

Examining The Relationship Between Food Insecurity, Nutrition, And Chronic Disease Risk Factors: Implications For Public Health Interventions

Yousef Mohammed Alshammari¹, Amal Hamdan Al Enezi²,
Amal Hussain Alsadah³, Saleh Taya Saleh Bawazeer⁴, Nuha
Sameer Al Anizi⁵, Awad Mohmmdh Al Qahtani⁶

¹Staff Nurse

²Clinical Nurse Coordinator (Cnc)

³Clinical Resource Nurse (Crn)

⁴Endoscopy Technician

⁵Nurse Manager

⁶Endoscopy Technician

Abstract

Food insecurity is a pressing public health issue that affects millions of individuals worldwide and is associated with poor nutrition and increased risk of chronic diseases. This review examines the relationship between food insecurity, nutrition, and chronic disease risk factors to inform public health interventions aimed at addressing this complex issue. We conducted a comprehensive literature review to synthesize current evidence on the pathways through which food insecurity influences dietary intake, nutritional status, and chronic disease risk factors.

Our findings highlight that food insecurity is associated with inadequate access to nutritious foods, leading to deficiencies in essential nutrients such as vitamins, minerals, and fiber. Individuals experiencing food insecurity are more likely to consume energy-dense, nutrient-poor foods, which can contribute to obesity, diabetes, cardiovascular disease, and other chronic conditions. Moreover, food insecurity is linked to disparities in diet quality, food access, and health outcomes across diverse populations, including children, elderly adults, racial and ethnic minorities, and low-income individuals. Public health interventions to address food insecurity should prioritize strategies that improve access to

healthy, affordable foods, promote nutrition education and cooking skills, and address social determinants of health that contribute to food insecurity. By addressing the underlying drivers of food insecurity and promoting healthy eating behaviors, policymakers, healthcare providers, and community organizations can mitigate the impact of food insecurity on chronic disease risk factors and improve population health outcomes.

Keywords: food insecurity, nutrition, chronic disease, public health interventions, diet quality, social determinants of health, health disparities, dietary intake, vulnerable populations, access to healthy foods.

Introduction

1.1. Research Background

Food insecurity is a pressing public health issue that affects millions of individuals and families globally, with significant implications for health and well-being (Ivers, L.C. ed., 2015). Food insecurity is defined as the limited or uncertain access to adequate and nutritious food due to financial constraints or other barriers. According to the Food and Agriculture Organization (FAO), approximately 820 million people worldwide suffer from chronic hunger, while millions more experience varying degrees of food insecurity. In developed countries, including the United States, food insecurity is a prevalent concern, affecting vulnerable populations such as low-income households, children, the elderly, and minority groups . Research has consistently shown that food insecurity is associated with a range of adverse health outcomes, including malnutrition, micronutrient deficiencies, obesity, diabetes, cardiovascular disease, and other chronic conditions. Individuals experiencing food insecurity often face challenges in obtaining and affording healthy foods, leading to poor dietary choices and compromised nutritional status. Moreover, the stress and anxiety associated with food insecurity can have negative impacts on mental health and overall quality of life (Weaver, L.J. and Fasel, C.B., 2018).

Despite the growing recognition of the health implications of food insecurity, there remains a need for

further research to deepen our understanding of the underlying mechanisms and pathways through which food insecurity influences health outcomes. Additionally, there is a lack of comprehensive studies that examine the relationship between food insecurity, nutrition, and chronic disease risk factors, particularly in the context of vulnerable populations. Understanding these complex interactions is essential for informing the development of effective public health interventions aimed at addressing food insecurity and improving health outcomes (Himmelgreen, et al.,; Hawkins and Panzera,; Gregory and Coleman- Jensen, 2017).

1.2. Research Problem

The research problem addressed in this study is the complex relationship between food insecurity, nutrition, and chronic disease risk factors, and the implications for public health interventions. While the adverse health effects of food insecurity are well-documented, there is a need for in-depth research that explores the underlying mechanisms through which food insecurity influences dietary patterns, nutritional status, and chronic disease risk factors (Raj, S., 2020). Additionally, limited studies have examined the effectiveness of existing public health interventions in addressing food insecurity and improving health outcomes among vulnerable populations (Bergmans, et al., 2018). Furthermore, disparities in food access and nutrition contribute to health inequities, with marginalized communities bearing a disproportionate burden of food insecurity and related health issues. Understanding the social determinants of food insecurity and its impact on health disparities is critical for developing targeted interventions that address the root causes of the problem. By investigating these complex interconnections, this research aims to contribute valuable insights to the field of public health and inform evidence-based strategies for mitigating the adverse effects of food insecurity on health and well-being .

Research Questions:

1. What are the key factors contributing to food insecurity among vulnerable populations, and how do these factors impact dietary choices and nutritional status?
2. How does food insecurity influence the prevalence of chronic disease risk factors, such as obesity,

hypertension, and diabetes, among individuals and communities?

3. What are the existing public health interventions aimed at addressing food insecurity, improving nutrition, and reducing chronic disease risk factors, and what are their effectiveness and limitations?

1.3. Aim and Objectives

The aim of this research is to examine the relationship between food insecurity, nutrition, and chronic disease risk factors and to identify implications for public health interventions. The specific objectives of the study are:

1. To assess the prevalence and determinants of food insecurity among vulnerable populations.
2. To investigate the impact of food insecurity on dietary patterns, nutritional status, and chronic disease risk factors.
3. To evaluate existing public health interventions targeting food insecurity, nutrition, and chronic disease risk factors.
4. To propose evidence-based recommendations for the development of effective public health interventions to address food insecurity and improve health outcomes.

1.4. Research Significance

This study is significant for several reasons. First, it addresses a critical public health issue by examining the complex relationship between food insecurity, nutrition, and chronic disease risk factors. By deepening our understanding of these interconnections, this research has the potential to inform evidence-based interventions that can effectively address food insecurity and improve health outcomes for vulnerable populations.

Second, this study contributes to the existing body of knowledge by filling important research gaps in the field of food insecurity and health. By investigating the underlying mechanisms through which food insecurity influences dietary patterns, nutritional status, and chronic disease risk factors, this research can provide valuable insights that can guide the development of targeted interventions and policies aimed at

reducing the burden of food insecurity and promoting health equity. Lastly, this study has practical implications for public health practice and policy. By identifying the specific needs of vulnerable populations affected by food insecurity and evaluating the effectiveness of interventions in addressing these needs, this research can help inform the design and implementation of programs that are tailored to the unique challenges faced by different groups. Ultimately, the findings from this study have the potential to drive positive change in public health efforts to combat food insecurity and improve health outcomes for all individuals and communities.

II. Food Insecurity and Dietary Patterns

2.1. Overview of Food Insecurity

Food insecurity is a pervasive issue affecting millions of individuals and households worldwide. It is defined as the lack of consistent access to enough food for an active, healthy life. Food insecurity can manifest in various forms, ranging from uncertainty about where the next meal will come from to limited access to nutritious and culturally appropriate foods. This condition is often driven by economic constraints, social inequalities, and systemic barriers that prevent individuals from obtaining an adequate and balanced diet (Sassi, M., Sassi and Acocella, 2018).

Food insecurity is a complex and multifaceted problem that impacts individuals of all ages, backgrounds, and socioeconomic statuses. It can have profound consequences on physical, mental, and social well-being, leading to malnutrition, chronic diseases, poor academic performance, and increased healthcare costs. Food insecurity is also closely linked to poverty, unemployment, inadequate social support systems, and food deserts, where access to fresh and affordable food is limited (Cafiero, C., 2019).

In recent years, the prevalence of food insecurity has been exacerbated by global crises such as the COVID-19 pandemic, natural disasters, and economic downturns. Vulnerable populations, including low-income households, children, the elderly, and minority groups, are disproportionately affected by food insecurity due to existing disparities in access to resources and social determinants of health. Addressing

food insecurity requires a comprehensive approach that involves policy interventions, community partnerships, and individual empowerment to ensure that all individuals have access to safe, nutritious, and culturally appropriate food (Musumari, et al., 2015).

2.2. Importance of Nutrition and Health Outcomes

Nutrition plays a crucial role in maintaining overall health and well-being. A balanced diet rich in essential nutrients is essential for growth, development, immune function, and disease prevention. Adequate nutrition is particularly important during critical life stages such as pregnancy, infancy, and childhood, as it can have long-lasting effects on physical and cognitive development. Poor nutrition, on the other hand, can lead to a range of health problems, including malnutrition, obesity, diabetes, cardiovascular diseases, and mental health disorders (Ohuruogu, et al., 2019).

The link between food insecurity, nutrition, and health outcomes is well-established in the literature. Individuals experiencing food insecurity are more likely to have limited access to healthy foods, leading to dietary deficiencies, micronutrient imbalances, and poor dietary quality. These nutritional inadequacies can contribute to a higher risk of chronic diseases, compromised immune function, cognitive impairments, and reduced quality of life (Davison, et al., 2017).

Furthermore, food insecurity can perpetuate a cycle of poverty and poor health outcomes, making it challenging for individuals to break free from the constraints of their circumstances. Addressing food insecurity and promoting nutrition security are critical components of public health efforts to improve population health, reduce health inequities, and enhance the overall well-being of communities. By recognizing the importance of nutrition in health outcomes and addressing the root causes of food insecurity, we can work towards creating a more equitable and healthier society for all individuals (Ayala,

A. and Meier, B.M., 2017).

2.3. Impact of Food Insecurity on Dietary Patterns

Food insecurity can have a profound impact on individuals' dietary patterns and nutrient intake. When faced with limited access to affordable and nutritious food options, individuals experiencing food insecurity may resort to less healthy and lower-cost alternatives. This can lead to a diet that is high in processed foods, sugary beverages, and refined carbohydrates, while lacking in essential nutrients such as fruits, vegetables, lean proteins, and whole grains. As a result, individuals may experience imbalances in their macronutrient and micronutrient intake, which can contribute to nutritional deficiencies and poor health outcomes .

Moreover, food insecurity can disrupt the regularity of meals and lead to irregular eating patterns, including skipping meals or reducing portion sizes to stretch limited food supplies. These disruptions in eating habits can impact individuals' metabolism, energy levels, and overall nutritional status, further exacerbating the risk of malnutrition and chronic diseases. Additionally, the stress and anxiety associated with food insecurity can also influence individuals' food choices and eating behaviors, potentially leading to emotional eating, binge eating, or other maladaptive coping mechanisms.

2.4. Studies on Food Insecurity and Dietary Intake

Numerous studies have examined the relationship between food insecurity and dietary intake, highlighting the significant impact of food insecurity on individuals' nutritional status and health outcomes. Research has consistently shown that individuals experiencing food insecurity are more likely to have diets that are low in essential nutrients, such as vitamins, minerals, and dietary fiber, while being high in unhealthy fats, sugars, and sodium. These dietary patterns are associated with an increased risk of obesity, diabetes, cardiovascular diseases, and other chronic conditions . Furthermore, studies have demonstrated disparities in dietary quality and nutrient intake among different population groups affected by food insecurity, including children, pregnant women, older adults, and minority populations. These disparities underscore the importance of addressing food insecurity as a public health priority to improve dietary patterns, promote healthy eating behaviors, and prevent nutrition- related diseases in vulnerable populations .

2.5. Influence of Food Insecurity on Food Choices

Food insecurity can significantly influence individuals' food choices and purchasing decisions, as they navigate limited resources and competing priorities. When faced with financial constraints, individuals may prioritize purchasing cheaper and less nutritious foods over healthier options, in order to stretch their food budget and feed their families. This can result in a reliance on energy-dense, nutrient-poor foods that are high in calories but low in essential nutrients, contributing to a cycle of poor dietary quality and health outcomes .

Moreover, food insecurity can impact individuals' access to fresh, affordable, and culturally appropriate foods, particularly in low-income neighborhoods and food deserts. Limited access to grocery stores, farmers' markets, and other sources of fresh produce can further restrict individuals' food choices and hinder their ability to maintain a balanced and varied diet. As a result, individuals experiencing food insecurity may face challenges in meeting their nutritional needs and achieving optimal health outcomes

III. Food Insecurity and Nutritional Status

3.1. Relationship between Food Insecurity and Nutritional Deficiencies Food insecurity is closely linked to nutritional deficiencies, as individuals facing limited access to adequate and nutritious food are at a higher risk of not meeting their daily nutrient requirements. When individuals do not have consistent access to a variety of foods that provide essential nutrients, they are more likely to experience deficiencies in key vitamins, minerals, and other micronutrients. Common nutritional deficiencies associated with food insecurity include deficiencies in iron, vitamin D, calcium, vitamin B12, and folate, among others .

3.2. Studies on Micronutrient Intake and Food Insecurity

Numerous studies have examined the relationship between food insecurity and micronutrient intake, highlighting the impact of food insecurity on individuals' nutritional status. Research has shown that individuals experiencing food insecurity are more likely to have inadequate intake of key micronutrients, such as vitamin C, vitamin E, magnesium, and zinc, compared to food-secure individuals. These deficiencies can have negative consequences on individuals' health, including impaired immune function,

cognitive deficits, and increased susceptibility to chronic diseases . Furthermore, studies have also demonstrated disparities in micronutrient intake among different population groups affected by food insecurity, such as children, pregnant women, and older adults. For example, children living in food-insecure households may be at a higher risk of micronutrient deficiencies due to inadequate access to nutrient-dense foods essential for growth and development. Pregnant women experiencing food insecurity may face challenges in meeting their increased nutrient needs during pregnancy, which can impact maternal and fetal health outcomes .

Effects of Food Insecurity on Overall Nutritional Status

Food insecurity can have a profound impact on individuals' overall nutritional status, leading to imbalances in macronutrient and micronutrient intake that can compromise their health and well-being. Inadequate access to a variety of nutrient-rich foods can result in suboptimal nutrient intake, which can contribute to nutritional deficiencies and poor health outcomes. Additionally, the stress and anxiety associated with food insecurity can further exacerbate the risk of poor nutrition by influencing individuals' eating behaviors and food choices (Basiry, et al.,; Lopes, et al.,).

Moreover, food insecurity can also affect individuals' ability to maintain a healthy weight and body composition. In some cases, individuals experiencing food insecurity may consume energy-dense, nutrient-poor foods that can contribute to weight gain and obesity, while lacking essential nutrients for overall health. On the other hand, individuals may also experience weight loss and malnutrition due to insufficient caloric intake and inadequate nutrient absorption, leading to a range of health complications .

3.3. Health Implications of Poor Nutrition due to Food Insecurity

Poor nutrition resulting from food insecurity can have significant health implications for individuals, increasing their risk of developing a wide range of chronic diseases and health conditions. Nutritional deficiencies associated with food insecurity, such as iron deficiency anemia, vitamin D deficiency, and inadequate intake of essential fatty acids, can impair immune function, cognitive development, and overall health . Furthermore, poor nutrition due to food insecurity can contribute to the development of obesity, diabetes,

cardiovascular diseases, and other chronic conditions. Individuals experiencing food insecurity may be more likely to consume high-calorie, low-nutrient foods that can lead to weight gain, insulin resistance, and inflammation, increasing their risk of metabolic disorders and cardiovascular complications. Additionally, inadequate intake of key nutrients, such as calcium and vitamin D, can weaken bones and increase the risk of osteoporosis and fractures .

IV. Food Insecurity and Chronic Disease Risk Factors

4.1. Association between Food Insecurity and Chronic Diseases

Food insecurity is closely linked to an increased risk of developing chronic diseases, such as obesity, diabetes, cardiovascular diseases, hypertension, and certain types of cancer. Individuals experiencing food insecurity often face challenges in accessing and affording nutritious foods, leading to poor dietary quality, imbalances in nutrient intake, and unhealthy eating patterns. These factors can contribute to the development and progression of chronic diseases over time (Laraia, B.A., 2013; Seligman, et al., 2010).

4.2. Impact of Food Insecurity on Chronic Disease Risk Factors

Food insecurity can impact several key risk factors for chronic diseases, including obesity, high blood pressure, elevated blood sugar levels, and dyslipidemia. Individuals facing food insecurity may be more likely to consume energy-dense, nutrient-poor foods that are high in sugar, salt, and unhealthy fats,

contributing to weight gain and obesity. Poor dietary quality and inadequate nutrient intake can also lead to metabolic imbalances, insulin resistance, and inflammation, increasing the risk of diabetes and cardiovascular diseases (Jih, et al., 2018).

Moreover, the stress and anxiety associated with food insecurity can further exacerbate chronic disease risk factors by triggering hormonal changes, promoting unhealthy coping behaviors, and affecting individuals' mental and emotional well-being. Chronic exposure to food insecurity can disrupt individuals' physiological responses to stress, leading to dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis and increased production of stress hormones, which can contribute to metabolic dysfunction and

chronic disease development (Ivers, L.C. ed., 2015; Seligman, et al., 2010).

4.3. Studies on Food Insecurity and Chronic Disease Outcomes

Numerous studies have demonstrated the association between food insecurity and chronic disease outcomes, highlighting the impact of food insecurity on individuals' health and well-being. Research has shown that individuals experiencing food insecurity are at a higher risk of developing obesity, type 2 diabetes, cardiovascular diseases, and other chronic conditions compared to food-secure individuals. Longitudinal studies have also found that persistent food insecurity is associated with poorer health outcomes, higher healthcare utilization, and increased mortality rates (Fernandes, et al., 2018; Weiser, et al., 2012).

Furthermore, studies have shown disparities in chronic disease outcomes among different population groups affected by food insecurity, such as children, older adults, racial and ethnic minorities, and individuals with low socioeconomic status. For example, children living in food-insecure households may be more likely to experience obesity and related health issues due to limited access to healthy foods and reliance on low-cost, calorie-dense foods. Older adults facing food insecurity may have higher rates of chronic diseases, functional limitations, and hospitalizations due to inadequate nutrient intake and compromised health status (Leung, et al., 2020; Nagata, et al., 2019).

4.4. Mechanisms Linking Food Insecurity to Chronic Diseases

Several mechanisms have been proposed to explain the link between food insecurity and chronic diseases, including physiological, behavioral, and psychosocial pathways. One key mechanism is the impact of food insecurity on individuals' dietary patterns and nutrient intake, leading to imbalances in energy, macronutrients, and micronutrients that can contribute to metabolic dysregulation, inflammation, and oxidative stress. Inadequate access to nutrient-dense foods can also impair individuals' immune function, hormonal balance, and cellular repair processes, increasing their susceptibility to chronic diseases (Leung, et al., 2020; Nagata, et al., 2019).

Additionally, food insecurity can influence individuals' health behaviors and lifestyle factors that contribute to chronic disease risk, such as physical inactivity, smoking, and alcohol consumption. The stress and uncertainty associated with food insecurity can lead to maladaptive coping strategies, emotional eating, and disordered eating behaviors, further exacerbating chronic disease risk factors. Moreover, food insecurity can impact individuals' mental health, social support networks, and access to healthcare services, affecting their ability to manage chronic conditions and adhere to treatment regimens (Jih, et al., 2018).

VI. Identified Gaps in Research on Food Insecurity

Despite the growing body of literature on food insecurity and its impact on health, there are still several gaps in research that need to be addressed. One key gap is the lack of standardized measures and definitions of food insecurity across studies, which can make it challenging to compare findings and draw meaningful conclusions. Additionally, many studies on food insecurity focus on individual-level factors and outcomes, overlooking the broader social, economic, and environmental determinants of food insecurity that contribute to disparities in access to healthy foods and health outcomes.

There is a lack of research on specific populations that may be disproportionately affected by food insecurity, such as racial and ethnic minorities, immigrant communities, rural populations, and individuals with chronic illnesses or disabilities. Understanding the unique challenges and barriers to food access faced by these populations is crucial for developing targeted interventions and policies to address food insecurity and improve health equity. More research is needed to explore the intersectionality of factors that contribute to food insecurity among diverse populations and inform tailored approaches to support their food security and well-being. While many studies have examined the cross-sectional associations between food insecurity and health outcomes, there is a need for more longitudinal research to understand the long-term impacts of food insecurity on individuals' health trajectories. Longitudinal studies can help elucidate the causal relationships between food insecurity and chronic diseases, mental health outcomes, and healthcare utilization over time, providing valuable insights into the mechanisms underlying these associations and

informing preventive strategies and interventions. By tracking individuals' experiences of food insecurity and health outcomes longitudinally, researchers can better capture the complex interplay of factors that influence individuals' vulnerability to poor health outcomes and inform targeted interventions to mitigate these risks. Further research is needed to explore the effectiveness of interventions and policies aimed at reducing food insecurity and improving health outcomes among at-risk populations. Evaluating the impact of nutrition assistance programs, community-based initiatives, and economic policies on food security, dietary quality, and health outcomes can help identify best practices and inform evidence-based strategies to address food insecurity at the individual, community, and policy levels. Additionally, research on the social determinants of food insecurity, such as income inequality, housing instability, and food deserts, can inform upstream approaches to prevent food insecurity and promote health equity. Policy implications of addressing food insecurity include the need for comprehensive, multi-sectoral strategies that address the root causes of food insecurity, such as poverty, unemployment, and inadequate social support systems. Policy interventions that strengthen social safety nets, improve access to affordable housing, and enhance economic opportunities for vulnerable populations can help alleviate food insecurity and its adverse health consequences. Collaborative efforts between government agencies, healthcare providers, community organizations, and advocacy groups are essential for developing and implementing sustainable solutions to food insecurity and advancing health equity for all individuals.

VII. Conclusion

5.1. Summary of Key Findings

The study has highlighted several key findings regarding the relationship between food insecurity, nutrition, and chronic disease risk factors. Food insecurity is associated with inadequate access to nutritious foods, leading to deficiencies in essential nutrients and poor diet quality. Individuals experiencing food insecurity are more likely to consume energy-dense, nutrient-poor foods, which can contribute to obesity, diabetes, cardiovascular disease, and other chronic conditions. Disparities in diet quality, food access, and health outcomes are evident across diverse populations, including children, elderly adults, racial and ethnic

minorities, and low-income individuals. Addressing food insecurity is crucial for improving nutrition and reducing chronic disease risk factors among vulnerable populations.

5.2. Implications for Public Health Practice and Policy:

The findings from this study have important implications for public health practice and policy. Public health practitioners and policymakers should prioritize strategies that improve access to healthy, affordable foods, promote nutrition education and cooking skills, and address social determinants of health that contribute to food insecurity. Collaborative efforts between government agencies, healthcare providers, community organizations, and advocacy groups are essential for developing and implementing sustainable solutions to food insecurity and promoting health equity for all individuals. Policy interventions that strengthen social safety nets, improve access to affordable housing, and enhance economic opportunities for vulnerable populations can help alleviate food insecurity and its adverse health consequences.

5.3. Recommendations for Future Research Directions:

Based on the study, several recommendations for future research directions are proposed:

(1) Longitudinal Studies: Conduct longitudinal studies to understand the long-term impacts of food

insecurity on individuals' health trajectories and chronic disease outcomes.

(2) Intersectionality of Factors: Explore the intersectionality of factors that contribute to food insecurity

among diverse populations to inform tailored interventions and policies.

(3) Effectiveness of Interventions: Evaluate the impact of interventions and policies aimed at reducing

food insecurity and improving health outcomes among at-risk populations.

(4) Social Determinants of Food Insecurity: Research on the social determinants of food insecurity, such

as income inequality, housing instability, and food deserts, to inform upstream approaches to prevent food insecurity and promote health equity.

(5) Policy Implications: Examine the policy implications of addressing food insecurity and develop comprehensive, multi-sectoral strategies to address the root causes of food insecurity.

By addressing these research gaps and recommendations, we can advance our understanding of food

insecurity, nutrition, and chronic disease risk factors, and inform evidence-based strategies to promote health equity and improve population health outcomes. Overall, addressing food insecurity is essential for promoting health equity, preventing chronic diseases, and improving overall well-being among individuals and communities. Collaborative efforts between researchers, policymakers, healthcare providers, community organizations, and advocacy groups are crucial for developing comprehensive solutions to food insecurity and advancing health for all. Together, we can work towards creating a more equitable and sustainable food system that ensures all individuals have access to nutritious and affordable foods.

References

Agurs-Collins, T., Alvidrez, J., Ferreira, S.E., Evans, M., Gibbs, K., Kowtha, B., Pratt, C., Reedy, J.,

Shams-White, M. and Brown, A.G.,. Perspective: Nutrition health disparities framework: a model to advance health equity. *Advances in Nutrition*, p.100194.

Ayala, A. and Meier, B.M., 2017. A human rights approach to the health implications of food and nutrition insecurity. *Public Health Reviews*, 38, pp.1-22.

Bergmans, R.S., Palta, M., Robert, S.A., Berger, L.M., Ehrental, D.B. and Malecki, K.M., 2018.

Associations between food security status and dietary inflammatory potential within lower-income adults from the United States national health and nutrition examination survey, cycles 2007 to 2014. *Journal of the Academy of Nutrition and Dietetics*, 118(6), pp.994-1005.

Cafiero, C., 2019. Measuring food insecurity. In Food security policy, evaluation and impact assessment (pp. 169-205). Routledge.

Castro, M.A.D., Fontanelli, M.D.M., Nogueira-de-Almeida, C.A. and Fisberg, M.,. Food insecurity reduces the chance of following a nutrient-dense dietary pattern by Brazilian adults: insights from a nationwide cross-sectional survey. *Nutrients*, 14(10), p.2126.

Davison, K.M., Gondara, L. and Kaplan, B.J., 2017. Food insecurity, poor diet quality, and suboptimal

intakes of folate and iron are independently associated with perceived mental health in Canadian adults. *Nutrients*, 9(3), p.274.

De Araujo, M.L., de Deus Mendonça, R., Lopes Filho, J.D. and Lopes, A.C.S., 2018. Association between food insecurity and food intake. *Nutrition*, 54, pp.54-59. and food insecurity on obesity in high-income countries. *Food Science & Nutrition*, 10(11), pp.3689-3723.

Facina, V.B., Fonseca, R.D.R., da Conceição-Machado, M.E.P., Ribeiro-Silva, R.D.C., Dos Santos,

S.M.C. and de Santana, M.L.P.,. Association between Socioeconomic Factors, Food Insecurity, and Dietary Patterns of Adolescents: A Latent Class Analysis. *Nutrients*, 15(20), p.4344.

Fernandes, S.G., Rodrigues, A.M., Nunes, C., Santos, O., Gregório, M.J., De Sousa, R.D., Dias, S. and Canhão, H., 2018. Food insecurity in older adults: Results from the epidemiology of chronic diseases cohort study 3. *Frontiers in medicine*, 5, p.203.

Gregory, C.A. and Coleman-Jensen, A., 2017. Food insecurity, chronic disease, and health among working-age adults.

Ivers, L.C. ed., 2015. Food insecurity and public health (pp. xxii+-232). Boca Raton, Fla, USA: CRC Press.

Jun, S., Cowan, A.E., Dodd, K.W., Tooze, J.A., Gahche, J.J., Eicher-Miller, H.A., Guenther, P.M., Dwyer,

J.T., Potischman, N., Bhadra, A. and Forman, M.R.. Association of food insecurity with dietary intakes

and nutritional biomarkers among US children, National Health and Nutrition Examination Survey (NHANES) 2011–2016. *The American Journal of Clinical Nutrition*, 114(3), pp.1059-1069.

Laraia, B.A., 2013. Food insecurity and chronic disease. *Advances in Nutrition*, 4(2), pp.203-212.

Leung, C.W., Kullgren, J.T., Malani, P.N., Singer, D.C., Kirch, M., Solway, E. and Wolfson, J.A., 2020.

Food insecurity is associated with multiple chronic conditions and physical health status among older US adults. *Preventive medicine reports*, 20, p.101211.

Lopes, S.O., Abrantes, L.C.S., Azevedo, F.M., Morais, N.D.S.D., Morais, D.D.C., Gonçalves, V.S.S.,

Fontes, E.A.F., Franceschini, S.D.C.C. and Priore, S.E.,. Food insecurity and micronutrient deficiency in adults: a systematic review and meta-analysis. *Nutrients*, 15(5), p.1074.

Musumari, P.M., Techasrivichien, T., Suguimoto, S.P., Ndarabu, A., Mboyo, A., Ngasia, B., El-Saaidi,

C., Lukhele, B.W., Ono-Kihara, M. and Kihara, M., 2015. Undernutrition, food insecurity, and antiretroviral outcomes: an overview of evidence from sub-Saharan Africa. *Health of HIV Infected People*, pp.181-201.

Nagata, J.M., Palar, K., Gooding, H.C., Garber, A.K., Bibbins-Domingo, K. and Weiser, S.D., 2019. Food insecurity and chronic disease in US young adults: findings from the National Longitudinal Study of Adolescent to Adult Health. *Journal of General Internal Medicine*, 34, pp.2756-2762.

Parekh, T., Xue, H., Cheskin, L.J. and Cuellar, A.E.,. Food insecurity and housing instability as

determinants of cardiovascular health outcomes: a systematic review. *Nutrition, Metabolism and Cardiovascular Diseases*, 32(7), pp.1590-1608.

Payán, D.D., Rios, L.K.D., Ramírez, A.S. and Young, M.E.D.T.,. Structural barriers influencing food

insecurity, malnutrition, and health among Latinas during and after COVID-19: considerations and

recommendations. *Journal of the Academy of Nutrition and Dietetics*, 121(5), p.837.

Raj, S., 2020. Influences of the nutrition transition on chronic disease. *Integrative and Functional Medical Nutrition Therapy: Principles and Practices*, pp.17-29.

Sassi, M., Sassi and Acocella, 2018. *Understanding food insecurity*. Cham: Springer.

Seligman, H.K., Laraia, B.A. and Kushel, M.B., 2010. Food insecurity is associated with chronic disease among low-income NHANES participants. *The Journal of nutrition*, 140(2), pp.304-310.

Weaver, L.J. and Fasel, C.B., 2018. A systematic review of the literature on the relationships between chronic diseases and food insecurity. *Food and Nutrition Sciences*, 9(05), p.519.

Weiser, S.D., Tsai, A.C., Gupta, R., Frongillo, E.A., Kawuma, A., Senkungu, J., Hunt, P.W., Emenyonu,

N.I., Mattson, J.E., Martin, J.N. and Bangsberg, D.R., 2012. Food insecurity is associated with morbidity and patterns of healthcare utilization among HIV-infected individuals in a resource-poor setting. *Aids*, 26(1), pp.67-75.

Zarei, M., Qorbani, M., Djalalinia, S., Sulaiman, N., Subashini, T., Appanah, G. and Naderali, E.K.,. *Food*

Insecurity and dietary intake among elderly population: a systematic review. *International journal of preventive medicine*, 12(1), p.8.