Standard	311 (46.1)	70 (4.2)	
University/graduate school	244 (36.2)	32 (18.4)	
Employment status			
Full- or part-time employment	421 (62.5)	23 (13.2)	<.001
Daily wages	14 (2.1)	119 (68.4)	
Unemployed	217 (32.2)	32 (18.4)	
Retired	22 (3.3)	0	
Total annual household income, $			
<318	159 (23.8)	100 (58.5)	<.001
318-573	261 (39.1)	52 (3.4)	
>573	247 (37.0)	19 (11.1)	
Welfare status			
No	617 (92.0)	115 (66.1)	<.001
Yes	54 (8.0)	59 (33.9)	
Health insurance status			
No	548 (81.3)	150 (86.2)	.25
Yes	126 (18.7)	24 (13.8)	
Length of stay, d			
1-5	375 (55.8)	39 (22.7)	<.001
6-10	156 (23.2)	33 (19.2)	
11-20	81 (12.1)	42 (24.4)	
>20	60 (8.9)	58 (33.7)	
Postoperative complication at initial hospitalization			
No	614 (91.6)	122 (71.3)	<.001
Yes	56 (8.4)	49 (28.7)	
New postoperative complication at 1-mo follow-up			
No	570 (93.4)	113 (74.8)	<.001
Yes	40 (6.6)	38 (25.2)	
New postoperative complication at 3-mo follow-up			
No	527 (94.8)	109 (8.7)	<.001
Yes	29 (5.2)	26 (19.3)	
Injury cause			

(continued)

Table 1. Demographics at Admission[a] (continued)

Characteristic	Baseline food, No. (%)		P value
	Security (n = 674 [79.5%])	Insecurity (n = 174 [20.5%])	
Road traffic injury	382 (56.8)	75 (43.1)	<.001
Burn	57 (8.5)	37 (21.3)	
Other[b]	234 (34.8)	62 (35.6)	
Injury Severity Score			
1-24	486 (75.5)	83 (53.2)	<.001
25-49	146 (22.7)	54 (34.6)	
50-75	12 (1.9)	19 (12.2)	
Surgery characteristics			
Major	352 (52.9)	116 (69.0)	<.001
Minor	314 (47.1)	52 (31.0)	
Operation types			
Amputations	18 (2.7)	11 (6.4)	<.001
Burn/acid attack surgeries	58 (8.6)	39 (22.8)	
Extremity surgeries	99 (14.7)	22 (12.9)	
Combined/multiple procedures	37 (5.5)	14 (8.2)	
Orthopedic surgeries	199 (29.6)	40 (23.4)	
Plastic and soft tissue trauma surgeries	250 (37.1)	41 (24.0)	
Other procedures	12 (1.8)	4 (2.3)	
Current housing			
No housing	57 (8.5)	19 (1.9)	<.001
Housing insecure	17 (2.5)	17 (9.8)	
Secure housing	599 (89.0)	138 (79.3)	
Transportation access difficulties			
No	659 (97.8)	120 (69.0)	<.001
Yes	15 (2.2)	54 (31.0)	
Hospital type			
Public	133 (20.3)	110 (63.2)	<.001
Private	537 (79.7)	64 (36.8)	

[a] Totals may not add to 100% due to missing data.

[b] Other injury cause includes industrial injury, assault, and fall injuries.

had a reported complication at the 1-month follow-up, and 29 (4%) had a reported complication at the 3-month follow-up. Among those in the cohort with FI, 49 (28%) had a complication during the initial hospitalization, 38 (22%) at the 1-month follow-up and 26 (15%) at the 3-month follow-up (Table 1). The incidence and types of complications are detailed in eTable 1 in Supplement 1.

Complications

In the univariate analysis, patients who were food insecure on admission had a higher risk of experiencing a complication at any point during the study compared with patients with food security (72 of 174 [41.4%] vs 84 of 587 [12.5%]; odds ratio [OR], 4.93; 95% CI, 3.38-7.21; $P < .001$). This association remained after multivariable adjustment, including with injury type, with an OR of 3.68 (95% CI, 2.24-6.05; $P < .001$) (**Table 2** and eTable 2 in Supplement 1).

Among the group that was food secure on admission, 78 individuals (12%) noted new FI after discharge at the 1-month follow-up time point. Of the individuals that remained food secure throughout follow-up, 4% (18 of 473 individuals) were diagnosed with a new complication at the 3-month follow-up, whereas 17% (11 of 66 individuals) of those with new FI after discharge experienced a new complication at the 3-month follow-up. New FI at the 1-month postoperative visit was associated with an increased risk of new complications at the 3-month follow-up with an OR of 5.06 (95% CI, 2.21-11.13; $P < .001$). The same association remained when patients with burn injury were excluded from the dataset (OR, 7.04; 95% CI, 2.90-16.54; $P < .001$).

LOS

We found that the group with FI had significantly longer overall LOS with a median (IQR) of 13 (6-28) days as compared with a median (IQR) LOS of 5 (3-9) days in the group with food security ($P < .001$) (Table 1). After multivariable adjustment, the group with FI had 1.51-fold longer LOS as compared with the group with food security (95% CI, 1.31-1.74; $P < .001$) (**Table 3** and eTable 3 in Supplement 1).

Discussion

In our multicenter, prospective cohort study of surgical trauma patients, we observed a significant association between FI and adverse clinical outcomes. Individuals facing preoperative and

Table 2. Multivariable Logistic Regression Model of Having a Postoperative Complication During Study Duration

Variable	OR (95% CI)	*P* value
Food security status at admission		
Food secure	1 [Reference]	NA
Food insecure	3.68 (2.24-6.05)	<.001
Age	1.00 (0.98-1.01)	.65
Sex		
Female	1.21 (.67-2.14)	.52
Male	1 [Reference]	NA
Total annual household income, $		
<318	1 [Reference]	NA
318-573	1.20 (.71-2.07)	.50
>573	1.05 (.55-2.01)	.88
Injury cause		
Road traffic injury	1 [Reference]	NA
Burn	3.31 (1.75-6.23)	<.001
Other[a]	1.33 (.79-2.21)	.28
Injury Severity Score		
1-24	1 [Reference]	NA
25-49	3.70 (2.34-5.85)	<.001
50-75	37.68 (13.12-137.29)	<.001

Abbreviations: NA, not applicable; OR, odds ratio.

[a] Other injury cause includes industrial injury, assault, and fall injuries.

Table 3. Multivariable Negative Binomial Regression Model of Length of Stay of Initial Hospitalization

Variable	IRR (95% CI)	*P* value
Food security status at admission		
Food secure	1 [Reference]	NA
Food insecure	1.51 (1.31-1.74)	<.001
Age	0.98 (0.96-1.00)	.13
Age^2	1.00 (1.00-1.00)	.08
Sex		
Female	1.14 (0.97-1.35)	.06
Male	1 [Reference]	NA
Total annual household income, $		
<318	1 [Reference]	NA
318-573	0.77 (0.67-0.89)	.31
>573	0.75 (0.64-0.88)	.17
Injury cause		
Road traffic injury	1 [Reference]	NA
Burn	1.62 (1.35-1.93)	<.001
Other[a]	0.85 (0.75-0.96)	.07
Injury Severity Score		
1-24	1 [Reference]	NA
25-49	1.94 (1.72-2.20)	<.001
50-75	3.12 (2.37-4.09)	<.001
Highest level of education achieved		
None	1 [Reference]	NA
1st to 8th Standard	0.98 (0.77-1.24)	.63
9th to 12th Standard	0.89 (0.71-1.11)	.30
University/graduate school	1.05 (0.82-1.34)	.86
People in household, No.		
0-3	1 [Reference]	NA
4-5	1.36 (1.20-1.55)	.06
≥6	1.60 (1.36-1.87)	<.001
Employment status		
Daily wages	1 [Reference]	
Full- or part-time employment	0.74 (0.56-0.98)	.006
Unemployed	0.54 (0.40-0.73)	<.001
Retired	0.48 (0.30-0.77)	.01

Abbreviations: IRR, incidence rate ratio; NA, not applicable.

[a] Other injury cause includes industrial injury, assault, and fall injuries.

perioperative FI had an associated 3-fold odds of postoperative complications and substantially prolonged hospital stays compared with individuals with food security. This study marks the first, to our knowledge, prospective evaluation of the association of food security with surgical outcomes.

Clinicians have been increasingly recognized for their crucial role in improving nutritional health. By screening for FI and facilitating connections between patients, community organizations, and government agencies, health care professionals can identify and assist individuals with FI and those at risk for FI.[27] However, there is a lack of data linking FI to clinically relevant outcomes in surgical patients. This limits the drive to implement universal screening and interventions.[28] Our findings underscore that FI was associated with poor surgical outcomes, providing a strong argument for clinicians and health care systems to prioritize comprehensive screening and intervention strategies for FI in a manner analogous to efforts to minimize surgical site infections.[29-31] Furthermore, our study highlights the importance of identifying high-risk cohorts—such as patients with larger household sizes, lower education, and income—who are particularly vulnerable to both FI and poor surgical outcomes.[32-34] It can be seen that these patients often face compounding challenges, including housing and transportation insecurities, which exacerbate food insecurity, delay care, and hinder recovery.[35] The higher prevalence of FI in public hospitals likely reflects the reliance of lower socioeconomic groups on subsidized care to overcome financial barriers.[36] This underscores the need to prioritize targeted interventions in these settings, where efforts to address food insecurity could have the greatest impact on improving surgical outcomes.

Our study aligns with existing nonsurgical literature, highlighting a strong link between FI and adverse health outcomes.[20,37] Data from the National Health Interview Survey and the National Health and Nutrition Examination Survey show that lower food security correlates with higher rates of chronic diseases, increased risk of premature mortality, and reduced life expectancy.[5,38] Berkowitz et al[39,40] found that FI is more common among individuals with cardiometabolic conditions and is associated with more frequent emergency department visits. In medical settings, interventions like medically tailored meals, food prescription programs, and government-funded food programs like the Special Supplemental Food Program for Women, Infants, and Children (WIC) reduce FI and improve health outcomes in chronically ill populations.[41] In terms of tailored interventions, randomized clinical trials have demonstrated that medically tailored

meals improve FI and quality of life for individuals with diabetes.[42] However, existing literature does not address surgery-specific outcomes. Our study addresses this gap and paves the way for initiation of interventional work. The strength of the association demonstrated between FI and complications suggests that programs similar to those tested in primary care settings could benefit surgical patients as well.[43]

The association between FI and poor surgical outcomes suggests several directions for future research to improve clinical outcomes. First, we should examine the impact of integrating FI screening and intervention protocols into standard surgical care. Efforts to raise awareness among clinicians about the significant impact of FI on postoperative patient well-being and implement routine screening for FI during hospital visits should be studied. These approaches could lead health care professionals to identify vulnerable patients promptly and connect them with necessary nutritional support services. Finally, efforts that foster stronger communication channels between health care professionals, policymakers, and community stakeholders should be studied for their ability to facilitate collaborative efforts to comprehensively address FI. This could be accomplished through the establishment of collaborative forums or by integrating health care providers into organizational structures where key global agenda decisions are made.

Limitations

Despite the significance of our findings, several limitations must be considered. First, the study's design precludes establishing causality. Second, although this study was conducted in India, the clinical care delivered at each site is comparable in quality to the clinical care provided in high-income countries. As such, although FI may not be as prevalent in the US, eg, we do believe that the findings regarding the association between FI and clinical outcomes are generalizable. We also tried to minimize limitations by using trained personnel for administering FI assessments, leveraging health care records to identify clinical outcomes, and conducting a multicenter study involving both public and private hospital settings to further enhance the generalizability of our findings. Future research endeavors should aim to overcome these limitations and provide greater insights into the relationship between FI and clinically relevant outcomes.

Conclusions

For policymakers and clinical practitioners seeking to mitigate FI, results of this cohort study underscore the critical need to consider FI as a determinant of clinical outcomes, in addition to a social need, in surgical cohorts. By elucidating the association between FI and adverse clinical events, our findings emphasize the importance of implementing targeted interventions to mitigate this risk. Through collaborative efforts at both the individual and systemic levels, health care systems and policies can work toward decreasing clinical complications by addressing specific unmet social needs like FI.

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