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Understanding food insecurity risk in the United States: A longitudinal analysis

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ABSTRACT

Background: Food insecurity, lack of consistent access to the food needed for an active, healthy life, harms population health. Although substantial biomedical evidence examines the connections between food insecurity and health, fewer studies examine why food insecurity occurs.

Methods: We propose a conceptual understanding of food insecurity risk based on institutions that distribute income—the factor payment system (income distribution stemming from paid labor and asset ownership), transfers within households, and the government tax-and-transfer system. A key feature of our understanding is 'roles' individuals inhabit in relation to the factor payment system: child, older adult, disabled working-age adult, student, unemployed individual, caregiver, or paid laborer. A second feature is that the roles of others in an individual's household also affect an individual's food insecurity risk. We tested hypotheses implied by this understanding, particularly hypotheses relating to role, household composition, and income support programs, using nationally-representative, longitudinal U.S. Current Population Survey data (2016–2019).

Results: There were 16,884 participants (year 1 food insecurity prevalence: 10.0%). Inhabiting roles of child (Relative Risk [RR] 1.79, 95% Confidence Interval [95%CI] 1.67 to 1.93), disabled working age-adult (RR 3.74, 95%CI 3.25 to 4.31), or unemployed individual (RR 3.29, 95%CI 2.51 to 4.33) were associated with a greater risk of food insecurity than being a paid laborer. Most food insecure households, 74.8%, had members inhabiting roles of child or disabled working age-adult, and/or contained individuals who experienced job loss. Similar associations held when examining those transitioning from food insecurity to food security in year 2.

Conclusions: The proposed understanding accords with the pattern of food insecurity risk observed in the U.S. An implication is that transfer income programs for individuals inhabiting roles, such as childhood and disability, that limit factor payment system participation may reduce food insecurity risk for both those individuals and those in their household.

1. Introduction

Food insecurity, lack of consistent access to the food needed for an active, healthy life, is understood to be a major threat to public health, associated with, among other conditions, greater prevalence of cardiometabolic disease and its complications, worse mental health and health-related quality of life, and greater short-term mortality risk (Coleman-Jensen, Rabbitt, Gregory, & Singh, ; Berkowitz, Berkowitz, Meigs, & Wexler, 2017; Crews et al., 2014; Seligman & Berkowitz, 2019; Seligman & Schillinger, 2010; Gundersen & Ziliak, 2015; Te Vazquez, Feng, Orr, & Berkowitz, 2021; Hanmer, DeWalt, & Berkowitz, 2021; Berkowitz, Palakshappa, Seligman, & Hanmer, 2022; Arenas, Thomas, Wang, & DeLisser, 2019; Walker et al., 2019; Banerjee, Radak, Khubchandani, & Dunn, 2021; Gundersen, Tarasuk, Cheng, de Oliveira, & Kurdyak, 2018). Further, food insecurity is increasingly a target of interventions, based both within healthcare and outside of it, which seek

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to improve health (Seligman & Berkowitz, 2019; De Marchis et al., 2019; Norris, Jilcott Pitts, Reis, & Haynes-Maslow, 2023; The Aspen Institute). Reducing food insecurity is both a Healthy People, 2030 goal and a UN Sustainable Development Goal (Healthy People, 2030; Food and Agriculture Organization of the United Nations). Indeed, in the 2022 White House Conference on Hunger, Nutrition, and Health, President Biden called for a 'whole-of-society' effort to address the health harms of food insecurity. (White House Conference on Hunger)

Given this attention, it is important to understand food insecurity risk in the U.S., as that understanding can inform efforts to reduce food insecurity and mitigate its consequences. A number of prior studies have found risk factors for food security, such as disability status or single parent households (Coleman-Jensen et al., ; Seligman & Berkowitz, 2019; Gundersen & Ziliak, 2015; Samuel et al., 2023; Schwartz, Buliung, & Wilson, 2019; Heflin, Altman, & Rodriguez, 2019; Balistreri, 2018). However, these studies have typically not included an explanation for that increased food insecurity risk—particularly not one that can unify observations made in different circumstances across multiple studies. Having such an explanation is important for policy, as it would provide a basis for food insecurity prevention, rather than responding to it once it occurs.

In this paper, drawing on a previously published understanding of poverty risk (Berkowitz & Palakshappa, 2023), we present a way to understand food insecurity risk in the U.S (Fig. 1). This understanding starts with the idea that, because food is allocated primarily through market mechanisms in the U.S., food insecurity risk principally relates to income distribution. In other words, if food insecurity represents insufficient 'consumption power' for food, the main barrier to sufficient consumption power is lack of purchasing power, which in turn relates to income distribution. This is in contrast to insufficient food production or availability, which can be drivers in other contexts, but are uncommon in the U.S. (Allcott et al., 2019; Berkowitz et al., 2018; Dix, 2021; Laraia et al., 2017; Sen et al., 1999)

The next questions then are 'how income is distributed in the U.S.?', and 'how might income distribution be inadequate to provide food security?'. Broadly, there are three answers, each related to one of the three major 'distributive institutions'—collections of both formal and informal policies and practices that distribute income (Berkowitz, 2022; Esping-Andersen, 1990; Brueniga; Bruenigb). First, income might be inadequate due to one's relationship with the 'factor payment system'. The factor payment system is the primary income distribution mechanism in the U.S.—distributing income to those who engage in paid labor and/or own productive assets (land, labor, and capital are the 'factors' of the economic production function). The income distributed by the factor payment system is called 'factor income', and is distinguished from 'transfer income' (income received without the exchange of goods or services). Relatively few individuals own productive assets sufficient to be a major source of income in the U.S., so factor payments for most people who receive them relate to paid labor (Bhutta et al.). Major 'roles' one might inhabit that typically preclude earning income from labor are being an older adult, being a child, and, among working age adults, having a work-limiting disability, being a full time student, being unemployed (that is, looking for work) and being engaged in unpaid caregiving (Berkowitz, 2022).

The second major distributive institution is household transfers, and the second reason income distribution might be inadequate to provide food security relates to household composition. Individuals often form households to pool resources, but households vary in composition. For instance, some households have young children or adults with disabilities who do not receive factor income. (People's policy Project) Depending on household composition, an amount of factor income that would provide food security for an individual may not be sufficient to avoid food insecurity for the household.

The third answer relates to the third major distributive institution: the government tax-and-transfer system (sometimes called the 'welfare state'). For example, government income support policies, typically tax financed, can provide transfer income like older-age pensions or child benefits (Esping-Andersen, 1990). Ideally, the tax-and-transfer system would distribute income to those at role-related risk of inadequate income. For instance, older adults in the U.S. have access to 'universalist' programs, like Social Security Old-Age and Survivor's Insurance (OASI), which provide transfer income for nearly all older adults, and are likely to prevent insufficient income that leads to food insecurity (Anttonen et al., 2012; Jacques et al., 2021a). However, in other cases policy

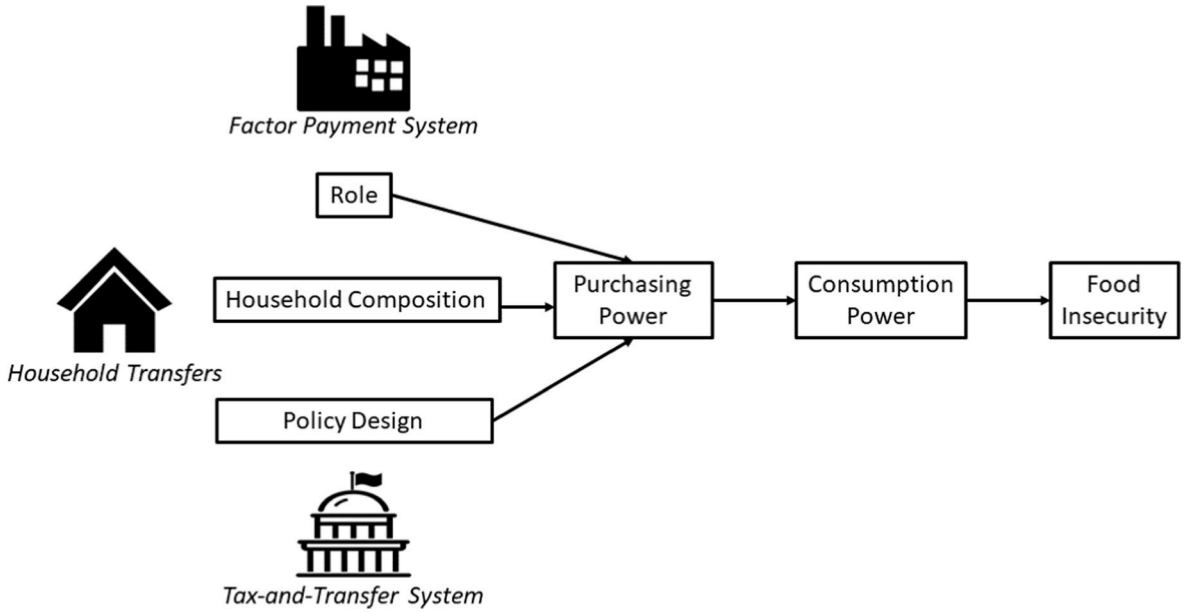

Fig. 1. Conceptual Model

Fig. 1Legend: Simplified illustration of how the three key distributive institutions, the factor payment system, household transfers, and the government tax-and-transfer system, shape food insecurity risk. One's role, in relation to the factor payment system, one's household composition, and the design of the policy environment one is enmeshed in shape income distribution and thus purchasing power. Purchasing power in turn affects consumption power, and when consumption power is insufficient, food insecurity results.

failures may mean that the tax-and-transfer system is insufficient to prevent or alleviate food insecurity. For instance, individuals in roles other than older adult may only have access to means-tested programs like the Earned Income Tax Credit (EITC), in which income must be below a certain level before one becomes eligible (Brady, 2023; Brady & Bostic, 2015; Jacques et al., 2021a, 2021b). This means that food insecurity can occur before a person receives benefits, even if the benefits received subsequently promote food security.

To better make sense of prior observations about food insecurity risk, the major goal of this study was to examine how well the understanding of food insecurity risk presented above accords with the experience of food insecurity for individuals in the U.S. To this end, we used a nationally-representative, longitudinal dataset to examine how food insecurity risk in the U.S. relates to distributive institutions.

2. Methods

2.1. Data sources

This study used longitudinal data from the U.S. Census Current Population Survey (US Census Bureaua) (CPS), downloaded from IPUMS (Flood et al., 2022). The CPS is a nationally-representative probability sample of the U.S. population. (US Census Bureaua) CPS participants are interviewed monthly for four months, are not interviewed for eight months, and then are interviewed monthly for four months again. For this study, we included CPS participants who were in-sample in December through the following March of year 1 (2016, 2017, or 2018) and then again from December through March in year 2 (one year after the initial year—2017, 2018, or 2019). We created the cohort this way because the CPS asks respondents a standard set of questions each month, but also asks supplemental questions in certain months. The December CPS supplement contains questions about food security over the prior 12 months, and the March Annual Social and Economic Supplement (ASEC) contains detailed questions about income and program participation for the prior calendar year (Fig. S1). Together, this design means that there is a subcohort within the CPS who reports on both food security and economic characteristics for each of two years, and that the look-back periods for these questions align (i.e., participants report on both food security and economic characteristics for the same calendar year). This subcohort formed the sample for our study. Participants were linked across years using a unique identifier available through IPUMS.

To increase sample size, we included three such cohorts, one reporting on their experiences in 2016–2017, one reporting on 2017–2018, and one reporting on 2018–2019. We selected these years because they are the most recent years that avoided both the disruption in data collection caused by the COVID-19 pandemic and COVID-era income support policies that have subsequently expired. Thus, the sample we selected experienced a policy environment more like the present time than CPS cohorts interviewed when COVID-era economic support policies were in effect.

The institutional review board at the University of North Carolina at Chapel Hill determined this analysis of publicly available deidentified data was not human subjects research. Analyses were conducted from April to September 2023.

2.2. Food insecurity

We categorized each individual respondent as living in a food secure or food insecure household based on the 18-item USDA Household Food Security Survey Module with 12-month look back period (Bickel, Nord, Price, Hamilton, & Cook, 2000; United States Department of Agriculture Economic Research Service). Following standard categorization, those with 2 or fewer affirmative responses were categorized as living in food secure households ('food secure'), and those with 3 or more affirmative responses were categorized as living in food insecure households ('food insecure'). (United States Department of Agriculture Economic Research Service) In supplementary analyses, we used a four category categorization: 'high food security' (0 affirmative responses), 'marginal food security' (1–2 affirmative responses), 'low food security' (3–5 affirmative responses in households without children or 3–7 affirmative responses in households with children), and 'very low food security' (6–10 affirmative responses in households without children or 8–18 affirmative responses in households with children).

2.3. Income

We used the Supplemental Poverty Measure resources (SPM) income concept for this study. (US Census Bureaub) We chose the SPM income concept because it is concordant with international guidelines for income-related research that recommend using an income concept that includes income sources at the household level, includes both factor income and transfer income, is net of taxes, and includes both cash and non-cash (e.g., Supplemental Nutrition Assistance Program [SNAP]) benefits (Berkowitz & Palakshappa, 2023; Brady, 2023; Fremsted). We express income on both a per capita basis (divided by the number of individuals within the household) and on an equivalized basis (divided by the square root of the number of individuals in the household, to account for within-household economies of scale), which is common in international income research (Brady, 2023). All dollar amounts were inflated to January 2023 dollars using the CPI-U index from the U.S. Bureau of Labor Statistics, as recommended by IPUMS. (IPUMS CPS Adjust Monetary Values)

2.4. Roles

Following prior work, we categorized participants as inhabiting one mutually exclusive 'role' that relates to their connection to the factor payment system (Berkowitz & Palakshappa, 2023; Berkowitz, 2022; Technical details for my analysis). Each participant was categorized into one and only one role for a given year using the following approach. We first used age in a given year of participation to categorize participants as older adults (age $\geq$65 years), children (age 17 years and younger), and working-age adults (age 18–64 years). We then further categorized the roles working-age adults inhabited as (1) engaging in paid labor if the individual reported working for pay at any time in the past year, (2) having a disability if the individual reported not working at any time in the past year and that their principal reason for this was disability, (3) being a student if the individual reported not working at any time in the past year and that their principal reason for this was going to school, (4) being a caregiver if the individual reported not working at any time in the past year and that their principal reason for this was taking care of others, (5) being unemployed if the individual reported not working at any time in the past year but that they were looking for work, and (6) other not in labor force if the individual reported not working at any time in the past year and could not be categorized into any of the other categories (prior work has shown that this category is principally individuals who have retired before age 65) (Berkowitz & Palakshappa, 2023).

2.5. Other key variables

We considered several other variables based on our conceptual model. These can be broadly categorized as demographic variables, household composition variables, and sources of income. Demographic variables included age, gender, race and ethnicity (a non-biological category of ascriptive identity included as it may reflect the experience of racism), and education. Household composition variables included household size, and the number and proportion of household members in different roles. Income source variables included personal factor income, and income from participation in government programs such as Social Security Disability Insurance or the Supplemental Nutrition Assistance Program (SNAP). Finally, to account for differences in

cost of living that may contribute to food security risk, we used the geographic cost of living adjustment, based on area median rents, created by the U.S. Census, which is used for setting different thresholds for the Supplemental Poverty Measure. (US Census Bureaub) For this measure, the center of the scale is 1.0 and greater values indicate greater cost of living.

2.6. Statistical analyses

The goal of this study was not to investigate whether particular exposures caused food insecurity, but rather to examine whether our conceptual understanding of food insecurity risk was consistent with the experience of individuals in the U.S. For instance, our question was not whether having a higher percentage of individuals with disabilities in the household caused food insecurity (as this is not an exposure we would wish to intervene on), but whether those in households with more individuals with disabilities were at greater risk of food insecurity than those with fewer household members with disabilities. Therefore, we did not conduct analyses with covariate adjustment, as the results of such analyses would not have been informative for our purposes. Instead, our statistical analysis focused on describing the situation, regarding food insecurity risk, of individuals in the US.

We first examined the cross-sectional relationship between income and food insecurity risk. To avoid assuming a particular relationship between income and food insecurity risk, we fit univariate logistic generalized additive models (GAM), and used them to estimate food insecurity risk at varying income levels. We then examined the cross-sectional association between food insecurity risk and key variables including individual role, household composition, and sources of income. Next, we conducted longitudinal analyses, categorizing individuals as being food insecure in both years, food insecure in year 1 and food secure in year 2, food secure in year 1 and food insecure in year 2, and food secure in both year 1 and year 2. We examined how the same factors as in the cross-sectional analyses were associated with food insecurity risk over time, using both year 1 and year 2 measurements of time-varying factors. Finally, we sought to understand factors associated with food insecurity among individuals whose income suggests lower food insecurity risk. To do this, we examined factors associated with those who did versus those who did not experience food insecurity in year 2 among those with a per capita and equivalized income (separate cohorts) greater than the threshold associated with 10% risk of experiencing food insecurity in the respective GAM models.

All analyses incorporated longitudinal national-representativeness weights available through IPUMS (which help account for missing data owing to non-response and loss to follow-up), and accounted for the complex survey design using the balanced repeated replication (BRR) approach to standard error estimation (US Census Bureaua; Flood et al., 2022). The longitudinal weights differ from the food insecurity weights used to produce estimates of cross-sectional food security prevalence, so we expected food insecurity prevalence estimates in these analyses to differ from USDA reports that use the same data source. Analyses were conducted in SAS version 14.1, Stata 16, and R version 4.2.0. A two-sided p-value $<.05$ was taken to indicate statistical significance.

3. Results

The longitudinal cohort included 16,884 individuals. Mean age was 43.2 (SD: 23.3) years, and 51.2% were women (Table 1). In year 1 of participation, 10.0% of individuals were in food insecure households. 74.8% of individuals in food insecure households were themselves, or had household members who inhabited a role of child or disabled working age adult, and/or experienced job loss in the last year.

Mean per capita and equivalized income was lower for those who experienced food insecurity, compared with those who were food secure (Fig. S2). For example, mean per capita income was $13,484 and mean equivalized income was $21,388 for those who experienced food

Table 1
Year 1 characteristics of participants.

Characteristic	Overall N = 16884[a]	Food Secure N = 15164[a]	Food Insecure N = 1720[a]	p-value
Age, y	43.22 (23.28)	44.05 (23.22)	35.72 (22.42)	<.0001
Female	51.19% (8784)	50.97% (7846)	53.17% (938)	.0002
Race and Ethnicity				<.0001
Non-Hispanic White	73.30% (12,209)	75.51% (11,257)	53.36% (952)	
Non-Hispanic Black	8.58% (1298)	7.20% (1005)	21.01% (293)	
Non-Hispanic American Indian and Alaskan Native	0.67% (150)	0.57% (105)	1.57% (45)	
Non-Hispanic Asian	4.29% (801)	4.51% (751)	2.29% (50)	
Non-Hispanic Native Hawaiian and Other Pacific Islander	0.10% (38)	0.10% (29)	0.11% (9)	
Non-Hispanic Multi-Racial	1.74% (339)	1.54% (278)	3.58% (61)	
Hispanic, any race	11.32% (2049)	10.58% (1739)	18.08% (310)	
Education				<.0001
Child, Education Incomplete	17.91% (3576)	16.96% (3080)	26.45% (496)	
Less than HS Diploma	6.85% (1206)	5.96% (942)	14.90% (264)	
HS Diploma or GED	22.36% (3730)	21.71% (3279)	28.23% (451)	
Greater than HS Diploma	52.89% (8372)	55.38% (7863)	30.43% (509)	
Personal Factor Income, year 1, $	44,535.00 (74,174.33)	47,090.20 (76,288.51)	18,789.02 (39,612.42)	<.0001
SPM Per Capita Resources, year 1, $	27,913.36 (27,826.78)	29,509.65 (28,603.70)	13,484.02 (12,120.56)	<.0001
SPM Equivalized resources, year 1, $	43,218.98 (38,952.35)	45,634.12 (39,867.15)	21,387.87 (18,342.25)	<.0001
Household Size, year 1	3.04 (1.70)	3.02 (1.69)	3.22 (1.81)	.0003
Number Under Age 18 in Household, year 1	0.82 (1.27)	0.78 (1.24)	1.18 (1.48)	<.0001
Proportion Under Age 18 in Household, year 1	0.18 (0.24)	0.17 (0.24)	0.26 (0.28)	<.0001
Number Age 65 or Older in Household, year 1	0.46 (0.74)	0.49 (0.76)	0.25 (0.51)	<.0001
Proportion Age 65 or Older in Household, year 1	0.23 (0.38)	0.24 (0.38)	0.13 (0.29)	<.0001
Number of Working-age Adults in Household, year 1	1.76 (1.20)	1.76 (1.21)	1.79 (1.03)	.31
Proportion of Working-age Adults in Household, year 1	0.60 (0.36)	0.59 (0.36)	0.61 (0.32)	.28
Number of Paid Laborers in Household, year 1	1.49 (1.09)	1.53 (1.10)	1.18 (0.96)	<.0001
Proportion of Paid Laborers in Household, year 1	0.52 (0.36)	0.54 (0.36)	0.40 (0.33)	<.0001
Number of Disabled Working-age Adults in Household, year 1	0.11 (0.36)	0.09 (0.33)	0.28 (0.53)	<.0001
Proportion of Disabled Working-	0.04 (0.15)	0.03 (0.13)	0.13 (0.27)	<.0001

(continued on next page)

Table 1 (*continued*)

Characteristic	Overall N = 16884[a]	Food Secure N = 15164[a]	Food Insecure N = 1720[a]	p-value
age Adults in Household, year 1				
Role				<.0001
Child	17.91% (3576)	16.96% (3080)	26.45% (496)	
Older Adult	22.03% (3739)	23.19% (3527)	11.50% (212)	
Having a Disability	4.12% (665)	3.17% (451)	12.71% (214)	
Being a Student	2.20% (288)	2.15% (245)	2.61% (43)	
Being a Caregiver	3.61% (640)	3.45% (548)	5.10% (92)	
Being Unemployed	0.45% (58)	0.37% (42)	1.23% (16)	
Other Not In Labor Force	3.15% (498)	3.27% (457)	2.08% (41)	
Being a Paid Laborer	46.53% (7420)	47.43% (6814)	38.32% (606)	

HS = high school.
GED = General Education Development certificate.
All dollar amounts are inflated to January 2023 dollars.
[a] N indicates unweighted counts of observations. Percentages and means are weighted to be nationally-representative.

insecurity, compared with $29,510 and $45,634 for those who were food secure ($p < .001$ for both comparisons). We fit two univariate generalized additive models to examine the probability of food insecurity by per capita income (c-statistic 0.77) and equivalized income (c-statistic 0.78) (Fig. 2a and b). The predicted probability of food insecurity was 10% at a per capita income of $21,509 and an equivalized income of $36,429. The predicted probability of food insecurity was 5% at a per capita income of $31,619 and an equivalized income of $49,701. The predicted probability of food insecurity was 1% at a per capita income of $57,089 and an equivalized income of $76,926.

Per capita income percentiles associated with 10%, 5%, and 1% predicted probability of food insecurity were 39th, 55th, and 89th, respectively. Equivalized income percentiles associated with 10%, 5%, and 1% predicted probability of food insecurity were 35th, 59th, and 87th, respectively.

Regarding household composition, larger household sizes and a greater share of the household consisting of individuals inhabiting the role of child or having a disability was associated with greater risk of food insecurity. For example, 26.0% of members of food insecure households were under age 18 years of age and 12.7% reported a disability, compared with 16.9% and 3.2% of members of food secure households ($p < .001$ for both comparisons).

Inhabiting the roles of child, having a disability, being a caregiver, being a student, or being unemployed was associated with a greater risk of food insecurity than being a paid laborer (Table 2, Fig. 3, and Fig. S2). Inhabiting roles of older adult and other not in labor force were associated with lower risk of food insecurity than being a paid laborer. Factors that may explain some of these associations are presented in Tables S1–S3. Virtually all older adults had sources of income (e.g.,

Table 2
Year 1 food insecurity risk by role.

	% Experiencing Food Insecurity	Relative Risk (95% CI)	P
Child	14.71%	1.79 (1.67–1.93)	<.001
Older Adult	5.20%	0.63 (0.57–0.71)	<.001
Having a Disability	30.71%	3.74 (3.25–4.31)	<.001
Being a Student	11.81%	1.44 (1.16–1.78)	0.003
Being a Caregiver	14.06%	1.71 (1.54–1.91)	<.001
Being Unemployed	27.03%	3.29 (2.51–4.33)	<.001
Other Not In Labor Force	6.58%	0.80 (0.65–0.99)	0.03
Being a Paid Laborer	8.20%	ref	ref

Percent weighted to be nationally-representative.
Relative risk represents risk of experiencing food insecurity, compared with the risk observed for paid laborers p-values are from predictive margins using delta-method standard errors are fitting a logistic regression model.

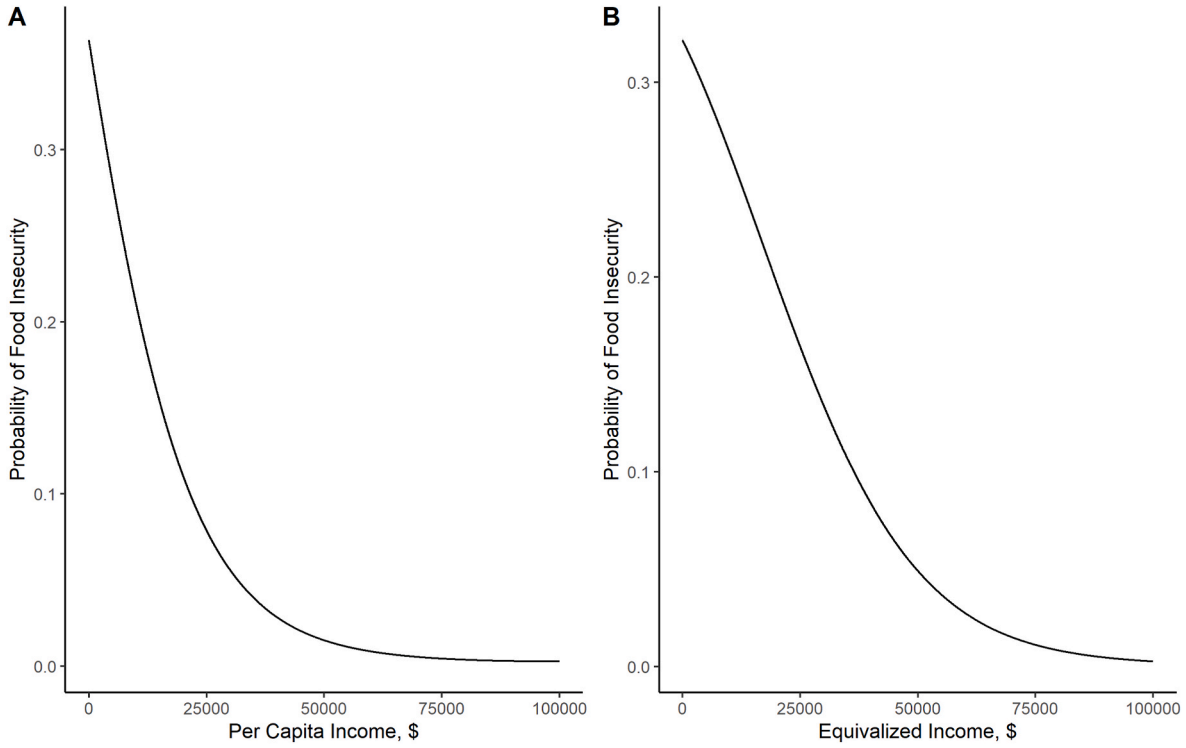

Fig. 2. Legend: Estimated relationship between per capita income and food insecurity risk (A), and estimated relationship between equivalized income and food insecurity risk (B), estimated using a univariate generalized additive model.

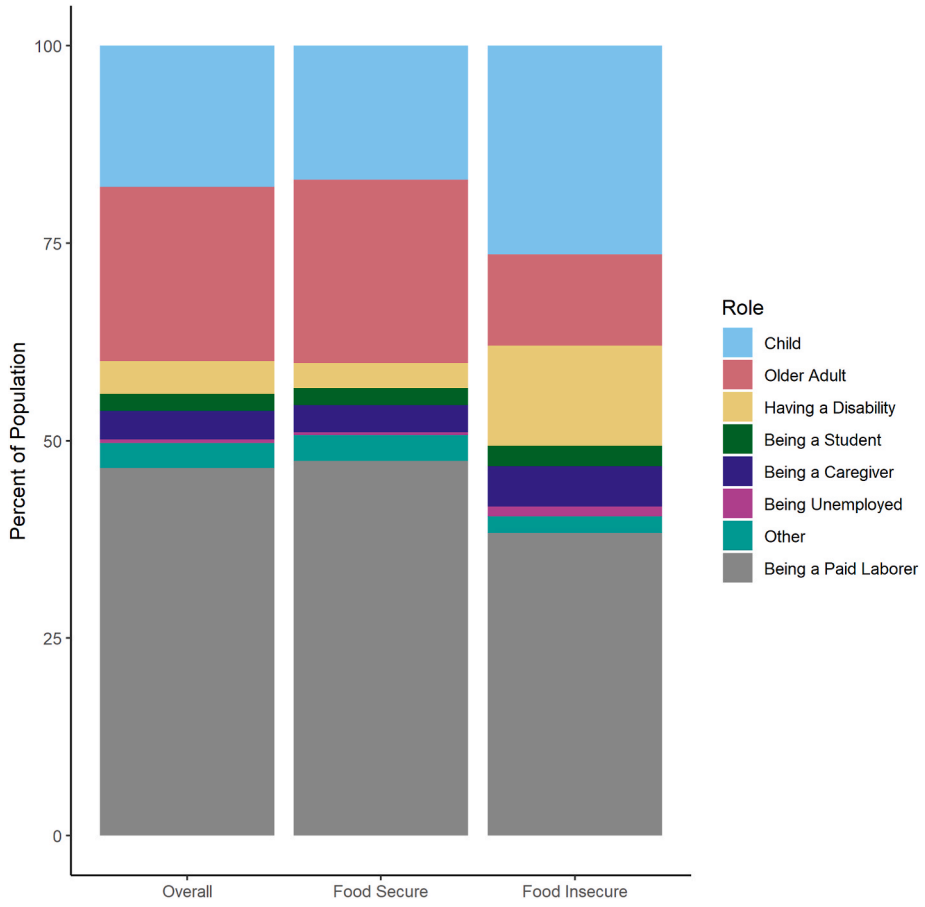

Fig. 3. Distribution of Roles by Food Security Status
Fig. 3 Legend: Distribution of roles in year 1 overall and by food security status.

Social Security Old Age and Survivor's Insurance income) that were not related to paid labor, and had relatively few individuals inhabiting the role of child or having a disability in their household. Similarly, many individuals inhabiting the 'other not in labor force' role were early retirees, with sources of income not tied to paid labor, and relatively few disabled adults in their household. Among those who experienced food insecurity despite working, 82.6% of those engaging in paid labor had personal factor incomes above threshold of 10% food insecurity risk using per capita income, which suggests that their food insecurity risk may be related to household composition rather than their ability to support their own individual needs. They were also more likely to have experienced spells of unemployment, and reported receiving little support through unemployment insurance income.

Overall, use of means-tested programs such as SNAP and Supplemental Security Income (SSI) was greater among those who experienced food insecurity, which is consistent with the intention for these programs to provide a 'safety-net' of income support for people who are experiencing material hardship.

We next examined how food security status and roles changed over time (Table 3, Tables S4–S8, Fig. 4, Figs. S3–4). We found that 51.2% of those who were food insecure in year 1 became food secure in year 2, and 4.1% of those who were food secure in year 1 became food insecure in year 2. One factor associated with transitioning from food insecurity to food security was greater year 2 income (for example, mean year 2 equivalized income was $26,245 for those who were food insecure in year 1 and food secure in year 2, compared with $20,081 for those who were food insecure in both years [$p < .0001$]). Other factors included being in the paid labor force, and household composition (particularly having a higher percentage of household members in the paid labor force and a lower percentage reporting a disability). Lower area cost of living was not associated with transitioning out of food insecurity (mean cost of living index 0.99 for those who transitioned from food insecurity to food security, and 0.98 for those who remained food insecure in both years [$p = .007$]).

With regard to roles, most individuals, 93.5%, either remained in or remained out of paid labor, rather than switching, and transitions between different roles were relatively uncommon. The most common roles involved in transitions were being a student and being unemployed. 53.7% of adults who were students in year 1 inhabited another role in year 2, and only 19.0% of individuals unemployed for all of year 1 were unemployed in year 2.

Factors associated with food insecurity among those with a per capita or equivalized income above the threshold associated with a less than 10% risk of food insecurity, included year 1 food security status, year 2 income, disability roles, and household composition (Tables S9–S10). Higher area cost of living was not associated with higher food insecurity risk in these higher income subsets.

4. Discussion

Overall, we found that food insecurity risk in the U.S. is consistent with our conceptual understanding of the relationship between distributive institutions and food insecurity. More specifically, we found that roles disconnected from the factor payment system, such as being a child, having a disability, being a caregiver, or experiencing unemployment, were associated with greater food insecurity risk. This suggests that individuals inhabiting these roles, which do not receive factor income, are not receiving sufficient transfer income to meet their needs. Further, household composition, such as having greater numbers of children and adults unable to engage in paid labor owing to disability in

Table 3
Longitudinal food security status.

Characteristic	Overall, N = 16884[a]	Food Insecure in Year 1 and 2 N = 843[a]	Food Insecure Year 1, Food Secure Year 2 N = 877[a]	Food Secure Year 1, Food Insecure Year 2 N = 609[a]	Food Secure in Year 1 and 2 N = 14555[a]	p-value
Age, y	43.22 (23.28)	36.72 (22.58)	34.78 (22.23)	37.57 (22.17)	44.32 (23.23)	<.0001
Female	51.19% (8784)	55.50% (474)	50.95% (464)	53.36% (334)	50.87% (7512)	<.0001
Race and Ethnicity						<.0001
Non-Hispanic White	73.30% (12,209)	52.16% (462)	54.51% (490)	55.78% (344)	76.35% (10,913)	
Non-Hispanic Black	8.58% (1298)	24.71% (170)	17.48% (123)	14.88% (79)	6.87% (926)	
Non-Hispanic American Indian and Alaskan Native	0.67% (150)	0.67% (14)	2.43% (31)	1.34% (12)	0.53% (93)	
Non-Hispanic Asian	4.29% (801)	2.32% (26)	2.26% (24)	4.14% (26)	4.52% (725)	
Non-Hispanic Native Hawaiian and Other Pacific Islander	0.10% (38)	0.04% (1)	0.18% (8)	0.00% (0)	0.11% (29)	
Non-Hispanic Multi-Racial	1.74% (339)	3.33% (31)	3.82% (30)	1.88% (8)	1.52% (270)	
Hispanic, any race	11.32% (2049)	16.78% (139)	19.32% (171)	21.98% (140)	10.09% (1599)	
Education						<.0001
Child, Education Incomplete	17.91% (3576)	26.45% (242)	26.45% (254)	22.27% (147)	16.73% (2933)	
Less than HS Diploma	6.85% (1206)	16.02% (135)	13.83% (129)	17.00% (107)	5.48% (835)	
HS Diploma or GED	22.36% (3730)	28.31% (218)	28.15% (233)	26.52% (161)	21.50% (3118)	
Greater than HS Diploma	52.89% (8372)	29.22% (248)	31.57% (261)	34.22% (194)	56.28% (7669)	
Personal Factor Income, year 1, $	44,535.00 (74,174.33)	16,792.82 (42,914.62)	20,696.45 (36,098.30)	25,469.72 (40,492.86)	47,965.53 (77,263.25)	<.0001
Personal Factor Income, year 2, $	44,973.27 (79,467.10)	15,434.95 (25,989.97)	21,399.25 (32,468.02)	20,933.04 (31,592.66)	48,707.71 (83,585.37)	<.0001
SPM Per Capita Resources, year 1, $	27,913.36 (27,826.78)	13,112.92 (12,066.72)	13,837.64 (12,167.96)	17,142.57 (16,241.91)	30,039.25 (28,898.11)	<.0001
SPM Per Capita Resources, year 2, $	29,064.53 (31,691.51)	12,993.60 (12,246.20)	15,591.70 (11,929.05)	16,039.02 (14,325.03)	31,322.87 (33,166.35)	<.0001
SPM Equivalized resources, year 1, $	43,218.98 (38,952.35)	20,259.93 (19,202.38)	22,462.66 (17,426.41)	28,095.82 (28,065.57)	46,385.16 (40,125.33)	<.0001
SPM Equivalized resources, year 2, $	45,407.38 (44,259.75)	20,081.41 (14,993.37)	26,245.20 (19,376.12)	25,592.16 (18,386.45)	48,813.55 (46,188.30)	<.0001
Household Size, year 1	3.04 (1.70)	3.09 (1.86)	3.35 (1.76)	3.36 (1.83)	3.01 (1.68)	<.0001
Household Size, year 2	3.08 (1.73)	3.19 (2.02)	3.45 (1.80)	3.44 (1.92)	3.04 (1.69)	<.0001
Number Under Age 18 in Household, year 1	0.82 (1.27)	1.15 (1.49)	1.21 (1.47)	1.04 (1.34)	0.77 (1.23)	<.0001
Number Under Age 18 in Household, year 2	0.79 (1.25)	1.16 (1.51)	1.18 (1.44)	1.00 (1.33)	0.74 (1.21)	<.0001
Proportion Under Age 18 in Household, year 1	0.18 (0.24)	0.26 (0.29)	0.26 (0.28)	0.22 (0.27)	0.17 (0.24)	<.0001
Proportion Under Age 18 in Household, year 2	0.17 (0.24)	0.26 (0.28)	0.25 (0.27)	0.21 (0.26)	0.16 (0.23)	<.0001
Number Age 65 or Older in Household, year 1	0.46 (0.74)	0.24 (0.47)	0.26 (0.54)	0.35 (0.68)	0.49 (0.76)	<.0001
Number Age 65 or Older in Household, year 2	0.51 (0.79)	0.29 (0.53)	0.31 (0.64)	0.36 (0.64)	0.54 (0.81)	<.0001
Proportion Age 65 or Older in Household, year 1	0.23 (0.38)	0.14 (0.29)	0.12 (0.28)	0.15 (0.31)	0.24 (0.39)	<.0001
Proportion Age 65 or Older in Household, year 2	0.24 (0.38)	0.15 (0.30)	0.13 (0.29)	0.16 (0.31)	0.26 (0.39)	<.0001
Number of Working-age Adults in Household, year 1	1.76 (1.20)	1.69 (1.05)	1.88 (1.00)	1.97 (1.23)	1.75 (1.21)	<.0001
Number of Working-age Adults in Household, year 2	1.78 (1.23)	1.74 (1.06)	1.96 (1.11)	2.07 (1.43)	1.76 (1.24)	<.0001
Proportion of Working-age Adults in Household, year 1	0.60 (0.36)	0.60 (0.33)	0.62 (0.31)	0.63 (0.32)	0.59 (0.36)	.02
Proportion of Working-age Adults in Household, year 2	0.59 (0.36)	0.60 (0.33)	0.61 (0.32)	0.63 (0.32)	0.59 (0.37)	.005
Number of Paid Laborers in Household, year 1	1.49 (1.09)	1.06 (0.96)	1.30 (0.94)	1.37 (1.06)	1.53 (1.10)	<.0001
Number of Paid Laborers in Household, year 2	1.52 (1.11)	1.17 (1.03)	1.41 (1.06)	1.34 (1.13)	1.56 (1.11)	<.0001
Proportion of Paid Laborers in Household, year 1	0.52 (0.36)	0.37 (0.33)	0.43 (0.32)	0.45 (0.35)	0.54 (0.36)	<.0001
Proportion of Paid Laborers in Household, year 2	0.52 (0.36)	0.38 (0.33)	0.44 (0.32)	0.42 (0.34)	0.54 (0.36)	<.0001
Number of Disabled Working-age Adults in Household, year 1	0.11 (0.36)	0.35 (0.56)	0.21 (0.48)	0.28 (0.54)	0.08 (0.31)	<.0001
Number of Disabled Working-age Adults in Household, year 2	0.10 (0.35)	0.33 (0.55)	0.20 (0.47)	0.32 (0.61)	0.08 (0.30)	<.0001
Proportion of Disabled Working-age Adults in Household, year 1	0.04 (0.15)	0.16 (0.30)	0.09 (0.23)	0.10 (0.23)	0.03 (0.12)	<.0001
Proportion of Disabled Working-age Adults in Household, year 2	0.04 (0.15)	0.16 (0.30)	0.08 (0.22)	0.12 (0.26)	0.03 (0.12)	<.0001
Role, year 1						<.0001

(*continued on next page*)

Table 3 (*continued*)

Characteristic	Overall, N = 16884[a]	Food Insecure in Year 1 and 2 N = 843[a]	Food Insecure Year 1, Food Secure Year 2 N = 877[a]	Food Secure Year 1, Food Insecure Year 2 N = 609[a]	Food Secure in Year 1 and 2 N = 14555[a]	p-value
Child	17.91% (3576)	26.45% (242)	26.45% (254)	22.27% (147)	16.73% (2933)	
Older Adult	22.03% (3739)	12.30% (105)	10.74% (107)	14.61% (101)	23.56% (3426)	
Having a Disability	4.12% (665)	16.59% (143)	9.02% (71)	10.29% (62)	2.87% (389)	
Being a Student	2.20% (288)	2.26% (19)	2.94% (24)	2.50% (11)	2.14% (234)	
Being a Caregiver	3.61% (640)	4.74% (40)	5.44% (52)	4.59% (29)	3.40% (519)	
Being Unemployed	0.45% (58)	0.62% (3)	1.81% (13)	1.10% (4)	0.34% (38)	
Other Not In Labor Force	3.15% (498)	2.15% (21)	2.02% (20)	3.22% (20)	3.27% (437)	
Being a Paid Laborer	46.53% (7420)	34.89% (270)	41.58% (336)	41.41% (235)	47.69% (6579)	
Role, year 2						<.0001
Child	16.91% (3401)	25.65% (233)	25.39% (245)	21.03% (138)	15.75% (2785)	
Older Adult	23.68% (4014)	14.06% (118)	12.19% (121)	15.20% (108)	25.26% (3667)	
Having a Disability	4.07% (658)	15.96% (139)	8.86% (68)	11.75% (65)	2.78% (386)	
Being a Student	2.40% (313)	1.26% (11)	3.11% (21)	3.95% (20)	2.36% (261)	
Being a Caregiver	3.31% (587)	4.88% (36)	5.17% (49)	5.02% (30)	3.04% (472)	
Being Unemployed	0.35% (49)	0.46% (5)	0.98% (9)	1.29% (6)	0.27% (29)	
Other Not In Labor Force	3.12% (496)	1.82% (21)	2.15% (20)	2.55% (17)	3.27% (438)	
Being a Paid Laborer	46.16% (7366)	35.91% (280)	42.13% (344)	39.21% (225)	47.27% (6517)	

HS = high school.
GED = General Education Development certificate.
All dollar amounts are inflated to January 2023 dollars.
[a] N indicates unweighted counts of observations. Percentages and means are weighted to be nationally-representative.

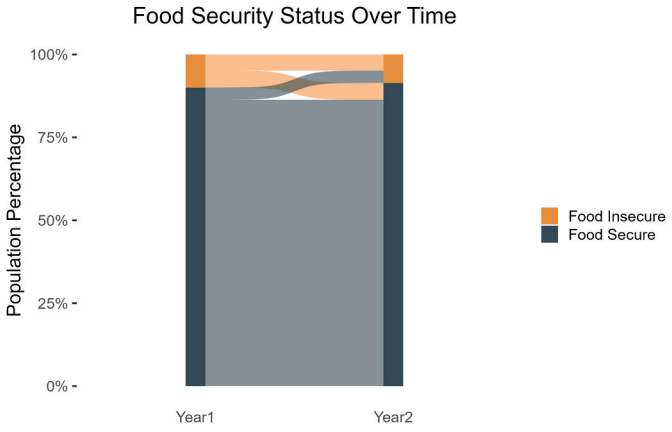

Fig. 4. Transitions in Food Security Status between Year 1 and Year 2
Fig. 4Legend: Changes in food security status between year 1 and year 2.

the household, was associated with greater food insecurity risk. This suggests that inadequate transfer income support not only affects individuals inhabiting roles disconnected from the factor payment system, but also others in their household. Finally, roles that have universalist income support programs available to them, such as older adults, were associated with lower food insecurity risk. Adults not in the labor force but who do not inhabit one of the other enumerated roles likely elect that status when they expect resources sufficient to meet their material needs will be available.

This study is consistent with and expands prior research on food insecurity risk. For instance, it extends and provides more detail regarding the known relationship between lower income and food insecurity risk (Coleman-Jensen et al., ; Gundersen & Ziliak, 2015; Bartfeld & Men, 2017; Bartfeld, Dunifon, Nord, & Carlson,). Though that relationship is well known in broad strokes, this study provides new data on the sources of income, examines how they relate to food insecurity risk in more detail, and embeds those empiric findings in a conceptual understanding of income distribution. Another area this study expands the current literature on is the known relationship between disability status and food insecurity risk (Heflin et al., 2019; Samuel et al., 2023; Schwartz et al., 2019). As prior studies have found, having a disability is strongly associated with food insecurity (Heflin et al., 2019; Samuel et al., 2023; Schwartz et al., 2019). The conceptual understanding and empirical details presented here help make sense of that association by relating it to factor income, transfer income, and household composition. One important contribution of this study is its longitudinal analysis, examining how food security status changes over time and factors associated with transitions out of food insecurity—highlighting in particular the key role of income in transitions out of food insecurity. Other important contributions of this study include the use of a more comprehensive income concept, and helping to provide a systematic approach to making sense of a number of risk factors for food insecurity typically examined independently (Coleman-Jensen et al., ; Gundersen & Ziliak, 2015; Samuel et al., 2023; Heflin et al., 2019).

This study has both research and policy implications. Researchers could use the way of thinking about food insecurity risk presented here to help support studies that seek to explain food insecurity prevalence patterned by systems of oppression like racism or sexism (Coleman-Jensen et al.,). For example, such studies could examine how the factor payment system contributes to food insecurity risk for individuals racialized as Black, through racial discrimination in the education system or labor market; or whether social forces may increase food insecurity risk for women by pressuring adoption of caregiving roles. From a policy perspective, this study suggests a few key areas for tax-and-transfer policy interventions that might reduce the risk of food insecurity. These include family benefits such as income support programs for children and caregivers (Bovell-Ammon et al., 2022; Parolin, Ananat, Collyer, Curran, & Wimer, 2023), reforms to disability income programs that make benefits easier to access and of sufficient amounts (Samuel et al., 2023; Silver & Zhang, 2022), and reforms to unemployment insurance to increase its coverage and the ease of access (Advisory Council on Unemployment Compensation, 1996; Berkowitz & Basu, 2020; Berkowitz & Basu, 2021; Men & Tarasuk, 2023).

This study also suggests directions for future work. An important finding is the relatively low food insecurity risk among older adults, especially when compared with other roles that similarly have limited engagement with the factor payment system, like children and adults who have disabilities. One possible explanation for this is the differing structures of income support programs available to people in these different roles, with much greater reliance on means-tested income support programs, like the EITC, for people inhabiting roles other than older adult. Greater use of means-tested programs in those with food insecurity is consistent with the idea that such 'targeted' designs respond

once needs are present, but do little to keep people out of need in the first place. This is not to say such programs are not beneficial—for example, there is robust evidence that SNAP benefits do reduce subsequent food insecurity once enrolled (Gundersen, Kreider, & Pepper, 2017; Ratcliffe & McKernan,). But this does illustrate important potential drawbacks of means-tested social policy designs—particularly the risk of experiencing the harms of destitution before becoming eligible. Another area that deserves further study is the relationship between variation in income among those receiving factor income and food insecurity risk, which we did not examine here. Further, future research could examine the connection between food insecurity risk and aspects of net worth, wealth, and debt.

We recognize several limitations to this study. Our goal was to describe and understand food insecurity risk in the United States, rather than to examine whether changes in specific factors were likely to reduce food insecurity risk. Therefore, we did not examine whether interventions on any of these factors would affect food insecurity. Next, this study relied on survey data, which can create measurement error, particularly for variables like income and program participation. Though the U.S. Census takes steps to minimize this error and account for it in data processing, measurement error could have affected the results of this study. (US Census Bureaua) Although the sample size was large overall, there were few observations with some combinations of characteristics, which does reduce the precision of estimates in these cases. Further, this study focused on relatively broad 'roles', but there is likely to be heterogeneity within role categories with regard to food insecurity risk. For example, households that include children with special healthcare needs may have greater food insecurity risk than household with children who do not have such needs (Rose-Jacobs et al., 2016). However, these limitations are balanced by several strengths—in particular the use of a nationally-representative dataset, and the availability of longitudinal data, which few prior studies have utilized.

Using nationally-representative longitudinal data, we found support for the idea that issues relating to distributive institutions—the factor payment system, household composition, and the tax-and-transfer system—are reflected in patterns of food insecurity risk. This understanding suggests social insurance policy approaches that provide transfer income support for individuals inhabiting roles, such as childhood and disability, that may limit their ability to receive factor income. Such policies may reduce food insecurity risk not only for individuals inhabiting those roles, but for others in the household. Together, such an approach may help reduce everyone's risk of experiencing food insecurity, and the harms to health that food insecurity presents.

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The funding organizations had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Prior presentation

None.

Author statement

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Ethical Statement

The institutional review board at the University of North Carolina at Chapel Hill determined that this secondary analysis of deidentified data did not constitute human subjects research.

Declaration of Competing Interest

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Data availability

We cannot share the data but they are publicly available for download through IPUMS

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Appendix A. Supplementary data

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