Short Communication

Association of Nonalcoholic Fatty Liver Disease Severity With General and Central Obesity, and Physical Activity in Adults

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ABSTRACT

A Nonalcoholic fatty liver disease (NAFLD) is one of the most common chronic liver diseases worldwide. Many risk factors are associated with NAFLD, such as a sedentary lifestyle and obesity. This study aimed to investigate the association between disease severity, obesity, and physical activity levels in adults with NAFLD. A total of 280 adults with NAFLD were selected by a gastroenterologist using convenience sampling. NAFLD severity was assessed by ultrasound, and participants' physical activity was evaluated using the short version of the International Physical Activity Questionnaire. Regarding NAFLD grade, 24.6% were grade 1, 63.2% were grade 2, and 12.2% were grade 3. The mean body mass index and waist circumference of the study participants were 29.19±4.14 kg/m^2 and 100.99±9.24 cm, respectively. A significant positive relationship was observed between the degree of general obesity and NAFLD severity. As obesity increased, NAFLD severity also increased (P=0.045). A significant inverse relationship was observed between the level of physical activity and NAFLD grade (P=0.002). Considering the association between NAFLD grade, obesity, and physical activity, it is recommended that health and educational programs be developed to promote a healthy lifestyle and physical activity to reduce the prevalence of obesity and NAFLD.

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Introduction

Nonalcoholic fatty liver disease (NAFLD) is one of the most common chronic liver diseases worldwide and is also considered a significant health issue in Iran [1]. The global prevalence of NAFLD is 25% [2], and in the adult population it ranges from 14–31% [3]. This rate is reported to be between 28% and 32.4% in Asia and 38% in Iran [4]. With the increase in obesity rates, the incidence of NAFLD is expected to reach 100.9 million by 2030 [5]. Diagnosis of NAFLD is not easy, as the condition may be asymptomatic until it progresses to end-stage liver disease. The disease can be diagnosed using ultrasound, magnetic resonance imaging, and liver biopsy [6]. Given the lack of specific drugs for the treatment of NAFLD, lifestyle interventions, such as diet and exercise, are essential for treatment [7]. Consequently, NAFLD prevention is crucial.

An imbalance between caloric intake and energy expenditure mainly causes obesity.. When energy intake exceeds energy requirements, it is stored as fat in subcutaneous adipose tissue and organs [8]. Generalized obesity refers to an increase in total body weight, whereas central obesity refers to fat accumulation in the abdominal and waist areas [9]. A body mass index (BMI) of >25 kg/m^2 is commonly used to define overweight, and a BMI of >30 kg/m^2 is used to define obesity [10]. Approximately one-third of the world's population is obese or overweight [11]. Previous studies have shown that obesity has been associated with the prevalence and progression of several chronic diseases [12]. Some studies have found a significant positive association between obesity and NAFLD [13, 14], while others have not shown an association between obesity and NAFLD [15-17]. In a study by Dai et al. the risk of NAFLD was observed in both obese and non-obese men; therefore, the odds ratio for the risk of NAFLD was higher in obese men than in non-obese men [18].

Physical activity has been reported to be beneficial in reducing intrahepatic fat content in NAFLD [19]. The role of exercise as a non-pharmacological treatment has been emphasized to provide clinicians with recent advances in this area [8].

Understanding the relationship between obesity and NAFLD could help identify therapeutic targets or diagnostic markers for obesity-induced inflammatory responses and provide new approaches to prevent and treat NAFLD. Given the conflicting results of some previous studies and the possibility of NAFLD in non-obese individuals, this study aimed to investigate the association between disease severity, obesity, and physical activity levels in adults with NAFLD.

Methods

This study included 280 adults with NAFLD who were diagnosed by ultrasound performed by a gastroenterologist and an endocrinologist in Gonabad, Khorasan Razavi Province, Iran. Ultrasound was performed by an expert radiologist. The samples were selected using convenience sampling, which enabled us to efficiently collect data from readily available participants. The inclusion criteria included individuals between 18 and 65 years of age with NAFLD (grades 1, 2, and 3), without other metabolic diseases, no alcohol or dietary supplements, no pregnancy or breastfeeding in women, and written informed consent to participate in the study. The exclusion criteria included incomplete cooperation in completing the required information. The sample size was obtained using G*Power software, version 3.1.9.7 and the t-test family using the statistical test of the difference in mean for two independent groups, considering a confidence interval of 99%, a test power of 90%, and an effect size of 0.499 based on data from a similar study (in Mashhad City, Iran) [20], which was 280 people considering a 15% probability of dropout.

Demographic characteristics were collected using a questionnaire, and NAFLD severity was assessed by ultrasound. NAFLD was graded based on liver echogenicity on ultrasound images, where grade 0 is considered normal, grade 1 represents mild steatosis (liver echogenicity similar to the renal cortex), grade 2 is moderate steatosis (with visible portal veins), and grade 3 signifies severe steatosis (with portal veins not visible). Liver ultrasound was performed using a Samsung RS80A device (Samsung Medison Co., Ltd., Seoul, South Korea), and based on these results, the samples were classified into three groups: Grades 1, 2, and 3. The weight of participants in minimal clothing and without shoes was measured with an accuracy of 100 g using a German-made Seca 881 digital scale. The height of the subjects, without shoes and with the shoulders in normal conditions, was measured with an accuracy of 0.1 cm using a non-elastic tape measure mounted on a vertical, flat wall. Then, BMI was calculated by dividing the weight in kilograms by the square of the height in meters. Waist circumference (WC) was measured in centimeters at the narrowest part of the waist, at the end of natural expiration, and without applying pressure to the body. The measurement was taken between the lowest rib and the iliac spine, with participants wearing light clothing and standing upright with completely exhaled breath. A flexible tape measure with an accuracy of 0.1 cm was used, placed tangentially to the skin. The dietary intake of the participants was evaluated by the 24-hour dietary recall method for three days (two weekdays and one weekend day). Then, participants' diets were assessed using Nutritionist software, version IV (first databank, San Bruno, CA, USA) modified, to reflect Iranian foods, to determine the participants' daily energy intakes. To assess the subjects' physical activity levels, the short version of the International physical activity questionnaire, validated for the Iranian population, was completed for each participant. Then, metabolic equivalents were calculated for the physical activities. For example, the metabolic equivalent of task (MET) equivalent for walking was 3.3, moderate activity was 4, and vigorous activity was 8. These numbers were multiplied by the duration of the physical activity in minutes and the number of days the activity was performed. MET scores were classified into three levels: A score of less than 600 MET min/week was considered low physical activity, a score of 600-3000 MET min/week was considered moderate physical activity, and a score of more than 3000 MET min/week was considered high physical activity.

Statistical analyses were performed using SPSS software, Version 19. Descriptive statistics (Mean±SD, frequency) were used to describe the data. The chi-square test and rank regression were used to examine the relationship between variables, and a significance level of <0.05 was considered.

Results

Table 1 shows the mean age of the participants was 46.12±12.37 years. In terms of NAFLD grade, 24.6% were in grade 1, 63.2% were in grade 2, and 12.2% were in grade 3. The mean BMI of the study subjects was 29.19±4.14 kg/m^2. The mean physical activity level of the participants was 761.63±1329.36 MET-min/week.

Table 2 presents the relationships between NAFLD grade, general and central obesity, and physical activity. A statistically significant relationship was observed between NAFLD grade and each of the three variables of general and central obesity and physical activity (P<0.001). Therefore, with increasing general and central obesity, NAFLD severity increased, whereas with increasing physical activity, it decreased.

Table 3 presents the results of the ordinal regression analysis to determine the association between NAFLD grade and general and central obesity, as well as physical activity. NAFLD grade was included as an ordinal variable in the model. In the adjusted model, the chance of having a high grade of NAFLD increases by 6.2% in the crude model (P=0.037) and by 6.8% in the adjusted model (P=0.045) with a one-point increase in BMI. Also, the chance of a high NAFLD grade decreases by 0.03% in the crude model (P=0.001) and by 0.01% in the adjusted model (P=0.002) with a one-point increase in physical activity level. In addition, the chance of a high NAFLD grade did not show a significant relationship with WC in either the crude or adjusted models (P>0.05).

Discussion

The results of this study showed a positive and significant relationship between general obesity and NAFLD severity, indicating that increased obesity leads to increased NAFLD severity. Elucidating the relationship between obesity and the severity of the disease is essential for understanding its cause and developing effective diagnostic, therapeutic, and preventive strategies.

Our data showed that the highest prevalence of NAFLD was in overweight and obese individuals, accounting for 87.5% of patients. These findings are consistent with the results of some previous studies. In a study by Liu et al. in 2020 in the United Kingdom, it was shown that general and central obesity increased the risk of NAFLD [14]. Also, a meta-analysis study by Moghaddasifar et al. in 2016 showed that the prevalence of NAFLD was associated with obesity, male gender, and age [13]. A cohort study by Xu et al. in 2013 in China showed that general obesity and central obesity were associated with NAFLD [21], which was consistent with our study for general obesity but inconsistent with our study for central obesity. However, a study conducted in 2015 in Iran by Karimi-Sari et al. ofbserved no association between BMI and NAFLD [16]. A 2012 study by Razavizade et al. in Iran showed no significant relationship between BMI and NAFLD [17]. Due to the presence of various confounding factors, such as lifestyle and socioeconomic status, observational associations are limited in elucidating causality [14]. In addition to obesity, the roles of genetic factors and diet in the pathogenesis of NAFLD should not be ignored. Certain genes, such as PNPLA3, are associated with an increased risk of NAFLD. Excessive consumption of carbohydrates and saturated fats can also lead to liver fat accumulation and disease progression. Non-obese steatosis patients may have other metabolic abnormalities that cause NAFLD. Other possible causes include genetic predisposition, intestinal motility disorders, and other metabolic abnormalities not associated with weight gain [15]. However, the results of risk

Table 1. General characteristics of the study participants (n=280)

Variables		Mean±SD/No. (%)	
		Male	Female
Age (y)		44.99±12.21	47.93±12.50
Sex		178(63.6)	102(36.4)
Marital status	Married	163(91.6)	96(94.1)
	Single	15(8.4)	6(5.9)
Education	Illiterate	2(1.1)	8(7.8)
	Primary education	14(7.9)	24(23.5)
	High school education	58(32.6)	42(41.2)
	Higher education	104(58.4)	28(27.5)
Job	Employed	168(94.4)	34(33.3)
	Unemployed	10(5.6)	68(66.7)
NAFLD grade	1	37(20.8)	32(31.4)
	2	124(69.6)	53(52.0)
	3	17(9.6)	17(16.6)
Weight (kg)		84.37±14.71	76.77±10.63
Height (cm)		172.02±8.08	158.57±6.28
BMI (kg/m^2)		28.40±3.85	30.57±4.27
WC (cm)		101.09±9.51	100.81±8.79
Physical activity (MET-min/week)		870.57±1467.08	571.51±125.83
Daily energy intake (kcal)		3180.47±732.03	2409.48±611.79

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Abbreviations: BMI: Body mass index; WC: Waist circumference; MET: Metabolic equivalent of task; NAFLD: Non-alcoholic fatty liver disease.

assessment in different Iranian studies were inconsistent, making it difficult to determine risk factors for NAFLD. Donghia et al. (2023) showed that the pathophysiological, genetic, and hormonal patterns of NAFLD are likely independent of weight [15].

Based on these findings, no relationship was observed between central obesity and NAFLD severity. In addition, the findings indicated an inverse and significant relationship between physical activity and NAFLD severity; therefore, with increasing physical activity levels, the severity of NAFLD decreases. Similarly, a cross-sectional study by Alferink et al. showed a negative association between physical activity level and NAFLD severity [22]. Increased physical activity can help reduce disease severity and improve liver function. A 2022 study by Pouwels et al. found that weight loss can improve liver function in patients with this disease [23]. One strategy to help reduce weight is physical activity and exercise. Regular physical activity increases insulin sensitivity, reduces inflammation, and improves lipid metabolism, all of which help reduce fat accumulation in the liver and prevent disease progression. A study by Nath et al. in 2020 showed that moderate-intensity physical activity significantly improved BMI in people with NAFLD compared to low-intensity physical activity [24]. In a study by van der Windt et al. in 2018, physical activity was shown to be a suitable therapeutic strategy

Table 2. Cross table of NAFLD grade with general and central obesity and physical activity (n=280)

Variables		No. (%)				Statistical Parameters
		Grade 1	Grade 2	Grade 3	Total	
General obesity	Normal weight	23(33.3)	9(5.1)	3(8.8)	35(12.5)	X^2=73.76 df=6 P<0.001
	Overweight	36(52.2)	98(55.4)	3(8.8)	137(48.9)	
	1st-class obese	10(14.5)	52(29.4)	21(61.8)	83(29.6)	
	2nd-class obese	0	18(10.2)	7(20.6)	25(8.9)	
Central obesity	Yes	34(49.3)	63(35.6)	3(8.8)	100(35.7)	X^2=16.237 df=2 P<0.001
	No	35(50.7)	114(64.4)	31(91.2)	180(64.3)	
Physical activity level	Normal intensity	31(44.9)	112(63.3)	34(100)	177(63.2)	X^2=29.738 df=4 P<0.001
	Moderate intensity	32(46.4)	54(30.5)	0	86(30.7)	
	High intensity	6(8.7)	11(6.2)	0	17(6.1)	
	Total	69(100)	177(100)	34(100)	280(100)	

Note: Data were analyzed using the chi-square test, P<0.05 was considered statistically significant.

Table 3. Association of NAFLD grade with general and central obesity and physical activity (n = 280)

Variables	OR	95% CI	P
BMI (kg/m²)	1.062 1.0682	1.004-1.125 1.0020-1.1399	0.037[a] 0.044[b]
WC (cm)	1.017 1.0202	0.992-1.041 0.9910-1.0491	0.191[a] 0.174[b]
Physical activity (MET-min/week)	0.9997 0.999904	0.9996-0.9999 0.999671-0.999918	0.001[a] 0.001[b]

Abbreviations: OR: Odds ratio; CI: Confidence interval; BMI: Body mass index; WC: Waist circumference; NAFLD: Non-alcoholic fatty liver disease; MET: Metabolic equivalent of task.

Note: The data were analyzed using ordinal regression, P<0.05 statistically significant, [a]crud model, [b]adjusted for age, gender, and daily energy intake.

for improving fatty liver disease [25], findings consistent with our study. These findings indicate the importance of weight management and increased physical activity in patients with NAFLD.

In general, NAFLD, a common metabolic disorder, is mainly associated with obesity, but other factors can also lead to this disease. General obesity is directly associated with an increased NAFLD risk. A lack of significant association between NAFLD grade and WC may be due to metabolic, genetic, or other population-specific factors. In addition, regular physical activity is an effective strategy for controlling and preventing NAFLD. As a result, weight management and regular physical activity are of particular importance not only in obese individuals but also in individuals with NAFLD for other reasons.

This study has some limitations that should be considered. First, this was a cross-sectional study and could not demonstrate a cause-and-effect relationship between the variables. Second, the lack of complete control over confounding factors (such as genetics) could affect the study's results. Also, the lack of complete coverage of the age range is another limitation of this study. Because this study focused only on a specific age group, the results may not be generalizable to other age groups.

Conclusion

The present study shows that general obesity and low physical activity levels are associated with NAFLD severity in adults with the disease. These findings emphasize the importance of a healthy lifestyle in preventing and managing NAFLD. By adopting effective preventive and therapeutic strategies to reduce obesity and increase physical activity, the progression of NAFLD can be prevented, and general health improved.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran (Code: IR.TBZMED.REC.1402.750).

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Authors' contributions

Study design and reviewing the manuscript: Maryam Rafraf, Roghayeh Molani-Gol, and Mehrdad Kianmehr; Data collection: Mehrdad Kianmehr and Alireza Hosseini; Statistical analysis: Mojtaba Kianmehr; Writing the draft of the manuscript: Mehrdad Kianmehr; Revising the manuscript: Maryam Rafraf and Roghayeh Molani-Gol.

Conflict of interest

The authors declared no conflicts of interest.

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