



Fatty Liver Disease and Food Insecurity: Excess in Scarcity

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Abstract

Purpose of Review Nonalcoholic fatty liver disease (NAFLD) is widely prevalent in the U.S and is the primary cause of chronic liver disease. Existing evidence shows that food insecurity may be an independent risk factor for fatty liver disease and is associated with poor health outcomes. Understanding the role of food insecurity in these patients can help develop mitigation strategies to address the growing prevalence of NAFLD.

Recent Findings Food insecurity is associated with increased overall mortality and health care utilization among patients with NAFLD and advanced fibrosis. Individuals from low-income households with diabetes and obesity are particularly susceptible. Trends in prevalence of NAFLD mirror that of obesity and other cardiometabolic risk factors. Several studies in both adult and adolescent population have described an independent association between food insecurity and NAFLD.

Summary Concentrated efforts to lessen food insecurity may improve health outcomes in this group of patients. High-risk patients with NAFLD should be linked with local and federal supplemental food assistance programs. Programs directed at addressing NAFLD-related mortality and morbidity should focus on improving food quality, access to these foods, and promote healthy eating habits.

Keywords Food insecurity · Nonalcoholic fatty liver disease · NAFLD · Nonalcoholic steatohepatitis · Fibrosis · NASH · Cirrhosis

Introduction

Food insecurity is defined as a lack of access to nutritious food in a consistent manner due to socioeconomic constraints [1]. Nearly 13 million households in the United States (U.S) struggle from food insecurity annually [2]. These numbers continued to rise during the COVID-19 pandemic due to increase in unemployment and lack of access to local and federal assistance programs. Although anyone can be susceptible to food insecurity, individuals from low-income households are particularly at risk. These households often depend on low-cost, energy-rich yet nutritionally

deficient foods. Food insecure individuals are more prone to obesity, diabetes, cardiovascular disease, and other chronic diseases such as fatty liver disease.

In recent years, food insecurity has been identified as a crucial social determinant in individuals with chronic liver disease, particularly nonalcoholic fatty liver disease (NAFLD) and advanced liver fibrosis [3•, 4]. NAFLD is predicted to become a primary indication for liver transplantation by 2030 [5]. NAFLD is associated with excessive fat stores in the liver and affects 1 in 3 adults in the U.S [6]. These fat stores ultimately lead to inflammation and scarring. Advanced liver fibrosis can eventually result in cirrhosis, portal hypertension, and hepatocellular carcinoma (HCC), which may ultimately necessitate liver transplantation. NAFLD is now a leading cause of chronic liver disease worldwide with an estimated global prevalence of 25% [7].

The purpose of this review is to understand the role of food insecurity in NAFLD and summarize available literature. Understanding mechanisms by which these entities co-exist can help develop mitigation strategies and improve health outcomes among NAFLD patients.

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Assessment of NAFLD and Food Insecurity

NAFLD encompasses a spectrum of histopathology, starting from simple fatty liver to nonalcoholic steatohepatitis (NASH) to fibrosis and cirrhosis (Fig. 1). Fibrosis is a crucial predictor of adverse outcomes in patients with NAFLD and is independently associated with progression to cirrhosis and HCC [5]. Diagnosis of fatty liver disease is often incidental. Most individuals are asymptomatic. Abnormal liver tests are noted on routine laboratory testing, usually not more than three times the upper normal limit. Typically, steatosis is present in the absence of secondary causes. Obesity, overweight, or rapid weight gain can result in NAFLD. Rise in prevalence of fatty liver disease parallels rising obesity among U.S. population.

Ultrasound can be used as an initial diagnostic tool however lacks sensitivity in detecting steatosis. Authenticated serological markers such as Hepatic Steatosis Index (HSI), Fatty Liver Index (FLI), and NAFLD Fat Score (NAFLD FS) have area under receiver operating characteristic (AUROC) values of 0.81, 0.83, and 0.80 correspondingly [8, 9]. Transient elastography machines use ultrasound waves to measure steatosis. Controlled attenuation parameter (CAP) is a function of elastography that particularly measures steatosis. Overall, a score of 250 dB/m is considered a reasonable cut-off to confirm diagnosis of NAFLD [10].

Presence of significant fibrosis portends poor prognosis in patients with NAFLD. Serological tests such as enhanced liver fibrosis score, Fibrotest, and Fibrosis-4 (FIB-4) use simple biochemical parameters to calculate degree of fibrosis. Transient elastography can be helpful with additional risk stratification. A meta-analysis

conducted by Kwok et al. evaluated performance of transient elastography in NAFLD patients. A stiffness of 7.5–10.4 kPa has sensitivity and specificity of 0.82 and 0.84 respectively for diagnosis of F3 fibrosis [11]. Most noninvasive testing has limitations when it comes to discriminating between early stages of fibrosis. A liver biopsy may be needed to diagnose NASH and fibrosis in patients identified to be at high risk.

Food insecurity assessment is performed using the U.S. Household Food Security Survey (HFSS) questionnaire. This survey was developed by U.S. Department of Agriculture. This survey consists of 18 items that evaluate food security of a household over a period of 12 months. These questions address availability of food to adults and children in the household, anxiety over inadequate food supply, or fear of food running out, along with quality or quantity of available food. Based on this, households are categorized as having high, marginal, low, or very low food security.

Food Insecurity and NAFLD Among Adult Population

Fatty liver disease in adults has become widely prevalent and is now a common cause of chronic liver disease in the U.S. Several studies have concluded that food insecurity is an independent risk factor for NAFLD and advanced fibrosis (Table 1). A recent study by Tamargo et al. looked at 603 patients with NAFLD and found that 32% of study population experienced food insecurity. In this study, food insecurity was associated with higher odds of liver fibrosis (odds ratio [OR], 1.65; 95% confidence interval [CI]: 1.01–2.72)

Fig. 1 Spectrum of fatty liver disease. Abbreviations: NAFLD, nonalcoholic fatty liver disease; NASH, nonalcoholic steatohepatitis; U.S., United States; HCC, hepatocellular carcinoma

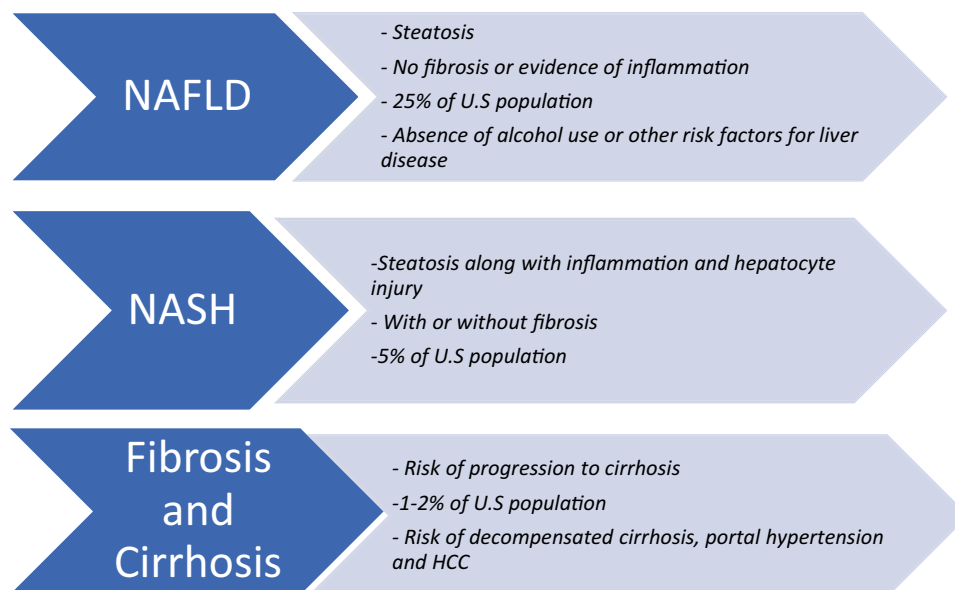


Table 1 Studies evaluating role of food insecurity in fatty liver disease

Authors	Type of study	Food insecurity assessment	Fatty liver disease assessment	Results
Tamargo et al. [12•]	Cross-sectional analysis of middle-aged, low-income, HIV patients from Miami	USDA Household Food Security Survey	MRI liver	<ul style="list-style-type: none"> o Of the total 603 study participants, 32% experienced food insecurity. o Increased odds of NAFLD in obese participants with food insecurity. o Increased odds of liver fibrosis (OR, 1.65; 95% CI, 1.01–2.72) and advanced liver fibrosis (OR, 2.82; 95%CI, 1.22–6.54) among food insecure population.
Kardashian et al. [14]	Cohort study of U.S adults in the NHANES Survey (1994–2014) with NAFLD	USDA Household Food Security Survey	NAFLD—U.S Fatty Liver index Advanced fibrosis – NAFLD fibrosis score, AST to platelet ratio index, Fib-4 Index	<ul style="list-style-type: none"> o Among 4816 NAFLD and 1654 advanced fibrosis patients, 28% and 21% experienced food insecurity respectively. o Food insecurity is associated with greater all-cause mortality in adults with NAFLD (HR, 1.46; 95% CI, 1.08–1.97) and advanced fibrosis (HR, 1.37; 95% CI, 1.01–1.86). o A greater utilization of outpatient resources was seen among food insecure patients with NAFLD (OR, 1.32; 95% CI, 1.05–1.67).
Golovaty et al. [3•]	Cross-sectional analysis of NHANES (2005–2014)	USDA Household Food Security Survey	NAFLD – U.S Fatty liver index Advanced fibrosis – NAFLD fibrosis score	<ul style="list-style-type: none"> o Among 2627 adults, 29% were food insecure. o Food insecure adults were more likely to have NAFLD (OR: 1.38; 95% CI: 1.08–1.77) and advanced fibrosis (adjusted OR: 2.20; 95% CI: 1.27–3.82).
Tutunchi et al. [19]	Case-control study	USDA household food security survey	Liver ultrasonography	<ul style="list-style-type: none"> o Among 210 adults, risk of NAFLD was 2.2 (95% CI: 1.12–3.43) times higher in food insecure group compared to food-secure population. o The odds of NAFLD were also higher in obese population and those with dyslipidemia.
Ley et al. [25•]	Focus group-based study	-	-	<ul style="list-style-type: none"> o Among 16 adolescents with NAFLD, 43.8% of adolescents in the focus group identified as food insecure

USDA United States Department of Agriculture, MRI magnetic resonance imaging, U.S United States, NHANES National Health and Nutrition Examination Survey (NHANES), Fib4 index Fibrosis 4 Index

and cirrhosis (OR, 2.82; 95% CI: 1.22–6.54) [12•]. Food insecurity particularly increased risk of NAFLD among obese patients [12•]. Similar results were also seen in two other studies published from National Health and Nutrition Examination Survey (NHANES). In a study conducted by Golovaty et al., among 2627 adults, 29% reported food insecurity. Food insecure individuals in this study were also more likely to have NAFLD (OR: 1.38; 95% CI: 1.08, 1.77) and advanced fibrosis (adjusted OR: 2.20; 95% CI: 1.27, 3.82) [3•]. A higher all-cause mortality and greater utilization of outpatient health resources were seen among these patients even after excluding those with advanced fibrosis [3•]. This is in alignment with existing literature that assessed use of outpatient resources among patients with chronic diseases, including diabetes and cardiovascular disease [6, 13]. Comparably, Kardashian and colleagues found that 28% of 4816 patients with NAFLD and 21% of 1654 patients with advanced fibrosis experienced food insecurity. Food insecurity was also associated with increased mortality among patients with NAFLD (HR, 1.46; 95% CI, 1.08–1.97) and advanced fibrosis (HR, 1.37; 95% CI, 1.01–1.86) along with higher utilization of outpatient resources (OR, 1.32; 95% CI, 1.05–1.67) [14••].

Food insecurity is particularly prevalent in low-income neighborhoods making this population highly susceptible to NAFLD. Golovaty and colleagues observed such a relationship in their study [3•]. Food insecure adults from these communities often resort to energy-dense, high-fat foods that are nutritionally deficient. A cohort study performed by Nouredin et al. concluded that poor food quality was associated with higher incidence of NAFLD [4]. In a meta-analysis performed by Zadeh and team, the standard Western diet raised the risk of NAFLD by 56% while Mediterranean dietary patterns reduced risk of disease by 23% [15]. A significant positive association between inappropriate dietary patterns and fatty liver disease was also reported by Amirjalali et al. and Yasutake et al. [16, 17].

In addition to lack of access to healthy foods, the food insecure population is also susceptible to financial instability, lack of access to adequate health care, medication non-adherence, and mental health disorders among other limitations (Table 2). NAFLD is likely a result of underlying metabolic disease.

Patients facing food insecurity are susceptible to greater burden of cardiometabolic disease. Emerging data suggest a bidirectional connection between NAFLD, diabetes, and hypertension [18]. A “dose–response” relationship between degree of food insecurity and severity of NAFLD has been described by Golovaty and colleagues [3•]. In previous studies, authors also described increased odds of NAFLD among food insecure adults with metabolic disease such as obesity, hyperlipidemia, and diabetes [3•, 19].

Food Insecurity and NAFLD Among Pediatric Population

Nonalcoholic fatty liver disease is thought to be the most common chronic liver disease in children [20]. A study by Yu et al. that involved screening 408 obese children for NAFLD found that NAFLD is present in 29.4% of obese boys, and 22.6% of obese girls [21]. Prevalence of pediatric NAFLD has been increasing, mirroring the rise in pediatric obesity [22]. In response to the increasing prevalence of pediatric obesity, the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) has provided recommendations on screening for fatty liver disease and obese/overweight children [23].

According to the United States Department of Agriculture (USDA) 2022 report on the prevalence of food insecurity among U.S households in 2021, 12.5% of households with children were found to be food insecure (food insecurity among a parent, child, or both). Food insecurity among children, specifically, was found in 6.2% of households [24].

As in the case of adults, a link between childhood food insecurity and NAFLD is becoming more apparent. A recent study that utilized focus groups to measure the experiences of adolescents diagnosed with NAFLD found that food insecurity was reported by 43.7% of participants. Adolescents in this study reported decreased access to healthy foods in the household [25•]. This poses a concern since dietary change is often recommended to treat NAFLD [26].

A recent retrospective review of questionnaires administered to patients and families seen at a steatohepatitis clinic provides additional insight into the association of food

Table 2 Mechanisms by which food insecurity impacts NAFLD

- Poor food quality and limited food choices resulting in inadequate dietary intake
- Disrupted eating patterns—periods of overconsumption followed by starvation
- Increased risk of metabolic diseases—diabetes, hypertension, and obesity
- Choosing between seeking health care and affording food
- Increased stress, rise in cortisol and systemic inflammation
- Hyperinsulinemia and insulin resistance
- Change in intestinal microbiota

NAFLD nonalcoholic fatty liver disease

insecurity and NAFLD. Orkin et al. administered questionnaires to assess whether these patients were able to meet their health-related social needs. Questionnaires were designed to screen for food insecurity, access to fresh produce, travel/housing difficulties, safety in the neighborhood, and other health-related social needs. The authors identified food insecurity in 13% of respondents by means of this questionnaire. Interestingly, the authors also found that families who were food insecure at the initial visit were 27-fold more likely (when compared to food-secure families) to have persistently unmet health-related social needs at subsequent visits [27].

Although these studies have their limitations (retrospective design, questionnaire/focus group based), they indicate a growing awareness of the association between childhood/family food insecurity and pediatric NAFLD among practitioners. Additional research is needed to further study this association.

Conclusion

An important strategy in management of NAFLD has always been weight loss and controlling underlying metabolic risk factors. However, this individual level strategy is not effective if upstream fundamental drivers of NAFLD are not addressed. Emerging data indicates that food insecurity is an independent risk factor for fatty liver disease. Therefore, addressing food insecurity can reduce prevalence of NAFLD and result in better health outcomes for those already diagnosed with fatty liver, NASH, or advanced fibrosis. However, this may prove to be a challenging endeavor. Food insecurity is widespread and universal. A few strategies that have been proposed include implementation of change from a local level. For example, supporting organizations such as Feeding America and mutual aid funds in addition to participating at local organizations, contacting local government officials, educating local communities, or organizing food drives. Those with financial means may donate at local food banks. Other community-partnered programs such as urban gardens, chronic disease programs, and integrated tailored nutrition programs can support consumption of quality food on a regular basis [28]. A few proposed policy strategies such as soda tax and fresh grocery vouchers can promote intake of nutritious food among low-income adults with NAFLD.

The “Hunger Vital Sign” is a two-question validated screen for childhood food insecurity that is endorsed by the American Academy of Pediatrics (AAP) and is incorporated into the Accountable Health Communities Screening Tool by the Center for Medicare and Medicaid Services [29–31]. This screening tool has also previously been endorsed for use in adult population [32]. Given the effect that food insecurity may have on the management of NAFLD, routine screening for food insecurity with validated screening tools may be considered in the practitioner’s office. Interventions

to support at risk population may reduce progression of fibrosis and offset annual health care costs of almost 100 billion that is attributed to NAFLD in our country [33].

To have a lasting change and truly work towards reducing mortality and morbidity associated with fatty liver disease, we must address the underlying etiology. Addressing food insecurity like a public health issue could result in improved outcomes for patients suffering from fatty liver disease.

Compliance with Ethical Standards

Conflict of Interest The authors do not have any potential conflicts of interest to disclose.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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