

Body Composition and Risk of Non-Alcoholic Fatty Liver Disease; A Case Control Study

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Abstract

Background: While evidence has been highlighted that obesity may be associated with the increased incidence of Nonalcoholic fatty liver disease (NAFLD), these data have depended on defective measures of obesity such as body mass index (BMI), and usually have not clearly well-known relationship between body composition (including fat within the nonfat mass) with NAFLD.

Methods: In a case control study of people aged 20–75 years, we directly measured body composition (using bioelectrical impedance analysis), height, weight and waist and hip circumferences who referred to radiology clinics in Kermanshah, Iran. Dietary intake was assessed by the food frequency questionnaire (FFQ).

Results: Among 231 people examined, 103 cases with NAFLD and 119 as control were established. The risk of NAFLD was positively associated with higher BMI and the components of the body composition. These associations were strengthened after adjusted for potential confounders including gender, age, marital status, education, smoking, alcohol consumption, and physical activity

Conclusion: An increasing prevalence of obesity may be associated with the increasing incidence of NAFLD as observed in many populations. We observed an increased risk of NAFLD associated with increased BMI, central adiposity and the fat component of weight, but found no association with nonfat mass.

Background

Non-alcoholic fatty liver disease (NAFLD) is rapidly becoming a public health problem around the world and is known as one of the greatest common forms of liver diseases with a reported prevalence of 10–24% in the total population (2). NAFLD defined a spectrum of liver disorders described by macro-vesicular hepatic fat accumulation alone (steatosis) or associated by signs of hepatocyte injury, mixed inflammatory cell infiltrate and hepatic fibrosis (non-alcoholic steatohepatitis). With the increased incidence of obesity, the incidence of NAFLD dramatically increased (3).

Although not completely dependable, evidence has been growing that obesity may be related to the increased incidence of NAFLD (4). While NAFLD is generally severe in more obese subjects. Nearly 10–19 percent of patients in Asia with BMI less than 25 kg/m^2 are also found to have NAFLD (5). On the other hand, there may be some differences in the type of obesity (generalized obesity or abdominal obesity) and NAFLD across regions (5, 6). In particular, even though BMI may capture most of the information on body composition contained in weight and height, it does not capture information on body size (7). Nevertheless, many studies categorized overweight and obesity based on the body mass index (BMI) (8). It should be noted that BMI is a simple tool to facilitate research and does not discriminate between fat and nonfat mass. Using a case-control study, we look at whether direct measurements of body composition were associated with the incidence of NAFLD or not.

Methods

The present case-control study was conducted on the patients who were referred to the radiology clinics for screening NAFLD in the city of Kermanshah, Iran. Patients would be eligible for the study if they were 20 years or older, and non-hospitalized, and consented to participate in the study. Patients would be excluded if they were any have mental illnesses, cardiovascular disease, and cancer. The study protocol was approved by governmental Regional Committee for Medical and Health Research Ethics (Kermanshah University of Medical Sciences (No: KUMS.REC.1397.384). Informed consent was obtained by the use of a written form, which was to be signed by the participants and parents and/or legal guardians.

Regarding the prevalence of NAFLD in prior studies, 250 patients within the age range of 20–65 years with $BMI > 25 \text{ kg/m}^2$ were recruited using a convenience sampling method. Based on the sonography reports, the patients with NAFLD were selected as the case group and the healthy subjects were negative in terms of sonography reports as controls. Case group was not treated before this study and they were invited to this study at the beginning of treatment. In this study, the subjects who did not complete the questionnaires were excluded from the study. Overall, 103 patients with NAFLD, and 119 healthy subjects were contributed in the current study.

Manuscript adheres to The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting of data.

Anthropometric Indices And Body Composition

Using a stadiometer, height was measured in a standing position with no shoes and minimum clothes, while shoulders, heels, and hips were in contact with the wall with the accuracy of one centimeter. Weight and body composition were measured using Body Analyzer (Jawon Medical Plus model Avis 333, JANEX MEDICAL Co, Seoul, Korea). This device evaluates body composition including body fat mass (BFM), percentage of body fat (PBF), soft lean mass (SLM) and waist to hip ratio (WHR). Body mass index (BMI) was calculated by dividing weight (kilograms) by height² (meters).

Statistical analysis

All statistical analyses were performed by SPSS software (version 20; SPSS Inc., Chicago, IL). To report subjects' characteristics, we used descriptive statistics such as frequency and mean \pm SD. Independent samples tests were used to compare the means of subjects' characteristics of the two groups. We used χ^2 test for determining the significant difference of the qualitative variables between the two studied groups. Binary logistic regression in crude and adjusted model was performed to assess the impact of some clinical important factors on NAFLD status.

Results

221 subjects completed the study. Among them, 103 subjects had NAFLD and the other were considered control group. There was no significant difference between two studied groups in term of demographic characteristics. Demographic characteristics of subjects are presented in table 1.

Table 1
Demographic characteristics of subjects

Variables		Case (%)	Control (%)	P_value
		(n=103)	(n=119)	
Gender	Men	30.1	34.4	0.48
		69.1	65.6	
Age group	<45	59.2	52.9	0.19
	45-55	26.2	36.9	
	>55	14.6	10.2	
Marital status	Single	6.9	14.7	0.06
	Married	93.1	85.3	
Cigarette of smoking	No	93.1	97.3	0.13
	Yes	6.9	2.7	
Alcohol consumption	No	98.1	97.3	0.75
	Yes	1.9	2.6	
Physical activity	Light	50	41.2	0.26
	Moderate	35	36.1	
	Intense	15	22.7	

P-value was obtained using chi-square.

The mean of BMI in case and control were 30.41 ± 5.74 and 26.41 ± 3.86 kg/m² and this difference was significant ($P < 0.001$). Our findings were showed that other components of the body composition of NAFLD subjects were significantly higher than healthy subjects (Table 2).

Table 2
Body composition analysis of the studied subjects

Variables	Case	Control	P- value
	Mean (SD)	Mean (SD)	
BMI (kg/m ²)	30.41(5.74)	26.41(3.86)	<0.001
PBF (%)	33.85(6.86)	30.73(6.56)	0.0007
BFM (kg)	27.91(8.83)	21.92(6.30)	<0.001
LBM (kg)	54.20(11.96)	49.01(9.23)	0.0003
TBW (kg)	39.02(8.61)	35.29(6.64)	0.0003
SLM (kg)	49.55(11.11)	44.97(8.61)	0.0007

*BMI: body mass index; PBF: percent of body fat; BFM: body fat mass; LBM: lean body mass; TBW: total body water; SLM: soft lean mass.

P- value was obtained using t-test.

In current study, we observed that higher BMI and the components of the body composition were associated with risk of the NAFLD. These associations were strengthened with adjusted for potential confounders including gender, age, marital status, education, smoking, alcohol consumption, and physical activity. (Table 3)

Table 3
Univariate and multiple Logistic regression analysis to determine the contribution of anthropometrics index/measurements to non- alcoholic fatty liver

Variables	Crude	Adjusted*
	OR(95%CI)	OR(95%CI)
BMI (kg/m ²)	1.23(1.14-1.33)	1.21 (1.12-1.32)
PBF (%)	1.07(1.02-1.11)	1.10 (1.03-1.17)
BFM (kg)	1.12(1.07-1.17)	1.12 (1.06-1.17)
LBM (kg)	1.04(1.02-1.07)	1.14 (1.08-1.20)
TBW (kg)	1.06(1.02-1.10)	1.20 (1.12-1.29)
SLM (kg)	1.04(1.01-1.07)	1.15 (1.09-1.22)

BMI: body mass index; PBF: percent of body fat; BFM: body fat mass; LBM: lean body mass; TBW: total body water; SLM: soft lean mass.

*Adjusted for gender, age, marital status, smoking, alcohol consumption, and physical activity

Discussion

Our findings demonstrate that patients with NAFLD were much more likely having higher BMI than healthy subjects; that support the hypothesis of NAFLD determination by body composition. Studies showed the prevalence of NAFLD is different between lean and obese people. Previous reports found an association between being overweight or obese and a higher prevalence of NAFLD (Church T.S.2006) and morbid obesity is associated with a higher prevalence of NAFLD (9, 10).

Just as some publications have reported obesity is closely related to NAFLD; our findings support this that suggests BMI, as an indicator of obesity, has a direct relationship with NAFLD. We demonstrated that BMI is higher in NAFLD than non-NAFLD subjects (adjusted OR: 1.21; CI 95%: 1.12–1.32). These findings support the study of Liu et al. that noticed the participants with NAFLD had higher BMI (11). On the other hand, Stranges et al concluded that BMI was not a reliable indicator of fatty liver disease (12).

Although many studies demonstrate BMI and general obesity associated with NAFLD, the components of body mass have different effect on NAFLD. Body composition in many aspects affects NAFLD. One of the components of body mass is fat mass. It decelerates as PBF and BFM. Studies have found that the accumulation of abdominal fat was positively correlated with liver fat (13), and increased in liver fat caused enhanced risk of NAFLD. The liver is a key organ to carbohydrate and lipid metabolism (14), so free fatty acid (FFA) concentrations resulting from lipolysis of body fat might be significantly greater than arterial FFA concentrations. So, the liver might be exposed to greater amounts of FFA, leading to an increased risk of NAFLD (15).

Our data reveal that there were differences in components of body mass including BFM, PBF, TBW, SLM between patients with NAFLD and healthy subjects after adjusting for confounding factors. However, we did adjust for several potential confounding factors such as gender, age, marital status, education, smoking, alcohol consumption, and physical activity. Our results imply that higher PBF might be a predictor of increased NAFLD (adjusted OR: 1.10; CI 95%: 1.03–1.17). As well as PBF, BFM (Adjusted OR: 1.12; CI 95%: 1.06–1.17), was significantly higher in NAFLD patients than healthy subjects. These findings agree with a recent study by Bhatt et al that concluded the body composition was different in NAFLD and without NAFLD patients. They measured body fat percent, arm fat, leg fat, total lean mass, and trunk fat by using whole-body dual-energy X-ray absorptiometry scan (16). Lawlor suggests the association between total fat mass with NAFLD (1). These findings are similar to our results. Because the pathophysiological mechanisms underlying the relationship between NAFLD and fat distribution remain unknown, further research is still needed to assess the predictive ability of each body fat parameter in terms of detecting NAFLD.

While increased BMI and obesity ($BMI \geq 30 \text{ kg/m}^2$) is the major risk factor for NAFLD, several studies have now reported an association between low skeletal muscle mass and NAFLD (1, 17). Sarcopenia, as loss of skeletal muscle mass, and NAFLD share similar pathophysiological mechanisms, and the relationship between Sarcopenia and NAFLD has been recently investigated. The results of Bhatt et al. study showed total skeletal mass (kg) was different in with or without NAFLD subjects (16).

Hong HC, 2014 found a significant inverse association between skeletal muscle mass and NAFLD. They calculated SMI by weight and arms and legs lean mass (17). Similarly, Kim HY from the fifth Korea national health and nutrition examination survey noticed that the SMI has a significant negative correlation with NAFLD in both genders (18).

Sarcopenia has been associated with severity of NAFLD in patients and increased the risk of NAFLD in the general population(19), so Kim et al suggested increases in relative skeletal muscle mass over time may lead to benefits either in the development of NAFLD or the resolution of existing NAFLD (20). On the other hand, some NAFLD patients with normal BMI were lean compared with obese NAFLD and healthy controls (21).

Whereas our data showed a positive correlation between NAFLD and LBM (adjusted OR: 1.14; CI 95%: 1.08–1.20) or SLM (adjusted OR: 1.15; CI 95%: 1.09–1.22). Because at the baseline of our study the mean of weight in case and control group were not matched, our findings showed the amount of LBM and SLM by Kg in NAFLD patients is more than control group and if the results declare in percent, it might be the current prelateship between LBM and SLM is reversed.

Besides the fact that NAFLD more often affects men than women(22), our results showed that the BMI, BFM, PBF, TBW, SLM in NAFLD males was higher than NAFLD females. Our study declares TBW (adjusted OR: 1.20; CI 95%: 1.12–1.29) is different between NAFLD patients and healthy individuals. Also, TBW is different between male and female with NAFLD. No, other study assessed this parameter for NAFLD patients.

Nevertheless, we must acknowledge that this study had some limitations. First, in this study, we just demonstrate the difference of body composition parameters especially PBF between NAFLD patients and healthy individuals and the trend of this difference was vague. Second, our findings are not generalizable to the population due to the diversity in socio-demographic variables. Further studies in larger and various populations are required to understand the relationships among body composition with the stage of NAFLD to validate our results. The strengths of this study is it is the first study to investigate whether the association between body composition parameters with NAFLD in Iranian population.

Conclusion

In summary, body fat parameters were higher in NAFLD patients compared to those without NAFLD. Additionally, body fat parameters were significantly associated with gender and their higher in men than women. Our information demonstrates the importance of identifying individuals with the higher PBM

have a higher-risk for developing NAFLD. Furthermore, BMI, as an indicator of obesity, could be considered as a predictor of NAFLD. These results may have important implications in the prevention and the clinical management of NAFLD. So, public health plan to prevent obesity may help to inverse the trend of increasing incidence of NAFLD.

Abbreviations

NAFLD

Nonalcoholic fatty liver disease

BMI

Body mass index

FFQ

food frequency questionnaire

BFM

body fat mass

PBF

percentage of body fat

SLM

soft lean mass

WHR

waist to hip ratio

Declarations

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

Our study was in agreement with the Helsinki Declaration of the World Medical Association (2000) and was accepted by our local ethics committee of Kermanshah University of Medical sciences as a proposal for PhD grade in Nutritional Sciences (IR.KUMS.REC.1397.384).

Consent for publication

All authors support the submission to this journal.

Informed Consent

Informed consent was obtained from all individual participants included in the study using opt-out procedure.

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Author contribution

Shima Moradi designed the study. Shima Moradi and Mehdi Moradinazar completed the entire studies. Jalal moludi collected and analyzed the data. Sara Moradi prepared the manuscript. Jalal moludi conducted statistical analysis. All of authors edited the manuscript.

Availability of data and materials

All data generated and analyzed during this study are included in the manuscript.

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Figures

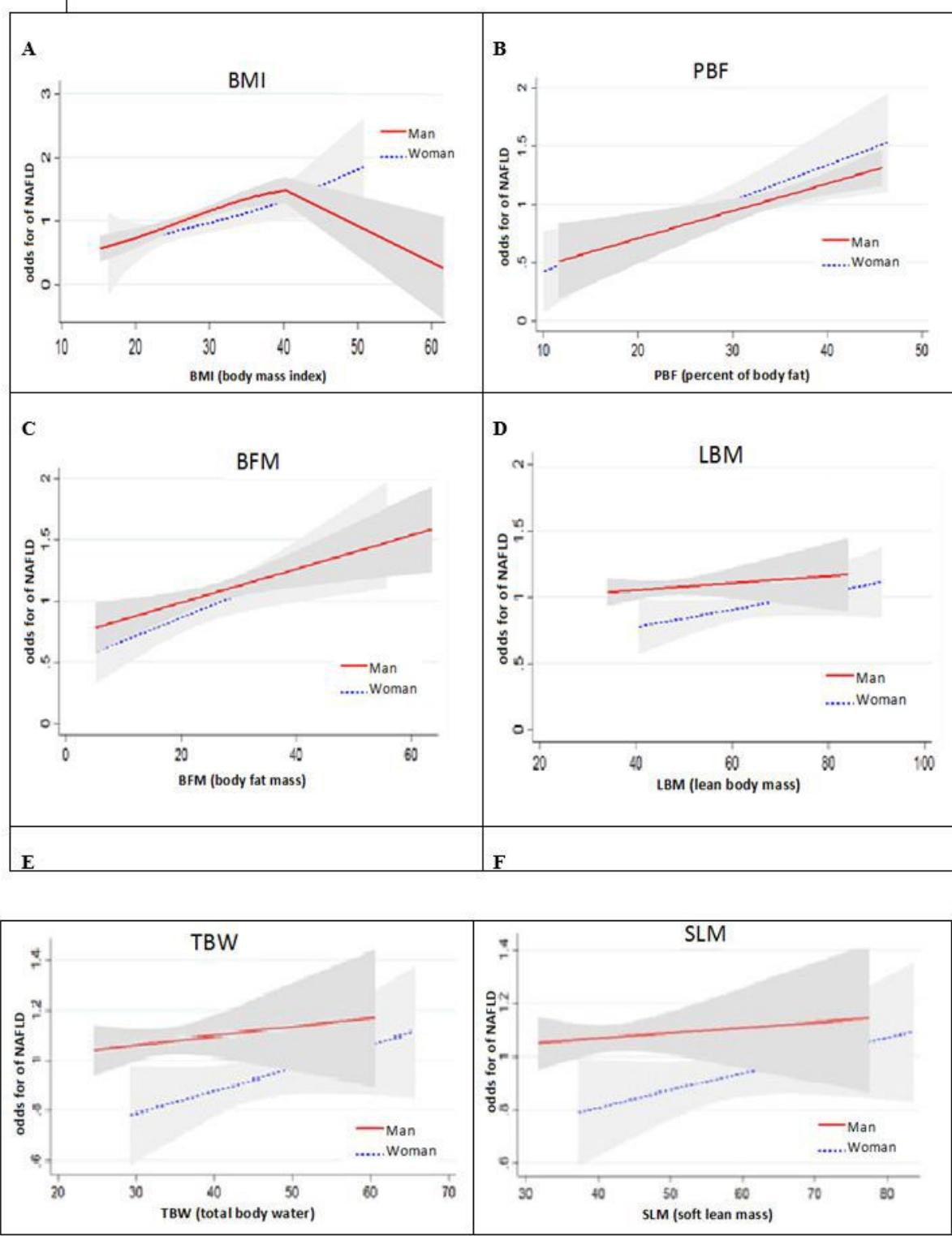


Figure 1

The relationship of body composition and NAFLD

Supplementary Files

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