JOURNAL OF NUTRITION FASTING AND HEALTH

The Associations of Anthropometric Parameters and Hepatic Steatosis

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ARTICLEINFO

Article type:
Research Paper

Article History:
Received: 29 Jun 2019
Accepted: 03 Jul 2019
Published: 1 Jan 2020

Keywords:
Non-alcoholic Fatty Liver Disease
Hepatic Steatosis
Transient Elastography
Fibroscan
Anthropometric

ABSTRACT

Introduction: Non-alcoholic fatty liver disease (NAFLD) is an important health concern across the world, which is characterized as a disease spectrum encompassing simple steatosis, non-alcoholic steatohepatitis, liver fibrosis, and liver cirrhosis. Recently, the prevalence of NAFLD has increased significantly. The present study aimed to investigate the associations between anthropometric parameters and hepatic steatosis.
Methods: This cross-sectional study was conducted on 415 eligible participants. Anthropometric parameters were evaluated using standard methods, and the fat mass was measured using the bioelectrical impedance analysis. Hepatic steatosis was diagnosed using fibroscan.
Results: Among 415 participants, 308 cases (74.2%) had hepatic steatosis. The body mass index and waist circumference were significantly higher in the patients with hepatic steatosis compared to the other subjects. In addition, hepatic steatosis had a significant, positive association with waist circumference, body fat mass, and trunk fat mass, with the trunk fat mass having the most significant association with hepatic steatosis.
Conclusion: According to the results, some anthropometric parameters had associations with the increased prevalence of hepatic steatosis even after adjustment for age and body weight.

► *Please cite this paper as*:
Dehnavi Z, Ghandehari M, Razmpour F, Miryan M, Soleimani D, Parizadeh SM, Jafarzadeh-Esfehani R, Sedaghat M, Esmaeili H, Nematy M. The Associations of Anthropometric Parameters and Hepatic Steatosis. J Nutrition Fasting Health. 2020; 8(1): 23-27. DOI: 10.22038/jnfh.2019.41464.1208

Introduction

Non-alcoholic fatty liver disease (NAFLD) is a common disorder characterized by the accumulation of extra fats in the hepatocytes (1). NAFLD represents a disease spectrum, including simple steatosis, non-alcoholic steatohepatitis, liver fibrosis, and liver cirrhosis (2). Recently, the global prevalence rate of NAFLD has been reported to be on the rise (3). Studies in this regard have denoted that in the general population, approximately 30% of adults (4, 5) and 10% of children and adolescents (3) have NAFLD.

Several factors are involved in the pathogenesis of NAFLD, including male gender, type II diabetes mellitus, obesity, metabolic syndrome, insulin resistance, abnormal lipid profile, prolonged starvation, sleep apnea syndrome, total parenteral nutrition, and polycystic ovarian syndrome (6). The majority of the patients with NAFLD are asymptomatic with or without the mild elevation of aminotransferases (7). Nevertheless, the symptomatic patients mostly manifest non-specific presentations, such as right upper-quadrant pain, fatigue, and malaise (6). Liver biopsy is considered to be the 'gold standard' method for the diagnosis of NAFLD. On the other hand, hepatic steatosis and fibrosis

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could be identified using noninvasive diagnostic methods, such as transient elastography (fibroscan) (8).
NAFLD is paralleled to the prevalence of obesity (9). According to the literature, the distribution of fats in various body parts could be associated with metabolic syndrome and NAFLD (10). Therefore, anthropometric measurements could accurately predict hepatic steatosis.
The present study aimed to investigate the associations between anthropometric parameters and hepatic steatosis.

Materials and Methods

This cross-sectional study was conducted on 415 participants referring to a nutrition clinic. The participants were selected via simple random sampling, and written informed consent was obtained prior to enrollment. The exclusion criteria of the study were as follows: 1) pregnancy; 2) presence of malignancies; 4) viral hepatitis B and C and 5) presence of congenital or autoimmune hepatic diseases.
Anthropometric measurements were performed by an expert nutritionist using a flexible ribbon tape to the nearest 0.1 centimeter. Body weight of the subjects was measured using a digital scale (SECA 704; made in Germany) to the nearest 0.1 kilogram and recorded in kilograms. The height of the subjects was determined in a standing position with elevated shoulders and in deep inspiration using a wall tape. In addition, body mass index (BMI) was calculated as the body weight (kg) divided by the square of the height (m), and waist circumference was measured at the midpoint between the last rib and iliac crest at two centimeters above the umbilicus. The fat mass was measured in standard conditions using the bioelectrical impedance analysis system (Tanita BC-418; Tanita Corporation, Tokyo, Japan). After three hours of fasting and keeping out the electronic and magnetic devices, hepatic steatosis and fibrosis in each participant were evaluated by fibroscan.

Statistical Analysis

Data analysis was performed in SPSS version 16.0 (SPSS, Inc., Chicago, IL, USA). The normal distribution of the continuous variables was evaluated using the Kolmogorov-Smirnov test. Moreover, independent samples t-test was applied for the data with normal distribution, and Mann-Whitney U test was used for the data with non-normal distribution. The correlations between the anthropometric parameters and hepatic steatosis were determined using linear regression analysis. In all the statistical analyses, P-value of less than 0.05 was considered significant.

Results

Table 1 shows the general characteristics and anthropometric measurements of the participants. Among 415 participants, 308 cases (74.2%) had hepatic steatosis. The mean age of the participants without hepatic steatosis and patients with steatosis was 29.65±14.5 and 38±15.45 years, respectively (P=0.001). According to the findings, BMI and waist circumference were significantly higher in the patients with hepatic steatosis compared to the other subjects.

Table 1. General Characteristics of Individuals with and without Non-alcoholic Fatty Liver Disease (NAFLD)

Variables		Without Steatosis	With Steatosis	P-value
N (%)		107 (25.8)	308 (74.2)	-
Gender	Male	44 (19)	188 (81)	0.001
	Female	63 (34.4)	120 (65.6)	
Age (year)		29.65±14.5	38±15.45	0.001
Body Mass Index (kg/m^2)		24.1±3.6	29.1±4.3	0.001
Waist Circumference (cm)		83.4±10.3	98.7±11.7	0.001
Fat-free Mass (kg)		44.6±10.7	52.24±14.75	0.001
Body Fat Mass (kg)		16.7±7.4	25±8.7	0.001
Trunk Fat Mass (kg)		8.3±3.9	13.4±4.1	0.001
Liver Stiffness (kPa)		5.1±3.5	5.9±2.1	0.006*

*Data expressed as mean±standard deviation or number (percentage); P-values calculated by Chi-square for qualitative variables and independent samples t-test for quantitative variables unless indicated otherwise; *Mann-Whitney U test due to non-normal distribution of data*

Table 2 shows the correlations between the anthropometric parameters and prevalence of hepatic steatosis. According to the obtained results, hepatic steatosis was positively correlated with waist circumference, body fat mass, and trunk fat mass. It is also notable that these associations remained statistically significant after adjustment for the other risk factors of the disease. Among various anthropometric parameters, trunk fat mass had the most significant association with hepatic steatosis (regression coefficient [β]: 1.45).

Table 2. Correlations between Anthropometric Parameters and Hepatic Steatosis

Variable		Steatosis (%)	
		β	P-value
Waist Circumference (cm)	Crude	1.4	0.001
	Model 1	1.36	0.001
	Model 2	0.83	0.001
	Model 3	0.77	0.001
Body Fat Mass (Kg)	Crude	1.55	0.001
	Model 1	1.50	0.001
	Model 2	0.45	0.01
	Model 3	0.47	0.007
Trunk Fat Mass (Kg)	Crude	3.66	0.001
	Model 1	3.52	0.001
	Model 2	1.56	0.001
	Model 3	1.45	0.001

Data obtained from linear regression analysis; Model 1: adjusted for age, Model 2: adjusted for body weight, Model 3: adjusted for age and body weight

Discussion

NAFLD is a chronic disease with a progressive nature, which could lead to liver cirrhosis and liver failure if untreated (11). Therefore, researchers have been attempting to modulate the main risk factors for NAFLD in order to prevent the progression of this disease. According to the results of the present study, BMI, waist circumference, fat-free mass, trunk fat mass, and body fat mass were higher in the NAFLD patients with steatosis. Furthermore, excessive body weight and accommodation of visceral fats were considered to be the main risk factors for this disease (12). The toxic nature of visceral fats causes its ability in the secretion of adipokines and cytokines (13). In a study in this regard, Van der Poorten et al. demonstrated a direct correlation between liver fibrosis and increased visceral fats (13). Furthermore, their findings indicated that visceral fats are an independent predictor of liver fibrosis along with parameters such as increased age, insulin resistance, and level of hepatic steatosis (13).

In another similar research, Rocha et al. reported that steatohepatitis and fibrosis were correlated with body weight and waist circumference in patients with NAFLD (12). In addition, they claimed that 68% of the NAFLD patients with steatohepatitis and fibrosis were overweight, and 41% had increased waist circumference. Moreover, they reported that BMI and waist circumference were correlated with the metabolic syndrome and insulin resistance, as well as steatohepatitis and fibrosis, in these patients (12).

According to the study by Weta et al., simple anthropometric and biochemical measurements (e.g., BMI, triglyceride, and waist circumference) could predict liver steatosis (14). In addition, they reported that waist circumference of more than 90 centimeters and BMI of higher than 30 kg/m^2 could predict liver steatosis with the sensitivity and specificity of 70% and 67.4% and 74.4% and 69.6%, respectively (14). A recent study conducted by Monteiro et al. demonstrated that in obese adolescents, parameters such as the trunk fat mass, intra-abdominal adipose tissue, and waist circumference had the highest potential to identify NAFLD (15).

According to the literature, the distribution of fats in various body parts could be correlated with the metabolic syndrome and NAFLD (10). The findings of the current research indicated that some anthropometric variables could affect steatosis. Considering various models and adjustments for age and body weight, we concluded that waist circumference, body fat mass, and trunk fat mass were correlated with steatosis with variable effects. On the other hand, it has been demonstrated that the trunk fat mass is a harbor of liver disease (16). According to a research by Ruhl et al., increased alanine transaminase is associated with the increased trunk fat mass, which highlights the possible correlation of the hepatic injuries and metabolic alterations induced by active intra-abdominal fats (17).

Waist circumference is another important risk factor for NAFLD, which could contribute to insulin resistance and NAFLD in healthy individuals (18). Evidence suggests that waist circumference alongside the fatty liver index could be effective in the diagnosis of NAFLD. In addition, the findings of Motamed et al. demonstrated that even waist circumference could be a more acceptable index for the diagnosis of NAFLD. In the mentioned study, the researchers claimed that the fatty liver index is strongly associated with NAFLD, and a single-unit increase in the fatty liver index could increase the risk of NAFLD by 5.8% (19).

According to the results of the present study, waist circumference is a simple and accessible index to detect the increased risk of steatosis whether adjusted for age, body weight or both these parameters. Similar results have been proposed in a study conducted on obese adolescents, denoting that waist circumference could predict the risk of NAFLD in these patients (20). On the other hand, a recent study by Yun et al. demonstrated that waist gain rather than waist circumference could increase the risk of developing NAFLD independent of the baseline waist circumference (21).

Conclusion

According to the results, individuals with and without NAFLD differed in term of BMI, waist circumference, fat-free mass, body fat mass, trunk fat mass, and liver stiffness. Moreover, anthropometric measurements (e.g., waist circumference, trunk fat mass, and body fat mass) were associated with the increased risk of hepatic steatosis even after adjustment for age and body weight.

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