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Health-related quality of life and its determinants among South Indian type 2 diabetes patients with and without non-alcoholic fatty liver disease

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Abstract

Background and aims Non-alcoholic fatty liver disease (NAFLD) is one of the leading causes of chronic liver disease in type-2 diabetics. The quality of life among those patients was not explored well. Hence, the present study aimed to correlate the determinants with the quality of life (QoL) among the study subjects.

Methods A hospital-based case–control study was conducted at Bhargavi Gastro and Surgical Hospital, Warangal, Telangana, with 358 subjects, from 1 November 2019 to 31 October 2021 (24 months). A 358 of cohort type-2 diabetes mellitus (T2DM) subjects were recruited with 1:1 of NAFLD and without NAFLD. QoL was determined with the SF-36 questionnaire, which comprises eight domains. Statistical analysis included *t* test, chi-square, and Spearman correlation performed with SPSSV.25 software.

Results Out of 358 subjects, 200 (55.8%) were males and 158 (44.1%) were females. Glycemic parameters (FBS and HbA1c), lipid profile, liver transaminases (SGPT and SGOT), and serum uric acid levels were significantly high in NAFLD subjects ($p < 0.05$). The SF-36 score, four domains (physical, energy, mental health, and pain) are significantly reduced in NAFLD subjects $p < 0.05$). A significant correlation between blood urea and impaired physical, emotional mental, and general health was observed in NAFLD subjects. In the NAFLD subjects, elevated FBS levels lead to impairment of physical and emotional status. Social functioning, general health, and pain were impaired with BMI and TG levels in NAFLD subjects. The mean, SD of SF-36 scores showed no significant difference in contrast to HbA1c among both groups ($p > 0.05$).

Conclusion The decreased QoL was observed in subjects of T2DM with NAFLD. The QoL is significantly influenced by elevated FBS, SGPT, SGOT, and TG levels. Hence, clinicians need to be vigilant and implement strategies to improve the quality of life in type 2 diabetics with NAFLD.

Keywords NAFLD, Quality of life, SF-36 Questionnaire, South India, Type 2 diabetes

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Introduction

Individuals with type 2 diabetes mellitus (T2DM) are at a high risk of developing non-alcoholic fatty liver disease (NAFLD), and evidence suggests that poor glycemic control is associated with a higher risk of developing NAFLD [1]. NAFLD comprises a group of increasingly common liver abnormalities that range from simple steatosis to non-alcoholic steatohepatitis (NASH), which may lead to cirrhosis and hepatocellular carcinoma (HCC) [2]. Its prevalence is steadily increasing among people who are obese or have type 2 diabetes (T2DM), and NAFLD is strongly associated with obesity, T2DM, and other features of the metabolic syndrome [3].

NAFLD is a noteworthy public health problem that requires the attention of clinicians and researchers. Understanding the baseline determinants of QoL in the context of NAFLD is critical for patient-centered outcomes and cost-effectiveness research [4, 5]. When compared to other liver diseases caused by alcohol, viruses, autoimmune, or cholestatic hepatopathies, NAFLD patients have lower QoL [6]. NAFLD has a significant impact on QoL as well as societal and financial burdens. Hence, clinicians have recently focused their attention on this topic [7–10]. QoL results are generally viewed as clinical and scientific end-points in order to treat the disease and make life better [11]. Hence, we aimed to evaluate the QoL in T2DM patients affected by NAFLD, sincere that the study findings would be useful for healthcare providers.

Methodology

It is a hospital-based, single-center, case–control study conducted at Bhargavi Gastro and Surgical Hospital, Warangal, Telangana, with 358 subjects, from November 2019 to October 2021 (24 months). A 358 of cohort type-2 diabetes mellitus (T2DM) subjects were recruited with 1:1 of NAFLD and without NAFLD.

Study subjects

Inclusion criteria

Subjects of either gender of ≥ 18 years of age, with a history of more than 1 year of T2DM, were recommended for ultrasonography (USG). Fatty liver was diagnosed based on histological or imaging findings, and the study participants who did not have a history of alcohol consumption (> 140 g/week) were included in the study.

Exclusion criteria

The exclusion criteria are based on the following: subjects with significant alcohol consumption of > 140 g/week for men and 70 g/week for women, subjects who were on lipid-lowering or any other known causes of long-lasting liver disease such as viral or autoimmune hepatitis, and subjects who are on hepatotoxic medications. The subjects with a history of cancer, renal, respiratory, or hepatobiliary disease; gout; and other rheumatologic diseases are excluded. Subjects with type-1 diabetes, gestational diabetes, or acute complications of diabetes are also excluded. All study participants provided informed written consent prior to participating in the study.

Socio-demographic variables

The data on different socio-demographic variables, including age, gender, education, and annual income, is obtained from the subjects. Anthropometrics like body mass index (BMI) and waist circumference (WC) were measured. BMI was calculated as weight in kilograms divided by the square of height in meters.

Measurement of biochemical parameters

The fasting blood samples were received from each subject to measure biochemical parameters. The parameters include fasting plasma glucose (FBS), glycated hemoglobin (HbA1c), serum uric acid (SUA), total proteins, albumin (A), globulin (G), A/G ratio, serum glutamate pyruvate transaminase (SGPT), serum glutamate oxaloacetate transaminase (SGOT), SGOT:SGPT ratio, alkaline phosphates (ALP), nitrogenous end product-blood urea nitrogen (BUN), serum creatinine (Cr), and fasting lipid profiles that comprise of triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol. All the biochemical parameters were analyzed through standard protocols with the aid of an automated immunochemical analyzer (Abbott AxSYM).

USG of abdomen

Considering the ultrasound imaging reports, the fatty liver was categorized into grades ranging from grade 0 to grade 3. Grade 0 indicates no steatosis with normal echogenicity of the liver; Grade 1 indicates mild steatosis and echogenicity of the liver was greater than that of the right renal cortex, but the echogenic wall of the main portal vein was greater than that of the right renal cortex; Grade 2 indicates moderate steatosis, impaired echogenicity of the main portal vein wall; and Grade 3 represents severe or impaired echogenicity of the main portal vein wall and impaired visualization of the posterior hepatic parenchyma or the diaphragm [12, 13].

Evaluation of QoL

A validated and self-reported questionnaire SF-36 (short form) (Version 1) [14, 15], which contains eight distinct domains was administered to the subjects. Those included (1) the physical functioning (PF) domain assesses how well the patients' physical activities were

restricted due to the subject's health, (2) the role physical (RP) domain assesses the impact of physical health of the patient in job and routine activities, (3) the bodily pain (BP) domain assesses the subjects' pain-related limitations, (4) the subject's personal health and its potential for decline were estimated by the use of general health (GH) domain, (5) the vitality (VT)/energy domain evaluates the sleepiness of the patient, (6) the degree of physical or emotional problems interfere with the normal social activities of the subjects was measured using social functioning (SF) domain, and (7) the influence of patients' emotional problems on their work and daily activities was estimated by role emotional (RE) domain whereas (8) mental health (MH) domain estimates the state of emotional feeling. The patient's responses for all the domains were calculated using Likert scales of different sizes ranging from 2 to 6 and then averaged and converted to a range 0–100. A higher score represents the absence of limitations in social functioning that indicate better health and functioning. The above questionnaire scale was (SF-36) translated into the local language (Telugu) by the language experts.

Sample size calculation

The sample size was calculated by using epi info software, assuming the expected alpha error probability to detect the difference in quality of life between non-alcoholic liver disease (NAFLD) subjects and without non-alcoholic liver disease (non-NAFLD) was to be about 5% and the anticipated odds ratio = 2, assuming 95%confidence interval and 90% Power (1-β), expected probability of exposure in control = 36, and expected probability of exposure in case = 52.9. Hence, the minimum sample required was 179 in each group, i.e., case and control. The total sample size was 358.

Statistical analysis

The SPSS v.25 software was used to analyze all of the data. The variables are represented as the mean and standard deviation. The categorical data were analyzed using the chi-square test. A comparison of the two groups was performed with a *t* test. The relationship between anthropometric and biochemical parameters and the SF-36 domain score was assessed using Spearman correlation. The *p* values less than 0.05 were considered as statistically significant.

Results

Subjects' demographic characteristics

The sociodemographic characteristics of subjects with and without NAFLD are represented in Table 1. In the present study, male (61.4%) patients outnumbered female (38.5%) patients. The mean age of NAFLD subjects was 48.94 ± 7.9 years, and without NAFLD, it was 49.28 ± 11.15 years. The literacy levels were significantly high (*p* 0.021) in patients without NAFLD. Most of the patients were on low incomes. Most of the NAFLD patients disregarded their diabetic dietary modifications advised by the health professionals. The investigations of anthropometric and biochemical investigations between the two groups revealed notable differences. The subjects with NAFLD had higher levels of SGOT and SGPT. In aspects of blood lipids, T2DM-NAFLD displayed significantly higher levels of total cholesterol, LDL, triglycerides, HBA1c, and SUA, and there was no difference

Table 1 Socio-demographic and clinical characteristics of study subjects

Variables	Subjects with NAFLD (*n* = 179)	Subjects without NAFLD (*n* = 179)	*P value*
Gender n (%) Male	110 (61.4)	90 (50.2)	0.0333*
Female	69 (38.5)	89 (49.7)	
Education n (%) Literacy	5 (2.8)	2 (1.11)	0.0214*
Middle	82 (45.8)	60 (33.5)	
College	92 (51.4)	117 (65.4)	
Income n (%) Low-income	94 (52.5)	98 (54.7)	0.908
Middle income	75 (41.8)	71 (39.6)	
High income	10 (5.5)	10 (5.5)	
Diabetic diet n (%) Yes	72 (40.22)	127 (69.83)	< 0.0001***
No	107 (59.77)	54 (30.16)	
Age (years)	48.94 ± 7.9	49.28 ± 11.15	0.866
BMI (kg/m^2)	23.23 ± 3.47	23.55 ± 3.7	0.92 ns
WC (cm)	88.96 ± 5.71	91.31 ± 3.5	< 0.0001***
FBS (mg/dl)	116.5 ± 35.76	123 ± 17.73	< 0.0001***
Diabetic duration (years)	4.46 ± 2.14	5.01 ± 2.36	0.0327*
HbA1c	7.62 ± 2.07	7.15 ± 1.83	0.023*
SGOT (U/L)	34.71 ± 15.38	24.84 ± 6.12	< 0.0001***
SGPT (U/L)	45.86 ± 13.70	31.32 ± 10.27	< 0.0001***
SUA (mg/dl)	7.398 ± 1.33	6.22 ± 1.65	< 0.0001***
Blood urea (mg/dl)	23.35 ± 6.05	21.15 ± 3.63	< 0.0001***
Total cholesterol (mg/dl)	204.9 ± 39.74	178.7 ± 31.21	< 0.0001***
LDL (mg/dl)	143 ± 30.83	120.8 ± 31.93	< 0.0001***
HDL (mg/dl)	47.44 ± 23.84	46.12 ± 18.17	0.812
Triglycerides (mg/dl)	176.2 ± 27.11	124.4 ± 37.12	< 0.0001***

BMI body mass index, *WC* waist circumference, *FBS* fasting blood sugar, *HbA1c* glycated hemoglobin, *SGOT* serum glutamate oxaloacetate transaminase, *SGPT* serum glutamate pyruvate transaminase, *SUA* serum uric acid, *LDL* low-density lipoproteins, *HDL* high-density lipoprotein

P value < 0.05 was considered as statistically significant

*$p < 0.05$; ***$p < 0.001$

in HDL levels ($p > 0.05$). Diabetics without NAFLD had a high level of FBS and aberrant waist circumference. Lying in the normal ranges, the blood urea levels in both groups were depicted significantly.

Correlation between clinical parameters and SF-36 score

Tables 2 and 3 represent the demographic and clinical variables correlated with the SF-36 score among the subjects. The significance of biochemical parameters on QoL was assessed by correlation analysis between biochemical investigations and eight domains of SF-36 questionnaires in subjects with NAFLD and without NAFLD. The linear dependence of SGPT with respect to physical domain and role was found to be statistically significant in NAFLD subjects (Table 1). We applied Spearman's correlation coefficient as the

Table 2 Correlation between biochemical parameters and quality of life in with NAFLD subjects

Parameters	Physical domain *r* (*p* value)	RP *r* (*p* value)	RE *r* (*p* value)	Energy *r* (*p* value)	MH *r* (*p* value)	SF *r* (*p* value)	Pain *r* (*p* value)	GH *r* (*p* value)
Age	0.02 (0.82)	0.12 (0.11)	0.09 (0.26)	−0.01 (0.94)	−0.06 (0.46)	0.04 (0.63)	−0.14 (0.07)	0.05 (0.48)
BMI	−0.03 (0.70)	0.08 (0.26)	−0.01 (0.94)	0.00 (0.98)	−0.11 (0.15)	0.23 (0.00)	−0.02 (0.79)	0.18 (0.01)
FBS	0.13 (0.08)	−0.18 (0.01)	−0.20 (0.01)	−0.14 (0.06)	−0.10 (0.16)	−0.03 (0.66)	0.09 (0.24)	−0.02 (0.75)
HbA1c	0.15 (0.04)	−0.10 (0.19)	−0.13 (0.08)	−0.05 (0.53)	−0.05 (0.54)	−0.06 (0.41)	−0.07 (0.38)	0.0 (1.0)
SGOT	−0.04 (0.60)	0.07 (0.34)	0.01 (0.92)	−0.01 (0.91)	0.02 (0.81)	−0.04 (0.59)	−0.09 (0.24)	−0.07 (0.39)
SGPT	−0.17 (0.02)	0.17 (0.02)	0.11 (0.14)	0.11 (0.14)	0.08 (0.29)	0.06 (0.39)	0.07 (0.34)	0.09 (0.24)
SUA	0.06 (0.40)	0.01 (0.85)	0.02 (0.83)	−0.06 (0.42)	0.02 (0.77)	−0.05 (0.53)	−0.05 (0.50)	−0.12 (0.11)
Blood Urea	0.22 (0.00)	−0.21 (0.00)	−0.35 (0.00)	−0.11 (0.13)	−0.25 (0.00)	−0.12 (0.11)	−0.03 (0.73)	−0.23 (0.00)
WC	−0.01 (0.95)	−0.04 (0.55)	0.01 (0.90)	0.00 (0.97)	0.04 (0.56)	−0.04 (0.56)	−0.11 (0.16)	−0.04 (0.64)
TC	−0.01 (0.84)	0.04 (0.56)	0.11 (0.14)	0.02 (0.82)	0.04 (0.607)	0.07 (0.34)	0.04 (0.56)	0.10 (0.19)
LDL	0.01 (0.94)	0.04 (0.62)	0.06 (0.44)	−0.02 (0.81)	0.01 (0.87)	0.01 (0.91)	0.04 (0.60)	0.05 (0.54)
HDL	−0.06 (0.41)	0.06 (0.40)	0.13 (0.08)	0.08 (0.29)	0.08 (0.28)	0.11 (0.15)	0.02 (0.81)	0.13 (0.08)
TG	−0.06 (0.41)	0.03 (0.72)	−0.04 (0.59)	0.10 (0.16)	0.09 (0.21)	−0.05 (0.46)	0.149* (0.046)	0.043 (0.56)

BMI body mass index, *FBS* fasting blood sugar, *HbA1c* glycated hemoglobin, *SGOT* serum glutamate oxaloacetate transaminase, *SGPT* serum glutamate pyruvate transaminase, *SUA* serum uric acid, *WC* waist circumference, *TC* toal cholesterol, *LDL* low-density lipoproteins, *HDL*, high-density lipoproteins, *TG* triglycerides, *RP* role physical, *RE* role emotion, *MH* mental health, *SF* social functioning, *GH* general health

P value < 0.05 was considered as statistically significant

**p < 0.05*

Table 3 Correlation between biochemical parameters and quality of life in subjects without NAFLD

Parameters	Physical domain *r* (*p* value)	RP *r* (*p* value)	RE *r* (*p* value)	Energy *r* (*p* value)	MH *r* (*p* value)	SF *r* (*p* value)	Pain *r* (*p* value)	GH *r* (*p* value)
Age	–0.11 (0.15)	0.02 (0.84)	0.03 (0.66)	0.07 (0.35)	0.06 (0.39)	0.08 (0.26)	–0.01 (0.85)	0.09 (0.24)
BMI	0.05 (0.48)	–0.05 (0.52)	0.06 (0.46)	0.02 (0.84)	0.00 (0.95)	0.05 (0.53)	–0.02 (0.80)	–0.04 (0.58)
FBS	0.02 (0.78)	–0.01 (0.93)	0.05 (0.47)	0.04 (0.63)	0.06 (0.43)	0.05 (0.52)	–0.06 (0.43)	0.02 (0.83)
HbA1c	0.005 (0.95)	0.05 (0.50)	–0.04 (0.60)	0.07 (0.36)	–0.15 (0.04)	0.16 (0.04)	–0.07 (0.37)	0.07 (0.34)
SGOT	0.04 (0.58)	0.03 (0.71)	0.05 (0.52)	–0.02 (0.81)	0.03 (0.70)	–0.01 (0.91)	–0.01 (0.88)	–0.03 (0.73)
SGPT	–0.01 (0.87)	–0.01 (0.90)	–0.07 (0.36)	–0.06 (0.45)	–0.11 (0.14)	–0.05 (0.48)	-0.02 (0.79)	0.00 (1.00)
Blood Urea	0.10 (0.19)	–0.06 (0.40)	–0.03 (0.70)	0.02 (0.82)	0.00 (0.97)	0.00 (0.98)	0.03 (0.69)	–0.01 (0.92)
SUA	0.02 (0.77)	–0.02 (0.74)	–0.01 (0.93)	0.05 (0.51)	0.03 (0.69)	0.02 (0.82)	0.02 (0.78)	–0.05 (0.53)
WC	0.02 (0.82)	–0.13 (0.09)	–0.08 (0.28)	–0.05 (0.54)	–0.09 (0.21)	–0.08 (0.31)	0.04 (0.63)	–0.08 (0.31)
TC	–0.09 (0.21)	–0.08 (0.28)	0.01 (0.91)	0.03(0.66)	0.07 (0.38)	0.08 (0.28)	0.00 (0.98)	0.08 (0.27)
LDL	–0.02 (0.81)	–0.10(0.17)	0.01 (0.93)	0.05 (0.54)	–0.02 (0.83)	.159* (0.03)	0.02 (0.80)	0.14 (0.06)
HDL	–.172* (0.02)	–0.01(0.87)	0.09 (0.25)	–0.02 (0.83)	.186* (0.01)	–0.07 (0.36)	0.03 (0.71)	0.07 (0.32)
TG	–0.118 (0.11)	0.023(0.76)	0.051 (0.49)	–0.07 (0.32)	0.04 (0.58)	–0.03 (0.65)	–0.04 (0.61)	0.116 (0.12)

BMI body mass index, *FBS* fasting blood sugar, *HbA1c* glycated hemoglobin, *SGOT* serum glutamate oxaloacetate transaminase, *SGPT* serum glutamate pyruvate transaminase, *SUA* serum uric acid, *WC* waist circumference, *TC* total cholesterol, *LDL* low-density lipoproteins, *HDL* high-density lipoproteins, *TG* triglycerides, *RP* role physical, *RE* role emotion, *MH* mental health, *SF* social functioning, *GH* general health

P value < 0.05 was considered as statistically significant

**p < 0.05*

variables were measured on an ordinal scale. The study observed an inverse relationship between the raised blood sugar levels (FBS) and the role of physical ($p=0.01$) and emotional well-being ($p=0.01$) of the subjects. There was a positive correlation between BMI and social function, and general health showed a positive correlation, whereas triglycerides showed a positive correlation with the pain domain. In the NAFLD group, HbA1c had a positive correlation with the physical domain, whereas in the non-NAFLD group, it showed a negative correlation with the mental and a positive correlation with the social function domain. The determination of QoL using SF-36 and NAFLD, being an underlying complication of diabetes, exhibited a strong correlation with biochemical parameters.

The general measure of health-related QoL was used again in patients without NAFLD. Pearson's correlation analysis in this group revealed that LDL has a positive correlation with social function. There was a negative correlation between HDL and the physical domain and a positive correlation with mental health. The SF-36 questionnaire consists of eight domains that are potentially relevant to disease conditions. The questionnaire focused on health-related measures and findings in non-NAFLD subjects who only had diabetes. In this study, we noticed that correlation analysis did not show any significance in most of the eight domains of SF-36 (Table 3).

Table 4 SF-36 questionnaire score in overall and eight domains

Parameters	Subjects with NAFLD ($n=179$) Mean ± SD	Subjects without NAFLD ($n=179$) Mean ± SD	*P value*
Physical	51.9 ± 20.85	58.1 ± 18.85	0.0056**
RP	69.69 ± 36.81	72.35 ± 33.57	0.7243
RE	78.43 ± 34.86	83.08 ± 30.66	0.2515
Energy	49.78 ± 17.42	57.09 ± 15.19	< 0.0001***
MH	55.96 ± 12.53	81.76 ± 30.77	< 0.0001***
Social function	71.72 ± 20.63	70.14 ± 21.25	0.9947
Pain	57.88 ± 26.93	76.35 ± 15.48	< 0.0001***
General health	55.82 ± 11.26	55.81 ± 10.03	0.9328

NAFLD non-alcoholic fatty liver disease, *RP* role physical, *RE* role emotion, *MH* mental health

P value < 0.05 was considered as statistically significant

**p < 0.05; ***p < 0.001

SF-36 score

QoL was assessed with SF-36 questionnaire scores, and all domains of SF-36 indicated a poor QoL in diabetics with NAFLD, in contrast to diabetic subjects without NAFLD. Among all eight domains of SF-36, lower scores of QoL for physical (51.9), energy (49.78), mental health (55.96), and pain (57.88) were noted in the subjects with NAFLD (Table 4). NAFLD impacted the subject's energy levels and physical functioning, as evidenced by the lowest subscale; however, even in subjects without NAFLD, general health was impacted. The internal consistency for a response to the SF-36 questionnaire by the subjects was estimated for NAFLD and without NAFLD groups using the Cronbach alpha coefficient. In both groups, the energy, emotional well-being, social functioning, pain, and general health domains revealed poor internal consistency (Table 5). The values of physical function, physical health, and emotional problems were indicated as stable and were unaffected by physiological changes.

Table 6 represents the QoL between different grades of fatty liver among 179 NAFLD subjects, 154 subjects had grade 1 fatty liver, and 25 subjects had grade 2 fatty liver. In this study, we observed no difference in the QoL between grade 1 and grade 2 fatty liver subjects. The mean, SD of SF-36 scores, showed no significant difference in contrast to HbA1c among both groups ($p>0.05$) (Table 7).

Table 6 Comparison of quality of life between Grade 1 and Grade 2 NAFLD subjects

Parameters	Grade 1 ($N=154$)	Grade 2 ($N=25$)	*P* value
Physical	55 ± 14.29	51.39 ± 21.7	0.52
RP	71 ± 30.35	69.48 ± 37.84	0.80
RE	82.67 ± 30.61	77.74 ± 35.55	0.61
Energy	49.94 ± 17.64	48.8 ± 16.28	0.86
MH	56.08 ± 12.45	55.20 ± 13.27	0.74
Social function	72.48 ± 20.93	67 ± 18.36	0.12
Pain	58.77 ± 26.60	52.40 ± 28.83	0.20
General health	56.11 ± 11.26	54.14 ± 11.30	0.36

NAFLD non-alcoholic fatty liver disease, *RP* role physical, *RE* role emotion, *MH* mental health

P value < 0.05 was considered as statistically significant

Table 5 Cronbach alpha coefficient for SF-36 scales in case and control populations

S. No	Physical function (PF)	Role limitation due to physical health	Role limitation due to emotional problems	Energy/fatigue	Emotional well being	Social function	Pain	General health
1	0.83	0.82	0.82	0.68	0.64	0.49	0.49	0.46
2	0.78	0.75	0.77	0.68	0.49	0.46	0.45	0.30

Table 7 Comparison of quality of life in type-2 diabetics with and without NAFD based on HbA1c levels

Parameters	HbA1c [< 6.5] (*N* = 61) Mean ± SD	HbA1c [> 6.5] (*N* = 118) Mean ± SD	*P value*
With NAFLD			
Physical	53.45 ± 20.29	48.9 ± 21.93	0.17
RP	75.82 ± 33.22	66.53 ± 38.29	0.12
RE	84.17 ± 30.79	75.46 ± 36.57	0.07
Energy	52.3 ± 19.14	48.47 ± 16.39	0.15
MH	55.74 ± 14.01	56.07 ± 11.76	0.76
Social function	74.39 ± 21.46	70.34 ± 20.14	0.16
Pain	61.23 ± 28.78	56.14 ± 25.88	0.02*
General health	56.33 ± 12.98	55.55 ± 10.31	0.84
Without NAFLD	**HbA1c < 6.5 *N* = 95 Mean ± SD**	**HbA1c > 6.5 *N* = 84 Mean ± SD**	
Physical	58.51 ± 16.8	57.74 ± 20.57	0.87
RP	74.7 ± 32.35	70.26 ± 34.65	0.34
RE	83.75 ± 28.56	82.48 ± 32.55	0.76
Energy	58.63 ± 14.94	55.74 ± 15.37	0.23
MH	57.48 ± 11.34	59.41 ± 10.98	0.11
Social function	76.93 ± 19.74	73.16 ± 19.12	0.09
Pain	76.58 ± 15.84	76.16 ± 15.23	0.98
General health	56.85 ± 10.32	54.89 ± 9.73	0.22

NAFLD non-alcoholic fatty liver disease, *HbA1c* glycated hemoglobin, *RP* role physical, *RE* role emotion, *MH* mental health

P value < 0.05 was considered as statistically significant

**p < 0.05*

Discussion

With new recommendations from the American Diabetes Association emphasizing the need for a "patient-centered" approach to the care of T2DM patients in terms of QoL, avoidance of diabetes complications, and accomplishment of glycemic objectives, QoL is increasingly gaining relevance. In contrast to the Indian situation, however, there is extremely little research accessible. Patients with NAFLD have decreased quality of life in the physical domain, indicating poor physical health.

In our study, age did not show a significant correlation with QoL in either group. This finding was similar to other studies reported earlier [16]. In steatohepatitis, elevated transaminases indicate liver injury [17]. In our study, the elevation of transaminases affects the QoL. Similar findings were noticed in previous studies [16, 18]; apart from these results, there was an association between abnormal lipid levels and NAFLD in our study population, and these findings are similar to Persian cohorts [19]. In T2DM patients, the SF-36 questionnaire showed that general health, physical functioning, and energy were most affected. A significant difference in mental health was observed between NAFLD and non-NAFLD patients. Comorbidities affected QoL in five domains in NAFLD patients. Fatty liver, metabolic syndrome, and depression are more common in obese people [20]. Diabetes with NAFLD showed poor QoL in this present study. The mental health domain of the SF-36 questionnaire was negatively affected by NAFLD findings and diabetes alone lowers mental health QoL. This might be due to a lack of adherence to medications, lifestyle, and physical exercise. Mental health issues worsened NAFLD. Both groups had uncontrolled FBS and HbA1c. Hyperglycemic patients are affected by bodily pain the most. The bodily pain score also changed. Diabetes causes nerve function and central pain processing changes in diabetics. The results indicated a deeper insight into pain perception in NAFLD patients [21]. Obesity hinders mental and physical health [22] and decreases QoL [23, 24]. In the present study, body weight was linked with QoL. However, in some studies, no association between BMI and QoL [22]. Unlike QoL in diabetics with NAFLD, several studies support our findings in patients without diabetes [25]. Physical activity was declined with diabetes [26]. In our study, the elevation of FBS levels is significantly high in the non-NAFLD group. In the NAFLD cohort, FBS and QoL were also associated with the RLP domain. NASH patients had lower HRQoL in CRN study [9]. Grade 1 fatty liver had better QoL than grade 2 in our study. T2DM-NAFLD had higher SGOT, SGPT, SUA, blood urea, total cholesterol, LDL, and triglycerides than those without NAFLD. Our study confirmed previous findings that T2DM-NAFLD patients had abnormal liver enzymes and lipid levels [27, 28]. Most of the patients in the NAFLD group had elevated transaminases and dyslipidemia. Furthermore, the present study observed that patients with NAFLD did not follow diabetic dietary recommendations suggested by the physician. They also reported lower physical health, mental health, and pain and energy scores in SF-36 domains when compared to subjects without NAFLD. A positive correlation between BMI, social function, and general health was observed. The SGPT and physical domain were positively correlated in T2DM-NAFLD.

Conclusion

The study observed that NAFLD and an increase in liver enzymes are major determinants of poor QoL in T2DM patients. Fasting blood sugar levels are negatively correlated with role physical and role emotion. Hence, clinicians should be constantly vigilant for NAFLD in T2DM patients, and regular NAFLD screening in type 2 diabetics should be considered and also advocate liver biopsy if the patients are with grade 3 fatty liver.

Limitations of the study

The first limitation is the diagnosis by US that has several limitations; it is subjective and operator-dependent, shows poor sensitivity for the detection of mild steatosis, and is a poor tool for quantifying the steatosis; however, abdominal ultrasonography is currently the most common method employed for qualitative assessment of hepatic steatosis because it is non-invasive, widely available, cheap, and provides useful information. Secondly, the current study was conducted in a single center, which limits the generalizability of the findings. Owing to the study design, causal conclusions cannot be drawn. The shortage of subjects with diabetes and NAFLD in the Indian scenario has made it difficult to compare and interpret different variables used in the study. For generalization of the findings, we recommend prospective multicenter studies with large sample sizes.

Abbreviations

BMI	Body mass index
BU	Blood urea
FBS	Fasting blood glucose
HCC	Hepatocellular carcinoma
HRQoL	Health-related Quality of life
NAFLD	Non-alcoholic fatty liver disease
NASH	Non-alcoholic steatohepatitis
QoL	Quality of life
SF-36	Short-form survey
SGOT	Serum glutamic-oxalacetic transaminase
SGPT	Serum glutamic-pyruvic transaminase
SUA	Serum uric acid (SUA) and
T2DM	Type 2 diabetes mellitus
USG	Ultrasound imaging

Authors' contributions

US.P—literature search, materials, data collection, and writing; VR.N and RK.P—concept and critical review; VS.M—supervision and statistical analysis; and SR.R and RK.P—design and critical review. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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Availability of data and materials

All the data generated through this study is incorporated within the manuscript.

Declarations

Ethics approval and consent to participate

The current study was approved by the institutional ethics committee (IEC/19/NOV/71/10) at the Sri Ramachandra Institute of Higher Education and Research, Chennai, India. The study was conducted at Bhargavi Gastro and Surgical Clinic, Warangal, Telangana, India. The ethical clearance was obtained from the study site (JCP/IRB/2019/11). The current study was conducted in accordance with the Declaration of Helsinki, Good Clinical Practice Guidelines.

Competing interests

The authors confirm that they have no competing interests.

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References

1. Alexopoulos AS, Duffy R, Kobe EA, German J, Moylan CA, Soliman D, Jeffreys AS, Coffman CJ, Crowley MJ (2021) Underrecognition of non-alcoholic fatty liver disease in poorly controlled diabetes: a call to action in diabetes care. J Endocr Soc 5(12):bvab155
2. Sharma P, Arora A. Clinical presentation of alcoholic liver disease and non-alcoholic fatty liver disease: spectrum and diagnosis. Transl Gastroenterol Hepatol. 2020;5:19
3. Younossi ZM (2019) Non-alcoholic fatty liver disease–a global public health perspective. J Hepatol 70(3):531–544
4. Anstee QM, Targher G, Day CP (2013) Progression of NAFLD to diabetes mellitus, cardiovascular disease or cirrhosis. Nat Rev Gastroenterol Hepatol 10(6):330–344
5. Tapper EB, Sengupta N, Hunink MM, Afdhal NH, Lai M (2015) Cost-effective evaluation of non-alcoholic fatty liver disease with NAFLD fibrosis score and vibration controlled transient elastography. Offic J Am College Gastroenterol|ACG. 110(9):1298–304
6. Afendy A, Kallman JB, Stepanova M, Younoszai Z, Aquino RD, Bianchi G, Marchesini G, Younossi ZM (2009) Predictors of health-related quality of life in patients with chronic liver disease. Aliment Pharmacol Ther 30(5):469–476
7. Younossi Z, Henry L (2016) Contribution of alcoholic and non-alcoholic fatty liver disease to the burden of liver-related morbidity and mortality. Gastroenterology 150(8):1778–1785
8. Sayiner M, Stepanova M, Pham H, Noor B, Walters M, Younossi ZM (2016) Assessment of health utilities and quality of life in patients with non-alcoholic fatty liver disease. BMJ Open Gastroenterol 3(1):e000106
9. David K, Kowdley KV, Unalp A, Kanwal F, Brunt EM, Schwimmer JB, NASH CRN research group (2009) Quality of life in adults with non-alcoholic fatty liver disease: baseline data from the non-alcoholic steatohepatitis clinical research network. Hepatology. 49(6):1904–12
10. Golabi P, Otgonsuren M, Cable R, Felix S, Koenig A, Sayiner M, Younossi ZM (2016) Non-alcoholic fatty liver disease (NAFLD) is associated with impairment of health related quality of life (HRQOL). Health Qual Life Outcomes 14(1):1–7
11 Flanagan S, Damery S, Combes G (2017) The effectiveness of integrated care interventions in improving patient quality of life (QoL) for patients with chronic conditions. An overview of the systematic review evidence. Health Qual Life Outcomes. 15(1):1–1
12. Dasarathy S, Dasarathy J, Khiyami A, Joseph R, Lopez R, McCullough AJ (2009) Validity of real time ultrasound in the diagnosis of hepatic steatosis: a prospective study. J Hepatol 51(6):1061–1067
13. Hernaez R, Lazo M, Bonekamp S, Kamel I, Brancati FL, Guallar E, Clark JM (2011) Diagnostic accuracy and reliability of ultrasonography for the detection of fatty liver: a meta-analysis. Hepatology 54(3):1082–1090
14. Ware JE Jr (2000) SF-36 health survey update. Spine 25(24):3130–3139
15. Framework IC. The MOS 36-item short-form health survey (SF-36). Med Care. 1992;30(6):473-83
16. Chawla KS, Talwalkar JA, Keach JC, Malinchoc M, Lindor KD, Jorgensen R (2016) Reliability and validity of the Chronic Liver Disease Questionnaire (CLDQ) in adults with non-alcoholic steatohepatitis (NASH). BMJ Open Gastroenterol 3(1):e000069

17. Angulo P, Keach JC, Batts KP, Lindor KD (1999) Independent predictors of liver fibrosis in patients with non-alcoholic steatohepatitis. Hepatology 30(6):1356–1362
18. Dan AA, Kallman JB, Wheeler A, Younoszai Z, Collantes R, Bondini S, Gerber L, Younossi ZM (2007) Health-related quality of life in patients with non-alcoholic fatty liver disease. Aliment Pharmacol Ther 26(6):815–820
19. Mansour-Ghanaei R, Mansour-Ghanaei F, Naghipour M, Joukar F (2019) Biochemical markers and lipid profile in non-alcoholic fatty liver disease patients in the PERSIAN Guilan cohort study (PGCS) Iran. J Fam Med Primary Care 8(3):923
20. Pelluri R, Kongara S, Chimakurthy J, Mahadevan S, Nagasubramanian V (2021) The role of body mass index or metabolic syndrome components causing depression in women: an observation from weight reduction clinical trial. J Clin Pharm Ther 46(6):1757–1763
21. Zurita-Cruz JN, Manuel-Apolinar L, Arellano-Flores ML, Gutierrez-Gonzalez A, Najera-Ahumada AG, Cisneros-González N (2018) Health and quality of life outcomes impairment of quality of life in type 2 diabetes mellitus: a cross-sectional study. Health Qual Life Outcomes 16(1):1–7
22. Sayiner M, Stepanova M, Pham H, Noor B, Walters M, Younossi ZM (2016) Assessment of health utilities and quality of life in patients with non-alcoholic fatty liver disease. BMJ Open Gastroenterol 3(1):1–6
23. Han TS, Tijhuis MA, Lean ME, Seidell JC (1998) Quality of life in relation to overweight and body fat distribution. Am J Public Health 88(12):1814–1820
24. Anderson RM, Funnell MM, Fitzgerald JT, Marrero DG (2000) The Diabetes Empowerment Scale: a measure of psychosocial self-efficacy. Diabetes Care 23(6):739–743
25. Dan AA, Kallman JB, Wheeler A, Younoszai Z, Collantes R, Bondini S et al (2007) Health-related quality of life in patients with non-alcoholic fatty liver disease. Aliment Pharmacol Ther 26(6):815–820
26. Kennedy-Martin T, Bae JP, Paczkowski R, Freeman E (2018) Health-related quality of life burden of non-alcoholic steatohepatitis: a robust pragmatic literature review. J Patient-Reported Outcomes 2(1):1–4
27. Birkenfeld AL, Shulman GI (2014) Non-alcoholic fatty liver disease, hepatic insulin resistance, and type 2 diabetes. Hepatology 59(2):713–723
28. Ismail MH (2011) Non-alcoholic fatty liver disease and type 2 diabetes mellitus: the hidden epidemic. Am J Med Sci 341(6):485–492

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