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The Health of Those Who Feed Us: An Assessment of Health Inequities Along the United States Food Chain

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Abstract

While the health of all depends on the food chain, few studies have focused systematically on the health of food chain workers themselves (production, manufacturing, wholesale, retail, and commercial and institutional services). In this study we used 2018 and 2019 data from the Behavioral Risk Factor Surveillance System (BRFSS) to examine health-related metrics of food chain workers, combined and by industry sector, compared to non-food chain workers, among 32 U.S. states. Logistic regression indicated U.S. food chain workers had higher prevalences of barriers to health care access, smoking, no physical exercise, and poor self-reported health than all other workers. Patterns were similar among food chain workers in all industry sectors except wholesale. Additionally, commercial food services workers had higher prevalence of poor mental health, while institutional food services workers had higher prevalences of obesity, diabetes, and hypertension than all other workers. We discuss implications of these results for interventions, with specific attention to improving employment conditions. Food chain worker health is critical for food system sustainability and population health equity.

Keywords

food workers, food chain, health care access, health status, employment conditions

The United States food chain was among the sectors of the economy most affected by the COVID-19 pandemic. Millions of food services workers were laid off with little safety net to rely on,[1] while workers in other food chain sectors were deemed essential and continued working, often without adequate workplace safety measures,[2] resulting in negative mental health effects[3,4] and elevated COVID-19 infection and mortality rates compared to other workforces.[5–7] This drew attention to the health consequences of food chain workers' employment and working conditions, and to their crucial role in ensuring the food supply for all.

Food chain workers constitute the single largest share of the U.S. workforce, estimated at over 21 million workers, or 14 percent of the workforce, in 2016.[8] The food chain has several main sectors (see Appendix A, Supplementary Material): agricultural production (farm workers, fishers, and ranchers); manufacturing and processing (workers involved with converting raw goods into foods ready to sell or eat); wholesale and logistics (truck drivers, forklift operators, and warehouse managers); retail (stockers, cashiers, and in-house cooks involved in food sales in supermarkets, grocery stores, and convenience stores); and services (workers involved with food and drink preparation, serving, and facilities cleaning in commercial and institutional settings).[8,9] Each component of the food chain has a different profile in terms of worker demographics, working conditions, and employment conditions (including pay, benefits, job security, and union representation). Understanding these between-sector differences and their impact on the health of workers in the different sectors is key to identifying workforce-appropriate resources to address health inequities.

Conceptualizing work as a social determinant of health[10] encourages a focus on the intersection of work and structural discrimination based on social position (including sex, race, ethnicity, and age) as co-drivers of social inequities in health. This approach also informs consideration of the potential contribution of both working conditions and employment

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conditions to those health inequities, and of the sociopolitical and economic forces that drive those conditions in each place. Thus, a social determinants of health framework brings attention to several characteristics and processes that might contribute to health inequities among U.S. food chain workers. Overall, the U.S. food chain is a highly racialized and gendered workforce, with women and people who are black, Latinx, and Asian overrepresented but also often performing the lower paid, more manual, and more hidden forms of labor compared to people in the sector who are white.[11,12] Many food chain jobs involve risks, such as injury, workplace violence, or exposure to infectious disease, that are inherent in activities like working with sharp tools or heavy products, in proximity to animals or the public, or in fast-paced environments. In several sectors of the food chain, these risks are exacerbated by components of poor employment quality: lack of job security, inadequate pay, unpredictable schedules, few benefits, and limited workplace power[8,13]—all of which are associated with mental and physical health harms.[14,15] In the United States, more than half of adults obtain health insurance through employment,[16] and the level of other social safety net provisions such as unemployment insurance and retirement income are also affected by employment. Notably, some groups of workers (including many food production and food services workers) have never had access to these provisions through their employment, while others have lost access over time with shifts in the economy and nature of work.[17]

Empirical studies suggest occupational stressors (e.g., workplace injuries, musculoskeletal symptoms), mental health, and physical health issues were common among food production,[18–21] retail,[22] and service workers[23–25] even prior to the COVID-19 pandemic. However, because these are industry-wide studies, identifying priority areas for interventions is difficult. There are few peer-reviewed systematic assessments of food chain workers' health, with the exception of an analysis of employer-reported occupational morbidity and mortality by Newman and colleagues (2015).[26] The researchers found that the occupational morbidity and mortality rates for food industries as a whole were higher than those of non-food industries combined. Within food industries, food warehousing and storage had the highest occupational morbidity rate, while food production had the highest occupational mortality rate.[26] Considering the food chain in its entirety, they argue, can help direct interventions towards this major part of the U.S. economy.

To our knowledge, a social determinants of health perspective has not yet been used to systematically assess U.S. food chain workers' health. Most public health research involving food workers has focused on the implications of worker knowledge, skills, and beliefs for consumers' food safety (see, e.g.,[27–30])—an important topic, but one that generally excludes the health needs and status of food chain workers themselves. Similarly, food system and food justice research, aimed at ensuring universal and environmentally sustainable access to nutritious, affordable, and culturally-appropriate food, often excludes the labor upholding the food system.[31] While the relationship between specific occupational exposures and illness and injury is well established for certain segments of the food workforce, a social determinants of health framework[10] pushes us to explore how other aspects of workers' health and well-being might be linked with their work, and how these aspects might contribute to work-related health inequities across society.

This study seeks to fill these gaps in the literature, and to complement Newman and colleagues' research,[26] by assessing food chain workers' health care access, health-related behaviors, and health outcomes, and by identifying needs for food chain subgroup-specific prevention and intervention efforts, including ones related to improving employment conditions. The COVID-19 pandemic brought acute and rapid changes to conditions, workforce sizes, and employer practices in some food industries that are still unfolding in many parts of the United States. In order to understand pre-existing stressors associated with food chain work, we aim to describe the baseline health of workers along the food chain before the pandemic by using 2018–2019 data from the Behavioral Risk Factor Surveillance System (BRFSS).

Materials and Methods

Study Design

We conducted a retrospective analysis of 2018–2019 data from BRFSS to compare: (*a*) food chain workers to all other workers combined, and (*b*) food chain workers by food chain sector (production, manufacturing, wholesale, retail, commercial services, and institutional services) to all other workers combined.

Study Sample

The BRFSS is a state-administered telephone survey of U.S. noninstitutionalized adults (>18 years) that consists of core questions (including the fixed core, asked annually, and the rotating core, asked every other year), optional modules, and questions on health-related topics added by individual states. States and localities can also opt to administer an industry and occupation module to currently and recently employed adults, in which industry and occupation information is collected using the following two questions, respectively: "What kind of work do you do? (For example, registered nurse, janitor, cashier, auto mechanic)," and "what kind of business or industry do you work in? (For example, hospital, elementary school, clothing manufacturing, restaurant)." Responses are recorded in free text form, then coded by the National Institute for Occupational Safety and Health (NIOSH) Industry and Occupation Computerized Coding System or by human coders using

computer-assisted coding to the 2010 U.S. Census Bureau industry and occupation codes.[32] The industry and occupation module is asked of respondents who report their employment status as "employed for wages," "out of work for less than one year," or "self-employed." Only currently employed civilian respondents (employed for wages or self-employed) were considered for the analysis. In 2018 and 2019, 32 states administered the industry and occupation BRFSS optional module at least one of those two years. BRFSS was reviewed by the Institutional Review Board of the Centers for Disease Control and Prevention, and it was determined to be exempt research. Survey information was collected under the United States Office of Management and Budget control number 0920-1061.

We conceptualized food chain workers as workers, supervisors, and managers who grow, harvest, process, butcher, pack, transport, prepare, serve, or sell food, or who clean the settings where those activities take place. We operationalized this definition using the 2010 U.S. Census industry and occupation codes shown in Appendix B. To develop this list, we started with five major census industry groups relevant to the food workforce and chose detailed industry groups within those five major groups that align with six stages of the food chain: production, manufacturing, wholesale, retail, commercial services, and institutional services. We conducted a similar exercise starting with six major census occupation groups relevant to the food workforce and chose detailed occupation groups within those six major groups that align with the activities described in our definition. Examples of occupations excluded based on this definition are business and financial operations occupations; most office and administrative support occupations; and installation, maintenance, and repair occupations (i.e., important to the labor process but not involving direct engagement with food). To be thorough, we included respondents who had food-related occupations, but who were not in one of the food industry groups, as "food chain workers in other industries." Examples of those respondents are cooks in unspecified manufacturing industries, landscaping services, or private households. We present results for that group for interested readers, but do not discuss them because they are a highly heterogenous group and constitute a small share of the food chain.

Measures

We analyzed measures of health care access (health care coverage, access to health provider, and routine check-up, influenza vaccination, and dental visit in the past year); health behaviors (smoking status, binge and heavy drinking in the past month, physical exercise in the past month, and inadequate sleep [<seven hours per 24-h period]); health status (self-rated general, physical, and mental health); and health outcomes (obesity, coronary heart disease, stroke, current asthma, chronic obstructive pulmonary disease [COPD], depressive disorder, diabetes, arthritis, and hypertension).

Statistical Analysis

We conducted logistic regression to obtain prevalence ratios for health-related metrics adjusted for sex, age, and race/ethnicity. Sex, age, and racism are known independent predictors of health and are implicated in processes of occupational segregation that likely contribute to social inequities in health. Household income was excluded in the primary analyses because it is closely associated with occupation and industry. However, we added household income in a second model to facilitate evaluation of income's additional effects; we describe the impact this additional adjustment has on the results.

Analyses were conducted using SURVEYFREQ and RLOGISTIC in SAS version 9.4, and SAS-callable SUDAAN version 11.0.1 to account for the complex survey design and to factor in respondent sampling weight in BRFSS. Results were weighted according to state demographics distributions. We considered 95 percent confidence intervals (CIs) for adjusted prevalence ratios that did not include the null as statistically significant.

Results

Of the 222,771 respondents to the 2018–2019 BRFSS survey who indicated they were employed or self-employed, 185,114 met the industry and occupation criteria and were included in the analyses. Of these, 19,866 respondents were in the food chain industry and occupations of interest: 7,359 (production), 1,110 (manufacturing), 382 (wholesale), 2,551 (retail), 6,972 (commercial services), 1,042 (institutional services), and 450 (other food industries). The comparison group (all other workers) comprised 165,248 respondents.

Food chain workers differed from all other workers on several socio-demographic characteristics (see Table 1). Food chain workers were more likely to be under the age of 35 (48%) than all other workers (30%). They were more likely to be Hispanic (32%) and less likely to identify with the other race/ethnicity categories available for analysis (50% non-Hispanic white, 10% non-Hispanic African American, and 7.5% non-Hispanic other). Food chain workers were 1.8 times more likely to rent their home and 1.8 times more likely to have a high school education or less than all other workers. Food chain workers were more likely to have household income of less than $50,000; 37 percent had household incomes of less than $25,000, compared to 14.3 percent of all other workers. Food chain workers were more likely to live in a nonmetropolitan urban (11%) or nonmetropolitan rural area (9%) than all other workers.

There were also significant sociodemographic differences comparing food chain workers by industry to all other workers. Food chain workers in commercial services, retail, and wholesale were more likely to be younger than 25 (33%, 24%, and 18%, respectively) than all other workers

Table 1. Demographics of all Food Chain Workers, Food Chain Workers by Sector, and all Other Workers, 2018–2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Weighted % (95% CI)								
Characteristic	All Food Chain Workers	Food Production	Food Manufacturing	Food Wholesale	Food Retail	Commercial Food Services	Institutional Food Services	Food Chain Workers in Other Industries	All Other Workers
Age									
Age 18 to 24	24.3 (22.7, 26.1)	9.0 (6.9, 11.6)	12.4 (8.4, 17.3)	17.7 (9.3, 29.2)	24.6 (20.1, 29.6)	33.4 (30.8, 36.1)	5.7 (3.6, 8.5)	18.8 (11.0, 29.1)	8.8 (8.5, 9.2)
Age 25 to 34	24.0 (22.5, 25.7)	20.7 (17.1, 24.6)	23.2 (18.0, 29.0)	24.9 (14.2, 38.6)	23.0 (19.2, 27.2)	26.3 (24.0, 28.6)	12.5 (8.7, 17.2)	31.5 (16.8, 49.4)	21.2 (20.7, 21.7)
Age 35 to 44	18.3 (17.0, 19.8)	22.6 (19.1, 26.5)	20.8 (15.3, 27.2)	14.0 (8.3, 21.6)	16.4 (12.8, 20.6)	17.2 (15.5, 19.1)	21.5 (16.2, 27.6)	9.9 (5.4, 16.3)	22.3 (21.8, 22.8)
Age 45 to 54	15.4 (14.2, 16.6)	17.8 (15.1, 20.7)	19.1 (15.1, 23.5)	23.9 (15.8, 33.6)	16.2 (13.2, 19.6)	12.7 (11.1, 14.4)	25.4 (19.0, 32.5)	16.4 (10.2, 24.4)	22.4 (21.9, 22.8)
Age 55 to 64	11.8 (10.8, 12.7)	17.1 (14.9, 19.5)	16.8 (12.5, 21.9)	15.1 (9.9, 21.7)	13.3 (10.6, 16.4)	7.4 (6.3, 8.6)	26.3 (21.2, 31.8)	12.6 (6.3, 21.8)	18.6 (18.1, 19.0)
Age 65 or older	6.1 (5.2, 7.1)	12.8 (11.0, 14.7)	7.8 (4.1, 13.3)	4.3 (2.4, 6.9)	6.4 (5.0, 7.9)	3.0 (1.7, 4.9)	8.7 (5.8, 12.5)	10.8 (3.1, 24.9)*	6.7 (6.5, 7.0)
Sex									
Male	55.9 (54.1, 57.7)	78.2 (74.7, 81.5)	64.8 (58.6, 70.7)	84.5 (77.5, 89.9)	54.2 (49.4, 58.9)	48.9 (46.2, 51.6)	22.8 (17.5, 28.8)	43.3 (30.4, 56.9)	54.1 (53.5, 54.6)
Female	44.1 (42.3, 45.9)	21.8 (18.5, 25.3)	35.2 (29.3, 41.4)	15.5 (10.1, 22.5)	45.8 (41.1, 50.6)	51.1 (48.4, 53.8)	77.2 (71.2, 82.5)	56.7 (43.1, 69.6)	45.9 (45.4, 46.5)
Race/Ethnicity									
Non-Hispanic white	50.0 (48.2, 51.9)	62.5 (58.4, 66.5)	43.4 (37.1, 49.8)	47.6 (36.7, 58.7)	63.9 (59.1, 68.5)	41.9 (39.4, 44.4)	55.6 (48.7, 62.4)	46.7 (33.3, 60.5)	61.3 (60.7, 61.9)
Non-Hispanic African American	10.0 (9.0, 11.0)	1.4 (0.8, 2.2)	12.0 (8.8, 15.9)	16.1 (6.5, 31.0)*	9.1 (7.0, 11.4)	11.9 (10.4, 13.6)	21.8 (16.9, 27.3)	15.6 (4.3, 35.6)*	11.7 (11.3, 12.0)
Non-Hispanic other	7.5 (6.4, 8.8)	3.5 (1.7, 6.3)*	6.6 (3.4, 11.2)	4.3 (1.5, 9.4)*	9.6 (6.7, 13.2)	9.0 (7.2, 11.1)	6.3 (2.7, 12.4)*	3.8 (2.0, 6.7)	9.3 (8.8, 9.7)
Hispanic	32.4 (30.6, 34.3)	32.6 (28.8, 36.6)	38.0 (31.6, 44.8)	32.0 (21.3, 44.4)	17.4 (13.8, 21.6)	37.2 (34.5, 40.0)	16.3 (10.6, 23.4)	33.8 (20.1, 49.9)	17.8 (17.3, 18.3)
Marital status									
Married	37.6 (35.8, 39.3)	57.1 (53.1, 61.0)	45.0 (38.6, 51.6)	56.6 (45.2, 67.5)	36.3 (31.8, 41.1)	28.0 (25.7, 30.3)	47.9 (41.2, 54.6)	37.9 (25.2, 51.9)	56.3 (55.7, 56.8)
Not married	62.4 (60.7, 64.2)	42.9 (39.0, 46.9)	55.0 (48.4, 61.4)	43.4 (32.5, 54.8)	63.7 (58.9, 68.2)	72.0 (69.7, 74.3)	52.1 (45.4, 58.8)	62.1 (48.1, 74.8)	43.7 (43.2, 44.3)
Education									
Below high school	24.1 (22.4, 26.0)	35.0 (31.0, 39.2)	30.0 (24.1, 36.6)	16.6 (7.0, 31.1)*	17.2 (12.5, 22.7)	22.4 (19.9, 25.0)	12.4 (8.2, 17.6)	26.6 (13.5, 43.6)	8.9 (8.5, 9.3)
High school graduate	36.3 (34.6, 38.0)	30.3 (26.7, 34.0)	38.0 (31.8, 44.5)	38.4 (28.1, 49.6)	38.6 (34.2, 43.1)	36.6 (34.1, 39.2)	47.9 (41.3, 54.6)	38.2 (24.6, 53.3)	24.2 (23.7, 24.7)
Some college or technical school	28.3 (26.7, 29.9)	20.5 (18.0, 23.1)	22.2 (16.9, 28.3)	33.0 (23.3, 43.9)	31.9 (27.6, 36.4)	30.7 (28.2, 33.2)	30.8 (24.5, 37.6)	25.7 (16.8, 36.4)	30.6 (30.1, 31.2)
College graduate or more	11.3 (10.4, 12.2)	14.3 (12.3, 16.4)	9.7 (7.1, 12.9)	12.0 (7.6, 17.7)	12.3 (9.9, 15.1)	10.3 (9.0, 11.7)	9.0 (5.9, 13.0)	9.5 (6.1, 13.9)	36.3 (35.8, 36.8)
Household income									
< $10,000	5.8 (4.8, 6.9)	4.8 (3.2, 6.9)	6.3 (3.0, 11.3)*	**	4.2 (2.4, 6.8)	7.1 (5.6, 8.9)	4.1 (1.9, 7.6)*	0.7 (0.1, 2.3)*	1.9 (1.7, 2.1)
$10,000-$14,999	7.0 (5.8, 8.4)	6.6 (4.7, 9.1)	3.6 (1.4, 7.3)*	**	8.0 (5.2, 11.7)	7.6 (5.6, 10.0)	6.3 (3.1, 11.3)*	**	2.0 (1.9, 2.3)
$15,000-$19,999	10.9 (9.8, 12.1)	9.0 (6.6, 12.0)	11.0 (7.1, 16.1)	3.6 (1.4, 7.5)*	10.3 (7.7, 13.4)	12.2 (10.6, 13.9)	11.3 (7.6, 15.8)	9.2 (3.4, 19.1)*	4.0 (3.8, 4.2)
$20,000-$24,999	13.4 (12.1, 14.6)	9.2 (7.3, 11.5)	14.1 (9.6, 19.8)	5.5 (2.3, 10.9)*	14.4 (11.0, 18.4)	14.9 (13.0, 16.9)	16.8 (12.1, 22.4)	8.7 (5.0, 13.8)	6.4 (6.1, 6.7)
$25,000-$34,999	14.1 (12.6, 15.6)	12.5 (9.9, 15.5)	12.7 (8.5, 17.9)	11.8 (5.0, 22.6)*	10.0 (7.3, 13.4)	15.1 (13.0, 17.4)	16.1 (11.7, 21.4)	34.0 (16.2, 55.9)	8.2 (7.8, 8.5)
$35,000-$49,999	14.7 (13.4, 16.0)	17.0 (13.6, 20.9)	18.7 (13.8, 24.4)	18.7 (7.8, 34.8)*	12.5 (10.1, 15.2)	13.3 (11.6, 15.2)	17.7 (11.7, 25.1)	18.6 (10.7, 29.0)	11.9 (11.6, 12.3)
$50,000-$74,999	12.8 (11.7, 13.9)	16.1 (13.5, 18.9)	12.6 (8.9, 17.0)	23.0 (14.7, 33.3)	14.3 (11.1, 17.9)	10.8 (9.3, 12.4)	13.0 (8.6, 18.5)	7.7 (4.3, 12.6)	16.1 (15.7, 16.6)
≥$75,000	21.5 (19.7, 23.3)	24.7 (21.3, 28.4)	21.1 (15.3, 28.0)	35.8 (25.1, 47.6)	26.3 (21.0, 32.1)	19.0 (16.5, 21.7)	14.7 (10.5, 19.9)	15.9 (8.9, 25.4)	49.5 (48.8, 50.1)

(continued)

Table 1. (continued)

Characteristic	Weighted % (95% CI)									
	All Food Chain Workers	Food Production	Food Manufacturing	Food Wholesale	Food Retail	Commercial Food Services	Institutional Food Services	Food Chain Workers in Other Industries	All Other Workers
Housing status									
Own home	47.9 (46.1, 49.8)	64.9 (60.9, 68.7)	52.7 (46.2, 59.1)	59.4 (47.0, 71.0)	49.4 (44.5, 54.2)	38.5 (35.8, 41.3)	64.2 (58.0, 70.1)	52.9 (38.4, 67.0)	70.6 (70.1, 71.1)
Rent home or other arrangement	52.1 (50.2, 53.9)	35.1 (31.3, 39.1)	47.3 (40.9, 53.8)	40.6 (29.0, 53.0)	50.6 (45.8, 55.5)	61.5 (58.7, 64.2)	35.8 (29.9, 42.0)	47.1 (33.0, 61.6)	29.4 (28.9, 29.9)
Location									
Metropolitan	81.1 (80.0, 82.2)	58.0 (54.4, 61.6)	78.2 (74.0, 81.9)	83.4 (76.1, 89.2)	84.7 (81.9, 87.2)	89.9 (88.8, 90.9)	73.8 (67.6, 79.4)	80.2 (71.9, 87.0)	87.3 (87.0, 87.6)
Nonmetropolitan urban	10.0 (9.2, 10.8)	17.4 (15.0, 20.1)	11.4 (8.7, 14.4)	9.3 (5.2, 15.3)	10.0 (7.8, 12.6)	6.5 (5.7, 7.3)	14.4 (10.3, 19.3)	13.8 (8.2, 21.4)	7.5 (7.3, 7.7)
Nonmetropolitan rural	8.9 (8.2, 9.6)	24.5 (21.9, 27.3)	10.5 (8.1, 13.3)	7.3 (3.8, 12.4)	5.3 (4.1, 6.6)	3.7 (3.1, 4.3)	11.8 (7.7, 17.1)	5.9 (3.7, 8.9)	5.2 (5.0, 5.4)

Abbreviation: Confidence interval (CI).
[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.
*30% < Relative Standard Error (RSE) ≤ 50%, interpret with caution.
**RSE > 50%, suppressed.

(9%), while institutional food services workers were more likely to be between 55 and 64 years of age (26%) than all other workers (19%). Food chain workers in production, manufacturing, and wholesale were more likely to be male (78%, 65%, and 85%, respectively), while institutional food services workers were more likely to be female (77%) than all other workers (54% male). Food chain workers in production, manufacturing, wholesale, and commercial services were more likely to identify as Hispanic (33%, 38%, 32%, and 37%, respectively), while those in institutional services were more likely to identify as non-Hispanic African American (22%) compared to all other workers.

Compared to all other workers. a greater share of respondents had less than a high school education among production (35%), manufacturing (30%), retail (17%), and commercial services (22%), and a greater share of institutional services workers (50%) reported high school as their highest level of education. Food workers in production, retail, and commercial services were most likely to be low income; food workers in manufacturing and institutional services were generally middle income, and workers in food wholesale had the largest percentage of higher income workers.

Health Care Access

Food chain workers fared worse on all health care access metrics compared to other workers (see Table 2). The unadjusted prevalences indicate the magnitude of need: food chain workers had higher prevalences of lacking health insurance (27.4% vs. 12.4%), lacking a personal doctor (38.6% vs. 24.0%), being unable to visit a doctor due to cost (20.4% vs. 12.7%), and not having a routine checkup (34.6% vs. 27.9%), flu shot (77.6% vs. 66.8%) or dental visit in the past year (43.9% vs. 30.4%). In the regression, the largest difference was in lacking access to health insurance (adjusted prevalence ratio [aPR] = 1.77). After adjusting for income, lacking health insurance, lacking a personal doctor, and not having had a flu shot or a dental visit in the prior year remained significantly elevated (see Appendix C1).

Commercial food services workers fared worse on all health care access measures compared to non-food chain workers, and food production workers fared worse on all measures except having access to a doctor limited by cost. Food manufacturing and retail workers had higher prevalences of lacking health insurance (aPR = 1.40 and aPR = 1.48, respectively), cost limiting access to a doctor (aPR = 1.63 and aPR = 1.37, respectively), and no dental visit in the previous year (aPR = 1.43 and aPR = 1.23, respectively); food manufacturing workers additionally had higher prevalence of lacking a personal doctor (aPR = 1.22). Food wholesale and institutional food services workers did not fare worse than all other workers on any health care access measure. Adding income to the model did not substantially

Table 2. Prevalence Estimates and Adjusted Prevalence Ratios for Health Care Access Metrics: all Other Workers Compared to all Food Chain Workers and to Food Chain Workers by Sector, 2018–2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Not covered by health plan	No personal doctor	No routine checkup within 1 year	Access to doctor limited by cost	No flu shot in past year	No dental visit in past year[c]
Workers	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)
All other workers	12.4 (12.0, 12.8) *Ref.*	24.0 (23.5, 24.5)	27.9 (27.4, 28.5)	12.7 (12.3, 13.1)	66.8 (66.2, 67.3)	30.4 (29.7, 31.1)
All food chain workers	27.4 (25.7, 29.1)	38.6 (36.8, 40.4)	34.6 (32.8, 36.4)	20.4 (19.0, 21.9)	77.6 (76.0, 79.1)	43.9 (41.3, 46.5)
	1.77 (1.64, 1.91)	1.32 (1.25, 1.39)	1.12 (1.06, 1.19)	1.41 (1.30, 1.53)	1.12 (1.10, 1.15)	1.34 (1.25, 1.44)
All food chain workers by sector						
Food Production	30.7 (26.8, 34.9)	40.8 (36.8, 44.9)	40.5 (36.6, 44.6)	11.6 (9.3, 14.2)	76.7 (73.4, 79.8)	45.9 (40.4, 51.5)
	2.12 (1.82, 2.47)	1.48 (1.33, 1.65)	1.33 (1.20, 1.48)	0.93 (0.76, 1.15)	1.13 (1.08, 1.18)	1.42 (1.24, 1.62)
Food Manufacturing	22.4 (17.4, 28.0)	34.5 (28.4, 40.9)	30.4 (24.6, 36.8)	22.4 (17.0, 28.6)	74.5 (67.9, 80.3)	47.9 (38.3, 57.7)
	1.40 (1.10, 1.79)	1.22 (1.03, 1.44)	1.02 (0.84, 1.24)	1.63 (1.25, 2.11)	1.07 (0.99, 1.17)	1.43 (1.16, 1.76)
Food Wholesale	19.3 (11.4, 29.4)	34.3 (24.1, 45.8)	26.0 (17.5, 36.0)	7.2 (2.7, 15.0)*	77.7 (68.6, 85.2)	29.5 (15.1, 47.7)
	1.09 (0.69, 1.75)	1.05 (0.76, 1.46)	0.79 (0.55, 1.13)	0.53 (0.24, 1.13)	1.10 (0.97, 1.23)	0.80 (0.44, 1.44)
Food Retail	19.1 (15.2, 23.5)	25.8 (22.1, 29.8)	29.3 (25.2, 33.6)	18.3 (14.9, 22.0)	73.3 (68.0, 78.1)	38.4 (32.6, 44.3)
	1.48 (1.19, 1.84)	0.95 (0.81, 1.10)	0.97 (0.83, 1.13)	1.37 (1.13, 1.67)	1.07 (1.00, 1.15)	1.23 (1.05, 1.44)
Institutional Food Services	12.5 (8.0, 18.2)	18.8 (13.8, 24.6)	19.9 (15.4, 25.0)	14.1 (10.1, 18.9)	60.2 (53.6, 66.6)	32.3 (24.6, 40.8)
	1.20 (0.85, 1.70)	1.06 (0.84, 1.33)	0.91 (0.73, 1.14)	1.10 (0.81, 1.50)	0.96 (0.87, 1.06)	1.14 (0.91, 1.44)
Commercial Food Services	31.1 (28.6, 33.7)	44.0 (41.3, 46.7)	36.0 (33.3, 38.7)	25.5 (23.2, 27.8)	80.7 (78.5, 82.7)	46.1 (42.2, 50.1)
	1.86 (1.70, 2.04)	1.41 (1.31, 1.51)	1.13 (1.04, 1.23)	1.64 (1.48, 1.81)	1.15 (1.11, 1.19)	1.39 (1.26, 1.53)
Food chain workers in Other Industries	13.8 (8.7, 20.5)	27.1 (17.4, 38.8)	28.2 (18.6, 39.6)	12.8 (7.8, 19.4)	84.1 (75.0, 90.9)	34.0 (19.9, 50.6)
	0.90 (0.55, 1.46)	0.98 (0.64, 1.49)	1.00 (0.72, 1.39)	0.87 (0.54, 1.41)	1.25 (1.13, 1.37)	1.14 (0.71, 1.81)

Abbreviations: Adjusted prevalence ratio (aPR), confidence interval (CI), referent group (Ref.). Estimates from logistic regression models.

[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.

[b]Prevalence ratios adjusted for age (18–24, 25–34, 35–44, 45–54, 55–64, 65+), sex (male, female), and race/ethnicity (Non-Hispanic white, Non-Hispanic African American, Non-Hispanic other, Hispanic).

[c]In 2018 survey only.

change differences in health care access among food production and commercial food services workers, while comparisons of the food manufacturing and retail subgroups to all other workers were attenuated and lost statistical significance.

Health Behaviors

Food chain workers were more likely than all other workers to be current smokers and to not participate in physical exercise (aPR = 1.39 and aPR = 1.47, respectively; see Table 3). After adjusting for income, the difference for smoking lost statistical significance (see Appendix C2). There were no significant differences between food chain workers and all other workers in the three other health behavior measures included in the analysis (binge drinking, heavy drinking, and short sleep).

Prevalence of being current smokers was higher among food workers in manufacturing (aPR = 1.62), retail (aPR = 1.44), institutional services (aPR = 1.57), and commercial services (aPR = 1.49) compared to non-food chain workers. Food wholesale workers had higher prevalence of binge drinking than non-food chain workers (aPR = 1.54). All food chain workers except food wholesale had higher prevalence of no exercise in the previous month, while food wholesale workers had higher prevalence of short sleep than non-food chain workers (aPR = 1.42). Several of these differences lost significance when income was added to the model. There were no differences in prevalence of heavy drinking.

Health Status and Outcomes

Food chain workers had higher prevalence of fair or poor health, poor physical health, and poor mental health than all other workers (aPR = 1.48, aPR = 1.24, and aPR = 1.26, respectively; see Table 4). They also had higher prevalence of stroke (aPR = 1.38), COPD (aPR = 1.21), and depressive disorder (aPR = 1.17) than all other workers. Adding income to the model, food chain workers had an attenuated but still significantly higher prevalence of fair/poor health than all other workers (see Appendix C3).

All food chain workers except those in wholesale had higher prevalence of fair or poor health than non-food chain workers. Prevalence of poor physical health was higher among food workers in retail (aPR = 1.63), institutional services (aPR = 1.57), and commercial services (aPR = 1.30) compared to non-food chain workers. Commercial food services workers had higher prevalence of poor mental health than non-food chain workers (aPR = 1.43).

Commercial food services had higher prevalence of coronary heart disease (aPR = 1.35), COPD (aPR = 1.30), and depressive disorder (aPR = 1.27). Food retail workers had higher prevalence of stroke (aPR = 1.79), depressive disorder (aPR = 1.29), and arthritis (aPR = 1.23). Institutional food services workers had higher prevalence of obesity (aPR = 1.36), diabetes (aPR = 1.60), and hypertension (aPR = 1.58). Food production workers had higher prevalence of stroke (aPR = 1.66), but along with food wholesale workers, had no other significant differences in prevalences of health outcomes compared to non-food chain workers. Some of these differences were attenuated and lost statistical significance after adjusting for income. Higher prevalences of fair or poor health and poor mental health remained statistically significant among commercial food services workers, while higher prevalences of obesity, diabetes, and hypertension remained statistically significant among institutional food services workers.

Discussion

Results from this examination of 2018–2019 BRFSS data indicate that, collectively, food chain workers had higher prevalences of barriers to health care access (lacking health insurance, lacking a personal doctor, and not having a flu shot or dental visit in the past year), smoking, no physical exercise, and poor self-reported health than all other workers. Patterns were similar for food chain workers in all industry sectors except wholesale, a group that was similar to all other workers. Additionally, commercial food services workers had higher prevalence of poor mental health, while institutional food services workers had higher prevalences of obesity, diabetes, and hypertension than all other workers. Most point estimates decreased somewhat after adjusting for income but retained statistical significance.

A focus on the entire food chain allows consideration of workers in different industries and occupations but who are unified by their role in the food system. A social determinants of health framework helps highlight the fact that unfortunately, though there are exceptions, many food chain workers are also unified by poor employment quality, as many food jobs are nonsupervisory positions with little job security, inadequate or unstable pay, unpredictable schedules, few benefits, and limited workplace power.[8,13] The food processing, wholesale, and retail industries have higher unionization rates (12.7%, 8.1%, and 13.9%, respectively, in 2015, based on the latest available comprehensive assessment conducted by the Food Chain Workers Alliance; 8) than average for the food chain workforce as a whole (6%), allowing workers to negotiate for better employment and work conditions than those in nonunionized positions. However, unionization in food production (1.4%) and services (1.6%), especially commercial food services, remains dismally low,[8] in context of low union membership nationwide.[33] The poor quality of employment in the food chain is attributed partly to historical exclusions of agricultural, service, and other workers from key labor protections (a practice with racist and anti-immigrant roots),[11] as well as increased consolidation of food chain components by large corporations,[34] whose use of temporary labor

Table 3. Prevalence Estimates and Adjusted Prevalence Ratios for Health Behaviors: all Other Workers Compared to all Food Chain Workers and to Food Chain Workers by Sector, 2018–2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Current smoker	Binge drinking (during the past 30 days had five or more drinks for men or four or more drinks for women on an occasion)	Heavy drinking	Did not participate in any physical activities or exercise during past month	Short sleep (less than 7 h per 24-hour period)[c]
Workers	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)
All other workers	14.7 (14.3, 15.1) *Ref.*	21.5 (21.0, 22.0)	7.8 (7.5, 8.2)	20.4 (19.9, 20.8)	37.2 (36.4, 37.9)
All food chain workers	19.6 (18.3, 21.0) 1.39 (1.29, 1.50)	22.8 (21.3, 24.5) 0.98 (0.91, 1.06)	7.9 (7.0, 8.9) 1.02 (0.90, 1.15)	30.7 (29.0, 32.4) 1.47 (1.38, 1.56)	37.2 (34.9, 39.7) 1.00 (0.94, 1.07)
All food chain workers by sector					
Food Production	14.5 (11.5, 17.9) 0.98 (0.79, 1.22)	20.8 (17.8, 24.0) 0.88 (0.76, 1.03)	7.4 (5.8, 9.4) 0.95 (0.75, 1.21)	38.0 (34.2, 41.9) 1.81 (1.64, 2.01)	28.1 (23.2, 33.5) 0.80 (0.68, 0.95)
Food Manufacturing	23.2 (18.1, 29.0) 1.62 (1.29, 2.04)	23.7 (18.2, 29.9) 1.07 (0.84, 1.35)	10.2 (6.2, 15.4) 1.37 (0.89, 2.11)	30.0 (24.5, 35.9) 1.35 (1.12, 1.64)	44.7 (35.1, 54.6) 1.19 (0.95, 1.48)
Food Wholesale	21.0 (13.8, 29.8) 1.35 (0.92, 1.98)	38.4 (26.4, 51.5) 1.54 (1.12, 2.13)	12.7 (6.3, 22.0) 1.63 (0.92, 2.89)	24.1 (16.2, 33.5) 1.15 (0.82, 1.61)	55.0 (37.3, 71.8) 1.42 (1.06, 1.90)
Food Retail	20.8 (17.4, 24.5) 1.44 (1.22, 1.71)	20.2 (16.4, 24.3) 0.86 (0.71, 1.04)	5.5 (3.6, 8.0) 0.68 (0.46, 1.00)	30.0 (25.4, 35.0) 1.54 (1.32, 1.81)	38.7 (32.9, 44.6) 1.04 (0.90, 1.21)
Institutional Food Services	20.5 (15.7, 26.0) 1.57 (1.26, 1.97)	12.4 (8.9, 16.7) 0.76 (0.58, 1.00)	5.1 (2.5, 9.2)* 0.71 (0.39, 1.27)	32.8 (27.0, 38.9) 1.49 (1.23, 1.81)	39.9 (31.1, 49.1) 1.06 (0.85, 1.32)
Commercial Food Services	20.5 (18.6, 22.5) 1.49 (1.36, 1.64)	24.7 (22.3, 27.2) 1.04 (0.94, 1.15)	8.6 (7.3, 10.1) 1.12 (0.95, 1.33)	27.8 (25.4, 30.3) 1.32 (1.21, 1.45)	38.7 (35.2, 42.3) 1.03 (0.94, 1.13)
Food chain workers in Other Industries	25.2 (16.6, 35.4) 1.87 (1.34, 2.63)	20.2 (11.9, 31.0) 0.97 (0.62, 1.52)	5.9 (3.3, 9.7) 0.80 (0.49, 1.32)	37.9 (23.7, 53.8) 1.72 (1.13, 2.61)	35.4 (20.4, 52.7) 1.00 (0.66, 1.51)

Abbreviations: Adjusted prevalence ratio (aPR), confidence interval (CI), referent group (Ref.). Estimates from logistic regression models.

[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.

[b]Prevalence ratios adjusted for age (18-24, 25-34, 35-44, 45-54, 55-64, 65+), sex (male, female), and race/ethnicity (Non-Hispanic white, Non-Hispanic African American, Non-Hispanic other, Hispanic).

[c]In 2018 survey only.

Table 4. Prevalence Estimates and Adjusted Prevalence Ratios for Health status and Outcomes: all Other Workers Compared to all Food Chain Workers and to Food Chain Workers by Sector, 2018–2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Fair or poor health	Physical health not good for ≥14 days out of 30	Mental health not good for ≥14 days out of 30	Obese	Coronary heart disease	Stroke	Current asthma	COPD
Workers	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)
All other workers	11.0 (10.6, 11.3) *Ref.*	6.6 (6.3, 6.8)	9.9 (9.6, 10.2)	31.5 (31.0, 32.1)	3.0 (2.9, 3.2)	1.1 (1.0, 1.2)	7.7 (7.4, 8.0)	3.2 (3.0, 3.4)
All food chain workers	17.6 (16.3, 19.1) 1.48 (1.35, 1.61)	7.9 (7.0, 8.9) 1.24 (1.10, 1.41)	14.2 (13.0, 15.5) 1.26 (1.14, 1.38)	30.6 (28.9, 32.3) 1.02 (0.96, 1.08)	3.0 (2.6, 3.5) 1.18 (1.00, 1.40)	1.3 (1.0, 1.6) 1.38 (1.08, 1.76)	7.6 (6.8, 8.5) 0.99 (0.87, 1.12)	3.4 (2.9, 3.9) 1.21 (1.04, 1.41)
All food chain workers by sector								
Food Production	17.2 (14.2, 20.4) 1.40 (1.17, 1.67)	5.8 (4.4, 7.6) 0.87 (0.67, 1.14)	6.9 (4.7, 9.6) 0.79 (0.57, 1.10)	31.0 (27.5, 34.7) 1.00 (0.90, 1.12)	4.3 (3.2, 5.6) 1.03 (0.77, 1.36)	2.1 (1.3, 3.2) 1.66 (1.05, 2.60)	4.5 (2.9, 6.4) 0.75 (0.52, 1.08)	3.1 (2.1, 4.4) 1.01 (0.71, 1.45)
Food Manufacturing	20.7 (15.8, 26.3) 1.58 (1.22, 2.03)	8.1 (5.5, 11.3) 1.18 (0.83, 1.67)	12.2 (8.3, 17.1) 1.26 (0.92, 1.73)	33.1 (26.7, 40.1) 1.03 (0.84, 1.27)	4.5 (2.0, 8.5)* 1.29 (0.68, 2.45)	0.5 (0.2, 1.1)* 0.42 (0.22, 0.78)	6.6 (4.1, 9.9) 0.96 (0.64, 1.45)	2.6 (1.5, 4.2) 0.91 (0.55, 1.50)
Food Wholesale	9.3 (4.8, 16.0) 0.74 (0.42, 1.30)	3.9 (1.7, 7.5)* 0.63 (0.32, 1.22)	10.0 (4.4, 18.9)* 1.07 (0.56, 2.06)	38.9 (27.9, 50.7) 1.20 (0.89, 1.62)	1.9 (0.7, 4.1)* 0.62 (0.29, 1.32)	** 0.52 (0.19, 1.41)	3.7 (1.3, 7.9)* 0.62 (0.28, 1.37)	1.0 (0.3, 2.6)* 0.38 (0.18, 0.82)
Food Retail	13.2 (10.7, 16.1) 1.28 (1.05, 1.56)	10.0 (7.2, 13.5) 1.63 (1.20, 2.21)	13.2 (10.3, 16.6) 1.15 (0.90, 1.47)	31.4 (27.2, 35.8) 1.09 (0.96, 1.24)	2.5 (1.7, 3.5) 1.00 (0.71, 1.41)	1.6 (0.9, 2.6) 1.79 (1.09, 2.93)	9.5 (6.9, 12.6) 1.18 (0.88, 1.58)	3.9 (2.6, 5.5) 1.31 (0.92, 1.87)
Institutional Food Services	18.8 (14.0, 24.3) 1.63 (1.23, 2.17)	11.5 (7.8, 16.0) 1.57 (1.11, 2.23)	13.5 (9.6, 18.4) 1.35 (0.98, 1.86)	45.7 (38.8, 52.7) 1.36 (1.16, 1.60)	3.5 (2.2, 5.3) 1.21 (0.79, 1.85)	2.1 (0.8, 4.4)* 1.49 (0.68, 3.25)	12.0 (7.8, 17.4) 1.32 (0.90, 1.94)	5.9 (3.4, 9.4) 1.56 (0.95, 2.55)
Commercial Food Services	19.0 (17.0, 21.2) 1.57 (1.39, 1.78)	8.0 (6.7, 9.5) 1.30 (1.09, 1.56)	17.9 (16.0, 19.9) 1.43 (1.27, 1.62)	28.1 (25.6, 30.7) 0.96 (0.88, 1.05)	2.4 (1.9, 3.1) 1.35 (1.03, 1.77)	1.0 (0.7, 1.4) 1.29 (0.90, 1.85)	8.2 (7.0, 9.5) 0.99 (0.84, 1.17)	3.3 (2.8, 3.9) 1.30 (1.07, 1.58)
Food chain workers in Other Industries	16.1 (8.9, 26.0) 1.30 (0.79, 2.16)	6.6 (3.5, 11.3) 0.99 (0.56, 1.74)	10.5 (6.5, 15.9) 0.94 (0.60, 1.49)	34.7 (20.1, 51.8) 1.10 (0.74, 1.65)	5.5 (1.6, 12.9)* 2.02 (0.76, 5.35)	1.0 (0.3, 2.4)* 0.90 (0.34, 2.38)	8.5 (3.3, 17.4)* 1.04 (0.49, 2.22)	3.8 (1.2, 9.1)* 1.26 (0.50, 3.15)

	Depressive disorder	Diabetes	Arthritis	Hypertension[c]
Workers	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)
All other workers	14.6 (14.3, 15.0) *Ref.*	7.0 (6.7, 7.3)	17.0 (16.6, 17.5)	25.2 (24.4, 25.9)
All food chain workers	17.7 (16.4, 19.0) 1.17 (1.08, 1.26)	6.3 (5.6, 7.0) 1.09 (0.96, 1.22)	14.0 (12.9, 15.1) 1.07 (0.99, 1.16)	21.5 (19.3, 23.7) 1.02 (0.93, 1.13)
All food chain workers by sector				
Food Production	10.2 (7.4, 13.6) 0.85 (0.65, 1.12)	7.0 (5.3, 9.0) 0.90 (0.70, 1.15)	17.7 (15.1, 20.5) 1.05 (0.91, 1.22)	24.5 (19.4, 30.2) 0.91 (0.73, 1.14)
Food Manufacturing	12.9 (9.2, 17.5) 1.01 (0.77, 1.32)	8.4 (4.9, 13.1) 1.05 (0.68, 1.64)	16.4 (11.5, 22.2) 1.13 (0.83, 1.52)	25.4 (17.2, 35.0) 0.96 (0.71, 1.31)
Food Wholesale	9.6 (4.9, 16.4) 0.86 (0.50, 1.45)	7.4 (3.5, 13.4)* 1.09 (0.59, 2.00)	10.9 (6.6, 16.5) 0.81 (0.56, 1.18)	26.9 (14.1, 43.3) 1.03 (0.65, 1.65)

(continued)

Table 4. (continued)

Workers	Depressive disorder	Diabetes	Arthritis	Hypertension[c]
	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)	Prevalence (%) aPR[b] (95% CI)
Food Retail	20.7 (17.3, 24.4)	6.3 (4.9, 7.9)	17.5 (14.2, 21.1)	23.0 (17.6, 29.2)
	1.29 (1.09, 1.53)	1.16 (0.92, 1.46)	1.23 (1.03, 1.46)	1.05 (0.83, 1.33)
Institutional Food Services	18.2 (14.3, 22.7)	13.1 (9.4, 17.5)	20.5 (16.4, 25.1)	42.0 (32.1, 52.4)
	1.12 (0.89, 1.40)	1.60 (1.19, 2.16)	0.96 (0.78, 1.16)	1.58 (1.25, 1.99)
Commercial Food Services	20.4 (18.5, 22.4)	5.2 (4.3, 6.3)	10.7 (9.4, 12.1)	18.0 (15.1, 21.2)
	1.27 (1.15, 1.40)	1.14 (0.94, 1.38)	1.04 (0.92, 1.18)	1.04 (0.90, 1.21)
Food chain workers in Other Industries	18.2 (11.4, 26.9)	4.1 (2.4, 6.5)	18.5 (9.5, 31.0)	13.8 (6.6, 24.3)*
	1.17 (0.79, 1.74)	0.62 (0.34, 1.13)	1.25 (0.84, 1.86)	0.72 (0.40, 1.29)

Abbreviations: Adjusted prevalence ratio (aPR), confidence interval (CI), referent group (Ref.). Estimates from logistic regression models.
[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.
[b]Prevalence ratios adjusted for age (18–24, 25–34, 35–44, 45–54, 55–64, 65+), sex (male, female), and race/ethnicity (Non-Hispanic white, Non-Hispanic African American, Non-Hispanic other, Hispanic).
[c]In 2019 survey only.

contracting to save costs, long common in food production where most workers are seasonal, has increased in food manufacturing, wholesale, and services. This strategy allows companies to avoid paying higher wages and providing health insurance and other benefits.[8,35]

Guided by the understanding that work is a social determinant of health and health equity[10,36] evidence of health issues from both employer-reported[26] and worker-reported data (the present study) among food chain workers strengthens the case for public health researchers and practitioners to turn our attention to the well-being of food chain workers, and not only to their role in preventing foodborne illness, in both our research and the types of interventions that should follow. In addition to workplace support for smoking cessation and physical exercise interventions, policies that ensure a living wage,[37] universal health care,[38,39] federal paid sick leave,[40] and protection of the right to organize[41,42] regardless of full- or part-time employee status, would all likely help reduce the inequities in health care access, health behaviors, and health outcomes between food chain workers and the rest of the workforce. An assessment of the 100 largest food companies in the United States found that few have pro-worker policies—for example, related to a living wage, freedom of association, and training—and where these exist, they are often not implemented well or enforced.[34] Employers clearly have an important role in providing these protections. Policy approaches that decouple vital resources such as health insurance from employment and ensure the right of all workers to a living wage are also needed to ensure social protection for all. Strengthening workers' influence in ensuring working conditions that enhance, rather than detract from, their health is also key.

Our results also highlight specific groups with the highest needs for workforce-specific resources such as prevention measures and interventions to improve working conditions and for effectiveness research to gauge the success of these changes. Though food wholesale workers, who are among the highest paid workers across the food chain,[9] did not fare as poorly as other food chain workers, they did have higher prevalences of binge drinking and short sleep. There is limited prior health research on this specific workgroup; however, among workers in the transportation/warehousing industry generally, existing studies suggest elevated rates of short sleep,[43] but not excessive alcohol consumption.[44] Additional research is needed to corroborate and explore the reasons for both positive and negative findings among food wholesale workers.

Our finding of higher prevalence of poor mental health among commercial food services workers builds on prior research linking tipped service work with risk for developing mental illness.[45] Possible explanations include irregular and unstable scheduling, which results in income instability and has been linked with psychological distress among hourly workers in services.[22] Workers in commercial food

services can also experience stressors related to the emotional labor of interacting with customers and managing sexualized or hostile customer behavior, which is associated with adverse mental health.[25,46]

Systematic data on institutional food jobs are lacking, as commercial and institutional food services workers are combined in most publicly available datasets, and there is limited prior research on the health of institutional food services workers. Institutional food services workers were more likely to be women between 55 and 64 years of age and to identify as African American than non-food chain workers. The regressions included age, gender, and race/ethnicity, but those variables may not fully account for differential exposure to stressors over the lifetime, including structural anti-black racism, that increase barriers to health care and risk for a range of chronic diseases,[47] including the elevated levels of obesity, hypertension, and diabetes that we observed. Though institutional food services workers constitute a smaller share of the food workforce than commercial food services workers (e.g., in 2019 there were 402,480 institutional and cafeteria cooks compared to 1,401,890 restaurant cooks[48];), their higher prevalence of chronic health conditions and the strong role of the U.S. government in setting standards and pay for these workers make them an important group to prioritize for intervention.

Among the study strengths, using both industry and occupation codes to isolate food chain workers allowed for more specificity than using industry alone, and disaggregating two types of food services workers revealed specific health needs among commercial and institutional food services workers that might not have emerged had the food services workers been grouped together. Strengths also pertain to the BRFSS's large sample size, standardized weighting across states, and validated health measures. The COVID-19 pandemic highlighted the crucial role of food chain workers in society, as well as differences within the food chain that have implications for health inequities. BRFSS 2018–2019 data include the last pre-pandemic year and thus provide the best opportunity to obtain a baseline on the health and well-being of workers in different parts of the food chain. This baseline data creates the opportunity for future analyses of changes in food chain worker health and health inequities since the start of the pandemic that can take preexisting stressors into account.

The study also has limitations. First, we excluded subsectors that are sometimes included in food chain conceptualizations, namely, those responsible for supplying manufactured inputs to the production sector (e.g., the agricultural chemical manufacturing industry), and for dealing with food loss, waste, and recovery. Second, the specific way industry and occupation are coded introduces some rigidity in the groups of food workers it was possible to isolate in the analysis (e.g., it is not possible to isolate food delivery workers classified as independent contractors). Misclassification bias is also possible because of errors in industry and occupation coding. Third, BRFSS is not nationally representative because 32 states used the optional industry and occupation module in 2018 and 2019, and the sample was designed to be representative across age, race/ethnicity, and gender, but not in terms of industry and occupation. Health indicators and outcomes are self-reported and thus subject to recall bias and social desirability bias; this may contribute to an underestimation of the true prevalence of harmful health behaviors and adverse health outcomes in this sample. Fourth, the income-adjusted models for the comparison of food chain sub-groups to all other workers are likely to be over adjusted, since income is part of the mechanism by which work influences health. However, the income-adjusted models are more useful for the first comparison, between all food chain workers and all other workers, given the variation in industries and occupations of the two groups.

The U.S. food chain is a highly racialized and gendered workforce, with women and people who are black, Latinx, and Asian both overrepresented and performing the lower paid forms of labor compared to people who are white in the sector.[11] There were clear signs of this occupational segregation in this analysis. Compared to the rest of the workforce, commercial food services workers were more likely to be younger, Hispanic, and to have less education and lower incomes; food manufacturing workers were more likely to be male, Hispanic, and to have less education but higher incomes; and institutional food services workers were more likely to be older, female, and African American, with higher levels of education and household income. This variation has implications for the ways work along the food chain might influence health risks, and for the types of interventions that might follow. This analysis points to the need for more granular work information in large-scale surveys such as the BRFSS to explore the relationship between work conditions, worker demographics and social stratification processes, and health. More broadly, conceptualizing work as a social determinant of health leads to the conclusion that addressing the health inequities observed in this study will require changing the sociopolitical and economic drivers of occupational segregation and low-quality employment.

A 2017 American Public Health Association policy statement notes that the millions of farm workers and food production workers in the United States who help meet the public health goal of ensuring an accessible supply of nutritious food face poor employment and work conditions, contributing to health disparities.[49] The statement makes the case for expanding sustainable food systems goals of food safety, accessibility, environmental protection, and animal welfare to include just and equitable labor practices. The results of this study support extending this argument to the entire food chain and to health issues beyond occupational injuries by integrating a concern for food chain workers' health and well-being—and the employer practices and labor policies contributing to these outcomes—into the broader public

health goals of ensuring sustainable and equitable food systems and reducing health inequities driven by social determinants including work.

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Disclaimer

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Supplemental Material

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Appendix A. The sectors of the food chain.

The food chain consists of several main sectors.

Agricultural production includes farm workers, fishers, and ranchers responsible for planting and harvesting agricultural products and raising livestock (fish, cattle, chicken).

Manufacturing and processing includes workers who clean and package fruits and vegetables, make baked goods and other handmade products, produce food on assembly lines, and who work in animal plants, all converting raw goods into foods ready to sell or eat.

Wholesale and logistics includes truck drivers, forklift operators, and warehouse managers responsible for storage, refrigeration, transportation, and logistical distribution of food and agricultural products between the production, processing, and sales sectors of the supply chain.

In the **retail** sector, food is sold directly to consumers in supermarkets, grocery stores, and convenience stores by stockers, checkers, cashiers, in-house cooks and bakers, and service and maintenance workers.

Services workers prepare, cook, and serve food, bartend, and wash dishes in **commercial** establishments such as restaurants, casual dining establishments, catering companies, and food trucks, and in **institutional** establishments such as hospitals, schools, correctional facilities, and food (soup) kitchens.

Appendix B. Food chain industries and occupations included in the analysis, grouped by sector.

Industry Description	Census Code	Occupation code restrictions
Food Production		
Crop production	0170	Included if occupation = *Management* (0010, 0050, 0140, 0150, 0160, 0205, 0310, 0430); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Building and Grounds Cleaning and Maintenance* (4200, 4220, 4230); *Sales and Related* (4700, 4710, 4720, 4740, 4760, 4850, 4965, 5150, 5240, 5350, 5620); *Farming and Fishing* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7700, 7800, 7810, 7830, 7840, 7850, 7855, 8800, 8965); *Transportation and Material Moving* (9000, 9130, 9420, 9500, 9600, 9620, 9630, 9640, 9740, 9750)
Animal production	0180	
Fishing, hunting, and trapping	0280	
Support Activities for Crop and Animal Production	0290	
Food Manufacturing		
Animal food, grain and oilseed milling	1070	Included if occupation = *Management* (0010, 0050, 0140, 0150, 0160, 0205, 0310, 0430); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Building and Grounds Cleaning and Maintenance* (4200, 4220, 4230); *Sales and Related* (4700, 4710, 4720, 4740, 4760, 4850, 4965, 5150, 5240, 5350, 5620); *Farming and Fishing* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7700, 7800, 7810, 7830, 7840, 7850, 7855, 8800, 8965); *Transportation and Material Moving* (9000, 9130, 9420, 9500, 9600, 9620, 9630, 9640, 9740, 9750)
Sugar and confectionery products	1080	
Fruit and vegetable preserving and specialty food manufacturing	1090	
Dairy product manufacturing	1170	
Animal slaughtering and processing	1180	
Retail bakeries	1190	
Bakeries, except retail	1270	
Seafood and other miscellaneous foods, n.e.c.	1280	
Not specified food industries	1290	
Food Wholesale		
Groceries and related products merchant wholesalers	4470	Included if occupation = *Management* (0010, 0050, 0140, 0150, 0160, 0205, 0310, 0430); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Building and Grounds Cleaning and Maintenance* (4200, 4220, 4230); *Sales and Related* (4700, 4710, 4720, 4740, 4760, 4850, 4965, 5150, 5240, 5350, 5620); *Farming and Fishing* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7700, 7800, 7810, 7830, 7840, 7850, 7855, 8800, 8965); *Transportation and Material Moving* (9000, 9130, 9420, 9500, 9600, 9620, 9630, 9640, 9740, 9750)
Farm product raw materials merchant wholesalers	4480	

Food Retail		
Grocery stores	4970	Included if occupation = *Management* (0010, 0050, 0140, 0150, 0160, 0205, 0310, 0430); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Building and Grounds Cleaning and Maintenance* (4200, 4220, 4230); *Sales and Related* (4700, 4710, 4720, 4740, 4760, 4850, 4965, 5150, 5240, 5350, 5620); *Office and administrative Support* (5510); *Farming and Fishing* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7700, 7800, 7810, 7830, 7840, 7850, 7855, 8800, 8965); *Transportation and Material Moving* (9000, 9130, 9420, 9500, 9600, 9620, 9630, 9640, 9740, 9750)
Specialty food stores	4980	
Miscellaneous general merchandise stores	5390	
Commercial Food Services		
Traveler accommodation	8660	Included if occupation = *Management* (0205, 0310); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Farming, Fishing, and Forestry* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7800, 7810, 7830, 7840, 7850, 7855)
Restaurants and other food services	8680	Included if occupation = *Management* (0010, 0050, 0140, 0150, 0160, 0205, 0310, 0430); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Building and Grounds Cleaning and Maintenance* (4200, 4220, 4230); *Sales and Related* (4700, 4710, 4720, 4740, 4760, 4850, 4965, 5150, 5240, 5350, 5620); *Office and administrative Support* (5510); *Farming and Fishing* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7700, 7800, 7810, 7830, 7840, 7850, 7855, 8800, 8965); *Transportation and Material Moving* (9000, 9130, 9420, 9500, 9600, 9620, 9630, 9640, 9740, 9750)
Institutional Food Services		
Educational Services		Included if occupation = *Management* (0205, 0310); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Farming, Fishing, and Forestry* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7800, 7810, 7830, 7840, 7850, 7855)
Elementary and secondary schools	7860	
Colleges and universities, including junior colleges	7870	
Business, technical, and trade schools and training	7880	
Other schools and instruction, and educational support services	7890	
Health Services		
Offices of physicians	7970	

Offices of dentists	7980
Offices of chiropractors	7990
Offices of optometrists	8070
Offices of other health practitioners	8080
Outpatient care centers	8090
Home health care services	8170
Other health care services	8180
Hospitals	8190
Nursing care facilities	8270
Residential care facilities, without nursing	8290
Social Assistance	
Individual and family services	8370
Community food and housing, and emergency services	8380
Vocational rehabilitation services	8390
Child day care services	8470

Food chain workers in Other Industries	
Any industry other than those specified above	Included if occupation = *Management* (0205, 0310); *Food Preparation and Serving Related* (4000, 4010, 4020, 4030, 4050, 4060, 4110, 4120, 4130, 4140, 4150, 4160); *Farming, Fishing, and Forestry* (6005, 6020, 6040, 6050, 6100, 6110); *Production* (7800, 7810, 7830, 7840, 7850, 7855)

Appendix C1. Prevalence ratios for healthcare access metrics, additionally adjusted for household income: all other workers compared to all food chain workers and to food chain workers by sector, 2018-2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Not covered by health plan	No personal doctor	No routine checkup within 1 year	Access to doctor limited by cost	No flu shot in past year	No dental visit in past year[c]
Workers	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**
All other workers	*Ref.*					
All food chain workers	1.32 (1.22, 1.44)	1.17 (1.10, 1.24)	1.06 (0.99, 1.13)	1.07 (0.98, 1.17)	1.09 (1.06, 1.12)	1.12 (1.04, 1.21)
All food chain workers by sector						
Food Production	1.51 (1.24, 1.83)	1.38 (1.22, 1.55)	1.29 (1.15, 1.44)	0.72 (0.57, 0.91)	1.11 (1.06, 1.16)	1.22 (1.04, 1.42)
Food Manufacturing	0.99 (0.78, 1.25)	1.01 (0.83, 1.24)	0.97 (0.78, 1.20)	1.16 (0.87, 1.54)	1.02 (0.93, 1.13)	1.25 (0.96, 1.62)
Food Wholesale	0.95 (0.55, 1.64)	0.83 (0.56, 1.24)	0.83 (0.57, 1.20)	0.55 (0.23, 1.32)	1.11 (0.99, 1.26)	0.70 (0.36, 1.40)
Food Retail	1.11 (0.87, 1.41)	0.83 (0.70, 0.98)	0.90 (0.76, 1.06)	1.00 (0.81, 1.25)	1.04 (0.96, 1.14)	1.01 (0.86, 1.19)
Institutional Food Services	0.82 (0.55, 1.22)	0.86 (0.66, 1.12)	0.84 (0.65, 1.07)	0.75 (0.52, 1.07)	0.90 (0.80, 1.00)	0.87 (0.66, 1.13)
Commercial Food Services	1.43 (1.30, 1.58)	1.26 (1.16, 1.36)	1.04 (0.95, 1.15)	1.26 (1.13, 1.40)	1.12 (1.08, 1.17)	1.15 (1.03, 1.28)
Food chain workers in Other Industries	0.62 (0.37, 1.04)	0.86 (0.51, 1.45)	0.93 (0.63, 1.38)	0.70 (0.40, 1.23)	1.19 (1.06, 1.34)	1.04 (0.59, 1.83)

Abbreviations: Adjusted Prevalence Ratio (aPR), Confidence Interval (CI), Referent group (Ref.). Estimates from logistic regression models.

[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.

[b]Prevalence ratios adjusted for age (18-24, 25-34, 35-44, 45-54, 55-64, 65+), sex (male, female), and race/ethnicity (Non-Hispanic white, Non-Hispanic African American, Non-Hispanic other, Hispanic) and household income (<$10,000, $10,000-$14,999, $15,000-$19,999, $20,000-$34,999, $35,000-$49,999, $50,000-$74,999, >=$75,000).

[c]In 2018 survey only.

Appendix C2. Prevalence ratios for health behaviors, additionally adjusted for household income: all other workers compared to all food chain workers and to food chain workers by sector, 2018-2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Current smoker	**Binge drinking** (during the past 30 d had five or more drinks for men or four or more drinks for women on an occasion)	**Heavy drinking**	**Did not participate in any physical activities or exercise during past month**	**Short sleep** (less than 7 h per 24-h period)[c]
Workers	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**
All other workers	*Ref.*				
All food chain workers	1.11 (1.02, 1.20)	1.03 (0.95, 1.11)	1.03 (0.90, 1.17)	1.28 (1.19, 1.37)	1.01 (0.94, 1.09)
All food chain workers by sector					
Food Production	0.79 (0.62, 1.01)	0.92 (0.79, 1.08)	0.97 (0.75, 1.25)	1.62 (1.44, 1.81)	0.83 (0.69, 0.99)
Food Manufacturing	1.30 (1.04, 1.64)	1.14 (0.90, 1.45)	1.47 (0.95, 2.28)	1.14 (0.91, 1.42)	1.14 (0.89, 1.46)
Food Wholesale	1.31 (0.88, 1.96)	1.63 (1.19, 2.23)	1.77 (1.00, 3.13)	1.14 (0.80, 1.62)	1.46 (1.10, 1.95)
Food Retail	1.08 (0.89, 1.31)	0.90 (0.73, 1.11)	0.66 (0.43, 1.02)	1.39 (1.15, 1.68)	1.09 (0.94, 1.28)
Institutional Food Services	1.13 (0.87, 1.46)	0.85 (0.64, 1.13)	0.70 (0.37, 1.36)	1.27 (1.02, 1.58)	1.06 (0.83, 1.34)
Commercial Food Services	1.20 (1.08, 1.33)	1.08 (0.97, 1.21)	1.12 (0.94, 1.33)	1.11 (1.00, 1.23)	1.03 (0.93, 1.14)
Food chain workers in Other Industries	1.61 (1.11, 2.34)	1.02 (0.62, 1.68)	0.83 (0.49, 1.41)	1.62 (1.04, 2.51)	0.96 (0.59, 1.55)

Abbreviations: Adjusted Prevalence Ratio (aPR), Confidence Interval (CI), Referent group (Ref.). Estimates from logistic regression models.

[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.

[b]Prevalence ratios adjusted for age (18-24, 25-34, 35-44, 45-54, 55-64, 65+), sex (male, female), and race/ethnicity (Non-Hispanic white, Non-Hispanic African American, Non-Hispanic other, Hispanic) and household income (<$10,000, $10,000-$14,999, $15,000-$19,999, $20,000-$34,999, $35,000-$49,999, $50,000-$74,999, >=$75,000).

[c]In 2018 survey only.

Appendix C3. Prevalence ratios for health status and outcomes, additionally adjusted for household income: all other workers compared to all food chain workers and to food chain workers by sector, 2018-2019 Behavioral Risk Factor Surveillance System (BRFSS).[a]

	Fair or poor health	Physical health not good for >= 14 days out of 30	Mental health not good for >= 14 days out of 30	Obese	Coronary heart disease	Stroke	Current Asthma	COPD
Workers	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**
All other workers	*Ref.*							
All food chain workers	1.15 (1.05, 1.26)	0.98 (0.85, 1.13)	1.06 (0.95, 1.17)	0.97 (0.91, 1.03)	1.00 (0.84, 1.20)	1.13 (0.87, 1.46)	0.96 (0.83, 1.10)	0.92 (0.78, 1.08)
All food chain workers by sector								
Food Production	1.02 (0.85, 1.23)	0.67 (0.50, 0.91)	0.59 (0.43, 0.81)	0.93 (0.83, 1.05)	0.92 (0.68, 1.25)	1.47 (0.92, 2.36)	0.75 (0.51, 1.11)	0.89 (0.62, 1.29)
Food Manufacturing	1.30 (1.00, 1.68)	0.95 (0.65, 1.39)	1.05 (0.76, 1.46)	0.96 (0.77, 1.20)	1.13 (0.58, 2.20)	0.31 (0.15, 0.62)	0.91 (0.58, 1.43)	0.79 (0.48, 1.32)
Food Wholesale	0.85 (0.48, 1.50)	0.70 (0.35, 1.39)	1.09 (0.53, 2.24)	1.14 (0.82, 1.58)	0.67 (0.32, 1.42)	0.27 (0.08, 0.93)	0.68 (0.30, 1.58)	0.41 (0.19, 0.88)
Food Retail	0.99 (0.80, 1.23)	1.21 (0.86, 1.69)	0.83 (0.66, 1.05)	1.07 (0.93, 1.23)	0.84 (0.57, 1.23)	1.38 (0.82, 2.34)	1.24 (0.90, 1.70)	0.95 (0.64, 1.41)
Institutional Food Services	1.15 (0.84, 1.57)	1.12 (0.73, 1.70)	1.19 (0.84, 1.69)	1.26 (1.05, 1.51)	0.90 (0.54, 1.48)	1.11 (0.47, 2.62)	1.19 (0.78, 1.81)	1.15 (0.66, 1.99)
Commercial Food Services	1.24 (1.08, 1.42)	1.06 (0.87, 1.29)	1.27 (1.11, 1.44)	0.92 (0.84, 1.01)	1.12 (0.84, 1.50)	1.02 (0.70, 1.50)	0.94 (0.78, 1.14)	0.93 (0.75, 1.17)
Food chain workers in Other Industries	1.12 (0.66, 1.89)	0.64 (0.37, 1.10)	0.88 (0.52, 1.48)	1.02 (0.64, 1.62)	1.34 (0.55, 3.28)	0.95 (0.35, 2.63)	0.79 (0.30, 2.08)	0.65 (0.35, 1.23)

Appendix C3. (Continued)

	Depressive disorder	Diabetes	Arthritis	Hypertension[c]
Workers	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**	**aPR[b] (95% CI)**
All other workers	*Ref.*			
All food chain workers	1.00 (0.91, 1.09)	0.98 (0.86, 1.11)	1.02 (0.93, 1.11)	0.97 (0.87, 1.08)
All food chain workers by sector				
Food Production	0.74 (0.55, 0.98)	0.80 (0.61, 1.05)	1.01 (0.86, 1.18)	0.85 (0.67, 1.09)
Food Manufacturing	0.84 (0.63, 1.11)	0.99 (0.63, 1.55)	1.13 (0.82, 1.55)	0.93 (0.68, 1.29)
Food Wholesale	0.91 (0.53, 1.55)	1.02 (0.52, 1.98)	0.82 (0.56, 1.21)	1.05 (0.63, 1.75)
Food Retail	1.05 (0.87, 1.27)	1.09 (0.85, 1.38)	1.19 (0.98, 1.44)	0.97 (0.74, 1.26)
Institutional Food Services	0.93 (0.72, 1.20)	1.41 (1.02, 1.95)	0.88 (0.71, 1.09)	1.43 (1.11, 1.83)
Commercial Food Services	1.10 (0.98, 1.23)	1.01 (0.81, 1.25)	0.98 (0.85, 1.13)	1.00 (0.86, 1.17)
Food chain workers in Other Industries	1.03 (0.66, 1.61)	0.62 (0.35, 1.10)	1.01 (0.73, 1.39)	0.57 (0.30, 1.07)

Abbreviations: Adjusted Prevalence Ratio (aPR), Confidence Interval (CI), Referent group (Ref.). Estimates from logistic regression models.

[a]California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Washington, Wisconsin.

[b]Prevalence ratios adjusted for age (18-24, 25-34, 35-44, 45-54, 55-64, 65+), sex (male, female), and race/ethnicity (Non-Hispanic white, Non-Hispanic African American, Non-Hispanic other, Hispanic) and household income (<$10,000, $10,000-$14,999, $15,000-$19,999, $20,000-$34,999, $35,000-$49,999, $50,000-$74,999, >=$75,000).

[c]In 2018 survey only.