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RESEARCH NOTE

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The association of food insecurity with non-alcoholic fatty liver disease (NAFLD) in a sample of Iranian adults: a path analysis of a cross-sectional survey

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Abstract

Objectives The present study aims to examine the hypothetical model of the relationship between food insecurity and Non-alcoholic fatty liver disease (NAFLD) in a sample of Iranian adults.

Methods In this cross-sectional study, 275 subjects (18–70 years old) who met the inclusion criteria were recruited. Fatty liver was diagnosed by abdominal ultrasonography, and eligible patients underwent liver fibro scan assessment to determine fibrosis and steatosis. Food insecurity was assessed using the validated six-item Short Questionnaire of Household Food Security Scale (SQHFSS). Data were analyzed using SPSS 24.0 and IBM SPSS Amos 24.0.

Results Among 275 subjects (44.37 ± 11.67 years old, 51.6% male) included in the analysis, 23.6% were food insecure. Food insecurity, general and abdominal obesity were associated with an increased risk of NAFLD, even after multiple adjustments (OR: 2.95, 95% CI: 1.02, 8.57; OR: 3.27, 95% CI: 1.50, 7.11; and OR: 3.81, 95% CI: 1.55, 9.32, respectively). According to the primary hypothesis, food insecurity and NAFLD were fitted into a model (χ^2/df = 1.36, GFI = 0.982, AGFI = 0.952, CFI = 0.954, IFI = 0.959, SRMR = 0.040, RMSEA = 0.037); accordingly, food insecurity and obesity (general and abdominal) directly affected NAFLD (β = 0.12, *P* = 0.03; β = 0.13, *P* = 0.02; β = 0.31, *P* < 0.001, respectively).

Conclusion Food insecurity was a predictor of, and directly associated with, NAFLD. Social determinants should be considered in the pathogenesis of NAFLD, although the possible underlying biological mechanisms in this association are yet to be determined.

Keywords Food insecurity, Obesity, Non-alcoholic fatty liver disease, Path analysis, Waist circumference

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Introduction

Food insecurity is defined as the inadequate availability of nutritious and safe foods or the limited ability to access foods in a socially acceptable manner [1]. Globally, around 2.3 billion world population suffer from food insecurity. Among these affected people, the greatest portion almost half (1.15 billion) belonged to Asia [2, 3]. According to a recent meta-analysis, the prevalence of general food insecurity has been reported by 56.5% among Iranian adults [4]. Social and economic factors can affect food security [5, 6]. Household economic resources greatly affect the family's capacity to purchase food, which pertains to the food accessibility domain of food security. Numerous pathways link wealth index and socioeconomic status (SES) with food security [7]. For instance, it can be argued that wealthier households are more inclined to obtain and offer nutritious food to family members. Furthermore, research indicates that lower-income households tend to purchase fewer vegetables, fruits, fiber-rich foods, and sugary items than higher-income households [8]. Another study found that families with lower incomes are less inclined to buy recommended healthy foods such as fruits and vegetables, allocating a larger portion of their budget to unhealthy food options. Compared to higher-income households, lower-income households tend to buy foods with lower nutritional value, which may contribute to the observed lower dietary quality among individuals with lower incomes [9]. On the other hand, some studies have reported food insecurity as a metabolic disease risk factor that has an independent effect on controlling blood sugar levels and indicators of dyslipidemia [10, 11]. Since metabolic diseases and Non-alcoholic fatty liver disease (NAFLD) have similar risk factors, food insecurity and NAFLD are posited to be associated [11–13].

Despite the reported associations between food insecurity and metabolic disorders [14, 15], as well as metabolic disorders and NAFLD [16, 17], no prior studies have examined the association of food insecurity with NAFLD in path analysis to assess the mechanisms and mediatory factors.

Given the growing prevalence of NAFLD in many countries, including Iran [18, 19], preventive approaches are needed to reduce their subsequent adverse results. Current individual-level strategies to address NAFLD, such as lifestyle modification for weight loss [20–22], may not be effective in low-income households as they do not address the underlying structural causes of the disease [23]. Therefore, a more comprehensive understanding of how food insecurity contributes to metabolic disorders and NAFLD is needed to develop targeted interventions.

The conceptual framework of the study was adapted from a previous model [23], as well as relevant literature (Fig. 1). Demographic and socioeconomic status along with food insecurity have been established as possible predictive of metabolic disorders, and NAFLD through mechanisms involving appetite-related hormones, increment in ghrelin, neuropeptide Y (NPY), cortisol, and insulin levels associated with obesity, diabetes, and NAFLD [12, 13, 23–25]. Food insecurity could alter the gut microbiota by changing the diet quality (diet with high fat and fructose) and, consequently, cause the risk of obesity and hepatic inflammation [23, 26].

Recent studies indicate a rising prevalence of food insecurity and NAFLD in Iran [4, 27]. Considering the negative health consequences of both, and the absence of prior research on the link between food insecurity and NAFLD using path analysis to address inter-relationships and multiple pathways into a single framework; thus, the present study aims to explore the hypothetical model of the relationship between food insecurity, associated risk factors, metabolic disorders and NAFLD in a sample of Iranian adults.

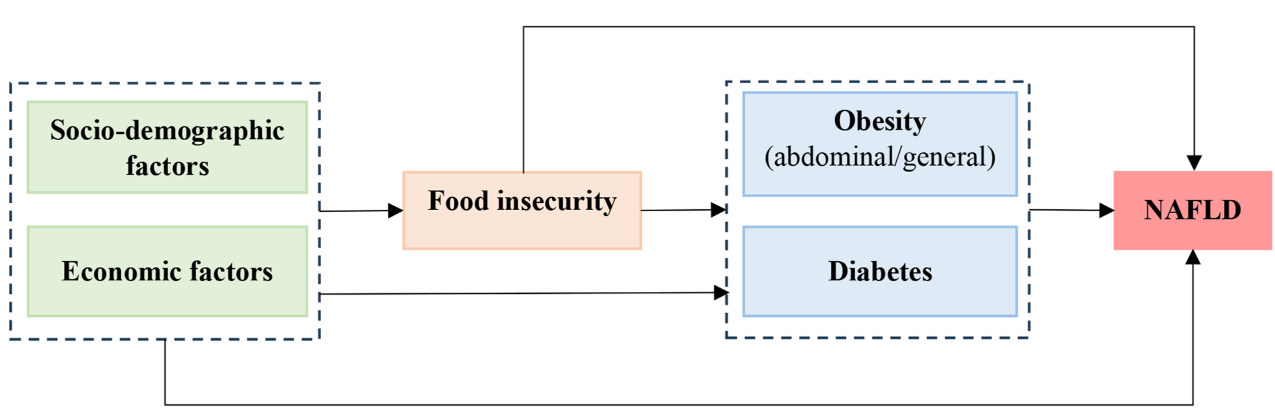

Fig. 1 The proposed conceptual structure derived from the suggested model of Golovaty et al. [23]

Materials and methods

Study design, setting, and sample size

The current study used a cross-sectional design and a hypothesized proposed model to explore the relationship between food security and NAFLD. This study was performed among patients referred to the liver clinic for fatty liver assessment in Firoozgar Hospital from June 2017 to June 2019. In path analysis, it is assumed that there is only a one-way causal flow. The sample size is therefore recommended to be 10–20 times the number of parameters considered in the analysis ($n=9$), of which 200 participants were appropriate and accepted [28, 29]. The current study included 200 participants using a non-probability convenient sampling method.

Participants

Eligible patients were 275 Iranian males (51.6%) and females (48.4%) without a history of viral hepatitis, autoimmune hepatitis, hepatic metabolic diseases, post-treatment of HCV infection, bariatric surgery, taking medication with effects on liver status such as silymarin, anti-inflammatory medications, and alcohol consumption > 30 g/day in men or > 20 g/day in women. Adult patients aged ≥ 20 years with fatty liver in ultrasonography, with/without abnormal liver enzymes according to laboratory scales, were included in the study.

Measurements

A questionnaire, including demographic, socioeconomic, anthropometric, medical history, and food security, was anonymously completed by trained interviewers for each participant after signing the informed consent letter.

NAFLD diagnosis

The diagnosis of NAFLD was based on the echogenicity of the liver during ultrasonography, liver-to-kidney contrast, and bright gallbladder and vessel wall definition [30].

Fibro scan evaluation was applied for all participants who had confirmed fatty liver by ultrasonography. The scan was performed according to standard protocol [31] by an expert clinical practitioner in Firoozgar Hospital using a Fibro scan device (Fibro Scan; Echosens, Paris, France) while the subjects were fasting. Non-NAFLD subjects were defined as the absence of fibrosis and the presence of low-grade steatosis in fibro scan assessment (fibrosis less than 5.9 KP and steatosis no more than 240dbm) without liver enzyme elevation. In fibro scan assessment, NAFLD was defined as liver steatosis > 240dbm with or without elevated liver enzymes.

Clinical and laboratory assessments

Five ml of fasting vein blood was drawn from each patient for laboratory assessment. An Auto-Analyzer BS200 (Mindray, Shenzhen, China) was used for biochemical analysis, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) using Pars Azmoon Company (Pars Azmoon Co., Tehran, Iran) commercial diagnostic kits.

Diabetes was determined by fasting glucose (> 126 mg/dl), glycosylated hemoglobin A1c (HBAIC) > 6.5% [32], or having been prescribed an anti-diabetic medication [33]. General and abdominal obesity was defined as a body mass index ≥ 30 kg/m^2, and waist circumference ≥ 90 cm based on Iranian cut-offs [34] of both genders, respectively.

Food insecurity assessment

Using the validated six-item Short Questionnaire of Household Food Security Scale (SQHFSS) [35], we ask households/individuals about their experiences of limited food security due to financial constraints or lack of resources for the prior 12 months. The questionnaire included items related to anxiety about food supply, compromised food quality and variety, insufficient food quantity, and experiencing hunger [35]. We constructed a dichotomized food insecurity indicator equal to one (food insecure) and zero (food secure).

Covariate variables

We included covariates, including demographic factors, socioeconomic status, and wealth index known to be associated with cardiometabolic disease and food insecurity.

Determination of Wealth Index (WI) - In order to avoid multicollinearity problems in regression models, an asset-based wealth index was used as an alternative indicator for households' socioeconomic status (SES) [36, 37]. The index was created based on information collected on ownership of durable household goods, sanitation facilities, number of rooms, and number of persons in a house. These factors were considered to reflect household wealth adequately [38–40]. The wealth index was used to create wealth quintiles, dividing the distribution into five equal categories, ranging from poorest to richest.

According to the Helsinki Declaration of Medical Ethics, the Iran University of Medical Sciences (IUMS) Ethics Board approved the study protocol with the ethics code IR. IUMS1397.32992 and all patients provided written informed consent prior to participation. All methods were carried out under relevant guidelines and regulations.

Statistical analysis

The statistical analysis in this study involved using the student's t-test for age and the $\chi 2$ test for categorical variables. The wealth index was calculated using principal component analysis (PCA) of various assets possessed by individuals. The first principal component was used to construct the index because it contained the most information common to all the variables (highest commonality) (Supplementary Table 1) [36]. Unadjusted and multivariable-adjusted logistic regression models were used to analyze the association between food insecurity and non-alcoholic fatty liver disease (NAFLD), after controlling for potential confounders. Path analysis investigated selected variables' direct and indirect effects on NAFLD within the proposed conceptual framework. Exogenous variables (general obesity, abdominal obesity, diabetes, NAFLD), endogenous variables (food insecurity, general obesity, abdominal obesity, diabetes), and adjustment variables (age, education, family size, and wealth index) were included in the path analysis. Model fit indices were used to assess the goodness-of-fit of the proposed conceptual model [41, 42]. We analyzed data using SPSS 24.0 and IBM SPSS Amos 24.0 (version 24.0; Amos Development Corp., Meadville, PA, USA) Statistical Software Packages. All statistical tests were two-tailed, and *p*-values less than 0.05 were considered statistically significant.

Results

Baseline characteristics

The characteristics of the participants are presented in Table 1. The mean age of subjects was higher in the NAFLD group compared with the non-NAFLD group ($p<0.001$). The proportion of general obesity and abdominal obesity was 48.7% and 88%, respectively. In addition, cardio-metabolic diseases, including obesity and abdominal obesity, were more prevalent (54% and 93.4%, respectively) among subjects with NAFLD ($P<0.001$). Further, most subjects in the NAFLD group were married (87.2%, $P=0.002$). The prevalence of NAFLD was significantly different by food security status (food secure 73.5% compared with food-insecure 26.5%, $p=0.01$). NAFLD subjects presented a significantly higher level of biochemical parameters compared with healthy subjects (all $P<0.001$).

Association of socioeconomic factors, food insecurity, and obesity with odds of NAFLD

Food insecurity and obesity (general and abdominal) were associated with increased odds of NAFLD, even after adjusting for potential confounding factors, including demographic and socioeconomic characteristics (OR: 2.95, 95% CI: 1.02, 8.57; OR: 3.27, 95% CI: 1.50, 7.11; and OR: 3.81, 95% CI: 1.55, 9.32, respectively) (Table 2).

Linking food insecurity to its determinants and related outcomes (path analysis modeling)

As shown in Fig. 2, sociodemographic factors (age, family size, and educational level) positively affected food insecurity ($\beta=0.25$, $P=0.03$), abdominal obesity ($\beta=0.29$, $P=0.006$), and NAFLD ($\beta=0.23$, $P=0.02$), and educational attainment had a negative relationship ($\beta=$ -0.14, $P=0.03$). Food insecurity ($\beta=0.12$, $P=0.03$), general ($\beta=0.13$, $P=0.02$), and abdominal obesity ($\beta=0.31$, $P<0.001$) were directly associated with NAFLD (Table 3). Based on the proposed model, the fit indices for the model of association between food insecurity and NAFLD (χ^2/df=1.36, GFI=0.982, AGFI=0.952, CFI=0.954, IFI=0.959, SRMR=0.040, RMSEA=0.037) suggested that the model fits the data well (Table 4).

Discussion

According to the current study, food insecurity strongly predicted NAFLD. Sociodemographic factors, such as old age, male gender, and marital status, were associated with a higher risk of NAFLD. In addition, food insecurity and obesity (general and abdominal) directly affected NAFLD and the final model of food insecurity, its determinants, and related outcomes demonstrated good fit indices.

Linking food insecurity to metabolic disorders and NAFLD

In agreement with our results, previous studies have shown a higher risk of NAFLD in food-insecure households [23, 43]. Evidence from meta-analytical studies revealed that food-insecure households had a significant risk of obesity [12]. The rate of obesity, BMI, body weight, and waist circumference was shown to be high in food-insecure groups due to high consumption of energy-dense, sugary, and fatty food, snacks, and low intake of animal protein [12, 23]. Additionally, the micronutrient intake was reported to be low in food-insecure groups [44].

Food insecurity causes periods of limited food intake due to insufficient food resources and overeating during food availability, which consequently causes obesity and metabolic changes [45]. Low intake of different nutrients and changing the dietary pattern in food-insecure groups could lead to physiological fluctuation to increase energy intake and fat storage, resulting in obesity that could subsequently lead to NAFLD [43]. In the current study, the prevalence of cardiometabolic diseases, including high waist circumference/abdominal obesity and general obesity, was higher in NAFLD patients. However, we did not detect any significant association between food insecurity and obesity. The association between food insecurity and obesity may vary depending on the measurement tools used and the target population (most previous studies were general population surveys) [12].

Table 1 Sample characteristics (overall and by NAFLD status) in Iranian adults ($n = 275$)

Characteristic		**NAFLD**			
		Overall (*n* = 275)	**No (*n* = 49)**	**Yes (*n* = 226)**	***P*-Value**[†]
Age (years)	Mean (SD)	44.37 (11.67)	38.23(10.09)	45.70(11.59)	< 0.001***
Sex	Female	133(48.40)	28(57.10)	105(46.50)	0.169
	Male	142(51.60)	21(42.90)	121(53.50)	
Marital status	Single/Divorced/ Widowed	44(16.00)	15(30.60)	29(12.80)	0.002**
	Married	231(84.00)	34(69.40)	197(87.2)	
Smoking	No	194(70.50)	40(81.60)	154(68.10)	0.059
	Yes	81(29.5)	9(18.40)	72(31.90)	
Education level (years)	< 12	70(25.50)	8(16.30)	62(32.00)	0.10
	≥ 12	205(74.50)	41(83.70)	164(72.60)	
Family size (person)	≤ 3	193(70.20)	37(75.50)	156(69.00)	0.358
	≥ 4	82(29.8)	12(24.50)	70(31.00)	
Occupation	Unemployed	19(6.90)	4(8.20)	15(6.60)	0.160
	Retired	24(8.70)	6(12.20)	18(8.00)	
	Employed	104 (37.80)	12 (24.50)	91(40.30)	
	Self-employed jobs	97(35.30)	24(49.00)	72 (31.80)	
	High-income jobs	31(11.30)	3(6.10)	30(13.30)	
Wealth Index	Poorest	54 (19.60)	6(12.30)	47(20.80)	0.061
	Poorer	53(19.30)	15(30.60)	39(17.20)	
	Middle	60(21.80)	10(20.40)	49(21.70)	
	Richer	53(19.30)	15(30.60)	39(17.20)	
	Richest	55(20.00)	3(6.10)	52(23.10)	
Food security	Secure	210(76.40)	44(89.80)	166(73.50)	0.011*
	Insecure	65(23.60)	5(10.20)	60(26.50)	
General obesity	BMI < 30	141(51.30)	37(75.50)	104(46.00)	< 0.001***
	BMI ≥ 30	134(48.70)	12(24.50)	122(54.00)	
Diabetes	No	100(36.40)	16(32.70)	84(37.20)	0.336
	Yes	175(63.60)	33(67.30)	142(62.80)	
Abdominal obesity	WC < 90	33(12.00)	18(36.70)	15(6.60)	< 0.001***
	WC ≥ 90	242(88.00)	31(63.30)	211(93.40)	
Biochemical parameters[††]					
FBS (mg/dl)	Median (IQR)	102.00(21.00)	90.00(11.50)	105.00(23.00)	< 0.001***
CAP score(dB/m)	Median (IQR)	310.00(90.00)	230.00(47.50)	320.00(501.00)	< 0.001***
AST (mg/dl)	Median (IQR)	35.00(34.00)	20.00(7.75)	41.00(36.00)	< 0.001***
ALT (mg/dl)	Median (IQR)	45.00(57.00)	17.50(14.50)	57.00(59.00)	< 0.001***
ALP (mg/dl)	Median (IQR)	188.00(114.00)	125.50(62.25)	199.71(119.00)	< 0.001***

Abbreviations: NAFLD: nonalcoholic fatty liver disease; WC: waist circumference; BMI: body mass index; FBS: Fasting blood glucose; CAP: controlled attenuation parameter; AST: Aspartate transaminase; ALT: Alanine transaminase; ALP: Alkaline phosphatase; interquartile range (IQR)

[†] Student's t-tests for the continuous variable (age), and x^2 test for the other categorical variables

[††]Mann-Whitney U test for non-normal continuous variables

* *P*<0.05

** *P*<0.01

*** *P*<0.001

Linking food insecurity, metabolic disorders, NAFLD, and their socioeconomic determinants

Another finding of the present study revealed that sociodemographic factors, including old age, large family size, and low educational level, were the main socioeconomic risk factors for food insecurity, metabolic disorders, and NAFLD. Older individuals may be more vulnerable to food insecurity due to factors such as limited income, health issues, and social isolation. Similarly, large family size may strain financial resources, making it more difficult to ensure an adequate and nutritious food supply for all family members. Additionally, these results contribute to the literature, highlighting that the high level of educational attainment may be an essential driver of food insecurity and NAFLD prevalence [46–48].

Socioeconomic status may be related to NAFLD risk by changing metabolic responses and increasing cortisol levels. These conditions and stress due to insufficient food supply and food insecurity, combined with other risk factors such as insulin resistance, abdominal

Table 2 Adjusted OR (AOR)[a] of food insecurity with NAFLD in Iranian adults

Characteristic	NAFLD	
	Crude OR (95% CI)	**AOR (95% CI)[a]**
Food insecurity	3.18(1.20–8.39) *	2.95(1.02–8.57) *
General obesity (BMI ≥ 30)	3.61(1.79–7.29) ***	3.27(1.50–7.11) **
Abdominal obesity (WC ≥ 90)	8.16(3.74–17.85) ***	3.81(1.55–9.32) **
Diabetes (yes)	0.82(0.42–1.57)	0.84(0.39–1.79)

[a] Adjusted for age, gender (male, female), marital status (single/ divorced/ widowed, married), smoking (no, yes), education (<12 yrs., ≥ 12 yrs.), family size (≤3, ≥ 4), occupation (unemployed, worker, clerk, high-income jobs, self-employed jobs, retired), wealth index (poorest, poorer, moderate, richer, richest)

* $P<0.05$

** $P<0.01$

*** $P<0.001$

obesity, and abnormal fatty acid metabolism, may lead to NAFLD risk [23]. It is plausible that a high level of education might increase the potential to employ some copying strategies adopted by subjects to control high and sustained food insecurity [49].

Although the wealth index had a negative effect on food insecurity in our study, the associations were not significant. Indeed, there are inconsistent results in this regard, where some studies suggested wealth index may be a protective factor for food security [50, 51], but other studies asserted that asset wealth index status might not guarantee food security [52]. Hu et al. concluded that if income is increased without improving the educational level and health, NAFLD prevalence will rise [48].

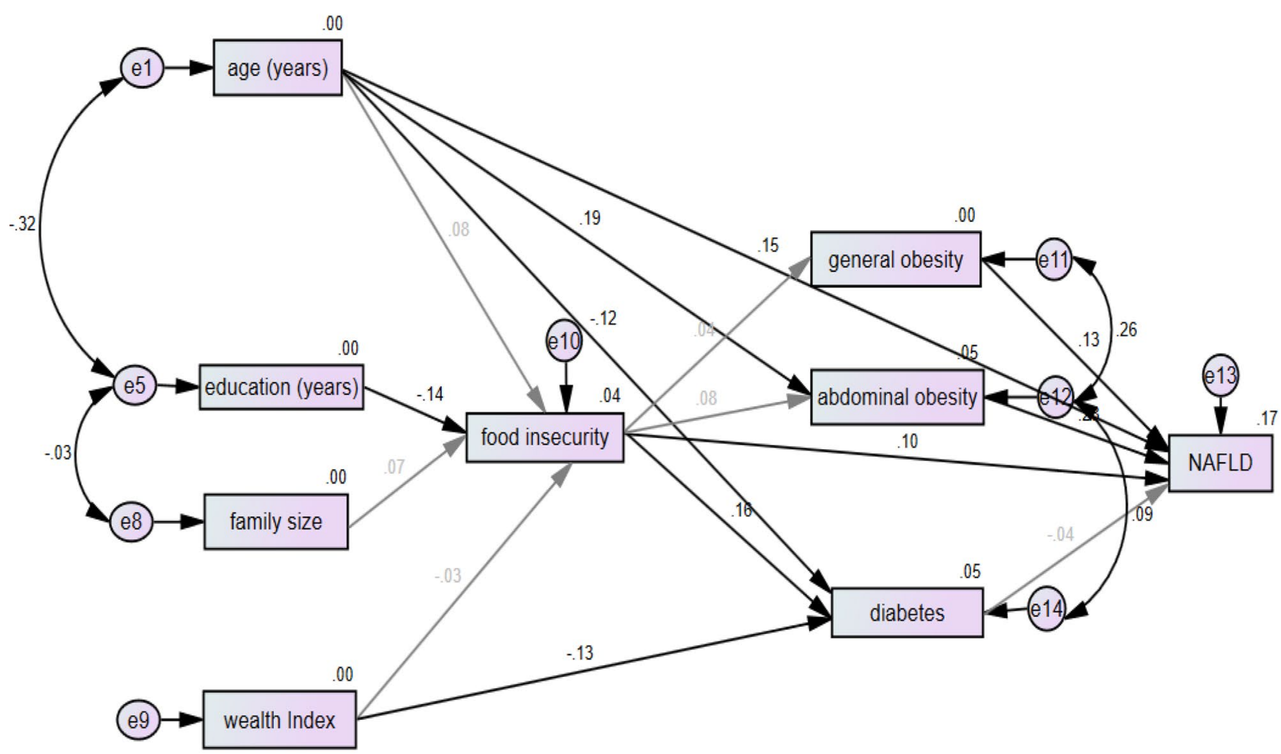

Fig. 2 Linking food insecurity to its determinants and related outcomes
Note: Statistically significant associations are shown in bold. Directional effects are illustrated through single-headed arrows originating from a predictor variable towards an endogenous variable. Nondirectional effects are depicted by double-headed arrows. χ2, Chi square; df, degree of freedom; GFI, goodness fit index; AGFI, adjusted goodness-of-fit index; CFI, Comparative Fit Index; IFI, Incremental Fit Index; SRMR: Standardized Root Mean Squared Residua; RMSEA, root-mean-square error of approximation. χ^2/df = 1.36, GFI = 0.982, AGFI = 0.952, CFI = 0.95, IFI = 0.959, SRMR = 0.040, RMSEA = 0.037
Abbreviations: NAFLD: non-alcoholic fatty liver diseases

Table 3 Direct, indirect, and total coefficients path analysis

Endogenous variables	Exogenous variables	Direct effect			Indirect effect			Total effect		
		β	*P*-value*	95%CI	β	*P*-value*	95%CI	β	*P*-value*	95%CI
Food insecurity	general obesity	0.04	0.511	-0.11, 0.154	-	-	-	0.04	0.511	-0.1, 0.15
Food insecurity	abdominal obesity	0.07	0.187	-0.08, 0.15	-	-	-	0.07	0.187	-0.08, 0.15
Food insecurity	diabetes	0.16	**0.010**	0.06, 0.28	-	-	-	0.16	**0.010**	0.06, 0.28
Food insecurity	NAFLD	0.10	**0.016**	0.01, 0.19	0.02	-	0.008, 0.041	0.12	**0.016**	0.01, 0.19

Abbreviations: NAFLD: nonalcoholic fatty liver disease

Table 4 Fit index values, acceptable levels, and interpretations

Model fit indices	Model fit index level	Acceptable level	Interpretation
GFI	0.982	0 (no fit) to 1 (perfect fit)	Values close to 0. 90 or 0.95 reflect a good fit
AGFI	0.952	0 (no fit) to 1 (perfect fit)	Value adjusted for *df*, with 0.90 or 0.95 a good model fit
CFI	0.954	0 (no fit) to 1 (perfect fit)	Values close to 0. 90 or 0.95 reflect a good model fit
IFI	0.959	0 (no fit) to 1 (perfect fit)	Values close to 0. 90 or 0.95 reflect a good model fit
SRMR	0.040	<0.05	Values less than 0.05 indicate a good model fit
RMSEA	0.037	<0.05 OR 0.05 to 0.08	Values less than 0.05 indicate a good model fit and values of 0.05 to 0.08 indicate a close fit

Abbreviations: SRMR: Standardized Root-mean square residual; RMSEA: Root-mean-square error of approximation

A multiethnic longitudinal cohort study on over 215,000 adult subjects by Noureddin et al., concluded that food insecurity and poor diet quality may be associated with NAFLD [53]. Food insecurity is a significant cause of chronic stress, which can contribute to the development and progression of various health issues, including liver diseases. Changes in stress-related hormones and inflammation are potential factors in liver damage.

Food insecurity may be linked to type 2 diabetes mellitus (T2DM) through two mechanisms. First, inadequate access to healthy foods may cause reliance on cheaper, processed foods high in salt, unhealthy fats, and refined carbohydrates, contributing to T2DM development. Second, food insecurity is a significant cause of chronic stress, which potentially triggers cortisol release pathways and exacerbates disruptions in glucose tolerance and insulin sensitivity, influencing the development of diabetes [54]. Previous studies have also reported the increased odds of NAFLD among food-insecure adults with metabolic diseases such as obesity and diabetes [23, 43].

Our results suggest clinical significance, supporting the use of food insecurity screening tools by healthcare providers to assess individual risk for type 2 diabetes mellitus (T2DM). On a public health level, these findings may justify interventions addressing food insecurity, aiming to alleviate individual risks and reduce the overall burden of T2DM and NAFLD in the population.

Strengths and limitations of the study

The study is the first to use a path analysis approach to examine the relationship between food insecurity and non-alcoholic fatty liver disease (NAFLD). The findings highlight an overlooked aspect of NAFLD development and can be used to inform disease prevention strategies [55]. However, the study has limitations, including its cross-sectional design, indirect measures of NAFLD, and a relatively small sample size. Regarding the small sample size, the study population did not reflect the general population, therefore, our results may not be generalized to other populations. Further research with larger sample sizes and consideration of stress and inflammation factors, as well as dietary intake, is needed for more accurate results.

Conclusion

Food insecurity was a predictor of, and directly associated with NAFLD. Social determinants should be considered in the pathogenesis of NAFLD, although the possible underlying biological mechanisms in this association are yet to be determined. Future strategies should also assess whether healthy eating patterns can decrease the burden of NAFLD among at-risk adults. Prospective studies with a large sample size are needed to verify our findings.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13104-024-06923-4.

Supplementary Material 1

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Author contributions

Masoudreza Sohrabi and Ali Gholami conceived and designed the research. Bahareh Amirkalali, Ali Gholami, Melika Hajjar, and Melika Sohrabi collected the data. Azam Doustmohammadian analyzed and/or interpretation of data. Masoudreza Sohrabi, Azam Doustmohammadian, and Melika Hajjar drafted the manuscript. Farhad Zamani, Azam Doustmohammadian, Masoudreza Sohrabi, Mohsen NasiriToosi, and Hossein Keyvani revised the manuscript critically for important intellectual content. All authors read and approved the final paper.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The Iran University of Medical Sciences (IUMS) ethical committee (NO. IR.IUMS1397.32992) approved the study. Written informed consent was obtained from all participants prior to the study. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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