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Effect of Lifestyle Intervention Program on the Clinical Profile of Patients with Nonalcoholic Fatty Liver Disease

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Abstract: Background: Nonalcoholic fatty liver disease (NAFLD) is the most widespread liver condition globally. Lifestyle modifications are considered the cornerstone and the primary approach in the management of NAFLD. **Aim:** This study aimed to determine the effect of lifestyle intervention program on the clinical profile of patients with nonalcoholic fatty liver disease. **Design:** The study applied a quasi- experimental design. **Setting:** This research was performed at the internal medicine outpatient clinics at Al - Azhar University Hospital, New Damietta, Egypt. **Subjects:** A total of 92 patients diagnosed with NAFLD were randomly assigned into two equal groups. **Tools:** The study employed two instruments. Tool I: A structured interview questionnaire with two distinct parts: Part I: Demographic characteristics of the study sample. Part II: Health history of the patients. Tool II: Clinical profile data. **Results:** After six months of the program implementation, the intervention group demonstrated significant improvements in all clinical profile variables (anthropometrics, blood pressure, lipid profile, blood glucose, liver enzymes, and fatty liver grades), with a statistically significant difference was found between both groups ($P < 0.05$). **Conclusion:** Lifestyle intervention program was effective in improving the clinical profile of the individuals with nonalcoholic fatty liver disease. **Recommendations:** Further lifestyle intervention program for NAFLD patients should be conducted to control the disease.
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Key words: Clinical profile; Lifestyle; Nonalcoholic fatty liver disease.

1. Introduction

Nonalcoholic fatty liver disease (NAFLD) has emerged as the primary cause of liver-related illnesses around the world. It is estimated that 32% of adults worldwide are affected by NAFLD, with a higher prevalence in males (40%) compared to females (26%) **(Teng et al., 2022).** In Egypt, the prevalence of NAFLD is growing due to rising obesity rates **(Eletreby et al., 2021).** NAFLD is characterized by the accumulation of excess fat in more than 5% of liver cells, in the absence of heavy alcohol consumption or other secondary causes of liver fat buildup. It encompasses two distinct pathological conditions with different prognoses, namely nonalcoholic fatty liver (NAFL) and nonalcoholic steatohepatitis (NASH) **(Kumar et al., 2020; Prasun et al., 2021).**

Metabolic conditions like obesity, insulin resistance, diabetes mellitus, dyslipidemia, and elevated blood pressure are frequently connected to NAFLD. Therefore, it is commonly identified as a hepatic presentation of metabolic syndrome **(Godoy-Matos et al., 2020).** Furthermore, most individuals with NAFLD remain asymptomatic, and only a small proportion experience symptoms which tend to be nonspecific including fatigue, general discomfort, pain in the upper right abdomen, and hepatomegaly **(Muhammad, 2019).**

As nonalcoholic fatty liver disease (NAFLD) progresses, it triggers inflammation and fibrosis in the liver. In particular, the development of liver fibrosis significantly increases the risk of serious complications such as cirrhosis, liver cancer, liver failure, and even death **(Younossi, 2019).** Furthermore, NAFLD is closely linked to a number of significant non-hepatic illnesses including cardiovascular disease, chronic renal disease, and certain types of cancer, all of which add to the disease's total burden. Notably, cardiovascular disease is the primary cause of mortality among NAFLD patients **(Mantovani et al., 2020).**

At present, there are no effective therapies for NAFLD. The existing management strategies primarily aim at addressing the metabolic syndrome and type 2 diabetes linked to NAFLD, as well as lowering inflammation **(Mobasheri et al., 2022;**

Spooner and Jump, 2019). However, lifestyle adjustments such as modifying eating habits, increasing physical exercise, and decreasing weight are recommended for treating individuals with NAFLD. Furthermore, A healthy diet combined with regular exercise is more effective in managing NAFLD than either alone **(Chalasani et al., 2018).**

Individuals with NAFLD need to reduce their body weight by at least 3%-5% to improve steatosis. However, a more considerable weight loss of 7%-10% is necessary to address most histological aspects of NASH, including fibrosis **(Semmler et al., 2021).** Moreover, individuals with NAFLD should adhere to Mediterranean diet, or a similar dietary pattern with an emphasis on limiting saturated fat intake particularly from red and processed meats, and avoiding commercially produced fructose. In addition, regular physical exercise should be regarded as it may improve NAFLD by decreasing hepatic fat accumulation, in part by enhancing peripheral insulin sensitivity, reducing de novo lipogenesis, minimizing lipolysis in adipocytes, and restricting free fatty acids transport to the liver **(Younossi et al., 2021).**

Patient clinical profile is a straightforward tool that enables patients or caregivers to keep track of important health information. In clinical settings, to detect NAFLD, several measurements related to the condition should be assessed including lipid profile, liver enzymes (AST and ALT), and fasting blood sugar level (FBS). Additionally, liver ultrasonography is the most commonly applied tool for identifying fatty liver in general population. These measures contribute to identifying the severity and prognosis of the condition, as well as facilitating early intervention **(Mansour-Ghanaei et al., 2019).**

Significance of the study

NAFLD is growing rapidly in Egypt, and has become the main cause of chronic liver illness, hepatic carcinoma, and transplantation of the liver. It is also significantly linked to a variety of systemic illnesses such as cardiovascular disease, chronic renal disease, diabetes, and multiple forms of cancer **(Fouad et al., 2022).** Lifestyle modifications are the main treatment strategy and the initial step in managing NAFLD **(Ahmed et al., 2019).** Developing a health educational program focused on these lifestyle changes can positively impact patients' beliefs and behaviors, improving their clinical profile and potentially slowing disease progression and related conditions. Therefore, this study intended to investigate the effect of a lifestyle intervention program on the clinical profile of patients with nonalcoholic fatty liver disease.

Aim of the research

This research intended to determine the effect of a lifestyle intervention program on the clinical profile of patients with nonalcoholic fatty liver disease.

Research hypotheses

Individuals with nonalcoholic fatty liver disease who receive a lifestyle intervention program will exhibit a significantly improved clinical profile than the control group.

2. Methods

Research design

This research was done utilizing a quasi-experimental approach.

Research setting

The study was performed at the outpatient clinics of the Department of Internal Medicine at Al-Azhar University Hospital in New Damietta, Egypt.

Subjects

This study involved a targeted sample of 92 NAFLD patients, assigned randomly to two equal groups: the intervention group (n = 46) and the control group (n=46). Based on literature data **(Tincopa et al., 2022)** and a significance level of 5% with 80% power, the sample size obtained using the following calculation:

$$n = \frac{(Z\alpha/2 + Z\beta)^2 \times 2(SD)^2}{d^2}$$

This calculation resulted in a required sample size of 46 patients per group. The patients in the control group received routine hospital care only, while the intervention group received the lifestyle intervention program regarding NAFLD, in addition to routine hospital care.

Inclusion criteria included patients diagnosed with NAFLD, aged 20-60 years of both genders, and who agreed to participate in the research. Exclusion criteria involved patients with other causes of liver illness (e.g., alcoholic- fatty liver disease (AFLD), viral hepatitis, autoimmune disease of the liver, genetic disorders, etc.), hepatic decompensation, or hepatocellular carcinoma, as well as patients using steatogenic drugs. Additionally, those with mental or behavioral disorders were excluded.

Tools of data collection:

The researcher developed two tools for this study after reviewing the relevant literature **(Jareena et al., 2019; Pande and Pande, 2017; Thomas et al., 2020; Tincopa et al., 2022),** as the following:

Tool I: A structured interview questionnaire

It is divided into two parts:

Part I: Demographic characteristics of the study sample

It includes six items designed to assess the demographic data of NAFLD patients including age, gender, marital status, level of education, employment status, and area of residence.

Part II: Health history of the patients

This part consists of five items to assess the health history of NAFLD patients including NAFLD related symptoms, comorbidities, prescribed medications, smoking habits and family history of NAFLD.

Tool II: Clinical profile data

This tool was used to assess the clinical profile of NAFLD patients. It consists of anthropometrics (BMI & WC), blood pressure (SBP & DBP), lipid profile (triglycerides & HDL-c), fasting blood glucose (FBG), liver enzymes (ALT & AST), and grade of fatty liver by ultrasonography.

Patients' clinical profiles were evaluated as the following:

Anthropometric measurements including BMI and WC, as well as blood pressure were taken using standard procedures **(WHO, 2000; Thomas et al., 2020).** Additionally, lipid profile, blood glucose level, and liver enzymes were obtained from the patients' medical records and analyzed according to standard methods **(ADA, 2022; Arora et al., 2022: National Cholesterol Education Program, 2002).** Fatty liver was identified using established criteria from transabdominal ultrasonography which assessed hepatorenal echo contrast, liver brightness, and vascular blurring. The ultrasound findings classified the degree of steatosis into four categories: none (grade 0), mild (grade 1), moderate (grade 2), and severe (grade3) **(Pande and Pande, 2017; Paul et al., 2018).**

Validity of the tools

The content validity was confirmed by five experts from nursing and medical fields. Their feedback was used to evaluate the tools' relevance, completeness, precision, and practical applicability, and any required changes were made.

Pilot study

The pilot study was conducted involving 10% of the sample (10 participants), drawn from the same setting. This was performed to test the clarity, practicality, and reliability of the research's tools, as well as to estimate the required time for data collection. Participants from the pilot study were eliminated from the main research population.

Field of work:

Once the necessary approvals were obtained to conduct the proposed study, data collection started on July 1, 2023, and continued until the end of June 2024. The study was implemented in four key phases: assessment, planning, implementation, and evaluation.

Assessment phase

This was the first stage, where the participants who met the research criteria were enrolled after the purpose of the study was explained and their consent was obtained. Individuals were divided randomly into two equal groups: the control group and the intervention group. Before initiating the scheduled program, each participant in the two groups was interviewed individually to gather baseline data using all the tools of the research. The time needed to complete each tool was about 30-45 minutes.

Planning phase

The researcher developed the lifestyle intervention program. The educational program aimed to promote healthy lifestyle behaviors among NAFLD patients (e.g. gradual weight loss, adherence to healthy, balanced diet, and engaging in consistent physical exercise). Additionally, the researcher designed an instructional colored booklet to be given to each individual in the intervention group during the implementation phase.

Implementation phase

The developed lifestyle intervention program was applied for the patients in the intervention group either individually or in small groups of 3-5 patients in the form of five consecutive sessions including four theoretical and one practical part. Each session required approximately 40 to 45 minutes.

The sessions of the lifestyle intervention program covered the following: Overview about NAFLD (e.g. definition of NAFLD term, risk factors, symptoms, diagnosis, complications and treatment modalities), nutrition management for NFLD patients, physical activity and exercise, behavioral therapy/ stress management techniques and, practical part regarding health checkup practices that can be managed by the patients including how to measure body weight, height, BMI, waist circumference, as well as how to measure blood pressure and random blood sugar.

A colored booklet was given to each individual in the intervention group to motivate and support them in reviewing the contents of the program. Additionally, patients received weekly telephone calls for 6 months to ensure adherence to the treatment plan and to facilitate communication.

The control group was received the usual care provided by routine hospital care only.

Evaluation phase

The baseline data were collected for both the control and intervention groups using all the study tools. After 3 months of the lifestyle intervention program, the researcher assessed both groups using study Tool II: Clinical profile data, which included BMI, WC, SBP, DBP, triglycerides, HDL-c, FBG, ALT, and AST. After 6 months, a follow-up evaluation was conducted incorporating additional measures alongside the previous measurements, such as fatty liver grades via ultrasonography.

Ethical considerations

The study was authorized with written consent from the hospital director. Individuals who accepted

to participate in the study received a detailed clarification of the study's objectives, possible benefits, and the study's structure before their informed consent was obtained. They were informed that their personal data would be kept confidential and secure, and that they could withdraw from the research at any time with no obligation or liability.

Statistical design

The statistical analyses were done using SPSS for windows version 20.0 (SPSS- Chicago, IL). Continuous variables were normally distributed and illustrated as mean ± SD, while categorical variables were presented as counts and percentages. For categorical variables comparisons, the chi-square test or fisher's exact test was used as needed. The Student's t-test was employed to compare mean values and detect statistical differences. The statistical significance level was set at $p < 0.05$.

3. Results

The results of the study demonstrated that, prior to the intervention, the control and intervention groups had comparable distributions, with no significant statistical differences observed in the baseline demographic data, health history, or clinical profile parameters between the two groups.

Table 1 shows the demographic data for both the control and intervention groups. The highest percentage of patients in both groups were between 40 and 50 years, with mean ages of 45.58 ± 8.96 and 46.41 ± 8.89, respectively. As well as, 56.5% of the control group and 60.9% of the intervention group were males. The majority of participants in the two groups were married. Moreover, 54.3% of the control group and 52.2 % of the intervention group had a secondary level of education, and 73.9% of the control group and 71.7% of the intervention group resided in rural regions.

Table (1): Demographic characteristics of the control and intervention groups (n=92)

Demographic characteristics	**Control (n = 46)**		**Intervention (n = 46)**		**Chi- square / Fisher exact test**	
	No.	**%**	**No.**	**%**	**X^2**	**P**
Age (in Years)						
20 – < 30	4	8.7	3	6.5	0.262	0.967
30 – < 40	11	23.9	12	26.1		
40 – < 50	21	45.7	22	47.8		
50 – ≤ 60	10	21.7	9	19.6		
Mean ±SD	45.58 ±8.96		46.41 ±8.89		0.444	0.658
Gender						
Male	26	56.5	28	60.9	0.179	0.672
Female	20	43.5	18	39.1		
Marital status						
Single	7	15.2	9	19.6	0.303	0.582
Married	39	84.8	37	80.4		
Educational level						
Illiterate	3	6.5	2	4.3	0.366	0.947
Read / write	4	8.7	5	10.9		
Secondary	25	54.3	24	52.2		
University	14	30.4	15	32.6		
Working status						
No work	14	30.4	16	34.8	0.198	0.656
Work	32	69.6	30	65.2		
Residence						
Urban	12	26.1	13	28.3	0.055	0.815
Rural	34	73.9	33	71.7		

Not statistically significant at p > 0.05

Table 2 illustrates the health history of both groups. The results show that 58.7 % of the control group and 56.5% of the intervention group were asymptomatic. The most common comorbidities were overweight/obesity (87.0% vs. 89.1%), diabetes mellitus (43.5% vs. 47.8%), hypertension (45.7% vs. 43.5%), and dyslipidemia (76.1% vs. 82.6%). Medication use was similar in both groups, with 43.5% of participants in the control group and 47.8% in the intervention group were using antidiabetics, 45.7% and 43.5% on antihypertensive medications, and 28.3% and 34.8% receiving antihyperlipidemic

treatments, respectively. Additionally, 50.0% of participants in the control group and 45.7% in the intervention group were smoking, and most patients in both groups had no family history of NAFLD.

Table (2): Health history of the control and intervention groups (n=92).

Health-related data	Control (n =46)		Intervention (n =46)		Chi- square / Fisher exact test	
	No.	%	No.	%	X^2	P
Disease symptoms						
No	27	58.7	26	56.5		
Yes	19	41.3	20	43.5	0.045	0.833
NAFLD related symptoms #						
Fatigue and weakness	13	28.3	12	26.1	0.055	0.815
Abdominal discomfort	15	32.6	14	30.4	0.050	0.822
Severe bloating and indigestion	18	39.1	19	41.3	0.045	0.832
Acidity	17	37.0	18	39.1	0.046	0.830
NAFLD related comorbidities #						
Overweight/Obesity	40	87.0	41	89.1	0.103	0.748
Diabetes	20	43.5	22	47.8	0.175	0.675
Hypertension	21	45.7	20	43.5	0.044	0.834
Dyslipidemia	35	76.1	38	82.6	0.597	0.440
Prescribed medications #						
Antidiabetic drugs	20	43.5	22	47.8	0.008	0.927
Antihypertensive drugs	21	45.7	20	43.5	1.741	0.187
Anti-hyperlipidemia	13	28.3	16	34.8	0.283	0.595
Antacid	12	26.1	15	32.6	0.300	0.584
Smoking						
No	23	50.0	25	54.3		
Yes	23	50.0	21	45.7	0.174	0.676
Family history of NAFLD						
No	42	91.3	43	93.5		
Yes	4	8.7	3	6.5	0.155	0.694

Not significant at p >0.05 # Not mutually exclusive NAFLD: Nonalcoholic Fatty Liver Disease.

Table 3 reveals the changes in anthropometrics measures and blood pressure for both groups. The findings presented in this table show that, following six months of the intervention, the mean values of BMI, WC, SBP, and DBP in the intervention group decreased significantly compared to the baseline (P = 0.007, P < 0.001, P = 0.004, and P < 0.001, respectively). In contrast, the control group exhibited no significant change (P>0.05). The difference between the two groups at six months following the intervention was statistically significant (P = 0.035, P = 0.008, P = 0.005, and P < 0.001, respectively).

Table 4 shows the values of lipid profile, blood glucose and liver enzymes for the two groups before and after the program implementation. The findings indicate that, in the intervention group, the mean triglyceride significantly decreased at both three and six months after the intervention when compared to the baseline (P<0.001), while the HDL level increased significantly at six months (P<0.001). In addition, the fasting blood glucose (FBG) decreased significantly at six months, while liver enzymes (ALT & AST) showed a significant decline at both three and six months in the intervention group (P<0.001). In contrast, the control group exhibited no statistical significant changes (P>0.05). The differences between both groups at six months after the intervention were statistically significant (P<0.001 for all).

Figure 1 illustrates fatty liver grades (steatosis grades) in both groups before and after the lifestyle intervention. The results show that no statistically significant difference was detected in fatty liver grades between the two groups before the program implementation (P>0.05). However, after six months of the intervention, the intervention group showed a significantly higher improvement in fatty liver grades compared to the control group (p < 0.001).

Table (3): Comparison of anthropometrics measurements and blood pressure between the control and intervention groups through program phases (n=92).

Variables	Program Phases	Control (n=46)	Intervention (n=46)	$t(P_3)$
		Mean ±SD	Mean ±SD	
BMI (kg /m^2)	Pre – Intervention	31.1 ±5.6	31.3 ±4.9	T= 0.215, P =0.830
	3 Months post	30.5 ±5.0	29.8 ±4.4	T= 0.662, P =0.509
	6 Months post	30.7 ±5.1	28.5 ±4.8	T= 2.130, P =0.035*
	$t(P_1)$	T= 0.542, P = 0.589	T=1.544, P = 0.125	
	$t(P_2)$	T= 0.358, P = 0.721	T=2.768, P = 0.007*	
WC (cm)	Pre – Intervention	105.9 ±8.9	106.7 ±8.9	T= 0.444, P= 0.658
	3 Months post	104.1 ±9.3	103.3 ±8.6	T= 0.454, P= 0.651
	6 Months post	104.9 ±9.0	99.8 ±8.9	T=2.698, P= 0.008*
	$t(P_1)$	T= 0.948, P = 0.345	T =1.863, P = 0.065	
	$t(P_2)$	T= 0.535, P = 0.593	T =3.718, P < 0.001*	
SBP (mmHg)	Pre – Intervention	136.3 ±10.5	135.3 ±11.3	T= 0.421, P = 0.675
	3 Months post	133.7 ±10.4	132.1 ±10.7	T= 0.742, P = 0.460
	6 Months post	134.9 ±10.6	128.8 ±9.6	T=2.880, P= 0.005*
	$t(P_1)$	T=1.167, P=0.246	T=1.404, P= 0.164	
	$t(P_2)$	T=0.622, P=0.535	T= 2.969, P = 0.004*	
DBP (mmHg)	Pre – Intervention	86.4 ±7.9	86.1 ±8.2	T= 0.156, P = 0.877
	3 Months post	84.2 ±7.6	83.6 ±7.2	T= 0.393, P= 0.695
	6 Months post	85.3 ±7.8	80.1 ±6.5	T= 3.424, P< 0.001*
	$t(P_1)$	T=1.167, P=0.246	T =1.404, P = 0.164	
	$t(P_2)$	T=0.622, P=0.535	T =3.885, P < 0.001*	

*t(P1): Pre – Intervention / 3 Months post for the group, t(P2): Pre – Intervention / 6 Months post for the group, t(P3): between intervention and control at current phase. *Significant at p < 0.05*

BMI: Body Mass index; WC: Waist circumference; SBP: Systolic Blood pressure; DBP: Diastolic Blood pressure

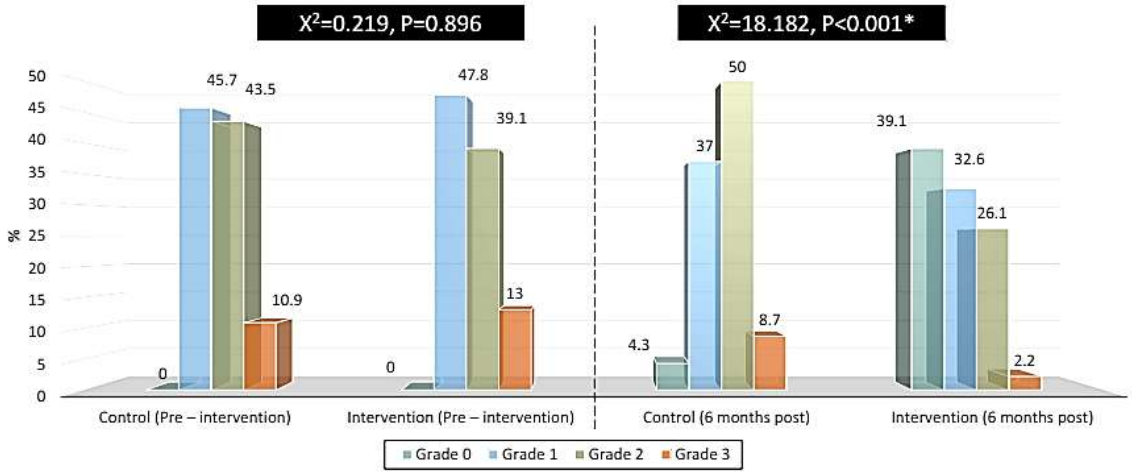
Table (4): Comparison of the lipid profile, blood glucose and liver enzymes between control and intervention groups through program phases (n=92)

Variables	Program Phases	Control (n=46)	Intervention (n=46)	$t(P_3)$
		Mean ±SD	Mean ±SD	
Triglycerides (mg/dL)	Pre – Intervention	161.1 ±9.6	162.5 ±8.4	T= 0.726, P = 0.470
	3 Months post	162.3 ±9.6	152.1 ±8.4	T=5.418, P < 0.001*
	6 Months post	163.4 ±9.3	145.7 ±9.9	T=8.889, P < 0.001*
	$t(P_1)$	T=0.599, P=0.550	T =5.937, P< 0.001*	
	$t(P_2)$	T=1.167, P=0.246	T =8.776, P< 0.001*	
HDL -c (mg/dL)	Pre – Intervention	46.4 ±8.6	45.9 ±8.5	T= 0.256, P= 0.798
	3 Months post	45.5 ±8.3	48.9 ±8.2	T=1.955, P=0.054
	6 Months post	45.1 ±6.6	52.8 ±8.2	T=4.954, P<0.001*
	$t(P_1)$	T = 0.482, P = 0.631	T =1.185, P = 0.239	
	$t(P_2)$	T = 0.181, P = 0.857	T =3.964, P< .001*	
FBG (mg/dL)	Pre – Intervention	115.1 ±23.2	114.2 ±22.2	T= 0.202, P = 0.840
	3 Months post	112.5 ±23.5	107.2 ±21.9	T= 1.120, P = 0.266
	6 Months post	113.5 ±23.5	98.1 ±19.1	T= 3.449, P < 0.001*
	$t(P_1)$	T= 0.545, P = 0.587	T =1.520, P = 0.132	
	$t(P_2)$	T= 0.326, P = 0.745	T =3.711, P<0.001*	
ALT (U/L)	Pre – Intervention	58.1 ±9.3	59.2 ±9.2	T= 0.576, P = 0.566
	3 Months post	55.3 ±9.6	46.1 ±8.0	T= 4.962, P< 0.001*
	6 Months post	56.1 ±9.8	36.2 ±8.8	T= 10.252, P < 0.001*
	$t(P_1)$	T=1.423, P=0.158	T=7.269, P< 0.001*	
	$t(P_2)$	T=1.017, P=0.312	T =12.271, P<0.001*	
AST (U/L)	Pre – Intervention	46.2 ±7.2	47.3 ±6.9	T= 0.738, P= 0.463
	3 Months post	43.4 ±7.3	34.7 ±12.4	T= 4.130, P < 0.001*
	6 Months post	44.5 ±7.4	28.7 ±11.9	T= 7.643, P < 0.001*
	$t(P_1)$	T=1.423, P=0.158	T=7.269, P<0.001*	
	$t(P_2)$	T=1.017, P=0.312	T =9.203, P<0.001*	

*$t(P_1)$: Pre – Intervention / 3 Months post for the group, $t(P_2)$: Pre – Intervention / 6 Months post for the group, $t(P_3)$: between intervention and control at current phase *Significant at p<0.05*

HDL- c: High Density lipoprotein- cholesterol; FBG: fasting Blood Glucose; ALT: Alanine Aminotransferase; AST: Aspartate Aminotransferase

Figure (1): Comparison of fatty liver grades between the control and intervention groups pre and post-program implementation (n=92).



4. Discussion

Adopting a healthy lifestyle, which includes dietary adjustments, regular physical exercise, and weight reduction represents the most effective strategies that should be clinically prescribed and implemented together as the initial approach to prevent and treat NAFLD **(Ahmed et al., 2019).** In this context, our research was designed to investigate the impact of lifestyle intervention program on the clinical profile of patients with NAFLD, providing valuable insights into non-pharmacological approaches to manage this prevalent condition.

The present study found that the largest proportion of participants in the two groups were in their fourth decade of life, specifically between the ages of forty and fifty. The mean age of the control group was approximately forty-five and a half years, while the intervention group had a mean age of around forty-six and a half years. Males were more common in the study sample. Additionally, more than half of both groups had a secondary level of education and around three-fourths of the individuals in both the control and intervention groups were from rural areas.

This finding is in agreement with **Farag et al. (2018),** who found that the largest proportion of the study group was between the ages of forty and forty-nine, with a mean age of approximately forty-seven years. Similarly, **Gelli et al. (2017)** reported a mean age of about forty-seven and a half years for their study group, with males being predominant compared to females in the studied sample. Furthermore, this result aligns with **Mobasheri et al. (2022),** who noted that approximately half of study sample was high school diploma, while this result contradicts the result of **Katsagoni et al. (2018),** who noted that most of the studied participants were residing at urban areas.

Several studies including those from western countries have reported that a notable proportion of NAFLD patients ranging from approximately half to up to two-thirds are asymptomatic **(Farag et al., 2018).** Similarly, **Sharma and Arora (2020)** noted that most individuals with NAFLD are often asymptomatic or present with non-specific symptoms prior to diagnosis, with common presenting symptoms including fatigue, right upper abdominal discomfort, bloating, irregular bowel habits, and disrupted sleep patterns. In line with this, over half of the participants in both groups of our study were asymptomatic. However, some individuals reported non-specific symptoms such as weakness, fatigue, abdominal discomfort, bloating, and acidity, which are consistent with the existing literature.

Nonalcoholic fatty liver disease (NAFLD) is often linked with other conditions such as diabetes, dyslipidemia, obesity, high blood pressure, and metabolic syndrome **(Almomani et al., 2022; Manikat et al., 2023).** In the present study, both the control and intervention groups shared similar characteristics, with the majority of participants being overweight or obese and had dyslipidemia. Additionally, nearly half of them had diabetes and hypertension.

The current study demonstrated that approximately half of the patients in both groups were using antidiabetic and antihypertensive medications. Additionally, more than one quarter of both groups were taking antihyperlipidemic drugs. This finding aligns with **Elwakil et al. (2021)**, who noted that around half of the participants in their study were taking antidiabetic medications. Additionally, **Eckard et al. (2013)** reported that about one third of the participants were taking cholesterol-lowering

medication. These findings can be clarified by the recognition that NAFLD is a hepatic aspect of metabolic syndrome. As a result, treatment modalities and management strategies for NAFLD typically focus on improving the components of this syndrome and managing conditions like type 2 diabetes which are commonly linked with NAFLD.

Smoking is a recognized risk factor for various health problems. A meta-analysis and systematic review by **Akhavan Rezayat et al. (2018)** revealed a significant link between smoking and NAFLD. In the current study, approximately half of both the control and intervention groups were smoking. This result aligns with the findings of **Mansour-Ghanaei et al. (2019),** who observed that about half of NAFLD subjects in their study were smoking.

The current study found that most of the individuals in the two groups had no family history of NAFLD. This finding aligns with **Chalasani et al. (2018),** who mentioned that although NAFLD has a genetic component, there is not enough confirmation of heritability.

In terms of the clinical profile of the study subjects, our study demonstrated a significant improvement among patients in the intervention group when compared to those in the control group at six months following the intervention. Specifically, a significant reduction was found in anthropometric measures like BMI and WC. Furthermore, blood pressure measurements, both systolic (SBP) and diastolic (DBP), also showed significant reduction. These improvements suggest that the intervention had a positive effect on the body composition as well as cardiovascular health.

In this context, our results align with a research done by **Sun et al. (2012)**, which evaluated the influence of the lifestyle modification intervention on NAFLD, the findings showed a notable improvement in weight, BMI, and WC in the lifestyle group compared to those in the control group following the intervention. Additionally, these findings are consistent with **Moneim et al. (2018)**, who noted that proper nutritional counseling based on the Mediterranean diet and different exercise recommendations for NAFLD patients was found to be linked with significant improvement in waist circumference (WC), blood pressure (BP), and other clinical parameters.

In contrast, our results contradict the findings of **George et al. (2022),** who found that in the dietary intervention group, weight, BMI and WC did not show significant differences from pre- to post-intervention.

The findings of this study demonstrated a significant improvement in lipid profile (Triglycerides and HDL-c), fasting blood glucose (FBG) and liver enzymes (ALT & AST) in the intervention group as compared to the control group following the intervention. These outcomes demonstrate the beneficial effect of the intervention on both metabolic health and liver function, suggesting a comprehensive benefit for patients.

These findings align with those of **Gelli et al. (2017),** who concluded that the Mediterranean diet (MedDiet), along with a more active lifestyle could be a safe and effective approach for decreasing the severity of NAFLD. Their study demonstrated significant improvements in several key parameters such as lipid profile (Triglycerides, HDL, total Cholesterol, and LDL), serum glucose, liver enzymes (ALT & AST), and other clinical markers from the baseline to the end of the study.

Additionally, these findings are in agreement with **Abdelbasset et al. (2020)**, who aimed to evaluate the impact of moderate intensity aerobic exercise on obese diabetic patients with NAFLD, it revealed that the aerobic exercise group exhibited a significant improvements in several key health parameters including serum triglycerides, HDLs, LDLs, total cholesterol, HbA1c, HOMA-IR, alanine transaminases (ALT), visceral fat, and BMI, while the control group demonstrated a non-significant changes. Furthermore a notable difference was observed between both groups.

The current study's findings exhibited a significant improvement in fatty liver grades (steatosis grades) in the intervention group compared to the control group at six months following the intervention. These results are consistent with those of **Nourian et al. (2020),** who investigated the impact of lifestyle modifications on NAFLD. Their study revealed significant improvements in ultrasonographic findings for the intervention group compared to the control group, with significant statistical differences between both groups.

Similarly, a study performed by **Kantartzis et al. (2009),** wherein lifestyle intervention was implemented for NAFLD patients, which included ten sessions with a dietitian and three hours of moderate intensity physical exercise each week. The findings revealed a marked decrease in both body fat and liver fat, along with an improvement in fitness levels. By the end of the intervention, NAFL had resolved in twenty of the patients.

In conclusion, from the researcher's viewpoint, the consistency observed in these results may be attributed to the patients' better adherence to lifestyle modifications (dietary changes combined with physical activity), along with their strong desire to lose weight. These results highlight the significant role of lifestyle interventions in improving the clinical profile of NAFLD patients particularly in terms of

improving metabolic health and liver function. Moreover, this commitment led to significant improvements in steatosis grades. Additionally, the positive outcomes of such interventions emphasize their potential as an effective strategy for managing conditions like nonalcoholic fatty liver disease (NAFLD).

Conclusion

Based on the outcomes of this study, we can conclude that the implementation of the lifestyle intervention program was beneficial in improving the clinical profile (anthropometrics, blood pressure, lipid profile, blood glucose, liver enzymes, and fatty liver grades) in patient with NAFLD.

Recommendations

According to the study's findings, the following recommendations are proposed:

- Intensive assessment of high risk population followed by health education targeting lifestyle changes should be one of the priorities to prevent NAFLD.
- Further health educational programs for NAFLD patients should be conducted to improve their clinical profile.
- Future research in different centers should be done with long-term follow-up to ensure a more effective intervention.

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