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Fast Food Consumption and the Risk of Non-Alcoholic Fatty Liver in Adults: A Community-Based Case-Control Study

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Abstract

Background: Despite many studies showing a correlation between fast food consumption and non-alcoholic fatty liver disease (NAFLD) known as the silent death, few studies have investigated the effects of different types of fast foods on this disease. This research aimed to evaluate the effect of consuming different types of fast foods on non-alcoholic fatty liver disease.
Materials and Methods: In this community based case-control study, 96 patients with non-alcoholic fatty liver disease whose disease was confirmed by a radiologist based on ultrasonography results, and 96 respondents with normal ultrasonography results were recruited as the case and control groups, respectively. The study checklist included demographic and anthropometric information, physical activity, as well as special items asking about the frequency and type of fast food consumed. Parametric (such as t-test) and non-parametric tests (such as Chi-Square and Mann Whitney U tests) were used to compare qualitative and quantitative variables, respectively. Further, logistic regression analysis was performed to find the effects of consuming different types of fast food on NAFLD, giving Odds Ratio along with 95% confidence interval.
Results: The mean number of monthly fast food consumption in patients (7.59±5.5) was significantly greater than that in the control group (5.35±4.7). Among various types of fast foods, the risk of consuming Pizza was highest in developing non-alcoholic fatty liver disease (OR=4.4, 95%CI= 1.9-9.9), with the lowest risk having belonged to chicken burgers (OR=0.7, 95%CI= 0.38-1.57).
Conclusions: In general, fast-food consumption has significant effects on non-alcoholic fatty liver disease and increasing the frequency of fast food consumption, thereby increasing the risk of non-alcoholic fatty liver disease.

Keywords: Non-alcoholic Fatty Liver, Fast Food, Adults, Case-Control Study

Introduction

Non-alcoholic fatty liver disease (NAFLD) is the most common form of chronic liver diseases [1]. NAFLD is currently the second leading cause of hepatocellular carcinoma and the second most frequent indication for liver transplantation [2]. The

World Health Organization (WHO) has anticipated that NAFLD will be the first cause of liver transplantation by 2020. In 2016, the prevalence of NAFLD was estimated to be about 10-35% in the world [3]. It is also reported that 7% of children and 35% of adults are affected with NAFLD in Iran [4-5]. The results of research on measuring the dietary intakes of NAFLD patients are inconsistent [4]. The increasing trend of NAFLD along with obesity could be associated with the inappropriate nutritional behavior of people around the word. Furthermore, the secrecy of the disease and its highly fatal nature at advanced stages, such as cirrhosis, necessitate the detection and control of this health problem at early stages [1]. Despite many studies conducted to assess the effects of nutrition and diet on NAFLD, there have been few well-designed studies on controlling the most effective confounders. It is obvious that lifestyle in both developed and developing countries has been dramatically changed in recent decades. New food and nutrition technologies, especially fast food, are the key elements in this change. Changing diet patterns, especially the increase in the prevalence of fast food consumption, have raised concerns about the increased prevalence of NAFLD [5]. In developing countries, such as Iran, NAFLD prevalence in children is a dire warning for the future [6]. Due to the limitations of past research and the role of nutrition in the etiology of NAFLD, the present study aims to evaluate the effects of consuming a variety of fast food on the incidence of NAFLD.

Materials and Methods

This double-blind case-control study was performed on 96 patients (cases) with NAFLD and 96 healthy adults (controls) aged 20-40. The respondents were referred to the main ultrasound clinic of Moradi hospital in Rafsanjan city, Iran, and were invited using the simple random sampling method. The primary information included the average number of weekly fast food consumption in the affected (μ1) and non-affected groups (μ2) using Kolahi et al.'s study (0.4 and 0.8, respectively) [7]. Given the significance level of 0.05 (α=0.05), the statistical test power of 90% (β=0.1), and using formula $n=\frac{2(Z_{1-\alpha/2}+Z_{1-\beta})^2\sigma^2}{(\mu_1-\mu_2)^2}$, the sample size was calculated to be 96 for each group (case and control groups). The selected patients showed grade two or a higher degree of fatty liver disease based on their ultrasound results. The healthy respondents (n=96) were pair matched with the patients in terms of the potential confounding factors, such as age (± 1 year), gender, economic status, BMI, physical activity, and the living place (rural or urban). The selected cases (patients) included individuals fully and definitively affected by fatty liver grade 2 or grade 3. To confirm the disease, the ultrasound results were determined by a radiologist not aware of the research objectives. The grading of fatty liver echo was done at 4 levels, including (1) grade 0= normal, (2) grade 1= mild steatosis (similar to the echo of renal cortex), (3) grade 2= moderate steatosis (visible portal vein), and (4) grade 3= severe steatosis (unobservable portal vein). Patient inclusion criteria were respondents aged from 20 to 40, having a fatty liver grade of 2 or higher, and having no comorbidity. According to the specialist diagnosis, the control group had a normal liver based on ultrasound results. The exclusion criteria included having a history of drinking alcohol or smoking, having hepatitis type B and C, celiac disease, cardiovascular diseases, chronic diseases, such as diabetes and dyslipidemia, autoimmune liver diseases, having an immune deficiency virus, gallstones, and liver fibrosis, as well as taking weight loss medications, or following weight loss programs. The respondents in the two groups would be asked to sign the consent form if they were willing to help the study. In addition, the Ethics Committee of Rafsanjan University of Medical Sciences approved the methods of the study and assigned an ethics code to it (IR.Rums.REC.1396/150).

Given the importance of the confounding role of physical activity, this variable was measured, and its effect was controlled. For this purpose, some questions were asked about the times and duration of vigorous (such as sports activities), moderate, and light activities (such as walking) over the last seven days using the International Physical Activity Questionnaire (IPAQ). Three levels of physical activity were defined as [1] respondents with vigorous physical activity, such as sports activities at least three sessions a week or respondents having a combination of rigorous, moderate, and mild physical activities on all/most days of the week; [2] respondents with moderate physical activity doing vigorous physical activity for 20 minutes a day, three or more days a week, or doing a combination of vigorous, moderate, and mild physical activities for at least 30 minutes a day, and five or more days a week; [3] respondents with mild physical activity not reporting to have had vigorous or moderate physical activities [8-9]. The monthly frequency of fast food consumption in the present researcher-made checklist includes a list of different types of fast food (made in restaurants or/and food shops) consumed within the past 30 days, which was completed by a trained interviewer. This checklist

consisted of pizza (all kinds), sausage and kielbasa sandwiches, Falafel (a mixture of fried chickpeas and oily eggs), Snack (a combination of minced meat, mushrooms, potatoes, onions, cheese, and spices pressed inside the toast), Bandary sandwiches (a combination of sausage and fried potatoes inside baguettes), French fries, Sambosa (a combination of boiled potatoes, aromatic vegetables, and spices wrapped in tortillas and fried), chicken burgers, cheeseburgers, and hamburgers. Furthermore, the demographic items were used to collect information about the living place, as well as economic, occupational, marital, and educational status of the respondents. A question was also asked about the reason for the ultrasound checkup. The interviewer as well as the respondents were fully unaware of the assignment of the respondents to the case and control groups.
Anthropometric measurements included height, weight, waist circumference, and the Body Mass Index (BMI). The respondents' height was measured without shoes, using a standard scale ruler (cm), with their weight measured by a digital scale in kilograms. The respondents' waist was measured horizontally using a metric bar placed at the region between the lowest rib and the iliac crest in centimeters. According to international standards, the waist circumference index over 102 cm in men and over 88 cm in women was considered as visceral or central obesity. The BMI was calculated through dividing the weight measured in kilograms by the square of the height measured in meters. In addition, WHO standards were used to categorize the BMI.
Data were analyzed using the Statistical Package for Social Sciences (SPSS), version 21. The mean and standard deviation of the study variables were reported. $P < 0.05$ was considered as a significant level. Due to the significant effects of drinking alcohol and tobacco on fatty liver disease, the restriction method was used to eliminate the effects of these variables. The increased risk of NAFLD was evaluated for each fast food individually, and multivariate regression models were used to calculate odds ratios along with the 95% confidence interval. Furthermore, a chi-square test and a t-test were used to compare qualitative and quantitative measures distributed in different groups.

Results

In this study, 192 respondents aged 20 to 40, who referred to the ultrasound clinic of Rafsanjan Moradi Hospital in 2018, were studied in the two equal case (n=96) and control (n=96) groups. The respondents in the two groups were matched in terms of age, sex, physical activity, the living place, the Body Mass Index (BMI), and economic status. The frequency distribution of respondents in the two case and control groups is presented in Table1 based on the respective variables.
According to Table 1, there has been no significant statistical difference between the two groups in terms of age, gender, the BMI, physical activity, as well as marital, occupational, and educational status. The respondents had referred to the ultrasound clinic for reasons, including abdominal pain, traumas, genitourinary system disorders, or checkups. The respondents' physical activity was the most effective variable which could distort the causal relationship between fast food consumption and NAFLD incidence. As Table 1 shows, this variable was matched successfully among the respondents in the two case and control groups.
In addition, the results showed no significant statistical difference between the two case and control groups in terms of height and weight (P> 0.05). However, the mean waist circumference of the case group (96.76 ± 10.88cm), i.e. the abdominal obesity index, was significantly greater than that of the control group (90.09 ± 11cm) (t= -4.22, df=190, p<0/001).
All and all, 78 individuals (40.6%) had abdominal obesity, among which 45 individuals (46.9% of the cases) belonged to the case group, and 33 individuals (34.4% of controls) belonged to the control group.

Table 1. Frequency distribution of respondents in the two groups based on demographic variables

Variable	Variable levels	Groups				Chi-square
		Case (n=96)		Control (n=96)		
		Frequency	Percent	Frequency	Percent	
Age	20-24	4	4.2	13	13.5	X2=5.624 Df =3 P=0.131
	25-29	15	15.6	15	15.6	
	30-34	20	20.8	15	15.6	
	>35	57	59.4	53	55.2	
Gender	Male	58	60.4	58	60.4	X2=0 Df =1 P=0.999
	Female	38	39.6	38	39.6	

1Physical activity	**Light**	34	35.4	34	35.4	X2=0 Df =2 P=0.999
	Moderate	52	54.2	52	54.2	
	Vigorous	10	10.4	10	10.4	
Living place	**Urban**	77	80.2	77	80.2	X2=0 Df =1 P=0.999
	Rural	19	19.8	19	19.8	
2BMI	**Underweight**	0	0	0	0	X2=0 Df =3 P=0.999
	Normal	47	49	47	49	
	Overweight	35	36.5	35	35.6	
	Obesity	14	14.6	14	14.6	
3Economic status	**Low-income**	30	31.3	30	31.3	X2=0 Df =2 P=0.999
	Moderate-income	61	63.5	61	63.5	
	High-income	5	5.2	5	5.2	
Marital status	**Single**	13	13.5	19	19.8	X2= 1.77 Df =2 P= 0.413
	Married	82	85.4	75	78.1	
	Widow & Divorced	1	1	2	2.1	
Occupational status	**Unemployed**	13	13.5	19	19.8	X2= 5.507 Df =4 P= 0.239
	Housewife	29	30.2	27	28.1	
	Employee	19	19.8	13	13.5	
	Free	23	24	31	32.3	
	Others	12	12.5	6	6.3	
Education level	**Illiterate**	6	6.3	5	5.2	X2= 2.416 Df =5 P= 0.789
	Elementary	10	10.4	7	7.3	
	Less than diploma	22	22.9	16	16.7	
	High school diploma	42	43.8	49	51	
	Bachelor's degree	13	13.5	16	16.7	
	Higher	3	3.1	3	3.1	
Cause of referral	**Abdominal pain**	44	45.8	43	44.8	X2= 3.741 Df =4 P= 0.442
	Trauma	2	2.1	3	3.1	
	Checkup	10	10.4	13	13.5	
	Genitourinary disorders	9	9.4	3	3.1	
	Others	31	32.3	34	35.4	

1- Light activity=energy consumed in each minute of rest being less than 600MET-min (metabolic equivalent/minute), moderate activity= energy consumed in each minute of rest being between 600 and 1500 MET-min, vigorous activity= energy consumed in each minute of rest being more than 1500 MET-min. 2- BMI above 30 kg/m2 = obese, BMI from 25 to 30 = overweight, BMI from 18.5 to 25 = optimal weight, and BMI less than 18.5 = underweight. 3- Low income= a monthly income of less than 10,500,000 Rials, moderate income= a monthly income of between 10,500,000 Rials and 30,000,000 Rials, high income= the monthly income equal to or higher than 30,000,000 Rials.

After stratifying the respondents in the two groups, based on abdominal obesity (with and without abdominal obesity), the risk of NAFLD in respondents with abdominal obesity, who were consuming fast food more than twice per month was 4.5 times greater than the risk among those consuming fast food only two or less times per month. This risk was statistically significant (p=0.004). In the respondents not having abdominal obesity but consuming fast food more than twice per month, the risk of having NAFLD was only twice greater than that of those who did not have abdominal obesity and consumed fast food two or less times per month. However, this risk was not statistically significant (p=0.123). Therefore, it could be concluded that abdominal obesity is an effect modifying variable in the relationship between fast food consumption and NAFLD (Table 2).

Table 2. The risk of NAFLD in respondents who consumed fast food more than twice per month compared to those who consumed fast food twice or less times per month (abdominal obesity as an effect modifier)

Abdominal obesity	Fast food consumption	The odds ratio for the fatty liver disease (95% confidence interval)	Chi-square test
Yes	**Equal or less than twice per month** **More than twice per month**	1 4.524 (1.570-13.091)	*p-value=0.004
No	**Equal or less than twice per month** **More than twice per month**	1 2.015 (0.820-4.50)	p-value=0.123
Total	**Equal or less than twice per month** **More than twice per month**	1 2.742 (1.388-5.415)	*p-value=0.005

*p<0.05, significant effect

The monthly number of different types of fast food consumed in the respondents of the two groups was normally distributed, and the variances were not significantly different. Therefore, an independent t-test was used to compare the mean number of fast food consumption in the two groups. In general, the mean number of the monthly fast food consumption (all types) in the case group (7.59 ± 5.5) was significantly greater than in the control group (5.35 ± 4.66) (t=-3.09, df=190, p=0.002). The risk of NAFLD among the respondents has been presented in Table 3 based on the consumption of each type of fast food.

Table 3. The effect of consuming different types of fast food on NAFLD in respondents

Type of fast food	**B	***SE	Odds ratio	P-value	Confidence interval
1Bandary sandwiches	0.777	0.298	2.174	*0.009	1.213-3.896
Hotdogs	1.048	0.548	2.851	0.056	0.974-8.339
Pizza	1.480	0.414	4.394	*<0/001	1.953-9.884
French fries	0.775	0.488	2.171	0.112	0.835-5.644
Kielbasa	0.140	0.305	1.15	0.647	0.632-2.092
Sausages	0.588	0.292	1.8	*0.044	1.016-3.188
2Falafel	1.308	0.246	3.698	*<0/001	2.004-6.823
3Sambosa	0.480	0.312	1.615	0.124	0.877-2.976
4Snack	-0.939	0.413	2.55	*0.023	1.138-5.745
Chicken burgers	-0.344	0.315	0.709	0.274	0.377-1.568
5Cheeseburgers	0.914	0.301	2.493	*0.002	1.383-4.494
Hamburgers	-0.203	0.213	1.460	0.193	0.826-2.581

*p<0.05, significant effect, ** Regression coefficient, *** Standard error

1-Bandary sandwiches: The combination of sausages, onions, tomatoes, spices, and fried potatoes inside baguettes; 2- Falafel: A mixture of fried chickpeas and eggs with spices in abundant oil; 3- Sambosa: A combination of squashed boiled potatoes, aromatic vegetables, and spices wrapped in Lavash bread and fried; 4- Snack: A combination of minced meat, mushrooms, potatoes, onions, cheese, pizza, and spices pressed inside the toast; 5- Cheeseburgers: hamburgers with cheese.

As Table 3 shows, six out of 12 different types of fast food presented in the table have a significant risk of NAFLD. The highest risk of NAFLD belonged to Pizza (OR=4.4, 95%CI = 1.9-9.89). The second and third most effective types of fast food to have caused NAFLD were Falafel (OR=3.7, 95%CI = 2-6.8) and Snack (OR=2.6, 95%CI = 1.1-5.7), respectively.

The lowest risk of NAFLD was reported for chicken burger consumption (OR= 0.71), which was not statistically significant (P=0.274). Other fast food types with significant effects on NAFLD included Bandary sandwiches (OR=2.17, 95%CI=1.2-3.9), sausages (OR=1.8, 95%CI=1.01-3.2), and cheeseburgers (OR=2.5, 95 %CI=1.4-4.5). Interestingly, hamburgers being a type of fast food similar to cheeseburgers, did not have a significantly high risk of NAFLD among the respondents (OR=1.5, 95%CI = 0.8-2.6).

Due to the significant effects of soft drinks (10) and sauces (11-12) usually consumed along with fast food, we used the multiple regression model so as to control the effects of consuming all kinds of sauces and drinks. According to the results, after controlling the effects of sauce consumption, sausages and Snack did not have a significant correlation with NAFLD.

To measure the increased risk of NAFLD due to fast food consumption, the regression model was used as well (Table 4).

Table 4. The correlation between the monthly frequency of fast food consumption and NAFLD in the respondents

Monthly frequency of 1fast food consumption	B	SE	Odds ratio	P-value	Confidence interval
0-2	-	-	1	0.018	-
3-5	0.713	0.417	2.04	0.087	0.902-4.616
6-8	1.224	0.447	3.40	0.006	1.414-8.173
>9	1.128	0.411	3.91	0.006	1.382-6.912

1- Bandary sandwiches, hotdogs, pizza, French fries, sausages, kielbasa, Falafel, Sambosa, Snack, chicken burgers, cheeseburgers, and hamburgers

The results showed that the increase in the number of fast food consumption by 3-5 times per month increased the risk of NAFLD by 2.04 times compared to the time when the number of consumption was 2 or less. However, the increase was not significant until the number of fast food consumption increased to 6-8 times per month, so the risk of NAFLD increased to 3.4 times compared to the time when fast food types were consumed 2 or less times per month, which was a significant risk. By the increase in the number of fast food consumption to 9 and more times per month, the risk of NAFLD increased to 3.9 times. All and all, the higher the monthly frequency of fast food consumption was, the greater the risk of NAFLD would be (Table 4).

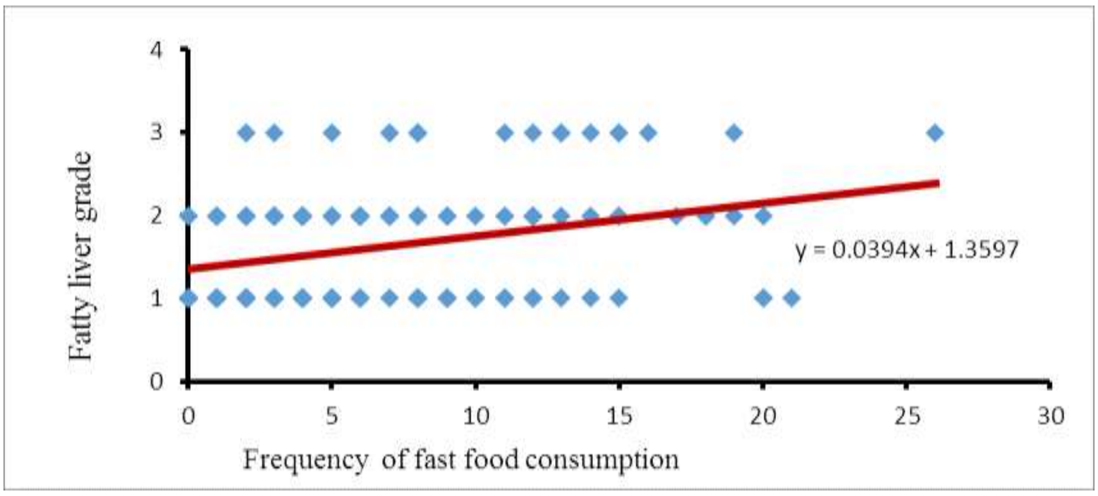

Fig. 1. Line equation between the frequency of monthly fast food consumption and the fatty liver grade

Fig Legend:
◆ : Frequency distribution of monthly fast food consumption based on the fatty liver grade (1, 2, and 3)
: The line trend between fast-food consumption and the fatty liver grade

Fig. 1 shows the increasing trend of the fatty liver grade upon an increase in fast food consumption per month. In addition, a linear equation is presented to illustrate the correlation between the number of fast food consumption and the risk of NAFLD.

Discussion

Our results provide substantial evidence obtained from a well-designed case-control study showing that more frequent fast food consumption results in a higher risk of NAFLD development. Many studies have introduced the excessive consumption of fast food as a nutritional risk factor in the development of NAFLD (13-14). Unfortunately, these studies have not estimated accurately the exact risk of different types of fast food in development and progression of NAFLD. Despite many past studies, the most effective confounders have been sufficiently controlled in the present retrospective study. The major confounding factors were matched in the two groups (Table 1), which greatly increased the validity of our results in comparison with similar studies (15-16). Our findings showed that the number of the monthly fast food consumption, including Bandary sandwiches, sausages, Falafel, Pizza, Snack, and cheeseburgers was significantly higher in the cases than in the control group. The average monthly number of all types of fast food, in the present research, was significantly higher in the case group than in the control group (p=0.002). Interestingly, Kolahi et al found out in their study that healthy people consumed fast food (hamburgers, sausages, kielbasa, and fries) more frequently (0.8 times per week) than the people with fatty liver disease (0.4 times per week). Their results are quite different from our results. This could be due to the big mistake in the design of Kolahi et al.'s study. They collected fast food consumption data after diagnosing NAFLD in the cases, exactly the time when fatty liver patients had decided to control fast food consumption. In the present study, fast food consumption was measured before developing the disease. However, similar studies in Brazil and the state of Virginia show that patients with fatty liver disease consume fast food more than controls (16-17), with their results having been in concordance with our results.

It is reported that fast food is rich in cholesterol, saturated fatty acids, and salt. It is also lacking in fibers, vitamins, and nutrients (18-20). Past research has also verified a significant positive correlation between blood cholesterol and the triglyceride level with the presence of fatty liver disease in the ultrasound (21). These effects could be confirmed by our study results.

Pereira et al reported that individuals who consumed fast food more than twice a week had 4.5 kilograms more weight gain than those who consumed fast food less than twice a week. They also reported that they were more than two times possible to have insulin resistance (22).

Although all kinds of fast food studied in the present research increased the risk of NAFLD, Pizza and chicken burgers had the highest and the lowest risks (OR=0.7) in developing NAFLD, respectively. According to Lutsey et al, consuming the western diet, including refined grains, processed meat, fried food, and fast food increases the risk of fatty liver disease by 18% (23). This result is in consistent with the present results.

Although keilbasa and sausages are almost the same in terms of formulation, the increased risk of NAFLD was higher by consuming sausages (OR=1.8, P<0.5) than consuming keilbasa (OR=1.1, P=0.65). This difference could be due to the difference in the preparation process of these types of fast food. For instance, fried sausages increase the development rate of fatty liver disease, which could be even elevated after the absorption of oil when frying sausages (18). The effect of oil was more verified when it was observed that consuming hotdogs increased the risk of NAFLD even more than consuming sausages (OR=2.85 v OR=1.8). Hotdogs are cooked in hot oil for several minutes, with this causing the absorption of a lot of oil by them. However, cooking sausages does not need a lot of oil. The more the influence of oil in the backing process is, the higher the risk of NAFLD will be.

The greatest risk of developing NAFLD in the present study belonged to pizza. Pizza has different ingredients according to its types and amounts of cheese, because it contains a lot of fat and salt being common in all types of pizza. In addition, sausages and keilbasa are common in many types of pizza. Given these components, the increased risk of developing NAFLD could be easily justified.

In our study, French fries increased the risk of developing NAFLD by twice as much, which was not statistically significant although they contain complex carbohydrates. According to some studies, complex carbohydrates prevent the development and progression of NAFLD (24). This diversity needs more investigations. Snack consumption also increases the risk of developing fatty liver disease by 2.5 times, with this effect being statistically significant (P<0.05). Sambosa was the other fast food studied in this research, which is fried in oil, but the effect of consuming Sambosa on developing NAFLD was not significant. The main difference between Sambosa and Snack is that there is a considerable amount of cheese and sauce in Snack. Unlike Snack, Sambosa is fried in oil. One could conclude that consuming processed cheese and sauce, which are the two main components of Snack, makes Snack develop a higher risk of NAFLD than Sambosa. Controlling the effect of sauce in the multivariate regression model showed that after keeping the effect of sauce consumption steady, Snack increased the chance of developing NAFLD by two times, but the risk was not statistically significant.

Zhu et al demonstrated that saturated fatty acids increase the likelihood of developing NAFLD (25). Shi et al found out that the average consumption of foods rich in cholesterol, including fast food by NAFLD patients, was significantly higher than that by healthy individuals (26). The lowest risk of developing NAFLD in this study was determined to be for chicken burgers, which was less than one (OR=0.7). The other finding of this study is the different risks of developing NAFLD by hamburgers and cheeseburgers. The risk of developing NAFLD among those consuming hamburgers was about 1.5 (OR=1.46, 95%CI=0.8-2.6), which was not statistically significant. However, this risk among those consuming cheeseburgers was about 2/5 (OR=2.5, 95%CI=1.4-4.5), which was statistically significant (p<0.05). Since all components of hamburgers and cheeseburgers are the same, except cheese that does not exist in hamburgers, it could be responsible for the extra risk of consuming cheeseburgers in developing NAFLD compared to consuming hamburgers. The effect of cheese on increasing the risk of developing NAFLD is verified once more by our findings, being similar to the results of past research (27-30).

Among the limitations of the present study was that we estimated the frequency of fast food consumption using the self-report of individuals, so the occurrence of recall bias was probable. Future studies on the relationship among inappropriate food consumption patterns, such as inappropriate time spent eating, eating styles, high eating speed, or skipping breakfast could be necessary.

Conclusion

In conclusion, fast food consumption was determined to be an independent risk factor for NAFLD development, and the higher monthly frequency of fast food consumption resulted in the higher risk of NAFLD. Furthermore, among all types of fast foods, pizza, Falafel, and cheeseburgers showed to have the highest levels of risk for developing NAFLD. According to the results, the amounts of cheese and oil as well as the style of cooking fast food are important in developing NAFLD. Providing adequate trainings through mass media on the risk of fast food consumption could be useful in reducing the development of NAFLD, which is known as silent death.

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