



Association Between Food Insecurity and Obstructive Respiratory Diseases in the U.S. Adults: Insights from NHANES 2005–2006

Ruan Pablo Duarte Freitas^{1*}, Victoria Gomes Andreato², Alaa Ali³, Alfredo Gabriele Nanni⁴, Ana Luíza Soares Pinto⁵, Bruno Meireles de Moraes⁶, Carol Arce Sanjur⁷, Caroline Borginho⁸, Claudia Gonzalez⁹, Cristal N. Pride¹⁰, Einer C.E. Arevalo-Rios¹¹, Erwin León¹², Glauco Marinho Plens¹³, Hiroshi Hayashi¹⁴, Jose Max Narvaez Paliza¹⁵, Justyna Garnier¹⁶, Karina Gisell Duerksen Crespo¹⁷, Keila Miranda-Limachi¹⁸, Kelvin Henrique Vilalva¹⁹, L. Angie Paucar Cisneros²⁰, Luiza Lara Gadotti²¹, Mariana Pilon Capella²², Mitha Al Balushi²³, Patricio A. Alfaro²⁴, Pedro Slindvain Freitas²⁵, Roksana Hasib²⁶, Sibin Marian²⁷, Staling Guillermo Pallares Escorcía²⁸, Supattana Chatromyen²⁹

¹Faculdade Zarns, Bahia, Brazil; ²College/University São Leopoldo Mandic, Campinas, Brazil; ³The View Hospital, Doha, Qatar; ⁴Neurology Unit, Department of Translational Biomedicine and Neurosciences (DiBraIn), University of Bari, Italy; ⁵Universidade Federal de São Paulo - Campus São Paulo: São Paulo, São Paulo, Brazil; ⁶Barretos Cancer Hospital, Brazil; ⁷Universidad de Ciencias Médicas, San José, Costa Rica; ⁸Children Institute, Hospital of the University of São Paulo, Brazil; ⁹Pontificia Universidad Católica Madre y Maestra, Santiago, Dominican Republic; ¹⁰International Health Alliance, United States; ¹¹Universidad Peruana Cayetano Heredia, Perú; ¹²Universidad Francisco Marroquín, Guatemala; ¹³Divisão de Pneumologia, Instituto do Coração, Hospital das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo, SP, Brazil; ¹⁴Tokyo Metropolitan Children's Medical Center, Tokyo, Japan; ¹⁵Beth Israel Deaconess Medical Center, Boston, United States; ¹⁶SWPS University of Social Sciences and Humanities, Department of Psychology, Warsaw, Poland; ¹⁷Universidad del Pacífico, Asunción, Paraguay; ¹⁸Escuela Profesional de Enfermería, Facultad de Ciencias de la Salud, Universidad Peruana Unión, Perú; ¹⁹Hospital Sirio Libanes / Instituto do Coração, Hospital das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo, SP, Brazil / Instituto Dante Pazzanese de Cardiologia; ²⁰Instituto Nacional Materno Perinatal, Lima, Perú; ²¹Hospital São Luiz Campinas, São Paulo, Brazil; ²²Instituto Brasileiro de Controle do Cancer (IBCC), Brazil; ²³Public Health Research Center, New York University-Abu Dhabi, United Arab Emirates; ²⁴Surgery Department, Universidad de Concepción, Chile; ²⁵College/University São Leopoldo Mandic, Campinas, Brazil; ²⁶PPD Clinical Research Laboratory, Zaventem, Belgium; ²⁷Principles and Practice of Clinical Research Program, Executive and Continuing Professional Education (ECPE), Harvard T.H. Chan School of Public Health, Boston, MA, USA; ²⁸Fundación Valle del Lili, Universidad Icesi, Cali, Colombia; ²⁹Neurological Institute of Thailand, Department of Medical Services, Ministry of Public Health, Bangkok 10400, Thailand.

Abstract

Introduction: Respiratory diseases such as asthma, chronic bronchitis, and emphysema pose major public health burdens. Food insecurity, a lack of consistent access to adequate nutrition, has been linked to worse respiratory outcomes via immune dysfunction, stress, and nutrient deficiencies. This study examined the association between food insecurity and respiratory conditions in U.S. adults aged 20 and older.

Methods: Using NHANES 2005–2006 data ($n = 4910$), we assessed food security via the USDA module and categorized responses into Full, Marginal, Low, and Very Low security. Primary outcomes were self-reported physician diagnoses of asthma, chronic bronchitis, or emphysema. Logistic regression models adjusted for sociodemographic and behavioral confounders.

Results: Very low food security was associated with higher odds of respiratory disease (adjusted OR: 2.18, 95% CI: 1.54–3.07, $p < 0.001$). Low security was also significant (adjusted OR: 1.62, 95% CI: 1.05–2.52, $p = 0.031$). Subgroup analyses highlighted elevated risks among older adults and lower-income populations.

Conclusion: Food insecurity is independently associated with obstructive respiratory diseases. Findings highlight the need for integrated public health and social interventions to address food insecurity and reduce respiratory health disparities.

Introduction

Respiratory health is greatly impacted by both physiological conditions and social determinants, such as asthma, emphysema, and chronic bronchitis, which present notable public health issues (Greene & Abdulkadir, 2024; Idrose et al., 2022). Recent studies have shed light on the significance of food insecurity, which refers to access to quality and nutritious food, as a contributor that could exacerbate respiratory conditions. Evidence suggests that the lack of access to food worsens these conditions by weakening immune responses, heightening psychological stress, and reducing overall health resilience (Mendoza et al., 2024). The association presented can be especially relevant in low-income and marginalized populations, who are disproportionately impacted by both food insecurity and long-term respiratory conditions, highlighting a major aspect of health disparities. Addressing food insecurity could therefore play a pivotal role in reducing the burden of respiratory diseases, lowering healthcare costs, and improving patient outcomes (Mendoza et al., 2024; Ribeiro-Silva et al., 2014). Recognizing the rising global prevalence of food insecurity, its impact on respiratory health warrants urgent investigation to guide the development of targeted public health strategies.

Previous studies have indicated that food insecurity is associated with poor asthma control and compromised lung function in individuals with chronic respiratory conditions. Inadequate nutrition, often resulting from food insecurity, may contribute to heightened inflammatory responses linked to stress, further exacerbating respiratory conditions (Mangini et al. 2015; Ribeiro-Silva et al. 2014). In addition, psychosocial factors such as stress associated with food insecurity may play a role in the morbidity of respiratory diseases. Studies suggest that food insecure individuals with asthma or chronic obstructive pulmonary disease (COPD) often exhibit reduced pulmonary function, including lower forced vital capacity (FVC), and experience more severe symptoms. However, many of these studies were conducted in relatively homogeneous populations, limiting the generalizability of their findings to broader and more diverse groups. However, food insecurity is related to other health determinants that must be considered and adjusted to associate food insecurity with respiratory health.

To address these gaps, the present study employed a cross-sectional design using secondary analysis of the 2005–2006 National Health and Nutrition Examination Survey (NHANES) dataset to examine the association between food insecurity and obstructive res-

piratory disorders, specifically emphysema, chronic bronchitis, and asthma, in U.S. adults. By evaluating how food insecurity worsens respiratory health outcomes and investigating its interactions with other covariates, this study provides a more comprehensive understanding of this relationship. These findings aim to support policymakers in developing targeted strategies to mitigate the effects of food insecurity, particularly among vulnerable populations disproportionately affected by chronic respiratory diseases (Corbera-Hincapie et al., 2022; Lim et al., 2022).

Materials and Methods

Study Design

This cross-sectional study analyzed data from 4910 adults in the National Health and Nutrition Examination Survey (NHANES) 2005-2006. This study was approved by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) and evaluates the health and nutritional status of non-institutionalized U.S. residents. The study focused on participants aged 20 years and older to examine adult diagnoses of chronic respiratory conditions, such as chronic bronchitis, emphysema, and asthma, thereby reducing variability from developmental respiratory factors in children. Furthermore, the database only provided information on emphysema and chronic bronchitis for individuals over the age of 20 years, which further justified restricting the analysis to this age group.

This approach is adequate for identifying associations between variables, such as food insecurity and respiratory conditions, but it does not establish causation because of the simultaneous measurement of exposure and outcome. This inherent limitation is acknowledged, and the findings are interpreted accordingly. However, the strengths of this approach include its cost-effectiveness and ability to leverage population-representative data for hypothesis generation.

Database Details

The NHANES 2005-2006 dataset is publicly available, de-identified, and representative of the U.S. population through a multistage probability sampling method. This ensures reliable data for public health research, particularly for exploring the association between food insecurity and respiratory conditions. The dataset includes comprehensive demographic, health, nutritional, and socioeconomic information. As the data were de-identified, no additional ethical approval was required (USDA ERS - Definitions of Food Security, n.d.). NHANES data have been

widely validated and used in previous studies to examine the association between food insecurity and chronic conditions, including respiratory diseases (Ribeiro-Silva et al., 2014; Mangini et al., 2015).

Exposure Description

The primary exposure variable is household food security status, assessed using the Food Security Survey Module (FSSM) developed by the U.S Department of Agriculture (USDA). Food security was classified into Full, Marginal, Low, and Very Low categories, indicating varying levels of food access limitations. Households with children completed an 18-item FSSM, whereas those without children used a 10-item version focused on adult food security (USDA ERS - Definitions of Food Security, n.d.). Participants reported their food security status by detailing experiences such as meal skipping and food insufficiency concerns. The FSSM has been extensively validated as a reliable measure of food security, although subjective reporting may introduce recall or response biases.

Outcome Description

The primary outcome was obstructive respiratory conditions, including asthma, chronic bronchitis, or emphysema, assessed using self-reported data from NHANES questionnaires. The participants were asked if they had ever diagnosed them under these conditions. Although self-reported diagnoses are a practical and commonly used method in population-based studies, they are subject to recall bias and potential underreporting, particularly for conditions with mild or intermittent symptoms. However, validation studies suggest that self-reported chronic disease diagnoses in the NHANES align well with medical records, supporting their use in epidemiological research (Barr et al. 2009). The outcome was evaluated in adult individuals aged 20 years or older, as the NHANES database only evaluated chronic bronchitis or emphysema in individuals in this age range.

Covariates included age, sex, education, race/ethnicity, smoking status (defined as having smoked at least 100 cigarettes in life), and income level to assess their impact on respiratory health outcomes.

Statistical Analysis

The primary exposure variable, household food security status, was a categorical variable with four levels, and the primary outcome measure was a composite

binary variable indicating a previous diagnosis of at least one of the following three obstructive respiratory conditions: asthma, chronic bronchitis, and emphysema. A complete case analysis was conducted, including only participants who answered all questions related to food security and respiratory health, to ensure data consistency and comparability.

Logistic regression was used to assess associations between household food security levels and respiratory conditions, controlling for confounders such as age, sex, race/ethnicity, smoking status, and socioeconomic factors such as education and income. A forward stepwise selection method identified covariates that significantly improved the model fit or altered the main effect estimates by more than 10%. This method was chosen for its efficiency in handling multiple potential confounders while avoiding overfitting, particularly in studies with complex datasets.

Other variable selection methods were considered but deemed less appropriate because of their higher computational complexity or reduced transparency in identifying key predictors.

Missing data were addressed through a complete case analysis, which assumes that the missingness is random. While this approach reduces the sample size, it ensures that only participants with complete exposure and outcome data are included, thus strengthening internal validity. Descriptive statistics were calculated for all variables, with continuous variables assessed for normality using histograms, Q-Q plots, and the Shapiro-Wilk test. Non-normally distributed variables (income) are summarized as medians and interquartile ranges (IQR), while normally distributed variables are reported as means and standard deviations. Categorical variables are expressed as proportions.

The final model, which was adjusted for key confounders, provided a robust examination of the association between food security and respiratory health. Odds ratios (ORs) with 95% confidence intervals (CIs) were used to quantify the strength of these associations. All analyses were conducted using Stata 18.5 BE, with statistical significance set at $p < 0.05$, ensuring that the observed relationships were unlikely to be due to random variation.

Results

Characteristics of Study Participants

The mean age of individuals was 48.27 years (SD = 19.09). Smoking patterns varied, with 45.29% of individuals reporting smoking at least 100 cigarettes in their lives, with a slight decrease (45.29%) in those who did not have respiratory problems versus (56.40%) those who did have said conditions.

Educational levels ranged from 7.66% at the lowest level (less than 9th grade) in those with respiratory problems, with the highest level being 34.89% (some college or associate degree) in those with respiratory conditions. The predominant racial/ethnic group was Category 4 (Non-Hispanic Black population with respiratory problems), compromising 34.89% of the sample. Food security, one of the main focuses of the study, showed that 76.71% of the participants had full food security, with 4.17% showing very low food security. Notably, those who reported very low food security had a higher percentage of respiratory problems (6.96%) compared to those with full food security (74.53%) (Table 1).

Flow of Study Participants

4968 individuals met the inclusion criteria. 58 individuals were excluded because of missing data regarding the outcome, resulting in a final sample of 4,910 adults. Most study participants had full food security (77.37%), and 4.17% experienced very low food security. Among the study participants, 17.2% reported obstructive respiratory problems. Covariates, such as education level, age, gender, smoking status (at least 100 cigarettes in life), annual income, and race/ethnicity, were summarized to contextualize the analysis. (Figure 1).

Logistic Regression Analysis

The results presented in Table 2 highlight the importance of considering food insecurity as a determinant of respiratory health. It displays the odds ratios (ORs) for respiratory conditions across all levels of food security, with 'Full' food security as the reference. In the unadjusted model, only Very Low food security was associated with significantly increased odds of respiratory conditions (OR: 2.02, 95% CI: 1.48–2.77; $p < 0.001$).

In the adjusted model, controlling for age, smoking, education level, annual income and race/ethnicity, showed that participants with 'Low' food security had 54% higher odds (OR: 1.54, 95% CI: 1.17–2.02, $p = p < 0.001$), while those with 'Very Low' food security had over double the odds (OR: 2.03, 95% CI: 1.44–2.87, $p < 0.001$) of reporting an obstructive respiratory problem. This demonstrates that individuals in the "Very Low" category have more than twice the risk of reporting obstructive respiratory problems compared to those with "Fully" food security. This finding has significant implications for public health planning, suggesting the need for urgent interventions that address severe food insecurity as part of integrated

respiratory disease prevention strategies. On the other hand, the absence of a significant association in the "marginal" category may indicate that early interventions at this stage could prevent the worsening of food insecurity and its effects on health.

Sensitivity Analysis and Interaction Effects

Table 3 presents the sensitivity analysis, which further examined the relationship between food security and respiratory conditions, focusing on different age groups (> 20 and > 40 years). The impact of low food security on respiratory health was more pronounced among participants aged 40 years and older. The adjusted odds ratio for respiratory conditions among those with very low food security in the 40+ age group was 2.65 (95% CI: 1.39–5.04, $p = 0.003$), compared to 2.42 in the overall cohort.

Interaction effects were also explored between food security and other covariates such as smoking and education. Smoking has emerged as a significant predictor of respiratory conditions, amplifying the risk across all food security levels. Lower educational attainment was associated with higher odds of respiratory problems, reflecting the interplay between socioeconomic factors in shaping health outcomes.

Forest Plot Overview

Figure 2 visually summarizes the results of the adjusted logistic regression models, illustrating the odds ratios for respiratory conditions across food security levels and key covariates. The forest plot showed a clear trend of increasing odds with decreasing food security, with the strongest association observed for participants with Very Low food security.

In addition to food security, smoking was identified as a significant risk factor, with individuals who had smoked at least 100 cigarettes in their lifetime exhibiting a markedly higher likelihood of respiratory condition. Lower educational levels also contributed to increased odds, emphasizing the importance of addressing broader social determinants of health.

Discussion

This study reported an independent association between food insecurity and a higher prevalence of obstructive respiratory diseases such as asthma, chronic bronchitis, and emphysema in adults in the United States. Participants with severe food insecurity were twice as likely to report these conditions, even after adjusting for confounding factors, such as age, education level, smoking, and ethnicity. These find-

Characteristic	Category	Resp_Prob_0	Resp_Prob_1	Total
Age (years)	Mean (SD)	48.15 (18.99)	31.32 (24.02)	43.46 (21.86)
Smoking	At least 100 Cigarettes in Life			
	(No) 0	2,247 (54.71%)	371 (43.60%)	2,618
	(Yes) 1	1,860 (45.29%)	480 (56.40%)	2,34
	Total	4,107 (100%)	851 (100%)	4,958
Education Level	1 (Least educated)	560 (13.64%)	65 (7.66%)	625 (12.61%)
	2	626 (15.25%)	137 (16.14%)	763 (15.40%)
	3	991 (24.14%)	187 (22.03%)	1,178 (23.77%)
	4	1,116 (27.18%)	297 (34.98%)	1,413 (28.52%)
	5 (Most educated)	813 (19.80%)	163 (19.20%)	976 (19.70%)
Race/Ethnicity	1	916 (22.27%)	274 (17.23%)	1,190 (20.87%)
	2	132 (3.21%)	57 (3.58%)	189 (3.31%)
	3	1,993 (48.46%)	691 (43.46%)	2,684 (47.06%)
	4	905 (22.00%)	489 (30.75%)	1,394 (24.44%)
	5	167 (4.06%)	79 (4.97%)	246 (4.31%)
Food Security	Full	3,167 (77.97%)	1,123 (70.94%)	4,290 (76.00%)
	Marginal	365 (8.99%)	137 (8.65%)	502 (8.89%)
	Low	384 (9.45%)	206 (13.01%)	590 (10.45%)
	Very Low	146 (3.59%)	117 (7.39%)	263 (4.66%)

Table 1: Baseline characteristics of study participants by food security levels.

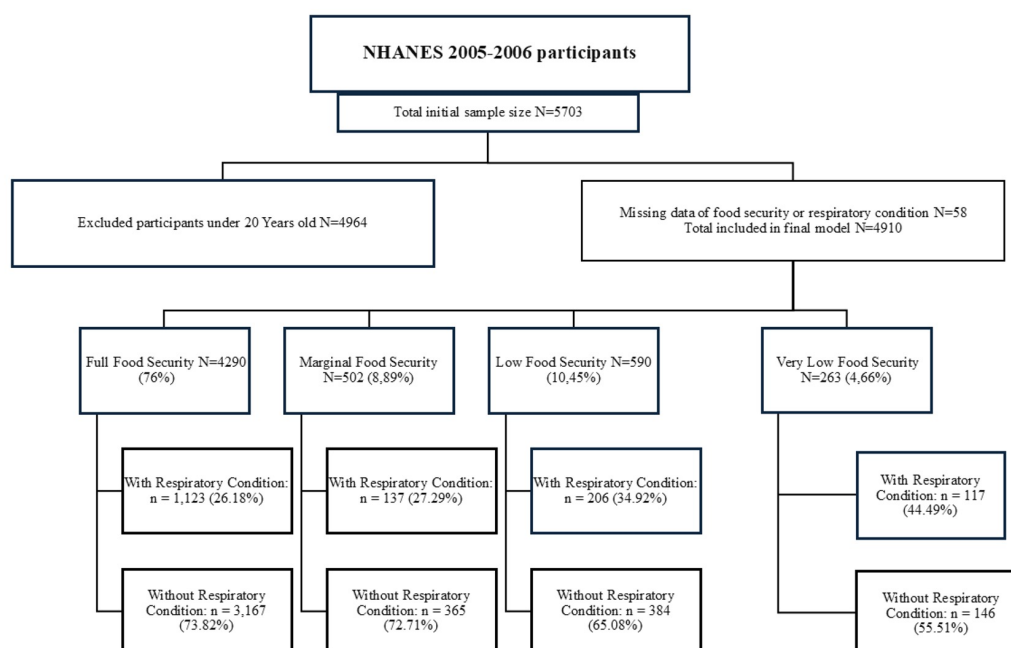


Figure 1: NHANES 2005-2006 participants.

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value	Sensitivity Analysis (Age ≥ 40) OR (95% CI)	p-value
Food Security						
Full (Reference)	Reference	-	Reference	-	Reference	-
Marginal	1.06 (0.86–1.30)	592	0.90 (0.53–1.52)	695	0.99 (0.68–1.44)	959
Low	1.51 (1.26–1.82)	0	1.62 (1.05–2.52)	31	1.55 (1.12–2.15)	7
Very Low	2.26 (1.76–2.91)	0	2.42 (1.51–3.86)	0	2.04 (1.33–3.14)	1
Covariates						
Age	-	-	0.997 (0.987–1.006)	511	-	-
Smoking	-	-	1.017 (0.996–1.038)	138	-	-
Education	-	-	1.088 (0.950–1.248)	228	-	-
Race/ Ethnicity	-	-	1.32 (1.12–1.55)	1	-	-

Table 2: Logistic regression results for association between food security levels and respiratory health outcomes.

Variable	Age ≥ 20: OR (95% CI)	Age ≥ 40: OR (95% CI)
Food Security: Marginal	0.90 (0.53–1.52)	1.02 (0.50–2.07)
Food Security: Low	1.62 (1.05–2.52)	1.89 (1.02–3.52)
Food Security: Very Low	2.42 (1.51–3.86)	2.65 (1.39–5.04)
Age	0.99 (0.99–1.01)	1.01 (1.00–1.03)
Smoking	1.02 (0.99–1.04)	0.99 (0.97–1.03)
Education	1.09 (0.95–1.25)	1.22 (1.02–1.47)
Race/Ethnicity	1.32 (1.12–1.55)	1.31 (1.06–1.62)

Table 3: Sensitivity analysis of respiratory condition odds ratios by food security and age groups (20+ and 40+).

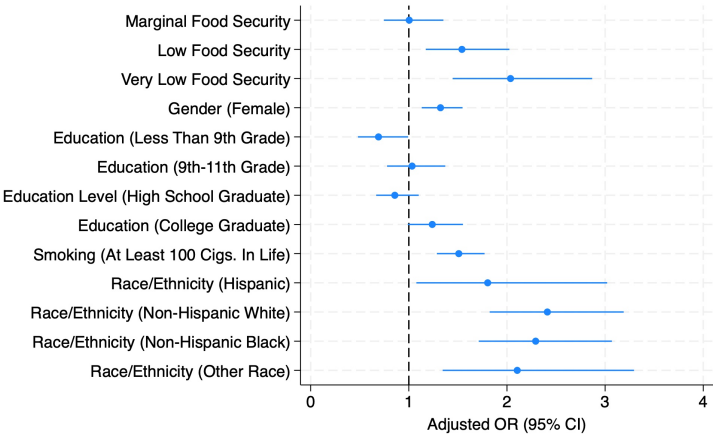


Figure 2: Odds ratios for respiratory conditions by food security level.

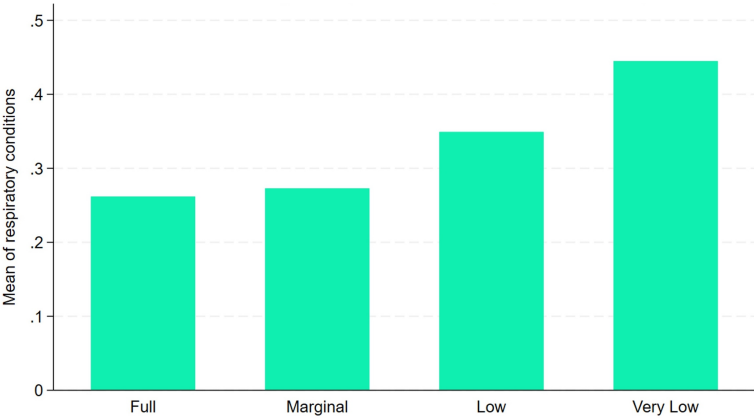


Figure 3: Prevalence of respiratory conditions by food security level.

Variable	Odds Ratio (OR)	Standard Error	95% Confidence Interval	p-value
Food Security				
Marginal	86	140	(0.004 – 2.061)	130
Low	362	377	(0.047 – 2.785)	329
Very Low	608	918	(0.032 – 11.713)	742
Smoking	1.006	13	(0.981 – 1.031)	647
Interaction: Food Security * Smoking				
Marginal	1.082	55	(0.980 – 1.194)	118
Low	1.016	31	(0.957 – 1.078)	601
Very Low	1.006	46	(0.920 – 1.099)	901
Education	986	82	(0.838 – 1.160)	867
Interaction: Food Security * Education				
Marginal	1.061	281	(0.631 – 1.784)	824
Low	1.457	312	(0.958 – 2.217)	78
Very Low	1.505	366	(0.935 – 2.423)	92
Age	997	5	(0.987 – 1.006)	481
Race/Ethnicity	1.278	108	(1.083 – 1.508)	4
Constant	126	69	(0.043 – 0.371)	<0.001

Table 4: Interaction effects of food security with smoking and education on respiratory conditions.

ings suggest that food insecurity can worsen respiratory health through mechanisms such as a worsened immune response, increased chronic stress, and nutritional deficiencies that affect overall disease resistance (Mendoza et al., 2024; Greene & Abdulkadir, 2024). In addition, the cumulative effects of poor diet can amplify vulnerabilities in subgroups, particularly the elderly, whose bodies are more susceptible to the consequences of prolonged nutritional deficits.

Potential biological and environmental mechanisms provide further context for the interpretation of these findings. Inadequate nutrition, a hallmark of food insecurity, may contribute to chronic inflammation and heightened immune dysregulation, both of which have been implicated in the pathophysiology of obstructive respiratory diseases (Mendoza et al., 2024). For example, deficiencies in micronutrients, such as vitamins C and D, commonly observed in food-insecure individuals, are associated with impaired lung function and increased susceptibility to respiratory infections (Ma et al., 2021). Additionally, the chronic stress of food insecurity likely compounds these effects, contributing to elevated levels of stress hormones, such as cortisol, which can aggravate asthma and COPD by promoting inflammation. Environmental factors such as increased exposure to indoor allergens and pollutants in low-income households may further exacerbate respiratory symptoms among food-insecure individuals, compounding health risks.

This analysis highlights that food insecurity has been a pre-pandemic issue and its prevalence has worsened globally. The UN reported an increase

from 23.3% in 2014 to 26.4% in 2018, with approximately 821 million people suffering from hunger in 2019 (Ling et al., 2020). The COVID-19 pandemic has further strained food access, with recent FAO estimates indicating that in 2023, up to 757 million people faced hunger and 2.33 billion were moderately or severely food insecure (The State of Food Security and Nutrition in the World 2024, n.d.). In previous reviews, participants reporting food insecurity showed higher incidences of moderate-to-severe COPD exacerbations, worsened dyspnea, poorer COPD health status, and reduced respiratory-specific quality of life. (Abrams, 2024; Belz, n.d.; Ma et al., 2021; Mahmood et al., 2020; Mendes et al., 2021).

The reported results are consistent with those of previous studies that have demonstrated the relationship between food insecurity and poor health conditions, showing lower functional vital lung capacity and a greater likelihood of spirometric restriction (Mendes et al., 2021). However, this study advances in the literature by performing a detailed analysis of interactions with sociodemographic factors, such as age, education level and socioeconomic status, and smoking.

This provides a more comprehensive view of the multiple factors that mediate the impact of food insecurity on respiratory health. Furthermore, the use of a model adjusted for a large national database, such as the NHANES, allows greater generalization of the results and highlights the relationship at different levels of food security.

In addition to corroborating the existing research, this study reveals novel insights into how the re-

relationship between food insecurity and respiratory health may vary across subgroups. For instance, sensitivity analyses suggest that older adults experience amplified adverse effects of food insecurity on respiratory outcomes, potentially owing to cumulative exposure to chronic stress and nutritional deficiencies over time. Interaction effects further indicate that the negative impact of food insecurity is exacerbated by modifiable factors, such as smoking and lower educational attainment. These results emphasize the importance of addressing multiple intersecting vulnerabilities to mitigate respiratory health disparities in socioeconomically disadvantaged populations.

However, this study has some limitations. Reliance on self-reported diagnoses introduces the possibility of reporting bias, particularly among individuals with lower access to healthcare, who may under-report respiratory conditions. This limitation may disproportionately affect subgroups with lower socioeconomic status, potentially underestimating the true burden of respiratory disease in food-insecure populations. The absence of objective measures, such as spirometry data, further restricts the ability to assess specific impairments in lung function. Furthermore, the cross-sectional design limits causal inference. Although statistical models adjust for potential confounders, unmeasured variables, such as medication use, preexisting conditions, and family history of respiratory disease, may influence the observed associations, as may lifestyle changes in individuals with severe respiratory disease. Finally, because the study uses data from 2005–2006, temporal changes in the prevalence of food insecurity and respiratory conditions may affect the generalizability of the findings to current populations.

Despite the limitations, this study reinforces the importance of considering food insecurity as a social determinant of health, with substantial impacts on respiratory health. The relationship between food insecurity and respiratory diseases reflects structural public health issues that may be replicable in other contexts with similar socioeconomic challenges. Public policies that address food insecurity, especially in vulnerable populations, can reduce the burden of respiratory diseases. Targeted nutritional interventions, food assistance programs, and initiatives that improve access to education and health services are potential strategies to mitigate these adverse effects.

Future research could clarify the specific nutritional and environmental pathways that link food insecurity to respiratory disease. Longitudinal studies incorporating objective clinical assessments could provide deeper insights into the causal relationships while exploring how targeted nutrition or lifestyle interventions might mitigate respiratory risk among

food-insecure populations. The connection between food insecurity and respiratory illnesses highlights the potential of health programs that could offer aid to make a significant difference in the management and prevention of respiratory diseases among individuals, especially in low-income populations.

Conclusion

This study demonstrates a significant association between food insecurity and respiratory health outcomes among U.S. adults, specifically asthma, chronic bronchitis, and emphysema. Individuals with "Low" and "Very Low" food security face higher chances of respiratory conditions compared to fully food-secure individuals. These elevated odds, even after adjusting for confounders, such as age, smoking, education, and race/ethnicity, highlight the role of socioeconomic factors in respiratory health. Furthermore, interaction effects indicate that the risks associated with low food security are amplified in subgroups with higher smoking rates and lower education, suggesting that the impact of food insecurity on respiratory health is compounded by lifestyle and demographic factors.

The findings highlight that food insecurity is significantly associated with an increased risk of obstructive respiratory conditions such as asthma, chronic bronchitis, and emphysema, even after accounting for sociodemographic and behavioral confounders. The amplified risks observed in vulnerable subgroups, such as older adults and those with lower socioeconomic status, underscore the urgent need for targeted interventions. Addressing food insecurity could reduce respiratory health disparities and improve outcomes in at-risk populations, supporting the development of integrated public health policies. Future research should further elucidate these relationships and explore targeted interventions that address the root causes of food insecurity.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

- Abrams, E. M. (2024). Food insecurity and respiratory ill health. In *Inequalities in Respiratory Health* (pp. 61–67). European Respiratory Society. <https://doi.org/10.1183/2312508X.10003722>

- Belz, D. C., Woo, H., Jackson, M. K., Putcha, N., Fawzy, A., Lorizio, W., McCormack, M. C., Eakin, M. N., Hanson, C. K., & Hansel, N. N. (2024). Food Insecurity is Associated With COPD Morbidity and Perceived Stress. *Chronic obstructive pulmonary diseases* (Miami, Fla.), 11(1), 47–55. <https://doi.org/10.15326/jcopdf.2023.0440>
- Berthon, B. S., & Wood, L. G. (2015). Nutrition and respiratory health—Feature review. *Nutrients*, 7(3), 1618–1643. <https://doi.org/10.3390/nu7031618>
- Corbera-Hincapie, M. A., Atteih, S. E., Stransky, O. M., Weiner, D. J., Yann, I. M., & Kazmerski, T. M. (2022). Experiences and Perspectives of Individuals with Cystic Fibrosis and Their Families Related to Food Insecurity. *Nutrients*, 14(13), 2573. <https://doi.org/10.3390/nu14132573>
- Greene, C. M., & Abdulkadir, M. (2024). Global respiratory health priorities at the beginning of the 21st century. *European Respiratory Review: An Official Journal of the European Respiratory Society*, 33(172), 230205. <https://doi.org/10.1183/16000617.0205-2023>
- Idrose, N. S., Lodge, C. J., Erbas, B., Douglass, J. A., Bui, D. S., & Dharmage, S. C. (2022). A Review of the Respiratory Health Burden Attributable to Short-Term Exposure to Pollen. *International Journal of Environmental Research and Public Health*, 19(12), 7541. <https://doi.org/10.3390/ijerph19127541>
- Lim, J. T., Ly, N. P., Willen, S. M., Iwanaga, K., Gibb, E. R., Chan, M., Church, G. D., Neemuchwala, F., & McGarry, M. E. (2022). Food insecurity and mental health during the COVID-19 pandemic in cystic fibrosis households. *Pediatric Pulmonology*, 57(5), 1238–1244. <https://doi.org/10.1002/ppul.25850>
- Ma, N. L., Peng, W., Soon, C. F., Noor Hassim, M. F., Misbah, S., Rahmat, Z., Yong, W. T. L., & Sonne, C. (2021). Covid-19 pandemic in the lens of food safety and security. *Environmental Research*, 193, 110405. <https://doi.org/10.1016/j.envres.2020.110405>
- Mahmood, S., Cheetham, S., Brown, L., Hawcutt, D., Lawrence, P., Mayell, S., Narayan, O., Simba, J., Thomas, M., & Sinha, I. (2020). A systematic review of the impact of food insecurity on the risk of developing asthma, or having poor asthma control, in childhood. *European Respiratory Journal*, 56(suppl 64). <https://doi.org/10.1183/13993003.congress-2020.3510>
- Mangini, L. D., Hayward, M. D., Dong, Y. Q., & Forman, M. R. (2015). Household Food Insecurity is Associated with Childhood Asthma. *The Journal of Nutrition*, 145(12), 2756–2764. <https://doi.org/10.3945/jn.115.215939>
- Mendes, F. de C., Ducharme-Smith, K., Mora-Garcia, G., Alqahtani, S. A., Ruiz-Diaz, M. S., Moreira, A., Villegas, R., & Garcia-Larsen, V. (2021). Household Food Insecurity, Lung Function, and COPD in US Adults. *Nutrients*, 13(6), 2098. <https://doi.org/10.3390/nu13062098>
- Mendoza, K., Calero, P., Etland, C., & Connelly, C. D. (2024). Food Insecurity Status and Health Care Utilization Among COPD Patients: A Retrospective Study. *Western Journal of Nursing Research*, 46(10), 811–820. <https://doi.org/10.1177/01939459241274850>
- NHANES Questionnaires, Datasets, and Related Documentation. (n.d.). Retrieved November 1, 2024, from <https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2005>
- Ribeiro-Silva, R. de C., Oliveira-Assis, A. M., Junqueira, S. B., Fiaccone, R. L., Dos Santos, S. M. C., Barreto, M. L., de Jesus Pinto, E., da Silva, L. A., Rodrigues, L. C., & Alcantara-Neves, N. M. (2014). Food and nutrition insecurity: A marker of vulnerability to asthma symptoms. *Public Health Nutrition*, 17(1), 14–19. <https://doi.org/10.1017/S1368980012005551>
- The State of Food Security and Nutrition in the World 2024. (n.d.). Retrieved November 1, 2024, from <https://openknowledge.fao.org/items/09ed8fec-480e-4432-832c-5b56c672ed92>
- USDA ERS - Definitions of Food Security. (n.d.). Retrieved November 1, 2024, from <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/definitions-of-food-security/>