CHAPTER IV

RESULTS AND DISCUSSION

The results of the phases of the research followed by discussion are presented beneath as follows:

Phase I

- **I(A):** Prevalence of non-alcoholic fatty liver disease (NAFLD) in association with cardio-metabolic risk factors among type 2 diabetes patients
    - Comparison between normal liver and NAFLD
    - Comparison between normal liver and different grades of hepatic steatosis
    - Assessment of probability of fibrosis through risk score calculation
- **I (B):** Quality of life of type 2 diabetes patients with NAFLD
    - From gender perspective
    - From grade of hepatic steatosis perspective

Phase II

- **II (B):** Knowledge attitude and practices of type 2 diabetes patients with NAFLD
- **II (C):** Impact of lifestyle modification therapy in the management of NAFLD in patients with type 2 diabetes mellitus
    - Impact of ≥7% weight loss on the anthropometric, bio-physical, biochemical, dietary, metabolic syndrome and liver status of NAFLD subjects on lifestyle modification therapy

Phase III

- **III (A):** Phytochemical profile of tinospora cordifolia stem
- **III (B):** Impact of tinospora cordifolia pure stem extract supplementation in the management of diabetic dyslipidemia

PHASE I (A): PREVALENCE OF NON-ALCOHOLIC FATTY LIVER DISEASE (NAFLD) IN ASSOCIATION WITH CARDIO-METABOLIC RISK FACTORS AMONG TYPE 2 DIABETES PATIENTS

Prevalence of Non-Alcoholic Fatty Liver Disease among Type 2 Diabetes Patients

Of the 105 type 2 diabetes patients that were enrolled for the study, two were diagnosed hepatitis B positive and another one with hepatitis C positive and they were excluded from the study. But, they were referred immediately to the concerned physician for medical correction of the hepatic abnormality that they were diagnosed with. Seven of the enrolled patients gave no concrete reason for failing to turn up for abdominal ultrasound and hence, their biochemical data was not considered for mapping the prevalence of NAFLD. Thus, the total data presented for this phase comprises of only those enrolled type 2 diabetic participants who underwent ultrasonography (N=95).

Almost every three out of four type 2 diabetes patients were diagnosed with NAFLD as the prevalence of NAFLD was alarmingly high to the tune of 77.9% (fig 4.1). With a prevalence of 80.8% of NAFLD among the females, they non-significantly (P 0.46) were a little ahead of the males (74.4%) (fig 4.2). Moderate steatosis or grade 2 steatosis was the most predominant form of hepatic steatosis (61.1%) (fig 4.3) and yet again, the females had a higher prevalence (65.4% vs. 55.8%) than the males in the said category (fig 4.4). Mild or grade 1 steatosis was prevalent in 10.5% of the subjects and more males (11.6%) were in this category than the females (9.6%). The most severe form of steatosis or grade 3 steatosis was seen in 6.3% of the type 2 diabetes patients. Here, males (6.9%) had a higher prevalence than the females (5.8%). Only a little over one fifth of the type 2 diabetes patients (22.1%) had a normal liver. Proportionately, more males (25.6%) had a normal liver than the females (19.2%). Gallstones were also diagnosed in three of the cases of NAFLD as against none in the normal liver group.

FIG 4.1: PREVALENCE OF NAFLD AMONG TYPE 2 DIABETES PATIENTS (%)

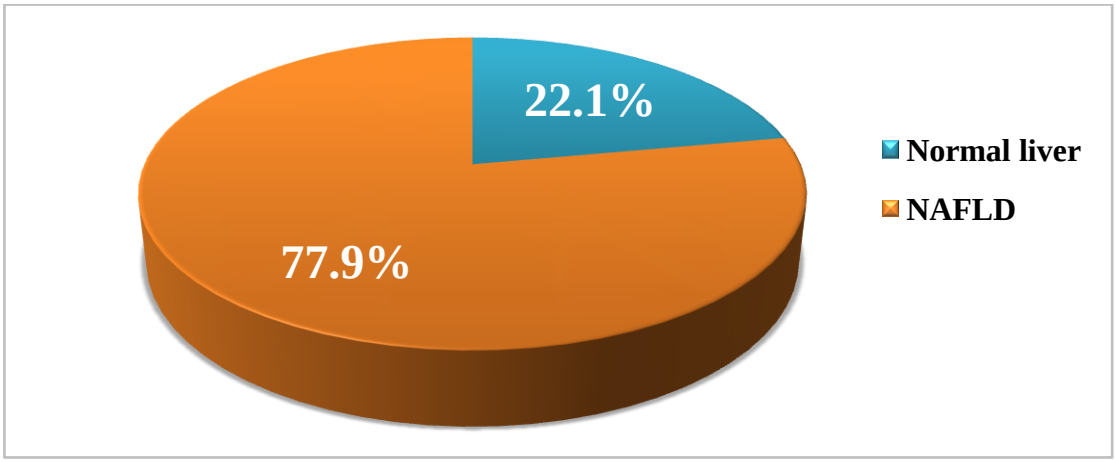


FIG 4.2: PREVALENCE OF NAFLD FROM GENDER PRESPECTIVE (%)

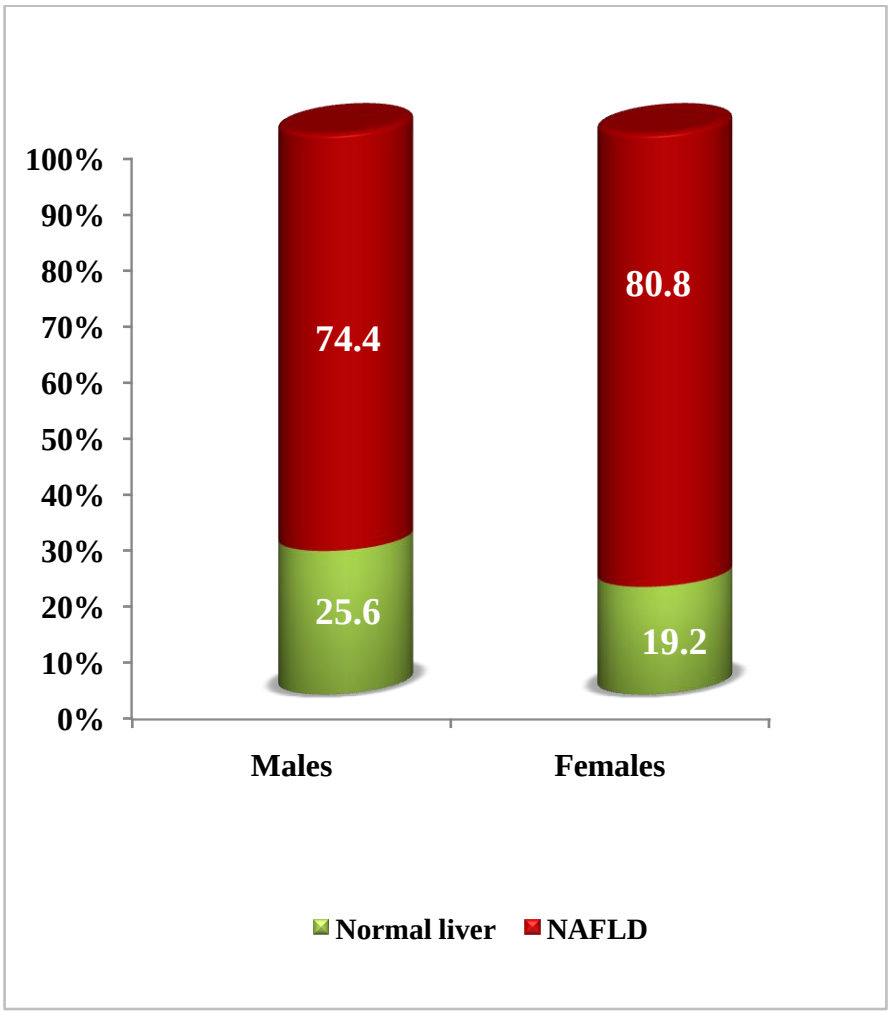


FIG 4.3: PREVALENCE OF ULTRASONOGRAPHIC GRADES OF HEPATIC STEATOSIS (%)

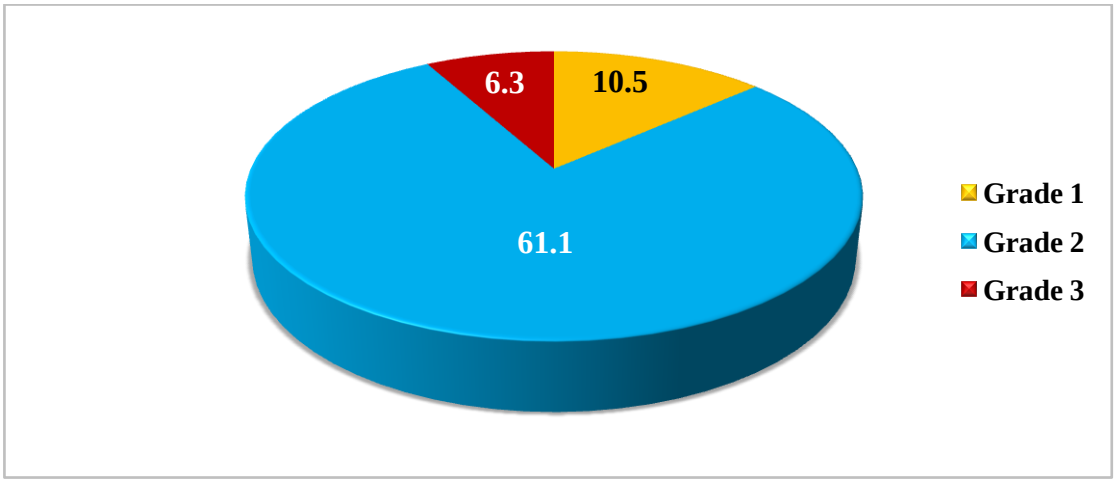
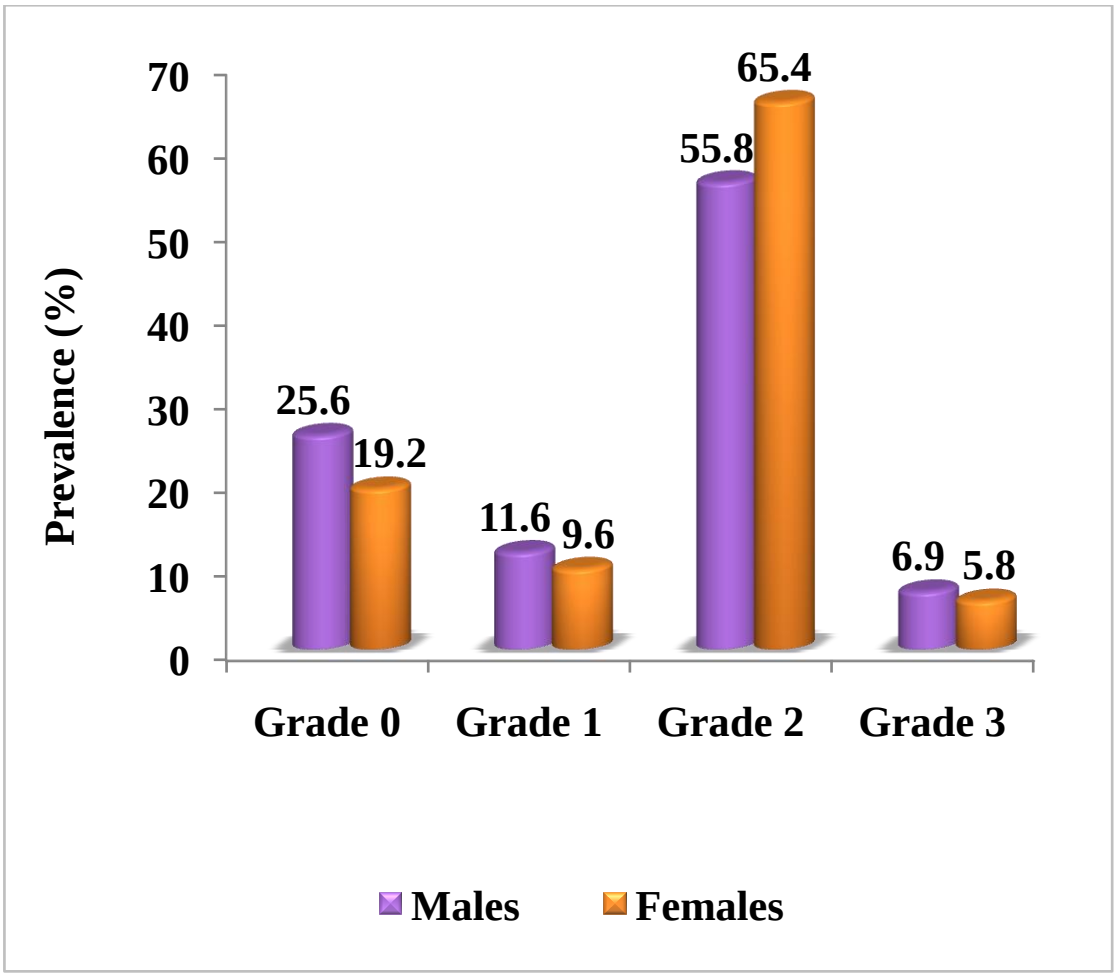


FIG 4.4: PREVALENCE OF ULTRASONOGRAPHIC GRADES OF HEPATIC STEATOSIS FROM GENDER PERSPECTIVE (%)



Age and Duration of Diabetes of Type 2 Diabetes Patients with NAFLD and Normal Liver

Age and duration of diabetes was similar in subjects with NAFLD and normal liver (table 4.1). However, the NAFLD males had significantly higher duration of diabetes (8.7 vs. 5.4 years, P 0.02) compared to the NAFLD females.

Amongst those who had NAFLD, a majority of them (44.6%) were in the 50-60 years age bracket, followed by one fourth of the patients (25.7%) in the 60-70 years age category. A normal liver was observed most in 60-70 years (38.1%) age category, followed by 28.6% in the 50-60 years age bracket (fig 4.5).

Disease Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

Prevalence of hypertension was similar in subjects with NAFLD and normal liver (fig 4.6). Hypothyroidism was more prevalent among NAFLD patients as compared to those with a normal liver and was primarily a problem of the females in both the groups. Among the other ailments that were reported were; gout, thalassemia, depression, asthma and rheumatoid arthritis.

The family history of NCDs was similar in the normal liver and NAFLD group; diabetes (66.7% vs. 68.9%), hypertension (47.6% vs. 45.9%) and between both the genders as well.

Drug Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

Majority of the type 2 diabetic patients with NAFLD (87.8%) were exclusively on oral hypoglycaemic agents (OHAs) (table 4.2). Anti-anginal drugs, thrombolytic agents, thyroid hormones, angiotensin receptor blockers, beta blockers were prescribed to more of NAFLD cases. Agents for treating dyslipidemia, ACE inhibitors, NSAIDs were more commonly prescribed to the normal liver group.

TABLE 4.1: AGE AND DURATION OF DIABETES OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER FROM THE GENDER PERSPECTIVE (MEAN ± SD)

Variables	Normal Liver (N=21)				NAFLD (N=74)			
	M	F	T	P	M	F	T	P
Age (years)	56.5 ± 9.5	58 ± 10.2	57.2 ± 9.6 NS1	0.73	56.3 ± 10.1	55 ± 7.6	55.5 ± 8.7	0.53
Duration of DM (years)	8.5 ± 6.5	5.6 ± 4.4	7.1 ± 5.7 NS2	0.25	8.7 ± 6.4	5.4 ± 5.6	6.9 ± 6.1	**0.02***

P<0.05*, P<0.01**, P<0.001***, NS1: Non-significant p value (0.45), NS2: Non-significant p value (0.86)

FIG 4.5: AGE DISTRIBUTION OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

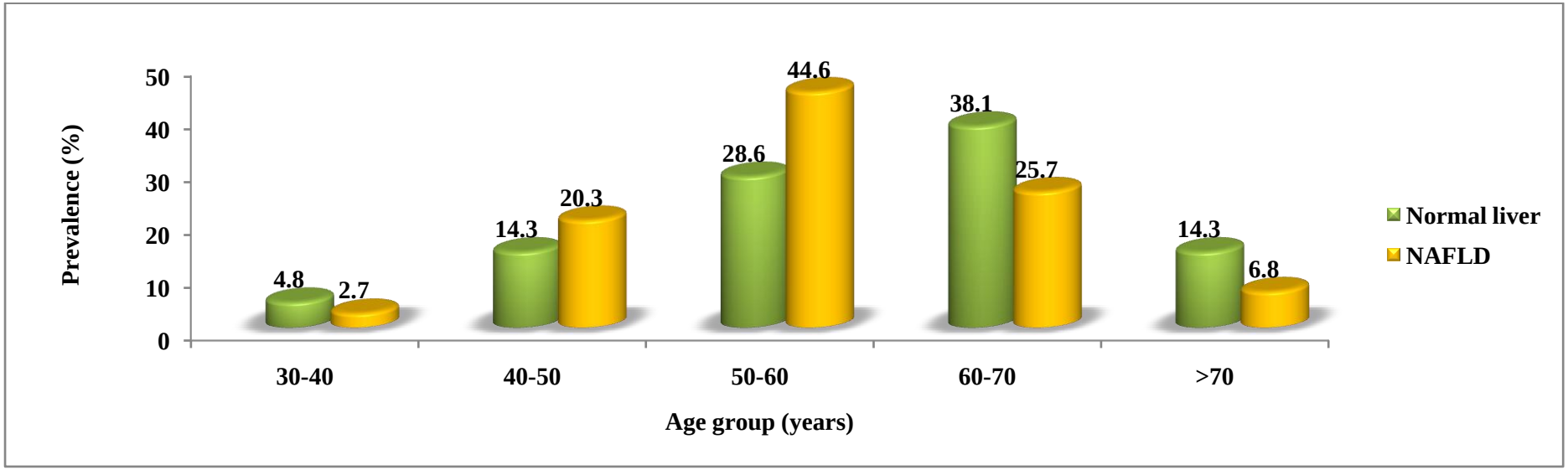


FIG 4.6: DISEASE PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

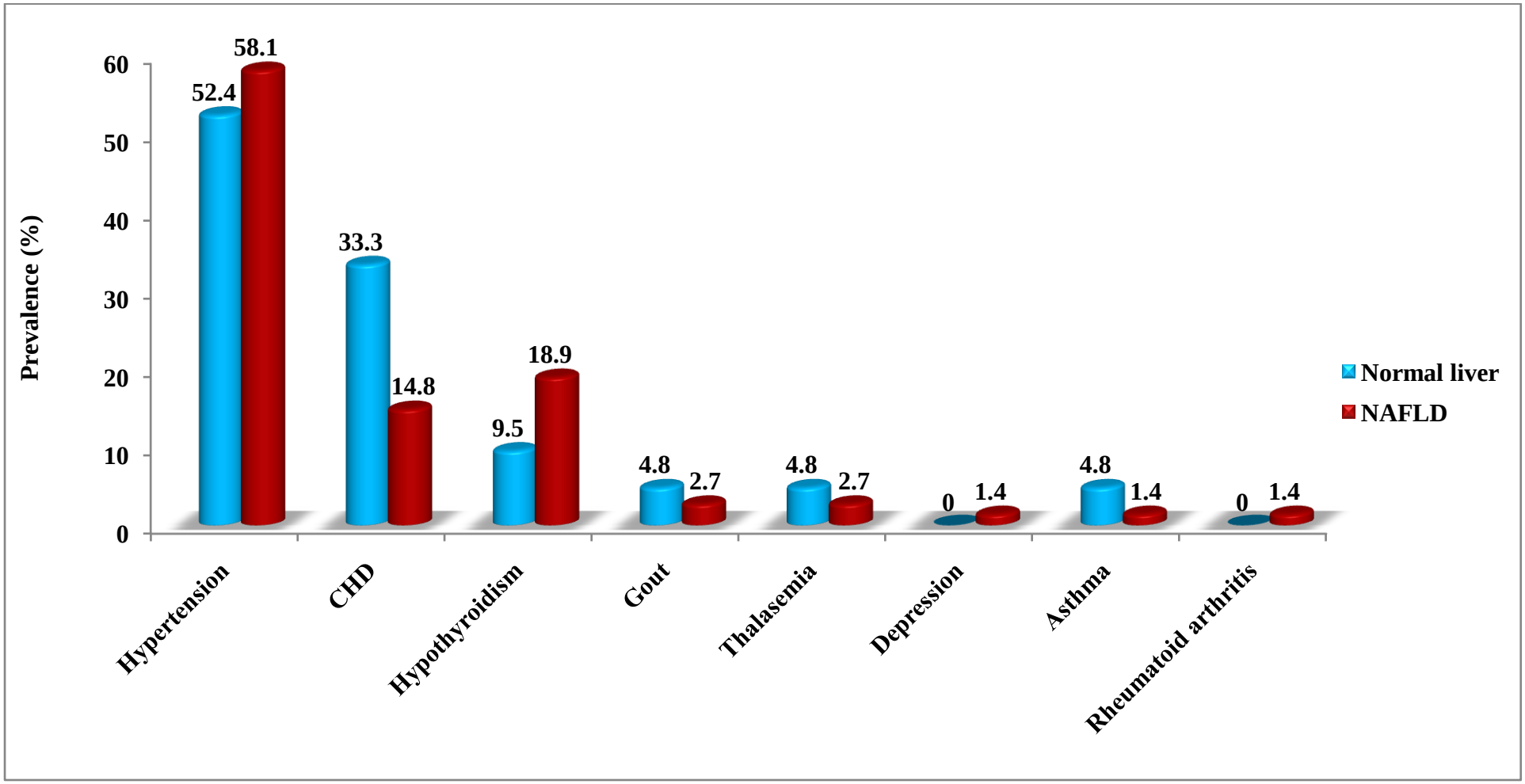


TABLE 4.2: DRUG PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (N, %)

Drugs	Normal Liver (N=21)	NAFLD (N=74)
Oral hypoglycaemic drugs	17 (80.9)	65 (87.8)
OHA + Insulin	4 (19)	9 (12.2)
Dyslipidemic agents	6 (28.6)	14 (18.9)
Anti-anginal agents	2 (9.5)	11 (14.9)
Anti-platelet agents	7 (33.3)	14 (18.9)
ACE inhibitor agents	3 (14.3)	3 (4.1)
Thyroid hormones	2 (9.5)	14 (18.9)
Angiotensin II antagonist agents	4 (19)	20 (27)
Beta blocker agents	4 (19)	19 (25.7)
NSAID agents	7 (33.3)	12 (16.2)
Anti-anemic agents	1 (4.8)	2 (2.7)
Anti-gout agents	1 (4.8)	2 (2.7)
Diuretic agents	0 (0)	3 (4.1)
Anti-depressant agents	0 (0)	1 (1.4)
Anti-asthmatic agents	1 (4.8)	1 (1.4)

Values in parenthesis indicate percentage

Supplement Usage and Addiction Patterns of Type 2 Diabetes Patients with NAFLD and Normal Liver

Vitamin B complex, hypoglycaemic powders (*methi ke daane*, *paneer ka phool* and spirulina), iron and omega 3 fatty acids, calcium and vitamin D supplements were most commonly consumed supplements. None in the normal liver group reported consuming tobacco or smoking as an addictive practice. A few of the grade 2 hepatic steatosis patients were addicted to tobacco chewing and smoking. In grade 3 hepatic steatosis, one third reported tobacco consumption.

Oils Consumed by Type 2 Diabetes Patients with Normal Liver and NAFLD

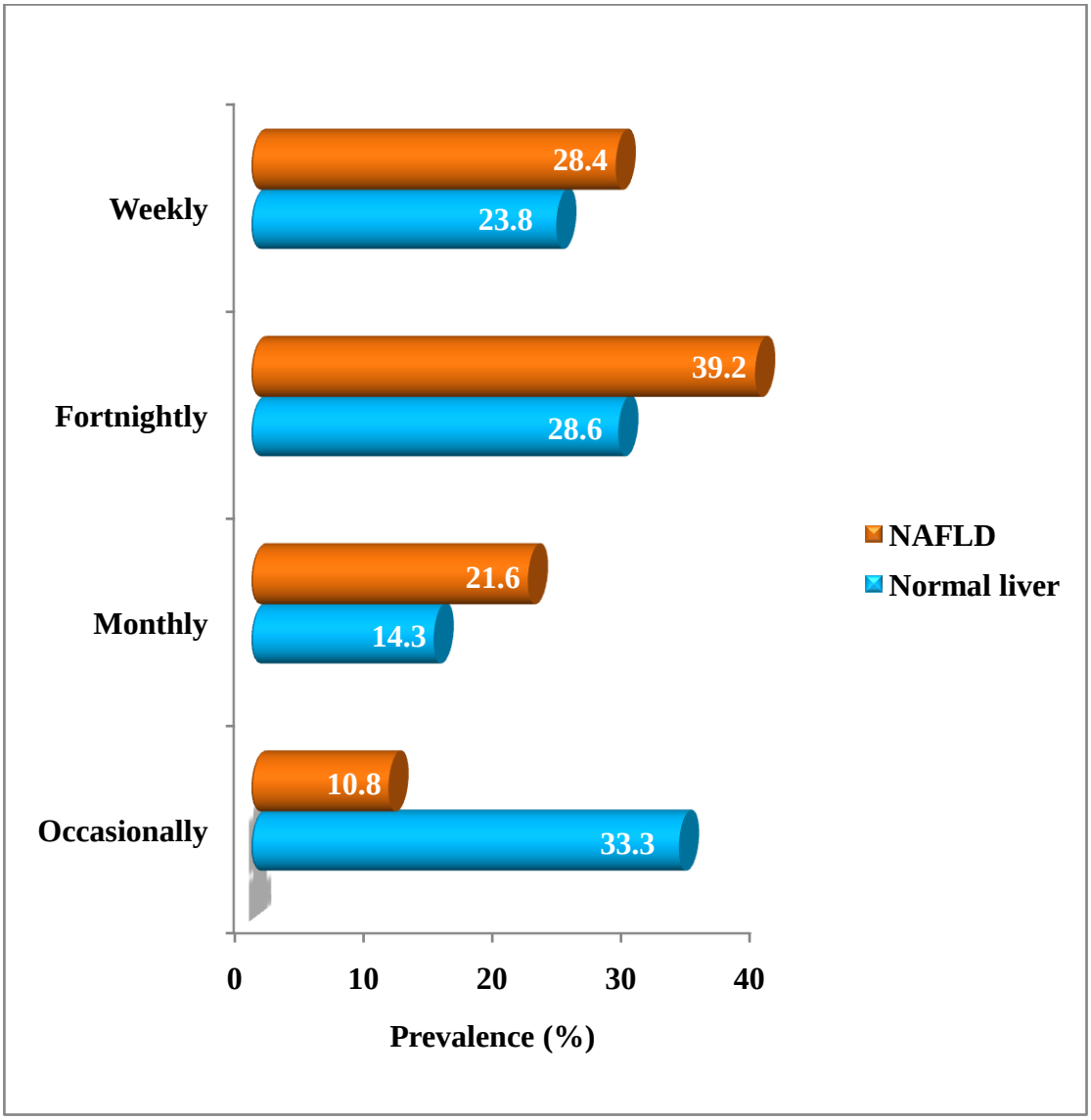
The most commonly consumed cooking oil by NAFLD subjects was cottonseed oil (45.9%), followed by corn oil (12.2%) and sunflower oil (12.2%). The normal liver group consumed more of sunflower oil and corn oil. There were a variety of other oils that were consumed by the patients in the different grades of hepatic steatosis. An increasing linear trend in the consumption of cottonseed oil was observed from grade 1 (40%) to, grade 2 (43.1%) to grade 3 hepatic steatosis (83.3%).

Frequency of Eating Out among Type 2 Diabetes Patients with NAFLD and Normal Liver

NAFLD subjects were frequently eating out than the normal liver subjects. The lesser frequencies of eating out were reported more by the type 2 diabetic patients in normal liver group than the type 2 diabetics in the NAFLD group. Weekly and fortnightly eating out was more common among NAFLD patients. Most of the normal liver type 2 diabetic patients and least of the NAFLD patients preferred to eat out either rarely or occasionally (fig 4.7).

Eating out on a weekly basis was most frequent with grade 2 hepatic steatosis patients and the least in grade 3 hepatic steatosis. Majority of the patients in grade 3 hepatic steatosis, grade 1 hepatic steatosis and grade 2 hepatic steatosis went to eat out on a fortnightly basis. Rarely or occasionally going to eat out was more common among those with a normal liver and those with grade 1 hepatic steatosis.

FIG 4.7: FREQUENCY OF EATING OUT AMONG TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)



Physical Activity Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

The type 2 diabetics with a normal liver had significantly higher (1200.5 vs. 703.8, P 0.017) total METminutes/week than the type 2 diabetics with NAFLD (table 4.3). Thus, those with a normal liver had improved and higher physical activity status than the NAFLD subjects. About 33.3% of the normal liver subjects had a low physical activity profile compared to more than half of the NAFLD cases (52.7%) having a similar profile. About 66.7% normal liver subjects had a medium physical activity status vs. 45.9% of the NAFLD cases (fig 4.8).

NAFLD males had a non-significantly higher (757.7 vs. 662.7) total METminutes/week as compared to the females. In the NAFLD group, more males (56.3% vs. 38.1%) had a medium physical activity profile and more females had a low physical activity profile (59.5% vs. 43.8%), though non-significant.

Physical Activity Profile of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

The difference between the total METminutes/week from the normal liver group and across the various stages of hepatic steatosis was significant (P 0.0003) (table 4.4). The total METminutes/week of the normal liver group were significantly higher than that of the total METminutes/week of the grade 2 (1200.5 vs. 663.5, P 0.01) and grade 3 hepatic steatosis (1200.5 vs. 154, P 0.00001) (table 4.5). Also, the total METminutes/week of grade 3 hepatic steatosis were found to be significantly lower than that of the grade 1 (154 vs. 1267.3, P 0.011) and grade 2 hepatic steatosis (154 vs. 663.5, P 0.00006).

All the subjects in grade 3 steatosis had a low physical activity profile and subjects with normal liver had the least prevalence of low physical activity (33.3%). The prevalence of medium physical activity was the highest in subjects with normal liver (66.7%) (fig 4.9).

TABLE 4.3: PHYSICAL ACTIVITY PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variable	Normal Liver (N=21)	NAFLD (N=74)	P value
METminutes/week	1200.5 ± 825.38	703.8 ± 670.8	**0.017***

p<0.05*, p<0.01**, p<0.001***

FIG 4.8: PHYSICAL ACTIVITY STATUS OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

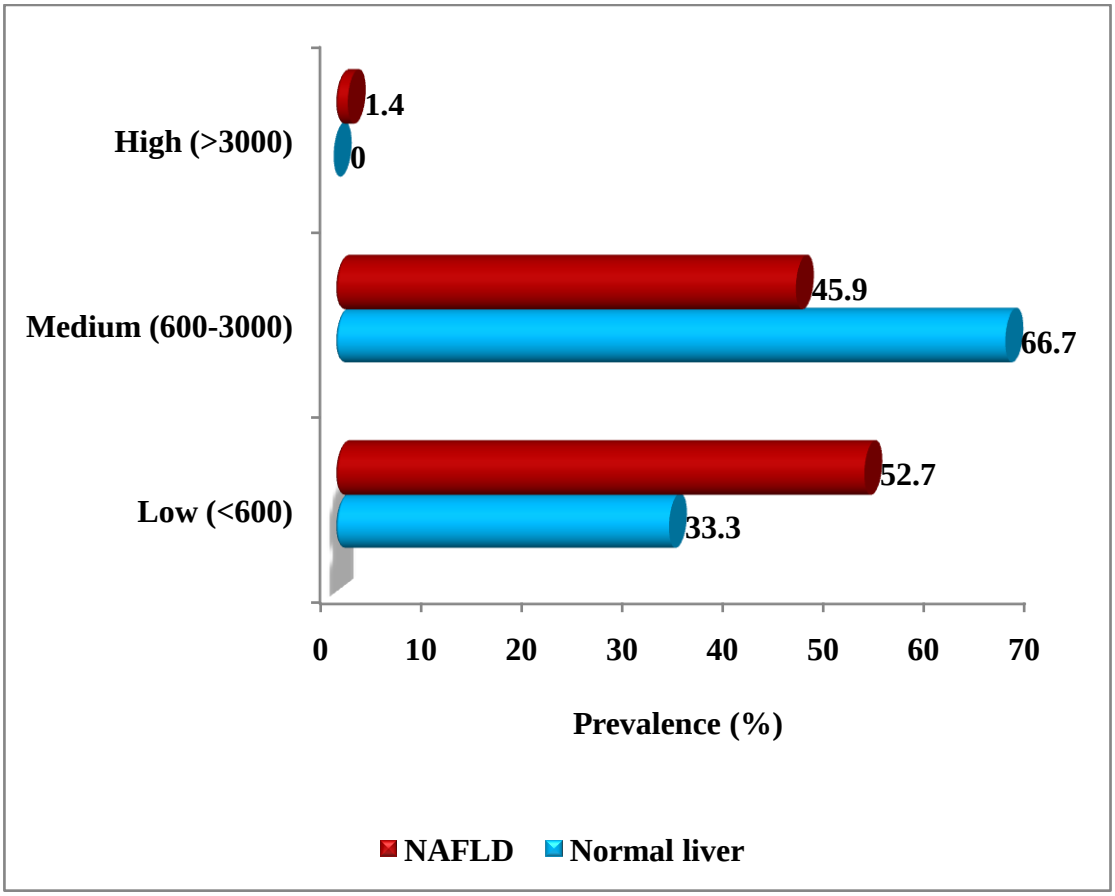


TABLE 4.4: PHYSICAL ACTIVITY OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD)

Variable	Normal Liver (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F value	P value
METminutes/week	1200.5±825.3	1267.3±1121.2	663.5± 534.8	154 ±172	6.68	**0.0003*** **

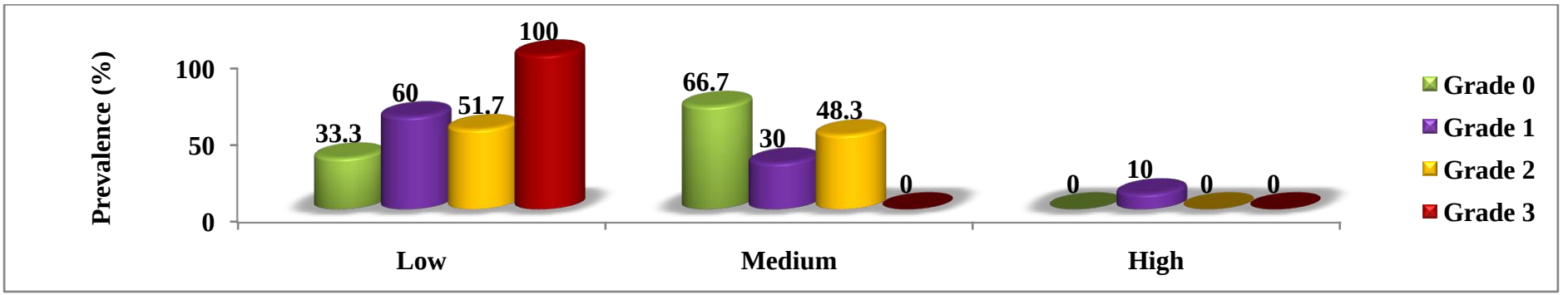
p<0.05*, p<0.01**, p<0.001***

TABLE 4.5: DIFFERENCE IN TOTAL METMINUTES/WEEK BASED ON LIVER STATUS

NL vs. Grade 1	NL vs. Grade 2	NL vs. Grade 3	Grade 1 vs. Grade 2	Grade 1 vs. Grade 3	Grade 2 vs. Grade 3
0.86	**0.01****	**0.00001*****	0.12	**0.011***	**0.00006*****

p<0.05*, p<0.01**, p<0.001***

FIG 4.9: PHYSICAL ACTIVITY PROFILE OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (%)



Anthropometric and Blood Pressure Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

Weight (72.4 vs. 65.7kg, P 0.021), BMI (28.4 vs. 25.3kg/m^2, P 0.007), WC (98.9 vs. 89.2cm, P 0.0006), HC (105 vs. 92.5cm, P 0.0002), WSR (0.62 vs. 0.55, P 0.001) and AVI (19.8 vs. 16.2, P 0.0015) was distinguishably higher among the NAFLD subjects compared to the normal liver counterparts (table 4.6). The total abdominal fat (P 0.0003) and subcutaneous abdominal adipose tissue (P 0.0006) were significantly higher in those with NAFLD compared to those with a normal liver, while the intra-abdominal fat was found to be similar between the groups. From the gender perspective, the male NAFLD patients had significantly higher height (166.9 vs. 154.7cm, 5.62 E) and WHR (0.98 vs. 0.91, P 1.39E) than the female NAFLD patients (table 4.7). The females of the NAFLD group had significantly higher BMI (30.1 vs. 26.1kg/m^2, P 0.0004), HC (109.4 vs. 99.3cm, P 0.0006) and WSR (0.64 vs. 0.58, P 0.0003) than the NAFLD males. Amongst those who had a normal BMI; WC (90.7 vs. 78cm, P 0.006) was significantly higher in those with NAFLD vs. those who had a normal liver.

Anthropometric Profile of Type 2 Diabetic Patients with Normal Liver and Different Grades of Hepatic Steatosis

Weight (P 0.018), BMI (P 0.007), WC (P 0.00004), HC (P 0.0001), WSR (P 0.0002) and AVI (P 0.00004) increased significantly across the transitions in the hepatic status (table 4.8). Height, WHR, SBP and DBP were similar across various hepatic stages. Weight and BMI were significantly higher in grade 2 hepatic steatosis (P 0.031 and P 0.008), grade 3 hepatic steatosis (P 0.004 and P 0.0002) compared to normal liver. Weight and BMI were significantly higher in grade 3 hepatic steatosis (P 0.029 and P 0.036) compared to grade 2 hepatic steatosis (table 4.9). The WC, HC, WSR and AVI were notably higher in grade 2 hepatic steatosis (P 0.002, P 0.0009, P 0.004 and P 0.004) and in grade 3 hepatic steatosis (P 0.0001, P 0.0005, P 0.00006 and P 0.00007) compared to normal liver. The same variables were distinguishably higher in grade 3 hepatic steatosis compared to grade 1 hepatic steatosis (P 0.014, P 0.038, P 0.022 and P 0.016) and grade 2 hepatic steatosis (P 0.0007, P 0.002, P 0.003 and P 0.0006).

TABLE 4.6: ANTHROPOMETRIC PROFILE OF TYPE 2 DIABETIC PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value
Weight (kg)	65.75 ± 12.08	72.44 ± 11.48	**0.021***
Height (cm)	160.62 ± 9.32	160.04 ± 9.02	0.79
BMI (kg/m^2)	25.33 ± 2.98	28.43 ± 4.95	**0.007****
WC (cm)	89.26 ± 11.11	98.97 ± 11.09	**0.0006*****
HC (cm)	92.52 ± 15.1	105.05 ± 12.93	**0.0002*****
WSR	0.55 ± 0.06	0.62 ± 0.07	**0.001*****
WHR	0.97 ± 0.1	0.94 ± 0.05	0.081
AVI	16.17 ± 3.96	19.83 ± 4.67	**0.0015****
SBP (mmHg)	137.9 ± 18.71	136.62 ± 15.71	0.75
DBP (mmHg)	85.42 ± 6.83	85.6 ± 8.05	0.92
Total abdominal fat	28687.7 ± 8342.1	37391.4 ±11019.4	**0.0003*****
Intra-abdominal adipose tissue	14704.4 ± 3179.1	15241.1 ± 3193.9	0.49
SCAT	14106.1 ± 8824.4	22488.2 ± 9513	**0.0006*****

P<0.05*, P<0.01**, P<0.001***

TABLE 4.7: ANTHROPOMETRIC PROFILE OF TYPE 2 DIABETIC PATIENTS WITH NAFLD AND NORMAL LIVER FROM GENDER PERSPECTIVE (MEAN ± SD)

Variables	Normal Liver (N=21)				NAFLD (N=74)			
	M	**F**	**T**	**P**	**M**	**F**	**T**	**P**
Weight (kg)	70.8 ± 13.8	60.1 ± 6.6	65.7 ± 12.08	**0.03***	72.8 ± 10.2	72.1 ± 12.4	72.44 ± 11.48	0.79
Height (cm)	166.4 ± 9.3	154.1 ± 2.8	160.6 ± 9.3	**0.001*****	166.9 ± 7.6	154.7 ± 5.9	160.04 ± 9.02	**5.62E*****
BMI (kg/m^2)	25.4 ± 3.5	25.2 ± 2.4	25.3 ± 2.9	0.9	26.1 ± 3.5	30.1 ± 5.2	28.43 ± 4.95	**0.0004*****
WC (cm)	89.5 ± 12.9	89 ± 9.3	89.2 ± 11.1	0.92	97.4 ± 11.8	100.1 ± 10.4	98.97 ± 11.09	0.29
HC (cm)	89.6 ± 18	95.6 ± 11	92.52 ± 15.1	0.36	99.3 ± 11.1	109.4 ± 12.5	105.05 ± 12.93	**0.0006*****
WSR	0.53 ± 0.07	0.57 ± 0.05	0.55 ± 0.06	0.19	0.58 ± 0.07	0.64 ± 0.07	0.62 ± 0.07	**0.0003*****
WHR	1.01 ± 0.11	0.93 ± 0.06	0.97 ± 0.1	0.06	0.98 ± 0.04	0.91 ± 0.05	0.94 ± 0.05	**1.39E*****
AVI	16.3 ± 4.6	15.9 ± 3.2	16.17 ± 3.96	0.85	19.2 ± 5.06	20.2 ± 4.3	19.83 ± 4.67	0.35
SBP(mmHg)	138.6 ± 22.7	137.1 ± 14.1	137.9 ± 18.71	0.85	135.3 ± 13.5	137.5 ± 17.2	136.62 ± 15.71	0.55
DBP(mmHg)	84.3 ± 8.3	86.6 ± 4.8	85.42 ± 6.83	0.46	85.1 ± 7.2	85.9 ± 8.7	85.6 ± 8.05	0.65

P<0.05*, P<0.01**, P<0.001***

TABLE 4.8: ANTHROPOMETRIC PROFILE OF TYPE 2 DIABETIC PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD)

Variables	NAFLD absent (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F value	ANOVA	Risk level
Weight (kg)	65.7 ± 12.08	69.6 ± 15.37	73.6 ± 15.23	82 ± 6.76	3.51	**0.018***	-
Height (cm)	160.62 ± 9.3	159.94 ± 9.08	155.34 ± 8.03	160.25 ± 12.3	0.02	0.99	-
BMI (kg/m^2)	25.33 ± 2.9	27.4 ± 6.7	30.52 ± 5.8	32.36 ± 5.3	4.28	**0.007****	18.5-22.9
WC (cm)	89.5 ± 10.8	97.2 ± 10.3	104.5 ± 11.3	113.5 ± 12.9	8.62	**0.00004*****	<80 (f), <90 (m)
HC (cm)	92.5 ± 15.1	103.9 ± 13.7	109.7 ± 12.9	118.4 ± 9	9.35	**0.0001*****	-
WSR	0.55 ± 0.06	0.6 ± 0.07	0.67 ± 0.07	0.7 ± 0.07	7.07	**0.0002*****	<0.53 (f), <0.55 (m)
WHR	0.97 ± 0.1	0.93 ± 0.05	0.95 ± 0.07	0.93 ± 0.08	1.4	0.24	<0.85 (f), <0.9 (m)
AVI	16.26 ± 3.8	19.09 ± 4.1	22.11 ± 5	26.04 ± 6.2	8.51	**0.00004*****	<16
SBP(mmHg)	137.9 ± 18.7	139.8 ± 17.6	143.6 ± 20.6	138.5 ± 8.6	0.22	0.88	<130
DBP(mmHg)	85.4 ± 6.8	86.5 ± 8.3	85.7 ± 8.5	86.5 ± 6.3	0.08	0.96	<85

P<0.05*, P<0.01**, P<0.001***

TABLE 4.9: DIFFERENCES IN ANTHROPOMETRIC INDICES AMONG TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS

Groups	**P Value**					
	Weight (kg)	**BMI (kg/m^2)**	**WC (cm)**	**HC (cm)**	**WSR**	**AVI**
Normal liver vs. Grade 1	0.45	0.24	0.073	0.052	0.067	0.072
Normal liver vs. Grade 2	**0.031***	**0.008****	**0.002****	**0.0009*****	**0.004****	**0.004****
Normal liver vs. Grade 3	**0.004****	**0.0002*****	**0.0001*****	**0.0005*****	**0.00006*****	**0.00007*****
Grade 1 vs. Grade 2	0.55	0.63	0.86	0.89	0.89	0.87
Grade 1 vs. Grade 3	0.08	0.14	**0.014***	**0.038***	**0.022***	**0.016***
Grade 2 vs. Grade 3	**0.029***	**0.036***	**0.0007*****	**0.002****	**0.003****	**0.0006*****

P<0.05*, P<0.01**, P<0.001***

Nutritional Status of Type 2 Diabetes Patients with NAFLD and Normal Liver

Obesity was significantly higher in NAFLD subjects than those with a normal liver (74.3% vs. 42.9%, P 0.006) (fig 4.10) and more prevalent among females than the males (80.9% vs. 65.6%), although non-significant. The prevalence of overweight was significantly higher in normal liver subjects compared to NAFLD subjects (38.1% vs. 14.9%, P 0.029). Indicators of abdominal obesity, namely; WC and WSR were alarmingly elevated in the NAFLD group (87.8%) and all the females had abdominal obesity as against 71.8% of the males in the NAFLD group (P 0.00025).

Nutritional Status of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

A steady decline in the proportion of NAFLD cases with a normal nutritional status was observed from grade 1 hepatic steatosis (30%) to grade 2 hepatic steatosis (8.6%) and with none in the grade 3 hepatic steatosis. With shift from each grade of hepatic steatosis, the proportion of obese in the NAFLD group increased from 60% in grade 1 hepatic steatosis to 74.1% in grade 2 hepatic steatosis to 100% in grade 3 hepatic steatosis. Prevalence of abdominal obesity also saw a steady rise with shift in grades of hepatic steatosis as 80% in grade 1 hepatic steatosis, 87.9% in grade 2 hepatic steatosis and all the type 2 diabetics in grade 3 hepatic steatosis had abdominal obesity, as defined by WC and WSR (fig 4.11).

FIG 4.10: NUTRITIONAL STATUS OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

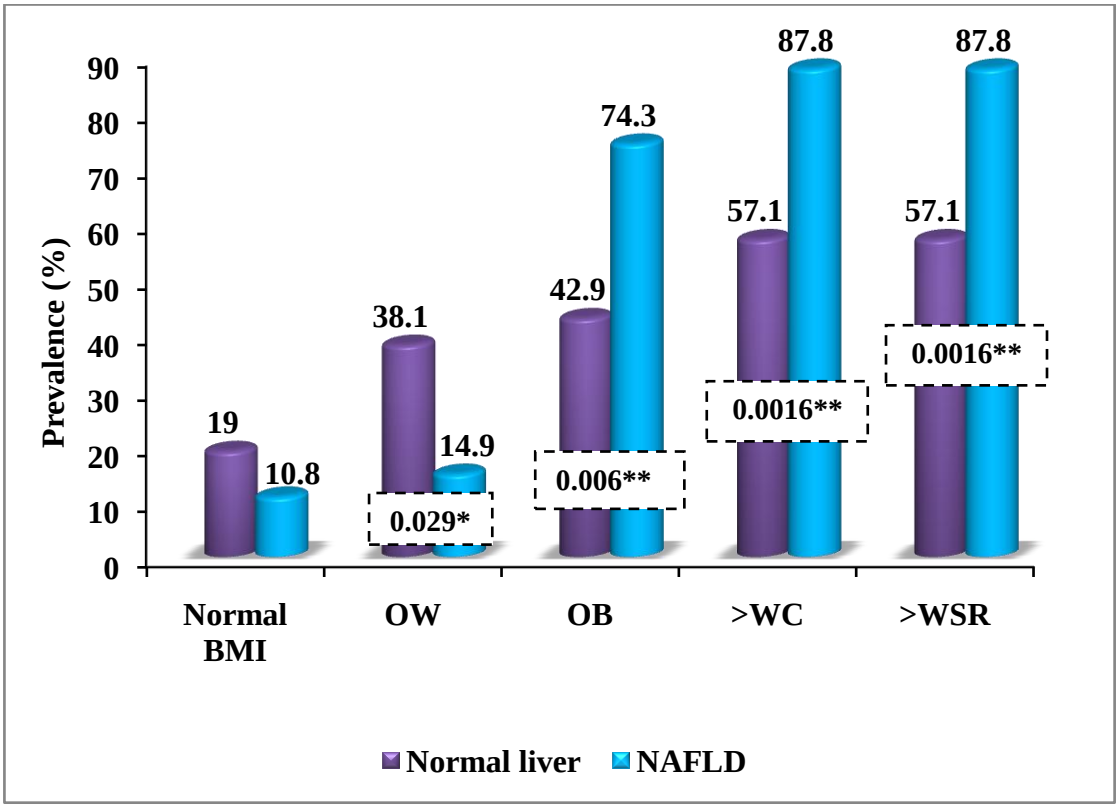
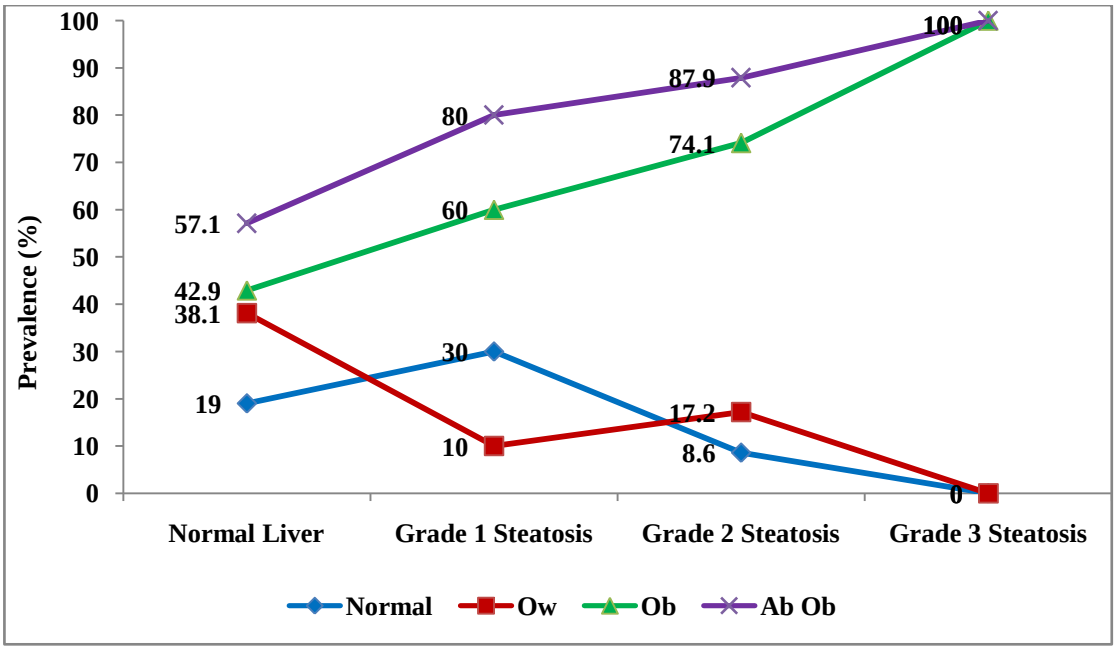


FIG. 4.11: NUTRITIONAL STATUS OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (%)



Dietary Habits and Nutrient Intake of Type 2 Diabetes Patients with NAFLD and Normal Liver

About 80.95% normal liver subjects and 78.37% NAFLD subjects were vegetarians (table 4.10).

The NAFLD subjects had similar intake of energy and carbohydrates and protein intake was non-significantly lower and fat intake was non-significantly higher than the normal liver subjects. The intake of crude fibre (5.4g vs. 6.7g, P 0.0031) and vitamin A (114.1 µg vs. 175.2 µg, P 0.025) was significantly lower in those with NAFLD compared to normal liver subjects. Sodium intake was significantly higher in normal liver subjects than those with NAFLD (158.1mg vs. 120.5mg, P 0.003).

The proportion of calories derived from carbohydrates (52.2% and 52.9%) and fat (34.2% and 32.1%) was similar in subjects who had NAFLD and a normal liver (table 4.11). However, the NAFLD subjects had significantly lower proportion of energy coming from proteins compared to normal liver subjects (10.9% vs. 12.6%, P 2.84E).

In subjects with NAFLD, males had significantly higher carbohydrates (204.4g vs. 182.8g, P 0.006) intake than the females (table 4.12). Consequently, the NAFLD males were consuming significantly higher proportion of CHO in their diet than the NAFLD females (53.8% vs. 51.08%, P 0.032) (table 4.13).

Dietary Habits and Nutrient Intake of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

The energy intake differed non-significantly across the various hepatic stages wherein normal liver subjects had the least energy intake (1444kcal) and grade 3 steatosis subjects (1560kcal) had the highest energy intake (table 4.14). The protein intake was also non-significantly different in terms of hepatic status, wherein least protein intake was observed in grade 2 steatosis (40.04g) and the highest intake was recorded in normal liver subjects (45.8g). Fat intake was the least in normal liver subjects (51.3g) and was the highest in grade 3 steatosis subjects (56.8g) but differed non-significantly. The carbohydrate intake was the least in grade 2 steatosis subjects (187.4g) and was the highest in grade 1 steatosis subjects (210.5g), although of non-

significant relationship. The intake of crude fibre (P 0.0004), vitamin A (P 0.003) and soluble fibre (P 0.03) differed significantly from normal liver to grade 3 hepatic steatosis. The crude fibre intake of grade 2 steatosis subjects was significantly lower from normal liver (P 0.0003) and grade 1 steatosis subjects (P 0.0025) (table 4.15). The vitamin A intake of grade 1 steatosis subjects (P 0.001) and grade 2 steatosis subjects (P 0.037) was significantly lower from normal liver subjects and grade 1 steatosis subjects had significantly lower intake of vitamin A than the grade 2 (P 0.027) and grade 3 hepatic steatosis subjects (P 0.034). The soluble fibre intake of grade 3 steatosis subjects (P 0.022) and grade 2 steatosis subjects (P 0.012) was significantly lower from grade 1 steatosis subjects.

The proportion of distribution of macronutrients did not differ significantly across the various hepatic stages, although fat's proportion was the lowest in grade 1 hepatic steatosis (32.1%) and the highest in grade 2 steatosis (34.5%) and that of CHO was least in grade 2 steatosis (51.9%) and was the highest in grade 1 steatosis (55.2%) (table 4.16). The proportion of protein intake differed significantly (P 0.0001) across the various hepatic stages and was significantly higher in the normal liver subjects (12.6%) compared to subjects with grade 1 steatosis (10.7%, P 0.004), grade 2 steatosis (11.07%, 2.5E) and grade 3 steatosis (11.1%, P 0.039) (table 4.17).

TABLE 4.10: DIETARY HABITS AND NUTRIENT INTAKE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN±SD)

Nutrients	Normal Liver (N=21)	NAFLD (N=74)	P value
Vegetarian	17 (80.95)	58 (78.37)	1
Ovo-vegetarian	0 (0)	2 (2.7)	1
Non-vegetarian	4 (19.04)	14 (18.91)	1
Energy (kcal)	1444 ± 365	1467 ± 182	0.78
Protein (g)	45.8 ± 13.1	40.4 ± 7.6	0.08
Fat (g)	51.3 ± 21.1	55.6 ± 10.1	0.37
Carbohydrates (g)	190.6 ± 60.5	192.2 ± 34.5	0.91
Crude fibre (g)	6.7 ± 1.9	5.4 ± 1.6	**0.0031****
Calcium (mg)	731.4 ± 350.7	605.4 ± 256.3	0.13
Phosphorus (mg)	1121.7 ± 295.8	1009.4 ± 206.6	0.11
Iron (mg)	13.5 ± 5.9	12.8 ± 5.5	0.61
Vitamin A (µg)	175.2 ± 102	114.1 ± 51.2	**0.025***
Vitamin C (mg)	80.7 ± 42.5	62.7 ± 54.7	0.11
Sodium (mg)	158.1 ± 48.1	120.5 ± 50.6	**0.003***
Potassium (mg)	1224.5 ± 300.1	1168.9 ± 294.6	0.45
Total dietary fibre (g)	12.9 ± 5.2	12.05 ± 5.02	0.49
Insoluble dietary fibre (g)	9.6 ± 4.03	9.2 ± 3.9	0.65
Soluble dietary fibre (g)	3.2 ± 1.3	2.8 ± 1.2	0.17

p<0.05*, p<0.01**, p<0.001***, values in parenthesis depict proportion

TABLE 4.11: PERCENT DISTRIBUTION OF CALORIES FROM MACRONUTRIENTS OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN±SD)

Macronutrients	Normal Liver (N=21)	NAFLD (N=74)	P value
Carbohydrates (%)	52.9 ± 10.4	52.2 ± 5.4	0.78
Protein (%)	12.6 ± 1.6	10.9 ± 1.2	**2.84E*****
Fat (%)	32.1 ± 9.4	34.2 ± 5.4	0.32

p<0.05*, p<0.01**, p<0.001***

TABLE 4.12: NUTRIENT INTAKE OF TYPE 2 DIABETES PATIENTS WITH NAFLD FROM GENDER PRESPECTIVE (MEAN±SD)

Nutrients	Males (N=32)	Females (N=42)	P value
Energy (kcal)	1514 ± 152	1432 ± 197	0.055
Protein (g)	41.9 ± 6.9	39.4 ± 8.07	0.15
Fat (g)	55.03 ± 9.1	56.04 ± 10.9	0.87
Carbohydrates (g)	204.4 ± 34.7	182.8 ± 31.6	**0.006***
Crude fibre (g)	5.6 ± 1.4	5.2 ± 1.7	0.27
Calcium (mg)	549.1 ± 216.3	648.3 ± 277.9	0.08
Iron (mg)	14.3 ± 6.2	11.7 ± 4.7	0.059
Vitamin A (µg)	104.1 ± 38.8	120.8 ± 62	0.20
Vitamin C (mg)	65.2 ± 55.4	60.8 ± 54.8	0.73
Total dietary fibre (g)	13.05 ± 4.7	11.3 ± 5.2	0.13
Insoluble dietary fibre (g)	9.8 ± 3.6	8.6 ± 4.1	0.16
Soluble dietary fibre (g)	3.2 ± 1.1	2.6 ± 1.2	0.07

p<0.05*, p<0.01**, p<0.001***

TABLE 4.13: PERCENT DISTRIBUTION OF MACRO-NUTRIENTS OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER FROM GENDER PRESPECTIVE (MEAN ± SD)

Macronutrients	Gender	Normal liver (N=21)	NAFLD (N=74)
Carbohydrates (%)	M	55.3 ± 10.9	53.8 ± 5.4
	F	50.2 ± 9.8	51.08 ± 5.3
	P value	0.28	**0.032***
Protein (%)	M	12.5 ± 1.5	11..04 ± 1.2
	F	12.8 ± 1.8	10.9 ± 1.3
	P value	0.69	0.73
Fat (%)	M	30.3 ± 10.4	35.2 ± 5.07
	F	34.1 ± 8.2	34.5 ± 6.2
	P value	0.36	0.067

p<0.05*, p<0.01**, p<0.001***

TABLE 4.14: NUTRIENT INTAKE OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN±SD)

Nutrients	Normal liver (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F value	ANOVA
Energy (kcal)	1444 ± 365	1521 ± 222	1447 ± 164	1560 ± 267	0.79	0.49
Protein (g)	45.8 ± 13.1	41.2 ± 9.7	40.04 ± 7.1	43.6 ± 9.2	2.1	0.09
Fat (g)	51.3 ± 21.1	53.2 ± 13.2	55.7 ± 9.5	56.8 ± 13.4	0.74	0.52
Carbohydrates (g)	190.6 ± 60.5	210.5 ± 43.3	187.4 ± 32	206.9 ± 34.1	1.1	0.32
Crude fibre (g)	6.7 ± 1.9	6.7 ± 1.5	5.1 ± 1.5	6.05 ± 1.82	6.5	**0.0004*** **
Calcium (mg)	731.4 ± 350.7	495.5 ± 215.2	614.8 ± 254	698.1 ± 324.2	1.8	0.14
Phosphorus (mg)	1121.7 ± 295.8	1046.2 ± 264.4	994.1 ± 183.5	1096.2 ± 315.1	1.7	0.16
Iron (mg)	13.5 ± 5.9	13.1 ± 5.3	12.8 ± 5.8	12.3 ± 2.6	0.10	0.95
Vitamin A (µg)	175.2 ± 102	75.4 ± 46.4	117.9 ± 53.2	141 ± 54.6	4.9	**0.003*** **
Vitamin C (mg)	80.7 ± 42.5	89.3 ± 47.8	60.3 ± 57.09	41.8 ± 22.6	1.8	0.13
Sodium (mg)	158.1 ± 48.1	118.8 ± 21.5	122.4 ± 55	105.6 ± 40.7	2.1	0.09
Potassium (mg)	1224.5 ± 300.1	1282.6 ± 336.5	1147.03 ± 285.8	1191.1 ± 316.4	0.80	0.49

$p<0.05$*, $p<0.01$**, $p<0.001$***

TABLE 4.14: NUTRIENT INTAKE OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN±SD)

Nutrients	Normal liver (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F value	ANOVA
Total dietary fibre (g)	12.9 ± 5.2	15.7 ± 4.2	11.6 ± 5.02	10 ± 3.5	2.5	0.06
Insoluble dietary fibre (g)	9.6 ± 4.03	12.01 ± 3.5	8.8 ± 3.9	7.6 ± 2.6	2.3	0.07
Soluble dietary fibre (g)	3.2 ± 1.3	3.7 ± 1.01	2.7 ± 1.1	2.4 ± 0.9	2.9	**0.03***

p<0.05*, p<0.01**, p<0.001***

TABLE 4.15: DIFFERENCE IN NUTRIENT INTAKE OF SUBJECTS WITH NORMAL LIVER AND DIFFERENT GRADE OF HEPATIC STEATOSIS

Categories	Crude fibre	Vitamin A	Soluble fibre
Normal liver vs. Grade 1	0.91	**0.001****	0.31
Normal liver vs. Grade 2	**0.0003*****	**0.037***	0.09
Normal liver vs. Grade 3	0.45	0.40	0.18
Grade 1 vs. Grade 2	**0.0025****	**0.027***	**0.012***
Grade 1 vs. Grade 3	0.39	**0.034***	**0.022***
Grade 2 vs. Grade 3	0.17	0.28	0.56

p<0.05*, p<0.01**, p<0.001***

TABLE 4.16: PERCENT DISTRIBUTION OF MACRONUTRIENTS OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN±SD)

Macro-nutrients	Normal Liver	NAFLD			F value	ANOVA
		Grade 1 steatosis	Grade 2 steatosis	Grade 3 steatosis		
Carbohydrates (%)	52.9 ± 10.4	55.2 ± 6.6	51.9 ± 5.5	53.2 ± 5.3	0.66	0.57
Protein (%)	12.6 ± 1.6	10.7 ± 1.5	11.07 ± 1.2	11.1 ± 0.9	7.6	**0.0001*** **
Fat (%)	32.1 ± 9.4	31.8 ± 7.7	34.5 ± 5.4	32.7 ± 4.9	0.94	0.42

p<0.05*, p<0.01**, p<0.001***

TABLE 4.17: DIFFERENCE IN PROPORTION OF PROTEIN INTAKE OF SUBJECTS WITH NORMAL LIVER AND DIFFERENT GRADE OF HEPATIC STEATOSIS

Categories	P value protein proportion
Normal liver vs. Grade 1	**0.004****
Normal liver vs. Grade 2	**2.5E*****
Normal liver vs. Grade 3	**0.039***
Grade 1 vs. Grade 2	0.49
Grade 1 vs. Grade 3	0.59
Grade 2 vs. Grade 3	0.90

p<0.05*, p<0.01**, p<0.001***

BIOCHEMICAL PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER

Complete Blood Count Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

The TLC counts, neutrophils, lymphocytes, monocytes, eosinophils and basophils, the platelet distribution width, hematocrit and the volume of platelets (MPV), MCV, MCH, total RBC were similar for the NAFLD and normal liver group and were within the normal range (table 4.18). The hemoglobin of the NAFLD group was non-significantly higher than the normal liver group. The MCHC was falling below the reference range for the normal liver group and the NAFLD group and also for both the genders. Moreover, females in the NAFLD group had a significantly lower (31.1 vs. 32%, P 0.008) MCHC than the males of the NAFLD group. The mean RDW-CV value for the NAFLD group and the normal liver group was above the reference range (except for males in the normal liver group) but not statistically significant. The thrombocyte count was within the reference range for both the groups but the males had a significantly lower platelet count than the females in both the groups.

Complete Blood Count Profile of Type 2 Diabetic Patients with Normal Liver and Different Grades of Hepatic Steatosis

The only CBC markers that had a significant variation among the different grades of NAFLD and normal liver, were MCHC (P 0.044) and the PDW (P 0.027). The MCHC mean values were lower than the reference value across all the grades of hepatic steatosis, indicating below normal concentration of hemoglobin in an average erythrocyte. The grade 2 hepatic steatosis mean MCHC (concentration of hemoglobin in an average erythrocyte) was significantly lower (31.7 vs. 32.6%, P 0.006) than the grade 1 hepatic steatosis value. The mean PDW value of all the grades of hepatic steatosis was above the reference range and a steady rise in the mean PDW was observed from grade 1 hepatic steatosis to grade 3 hepatic steatosis. Also, the grade 3 hepatic steatosis mean PDW value was greater than that of the normal liver (16.7 vs. 14.4fL, P 0.003) and grade 2 hepatic steatosis (16.7 vs. 15.9fL, P 0.004) mean PDW value, respectively.

Iron profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

The parameters of iron status, namely, iron, TIBC, transferrin saturation and ferritin were similar and in the normal range in the NAFLD and normal liver group (table 4.19). However, from the gender perspective, the mean serum iron of the females in the NAFLD group was significantly lower (60.5 vs. 82.7mcg/dl, P 0.0003) than the males in the NAFLD group. The transferrin saturation of the females in the NAFLD group was significantly lower (17.2 vs. 23.4%, P 0.0001) than the males. Thus, no association of NAFLD with iron status could be established.

Iron Profile of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

The serum iron, transferrin saturation and ferritin were similar and in the reference range across the different categories of liver status. The only heam profile fraction that was significantly different (P 0.0014) among the various grades of hepatic steatosis was the TIBC with a significant (424.4 vs. 354.3mcg/dl, P 0.02) rise in grade 3 compared to grade 2 hepatic steatosis. Thus, the iron status remained unchanged and within the reference range in different stages of NAFLD.

TABLE 4.18: COMPLETE BLOOD COUNT PROFILE OF TYPE 2 DIABETIC PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Reference range
TLC X 10 raised to 3/microL	7.98 ± 1.82	8.14 ± 1.74	0.71	4.4-11
Neutrophils (%)	58.18 ± 8.52	59.51 ± 7.7	0.49	40-80
Lymphocyte (%)	31.9 ± 5.41	31.5 ± 7.15	0.77	20-40
Monocytes (%)	4.75 ± 2.37	4.3 ± 1.68	0.32	0-10
Eosinophils (%)	4.6 ± 3	4.2 ± 2.63	0.54	0-6
Basophils (%)	0.34 ± 0.16	0.33 ± 0.2	0.73	0-1
Total RBC X10^6/microL	4.59 ± 0.53	4.78 ± 0.48	0.13	3.5-5.9
Hb (g/dl)	12.65 ± 1.5	13.1 ± 1.5	0.22	>12
Hematocrit (%)	39.74 ± 3.78	41.25 ± 4.11	0.13	34.9-56.9
MCV (fL)	87.07 ± 8.03	86.64 ± 9.02	0.91	76-100
MCH (pg)	27.7 ± 3.08	27.45 ± 3.2	0.74	27-33
MCHC (%)	31.56 ± 1.5	31.54 ± 1.5	0.94	33.4-37
RDW CV (fL)	14.62 ± 1.89	14.85 ± 1.49	0.55	11.5-14.5
Platelet Count X 10 raised to 3/microL	261.09 ± 72.68	264.27 ± 67.17	0.85	150-400
PDW (fL)	14.41 ± 1.9	14.76 ± 2	0.47	9.6-15.2
MPV (fL)	9.19 ± 1.18	9.33 ± 1.59	0.69	6.5-12

P<0.05*, P<0.01**, P<0.001***

TABLE 4.19: IRON PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Reference Range
Iron (mcg/dl)	71.23 ± 25.44	70.1 ± 27.61	0.86	60-180
TIBC (mcg/dl)	375.17 ± 57	357.59 ± 47.83	0.15	215-535
Transferrin saturation (%)	19.59 ± 7.73	19.9 ± 7.37	0.86	13-45
Ferritin (ng/ml)	53.73 ± 42.1	65.27 ± 62.13	0.32	10-322

P<0.05*, P<0.01**, P<0.001***

Prevalence of Anaemia among Type 2 Diabetic Patients with NAFLD and Normal Liver

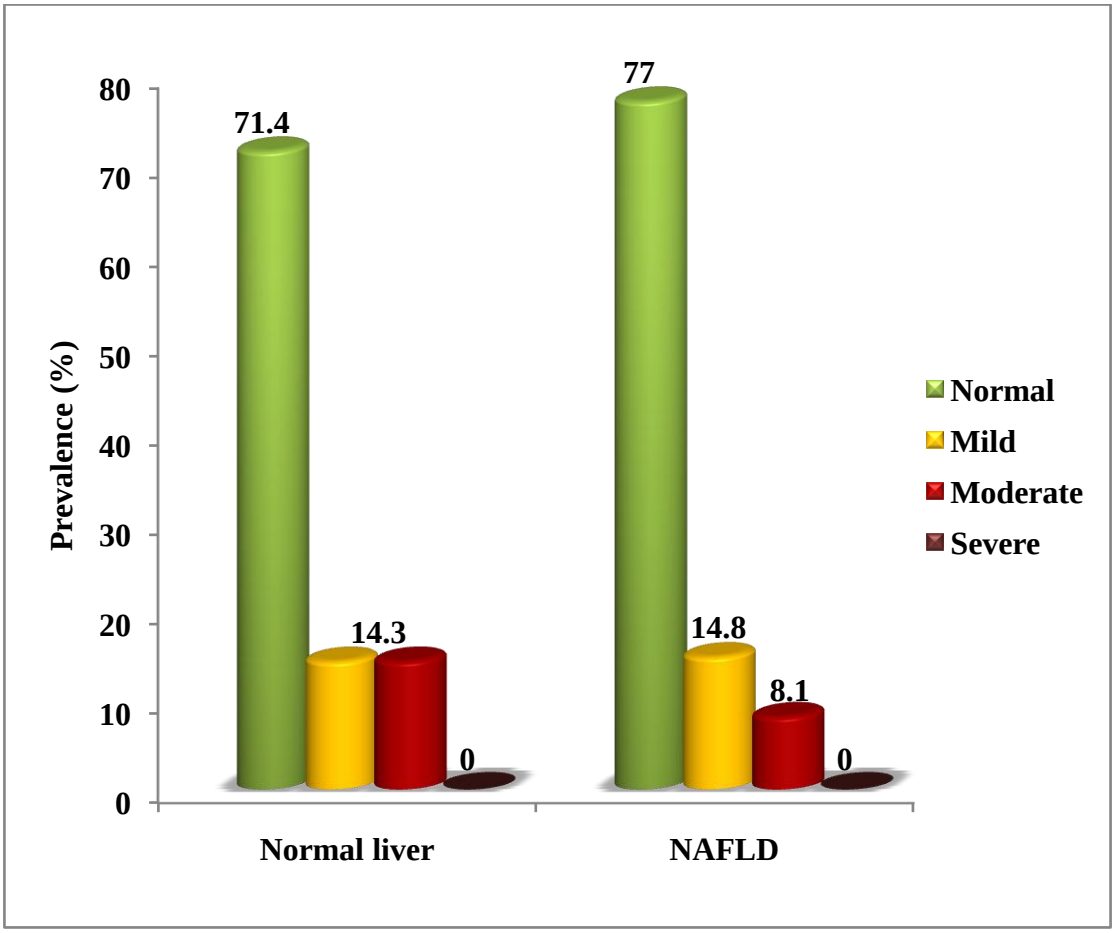
Anemia was more prevalent in the normal liver group (28.6%) as compared to the NAFLD group (22.9%) (fig 4.12). However, anemia was more prevalent among NAFLD females than NAFLD males (33.3% vs. 9.3%, P 0.015). The prevalence of mild anemia was similar for the normal liver group (14.3%) and the NAFLD group (14.8%) and again females in both the groups had a proportionately higher deficiency than the males. The prevalence of moderate anemia was higher in the normal liver group (14.3%) as compared to the NAFLD group (8.1%) and all the moderately anemics were females.

Mild and moderate anemia was similar in normal liver and NAFLD patients. In grade 1 steatosis, only one patient had mild anemia and none had moderate anemia. In grade 2 hepatic steatosis, 17.2% and 10.3% of the patients had mild and moderate anemia, respectively. All the patients in the grade 3 hepatic steatosis had a normal hemoglobin status.

Red Cell Morphology Abnormalities among Type 2 Diabetes Patients with NAFLD and Normal Liver

Majority of the red cell morphological abnormalities were reported in the NAFLD group like; marked anisopoikilocytosis, microcytic hypochromic cells with ovalocytes and elliptocytes, mild anisocytosis, moderate anisocytosis, thrombocytopenia, hypochromic erythrocytes, moderate anisopoikilocytosis, predominantly macrocytic normochromic with macro-ovalocytes and moderate anisocytosis along with mild poikilocytosis, predominant microcytic hypochromic cells with ovalocytes and elliptocytes.

FIG 4.12: PREVALENCE OF ANAEMIA AMONG TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)



Renal Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

The blood urea nitrogen (BUN), creatinine, uric acid were in the normal range for the normal liver group as well as the NAFLD group (table 4.20). Calcium metabolism was not altered as the calcium values were within the reference range in the normal liver group and the NAFLD group. The estimated glomerular filtration rate was non-significantly lower in the hepatic steatosis group of type 2 diabetic patients as compared to the normal liver group. From the gender perspective, creatinine of the males in the NAFLD group (0.81 vs. 0.6mg/dl, P 3.38E) was significantly higher than the females of the NAFLD group, though within the reference range (table 4.21).

The BUN, creatinine, uric acid and the calcium values were within the reference range across all the categories of hepatic steatosis with no major difference between the genders either. Though the mean value of BUN, uric acid and the calcium was the highest in the grade 3 hepatic steatosis, all these values were falling in the reference range and had no statistical increase as compared to the other stages.

More of normal liver type 2 diabetic patients had a normal renal status compared to those with a fatty liver, based on estimated glomerular filtration rate (eGFR) (85.7% vs. 83.8%). Mild chronic kidney disease (CKD) was more prevalent in those with fatty liver compared to those with a normal liver (14.9% vs. 9.5%). However, moderate CKD stage 3A was more evident in the normal liver group vs. the fatty liver group. None of the type 2 diabetic patients had moderate 3B CKD or severe CKD or end stage CKD (fig 4.13).

TABLE 4.20: RENAL PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Reference Range
BUN (mg/dl)	11.58 ± 4.09	10.86 ± 3.27	0.4	7.9-20
Creatinine (mg/dl)	0.7 ± 0.18	0.69 ± 0.18	0.85	0.5-1.1
Uric acid (mg/dl)	5.28 ± 1.33	5.37 ± 1.35	0.78	2.6-7.2
Calcium (mg/dl)	9.62 ± 0.41	9.59 ± 0.33	0.74	8.8-10.6
eGFR (ml/min/1.73m^2)	113.8 ± 28.2	111.8 ± 23	0.73	>90

P<0.05*, P<0.01**, P<0.001***

FIG 4.13: CKD STATUS OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

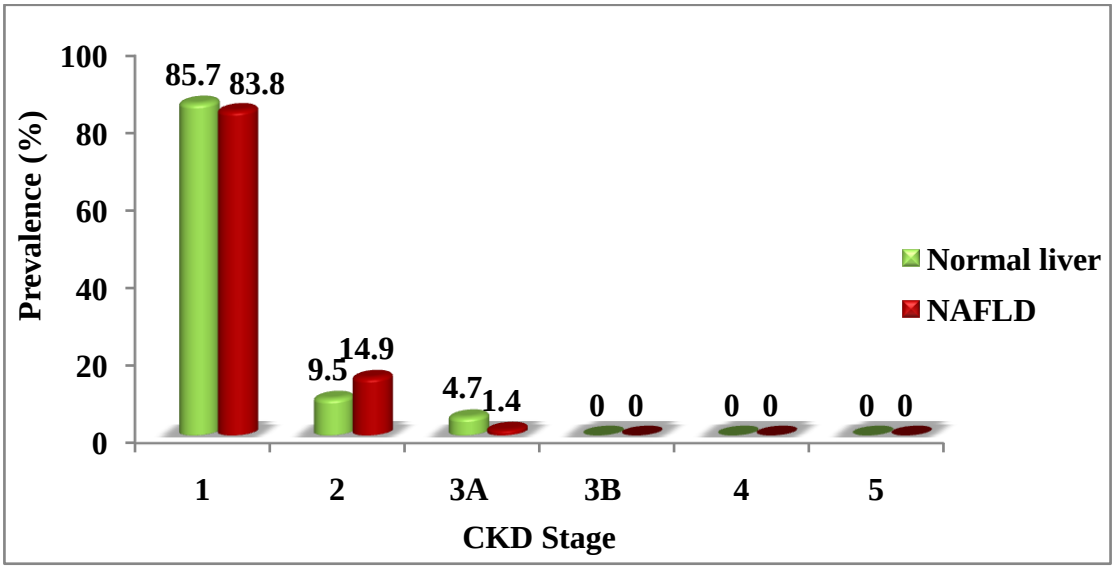


TABLE 4.21: RENAL PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD FROM GENDER PERSPECTIVE (MEAN±SD)

Variables	Males (N=32)	Females (N=42)	P value
BUN (mg/dl)	11.7 ± 3.3	10.2 ± 3.1	0.051
Creatinine (mg/dl)	0.81 ± 0.19	0.6 ± 0.11	**3.38E*** **
Uric acid (mg/dl)	5.6 ± 1	5.1 ± 1.5	0.13
Calcium (mg/dl)	9.6 ± 0.33	9.5 ± 0.34	0.22

P<0.05*, P<0.01**, P<0.001***

Lipid Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

Non-HDL-C (135.9 vs. 119.4mg/dl, P 0.03), non HDL/HDL (3.03 vs. 2.58, P 0.05) and LDL/HDL (2.3 vs. 1.9, P 0.02) were significantly higher in subjects with NAFLD (table 4.22). The TC, LDL-C, triglycerides, TG/H, AIP, VLDL-C, TC/HDL were non-significantly higher in the NAFLD group and HDL-C was non significantly lower than the normal liver group.

From the gender perspective, the females in the NAFLD group had HDL-C below the reference range. But, the mean HDL-C value of the females was higher (49.7 vs. 43.3mg/dl, P 0.004) than the males in the NAFLD group.

Prevalence of Dyslipidemia among Type 2 Diabetes Patients with NAFLD and Normal Liver

Prevalence of dyslipidemia revealed a better picture of the lipid profile aberrations (fig 4.14). Although the prevalence of hypercholesterolemia (32.4% vs. 14.28%, P 0.10), low HDL-C (44.6% vs. 38.09%, P 0.59), LDL-C>100mg/dl (58.1% vs. 38.09%, P 0.10), hypertriglyceridemia (33.8% vs. 23.8%, P 0.38), TC/H>5 (16.2% vs. 9.5%, P 0.72), TG/H>3 (44.6% vs. 28.57%, P 0.19), LDL/HDL>3.5 (6.8% vs. 0%, P 0.58) was higher in subjects with NAFLD than those with normal liver, none of it was significant. However, the prevalence of non-HDL-C>130mg/dl was significantly higher in the NAFLD subjects (56.75% vs. 33.3%, P 0.03).

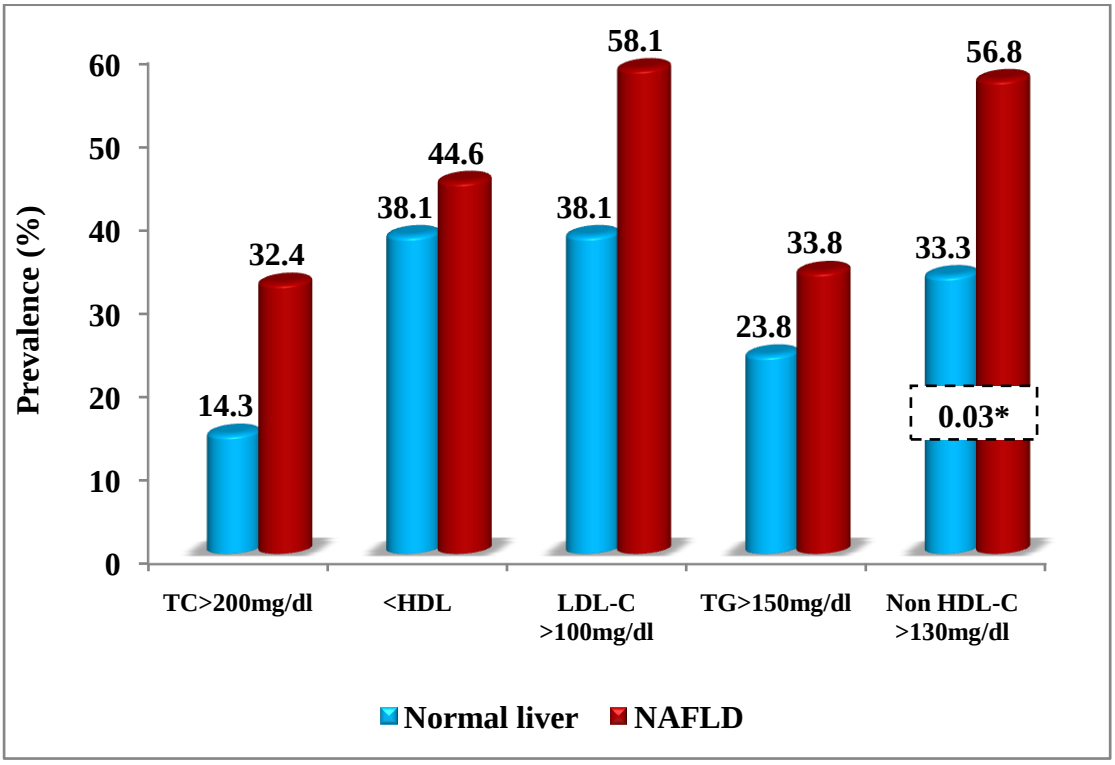
In NAFLD group, non-significantly more females were hypercholesterolemic compared to the males (40.5% vs. 21.9%). More NAFLD cases (44.6%) had lower HDL-C concentration with more females (47.6%) having a lower concentration of HDL-C than the males (40.6%). In the NAFLD group, more males had hypertriglyceridemia than the females, non-significantly (40.6% vs. 28.6%).

TABLE 4.22: LIPID PROFILE AND HS-CRP OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Risk
TC (mg/dl)	168.19 ± 25.83	182.9 ± 42.03	0.053	>200
HDL-C (mg/dl)	48.71 ± 11.28	47 ± 9.9	0.49	<40 F, <50 M
LDL-C (mg/dl)	95.66 ± 24.25	107.51 ± 36.8	0.08	>100
Triglycerides (mg/dl)	119.04 ± 53.1	141.94 ± 69.72	0.11	>150
TG/H	2.6 ± 1.5	3.3 ± 2.3	0.12	>3
VLDL-C (mg/dl)	23.79 ± 10.6	28.38 ± 13.93	0.16	>40
Non-HDL-C (mg/dl)	119.4 ± 25.8	135.9 ± 41.1	**0.03***	>30 mg/dl than LDL-C
Non HDL/HDL	2.58 ± 0.8	3.03 ± 1.17	**0.05***	-
TC/HDL	3.5 ± 0.82	3.9 ± 1.2	0.13	>5
LDL/HDL	1.9 ± 0.6	2.3 ± 0.9	**0.02***	>3.5

P<0.05*, P<0.01**, P<0.001***

FIG 4.14: PREVALENCE OF DYSLIPIDEMIA AMONG TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)



Lipid Profile of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

A steady but non-significant rise was observed in TC, LDL-C, triglycerides, AIP, VLDL-C, TG/HDL, TC/HDL and LDL/HDL from the normal liver to grade 3 hepatic steatosis (table 4.23). Also, the HDL-C non-significantly declined from the stage of normal liver to grade 3 hepatic steatosis. Hepatic grade wise also non HDL-C and non HDL/HDL ratio did not differ significantly.

Prevalence of Dyslipidemia among Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

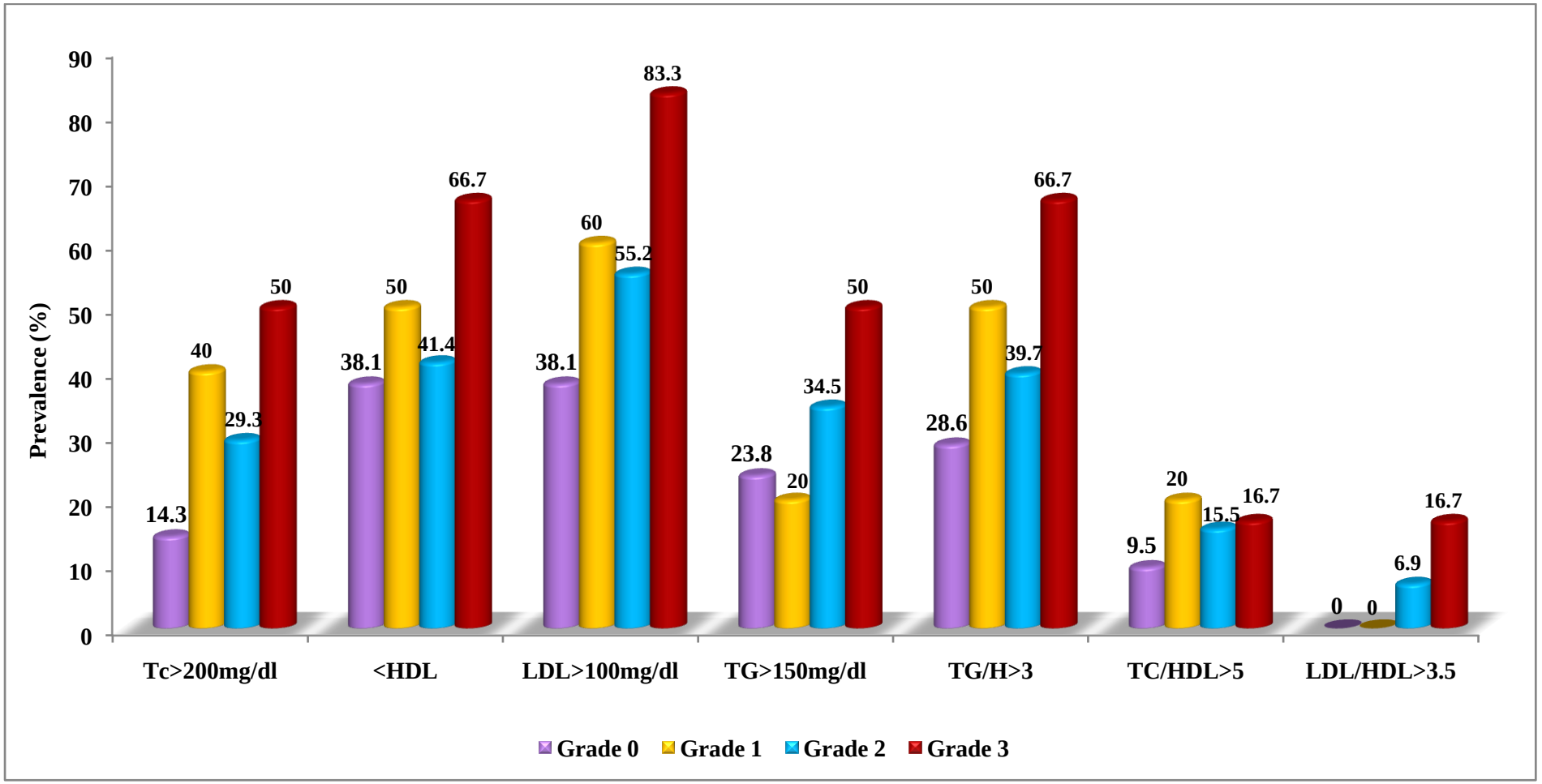
The prevalence of all the lipid fraction aberrations was found to be the highest in grade 3 hepatic steatosis patients (fig 4.15). Hypercholesterolemia was least prevalent in normal liver group (14.3%) and highest (50%) in the grade 3 hepatic steatosis patients. Similarly, prevalence of low HDL-C levels was least in the normal liver group (38.1%) and the highest (66.6%) in the grade 3 hepatic steatosis cases. The atherogenic lipid fraction, LDL-C was elevated in 38.1% of the type 2 diabetes patients with a normal liver and was 83.3% among those with grade 3 hepatic steatosis. Prevalence of hypertriglyceridemia was again the highest in grade 3 hepatic steatosis (50%). The prevalence of elevated TG/H, TC/HDL and LDL/HDL saw an increasing trend from the stage of normal liver onwards.

TABLE 4.23: LIPID PROFILE OF TYPE 2 DIABETIC PATIENTS WITH NORMAL LIVER AND WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD)

Variables	Normal Liver (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F Value	ANOVA
TC (mg/dl)	168.1 ±25.8	185.8 ± 46.7	184.0 ±41.6	201.5 ± 35.3	1.31	0.27
HDL-C (mg/dl)	48.71 ± 11.2	46.7 ± 11.3	46.42 ± 8.2	44.33 ± 6.7	0.3	0.81
LDL-C (mg/dl)	95.66 ± 24.2	114.84 ±42.6	104.42 ±36.1	121.5 ± 24.4	2.7	0.28
Triglycerides (mg/dl)	119.04 ±53.1	121.3 ± 42.6	156.52 ± 75.9	157.5 ± 75.9	1.08	0.35
VLDL – C (mg/dl)	23.7 ± 10.6	24.26 ± 8.5	31.29 ± 15.1	31.49 ± 11.1	1.08	0.35
Non HDL-C (mg/dl)	119.4 ± 25.8	141.1 ± 43.6	134.2 ± 40.6	138.3 ± 42.3	1.07	0.36
Non HDL-C/HDL-C	2.58 ± 0.8	3.1 ± 1.1	2.95 ± 1.2	3.57 ± 0.93	1.4	0.22
TG/H	2.6 ± 1.5	2.9 ± 1.4	3.3 ± 2.5	3.6 ± 2	0.65	0.58
TC/HDL	3.5 ± 0.82	4.1 ± 1.1	3.9 ± 1.1	4.2 ± 0.8	0.92	0.43
LDL/HDL	1.9 ± 0.6	2.4 ± 0.9	2.3 ± 0.9	2.4 ± 0.6	1.1	0.31

P<0.05*, P<0.01**, P<0.001***

FIG 4.15: PREVALENCE OF DYSLIPIDEMIA AMONG TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (%)



Atherogenic Index of Plasma of Type 2 Diabetes Patients with NAFLD and Normal Liver

AIP was non-significantly higher in subjects with NAFLD (0.44 vs. 0.35, P 0.17) (table 4.24). A high risk of atherogenecity was more prevalent in the NAFLD subjects (82.4% vs. 57.1%, P 0.015) and the vice-versa trend was observed in case of intermediate risk which was more prevalent in normal liver (28.6% vs. 8.1%, P 0.013) (fig 4.16). AIP did not vary significantly between normal liver and different grades of hepatic steatosis although it was the highest in grade 3 steatosis wherein 83.3% subjects had high risk of atherogenecity.

Hs-CRP of Type 2 Diabetes Patients with NAFLD and Normal Liver

Hs-CRP (4.8 vs. 2.7mg/l, P 0.017) was significantly higher in NAFLD subjects than the normal liver subjects (table 4.24). Also, the NAFLD females had significantly higher (5.5 vs. 3.8mg/l, P 0.042) hs-CRP than the NAFLD males, though both the values translated into high risk of adverse cardiac events. Majority of the type 2 diabetes patients with a normal liver (38.1%) depicted a low risk of future adverse cardiac events vs. 12.2% in NAFLD (P 0.010) (fig 4.17). About 58.1% NAFLD subjects had hs-CRP>3mg/l vs. 28.5% in the normal liver group (P 0.017). The NAFLD females had a significantly high risk of CVD than the NAFLD males (69% vs. 43.7%, P 0.029).

Hs-CRP of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

The Hs-CRP (P 0.048) increased steadily from the stage of normal liver, reaching peak in grade 2 hepatic steatosis and then had sudden drop in stage 3 of hepatic steatosis (table 4.25). The hs-CRP of grade 2 steatosis subjects was significantly higher from the normal liver subjects (5.98mg/l vs. 2.64mg/l, P 0.012) (table 4.26). As the grades of hepatic steatosis increased, so did the risk of CVD, being about 66.6% in grade 3 hepatic steatosis subjects (fig 4.18).

TABLE 4.24: ATHEROGENIC INDEX OF PLASMA AND Hs-CRP OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN±SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Risk
AIP	0.35 ± 0.24	0.44 ± 0.25	0.17	>0.21
Hs-CRP (mg/l)	2.74 ± 3.23	4.83 ± 3.55	**0.017***	>3

P<0.05*, P<0.01**, P<0.001***

FIG 4.16: ATHEROGENIC INDEX OF PLASMA PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

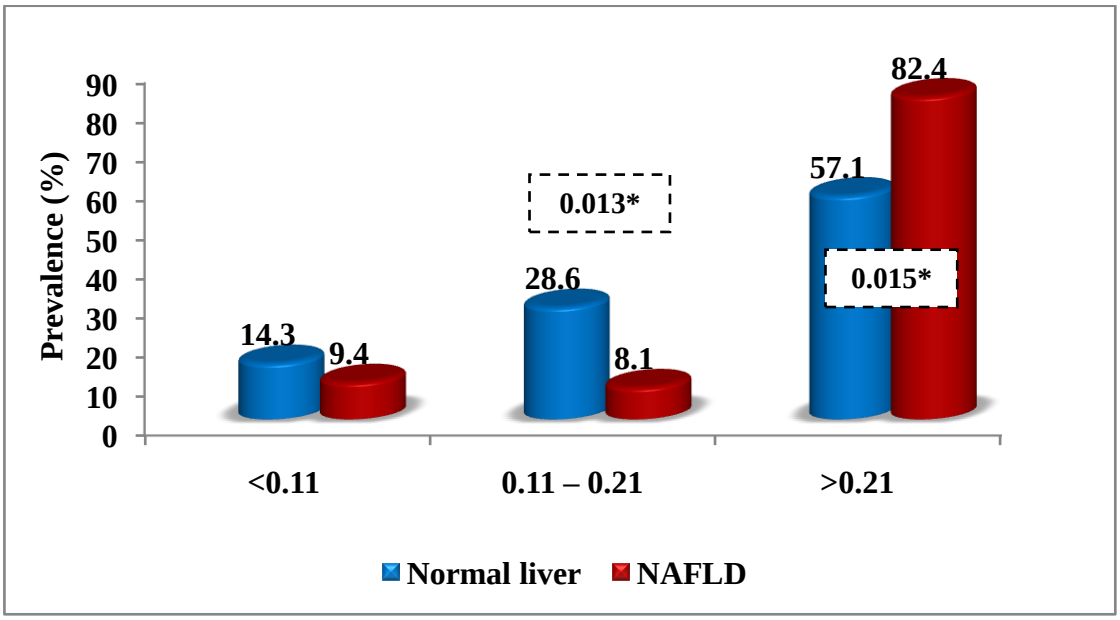


FIG 4.17: Hs-CRP PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

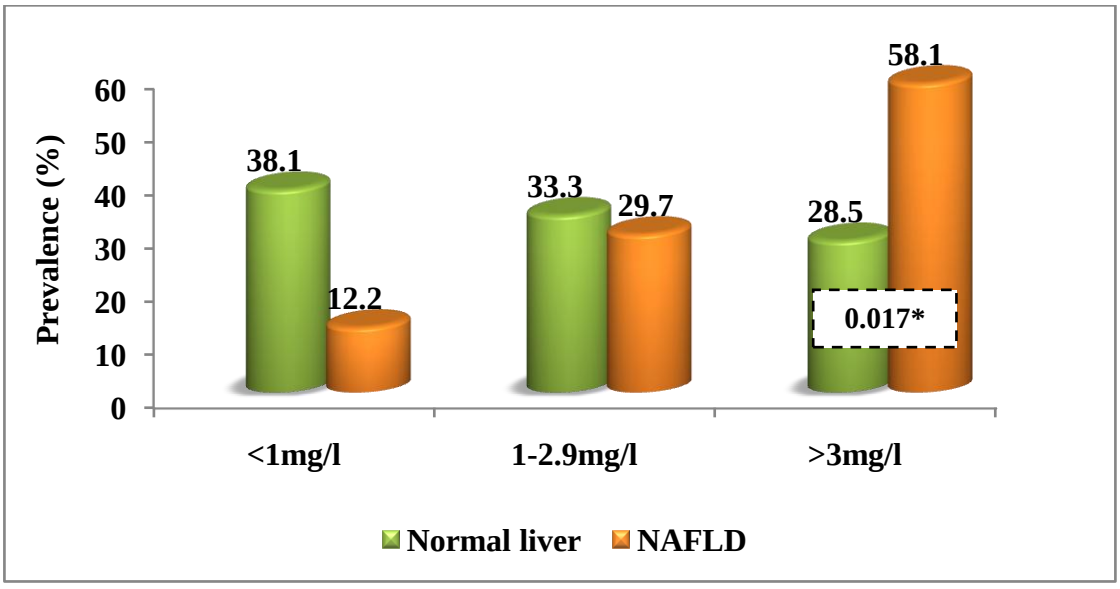


TABLE 4.25: Hs-CRP OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD)

Variable	Normal Liver (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F value	ANOVA
Hs-CRP (mg/l)	2.64 ± 3	4.31 ± 2.9	5.98 ± 3.5	3.39 ± 2.19	2.72	**0.048***

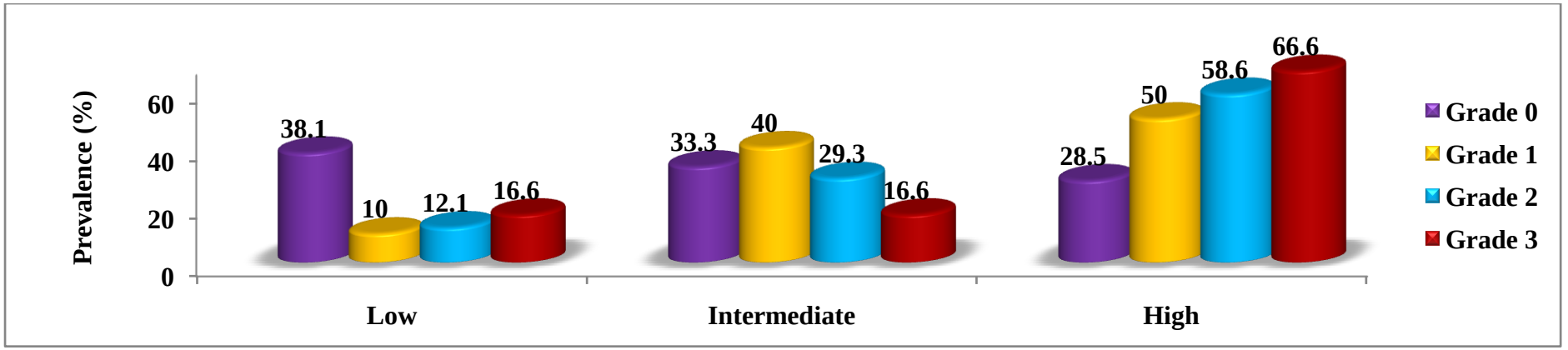
P<0.05*, P<0.01**, P<0.001***

TABLE 4.26: DIFFERENCES IN Hs-CRP ACROSS DIFFERENT HEPATIC STATUS

	NL vs. Grade 1	NL vs. Grade 2	NL vs. Grade 3	Grade 1 vs. Grade 2	Grade 1 vs. Grade 3	Grade 2 vs. Grade 3
Hs-CRP	0.17	**0.012***	0.6	0.54	0.52	0.28

P<0.05*, P<0.01**, P<0.001***

FIG 4.18: Hs-CRP PROFILE OF TYPE 2 DIABETCS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (%)



Hepatic Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

Though within the reference range, the alkaline phosphatase levels of NAFLD subjects was significantly higher (92.7 vs. 73.8U/L, P 0.0008) than the normal liver subjects (table 4.90). However, the alkaline phosphatase of the females in the NAFLD group was above the reference range and also significantly higher (99.1 vs. 84.4U/L, P 0.003) than that of the males (table 4.27). The direct bilirubin, total bilirubin, unconjugated bilirubin, total protein, albumin and SGOT (AST) were within the reference range in the NAFLD group as well as the normal liver group. GGT (30 vs. 21.2U/L, P 0.023) and SGPT (26.3 vs. 19.6U/L, P 0.002) were significantly higher in NAFLD compared to the normal liver group, but, they were in the normal range. No significant differences in GGT were observed between the genders in either of the groups.

Hepatic Profile of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

Alkaline phosphatase (table 4.28), when compared across the various hepatic stages was found to be significantly different (P 0.011). The alkaline phosphatase was significantly elevated in grade 1 hepatic steatosis (93.6 vs. 73.8U/L, P 0.034) and grade 2 hepatic steatosis (89.2 vs. 73.8U/L, P 0.0012) as compared to the value in the normal liver group (table 4.29). Conjugated bilirubin was above the reference range in grade 1 hepatic steatosis, however, it was not significantly elevated as compared to the other categories. The total bilirubin and unconjugated bilirubin were in the normal range across all the categories of liver status with no significant differences. GGT differed significantly (P 0.003) across the various stages of hepatic steatosis and the grade 2 hepatic steatosis (31.7 vs. 21.2U/L, P 0.041) and the grade 3 hepatic steatosis GGT (47.1 vs. 21.2U/L, P 0.006) was significantly higher than that of the normal liver. Also, the GGT in grade 3 hepatic steatosis was above the reference range. A non-significant steady rise within the normal range in SGOT, SGPT, total protein and albumin was observed from normal liver group across all the stages of hepatic steatosis. However, the rise was not statistically significant between any of the stages and the values were also within the reference range.

TABLE 4.27: HEPATIC PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Reference range
Alkaline phosphatase (U/L)	73.86 ± 23.91	92.72 ± 21.59	**0.0008*** **	42-128
Bilirubin direct (mg/dl)	0.18 ± 0.08	0.18 ± 0.05	0.98	0-0.2
Bilirubin total (mg/dl)	0.64 ± 0.34	0.62 ± 0.21	0.77	0.3-1.2
Bilirubin indirect (mg/dl)	0.46 ± 0.27	0.44 ± 0.16	0.73	0-0.9
GGT (U/L)	21.2 ± 13.2	30.04 ± 16.03	**0.023***	0-35
SGOT (U/L)	19.01 ± 6.67	22.73 ± 9.3	0.09	0-37
SGPT (U/L)	19.65 ± 6.39	26.31 ± 13.36	**0.002****	10-40
Total protein (g/dl)	7.3 ± 0.44	7.41 ± 0.44	0.30	6.6-8.3
Albumin (g/dl)	4.23 ± 0.37	4.24 ± 0.29	0.89	3.5-5.2

P<0.05*, P<0.01**, P<0.001***

TABLE 4.28: HEPATIC PROFILE OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD)

Variables	Normal Liver (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F Value	ANOVA	Reference Range
Alkaline phosphatase (U/L)	73.86 ± 23.9	93.67 ± 21.5	89.25 ± 22.8	93.2 ± 29.7	3.89	**0.011***	42-128
Bilirubin direct (mg/dl)	0.18 ± 0.08	0.21 ± 0.03	0.17 ± 0.06	0.19 ± 0.04	0.97	0.4	0-0.2
Bilirubin total (mg/dl)	0.64 ± 0.34	0.79 ± 0.25	0.58 ± 0.2	0.63 ± 0.16	2.01	0.11	0.3-1.2
Bilirubin indirect (mg/dl)	0.46 ± 0.27	0.58 ± 0.23	0.4 ± 0.13	0.44 ± 0.11	2.26	0.08	0-0.9
GGT (U/L)	21.2 ± 13.2	30.43 ± 12.2	31.79 ± 17.3	47.1 ± 33	4.8	**0.003****	0-35
SGOT (U/L)	19.01 ± 6.6	20.2 ± 3.6	23.37 ± 11.7	23.45 ± 5.9	1.27	0.28	0-37
SGPT (U/L)	19.65 ± 6.3	22.74 ± 5.9	25.14 ± 15.6	28.15 ± 7.6	1.96	0.12	10-40
Total protein (g/dl)	7.3 ± 0.44	7.41 ± 0.32	7.65 ± 0.47	7.84 ± 0.35	2.49	0.065	6.6-8.3
Albumin (g/dl)	4.23 ± 0.37	4.31 ± 0.19	4.31 ± 0.26	4.37 ± 0.31	0.63	0.59	3.5-5.2

P<0.05*, P<0.01**, P<0.001***

TABLE 4.29: DIFFERENCES IN AP AND GGT ACROSS DIFFERENT HEPATIC STATUS

	NL vs. Grade 1	NL vs. Grade 2	NL vs. Grade 3	Grade 1 vs. Grade 2	Grade 1 vs. Grade 3	Grade 2 vs. Grade 3
AP	**0.034***	**0.0012****	0.8	0.87	0.97	0.94
GGT	0.074	**0.041***	**0.006****	0.62	0.28	0.22

P<0.05*, P<0.01**, P<0.001***

Thyroid Profile of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

The T3, T4 and TSH were not significantly different between the normal liver group and the NAFLD group and were within the reference range (table 4.30). Prevalence of TSH >5.5 (microIU/ml) was similar in NAFLD and normal liver.

The T3, T4 saw a steady rise from the normal liver group till grade 2 hepatic steatosis and then witnessed a dip in grade 3 hepatic steatosis. But, the rise and the fall were not significant at any stage. Though no statistical differences were observed between any of the categories, the grade 1 hepatic steatosis and grade 3 hepatic steatosis mean TSH values were above the reference range and grade 3 steatosis had the highest TSH abnormality. TSH abnormality was more prevalent in those with grade 3 hepatic steatosis, followed by those with grade 1 hepatic steatosis and was the least in those with grade 2 hepatic steatosis.

Prevalence of Vitamin D Deficiency of Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

High VDD was prevalent among the type 2 diabetes patients with NAFLD, with every three out of four having VDD (75.67%) (table 4.31 and fig 4.19). Also, the 25 OH Vitamin D level of the NAFLD group was falling in the deficient category. However, those with a normal liver were found to be having a higher prevalence (80.95%) of VDD as compared to those with NAFLD. A very meagre proportion of the type 2 diabetics had sufficiency of vitamin D and it was more prevalent among the type 2 diabetics in the NAFLD group.

Sufficiency of vitamin D was the highest in type 2 diabetic patients in grade 3 hepatic steatosis (16.7%). Insufficiency of vitamin D was again, the highest in grade 3 hepatic steatosis (16.7%). VDD was very high across all the stages of hepatic steatosis.

TABLE 4.30: THYROID PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value	Reference range
T3 (ng/dl)	97.76 ± 17.7	103.89 ± 17.92	0.16	60-200
T4 (mcg/dl)	8.78 ± 2.19	9.2 ± 1.95	0.39	4.5-12
TSH (microIU/ml)	4.23 ± 4.66	3.91 ± 3.84	0.77	0.3-5.5
TSH >5.5 (microIU/ml)	3 (14.28)	12 (16.21)	1	

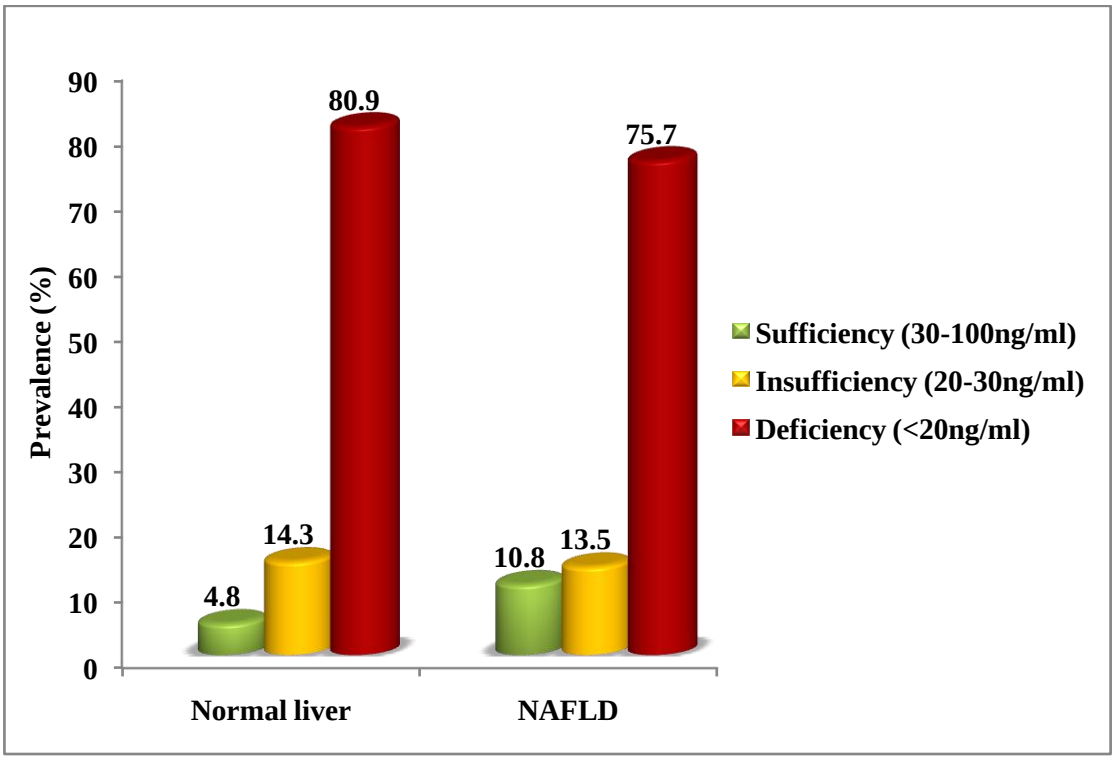
P<0.05*, P<0.01**, P<0.001***

TABLE 4.31: VITAMIN D STATUS OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value
25 OH Vitamin D (ng/ml)	16.56 ± 6.08	17.73 ± 11	0.52

P<0.05*, P<0.01**, P<0.001***

FIG 4.19: PREVALENCE OF VITAMIN D DEFICIENCY IN TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)



Glycemic Profile of Type 2 Diabetes Patients with NAFLD and Normal Liver

The HbA1c of the normal liver subjects, NAFLD subjects, across different grades of hepatic steatosis was suggestive of poor glycemia with no statistical difference between the two groups (table 4.32). HbA1c and average blood glucose was higher among females in the NAFLD group as against males. More normal liver type 2 diabetic patients (9.5%) had excellent glycemic control than the NAFLD patients (1.4%) (fig 4.20). A good glycemic control was observed in more NAFLD patients than the normal liver type 2 diabetic patients. Males were found to be having good glycemic control in comparison to the females in the NAFLD group as well as among type 2 diabetics with a normal liver. An alarmingly high poor glycemic control was prevalent in 61.9% of the type 2 diabetic patients with a normal liver and in 37.8% of the NAFLD cases. More females in the NAFLD group were found to be having poor glycemic control.

Liver Span of Type 2 Diabetes Patients with NAFLD and Normal Liver

The liver span of the type 2 diabetics with NAFLD was not only above the reference range of 160mm for both the genders, but was also significantly higher (168.3 vs. 157.3mm, P 0.019) than that of the normal liver and differed proportionately as 64.9% had a liver span of more than 160mm in the NAFLD group as against 38.1% in the normal liver group (table 4.33).

A steady and significant rise (P 0.007) in the liver span was observed from the normal liver to grade 3 hepatic steatosis (fig. 4.21). The liver span in grade 3 hepatic steatosis was significantly higher from all the other categories; normal liver type 2 diabetics (P 0.0003), grade 1 hepatic steatosis (P 0.045) and grade 2 hepatic steatosis (P 0.029). Also the liver span of grade 2 hepatic steatosis was significantly higher (P 0.032) than that of the mean liver span of type 2 diabetics in the normal liver group (table 4.34).

The prevalence of hepatomegaly increased from 38.90% in normal liver to 60% in grade 1 steatosis, 62.06% in grade 2 steatosis and all the grade 3 subjects had hepatomegaly.

TABLE 4.32: GLYCEMIC PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value
HbA1c (%)	8.38 ± 1.62	8.04 ± 1.6	0.39
ABG (mg/dl)	194.46 ± 50.14	183.88 ± 50.01	0.39

P<0.05*, P<0.01**, P<0.001***

FIG 4.20: HbA1c PROFILE OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

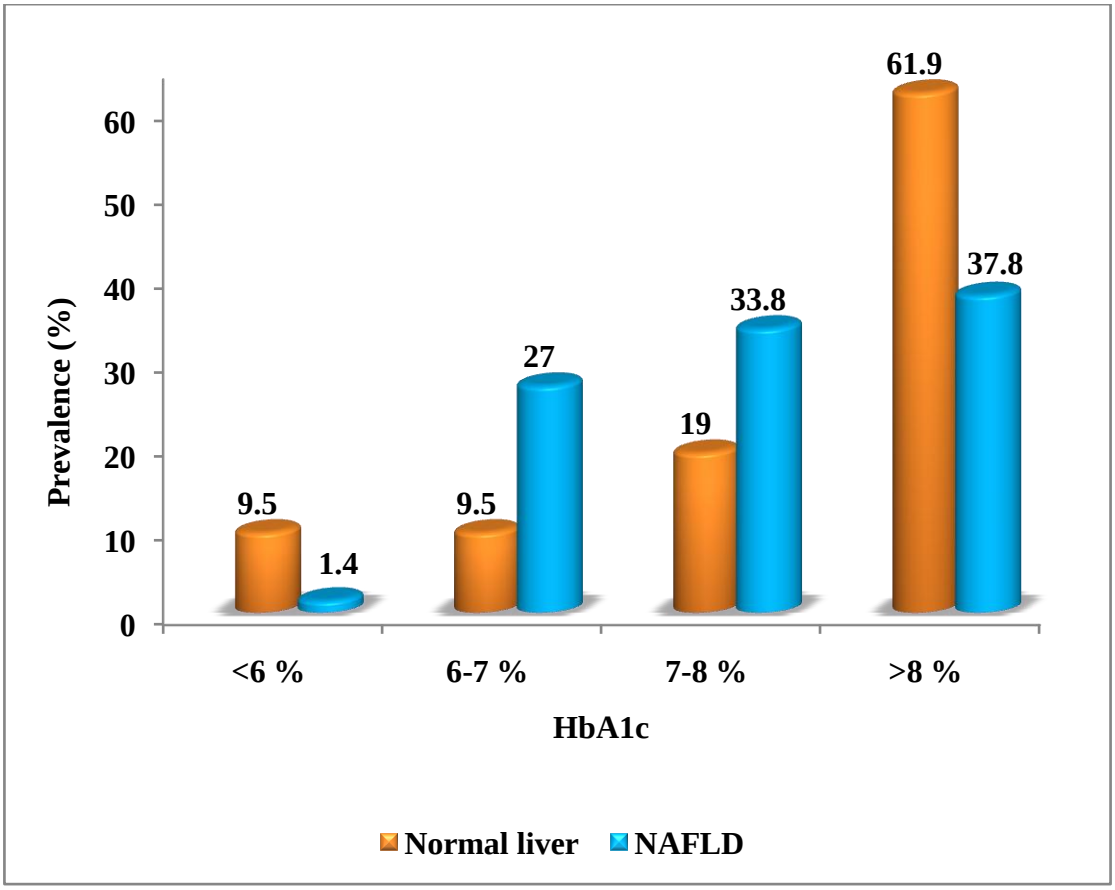


TABLE 4.33: LIVER SPAN OF TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD, N, %)

Variables	Normal Liver (N=21)	NAFLD (N=74)	P value
Liver span (mm)	157.25 ± 15.96	168.29 ± 20.08	**0.019***
Liver span >160mm	8 (38.1)	48 (64.9)	**0.028***

P<0.05*, P<0.01**, P<0.001***, values in parenthesis indicate percentage

FIG. 4.21: LIVER SPAN OF TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD, N, %)

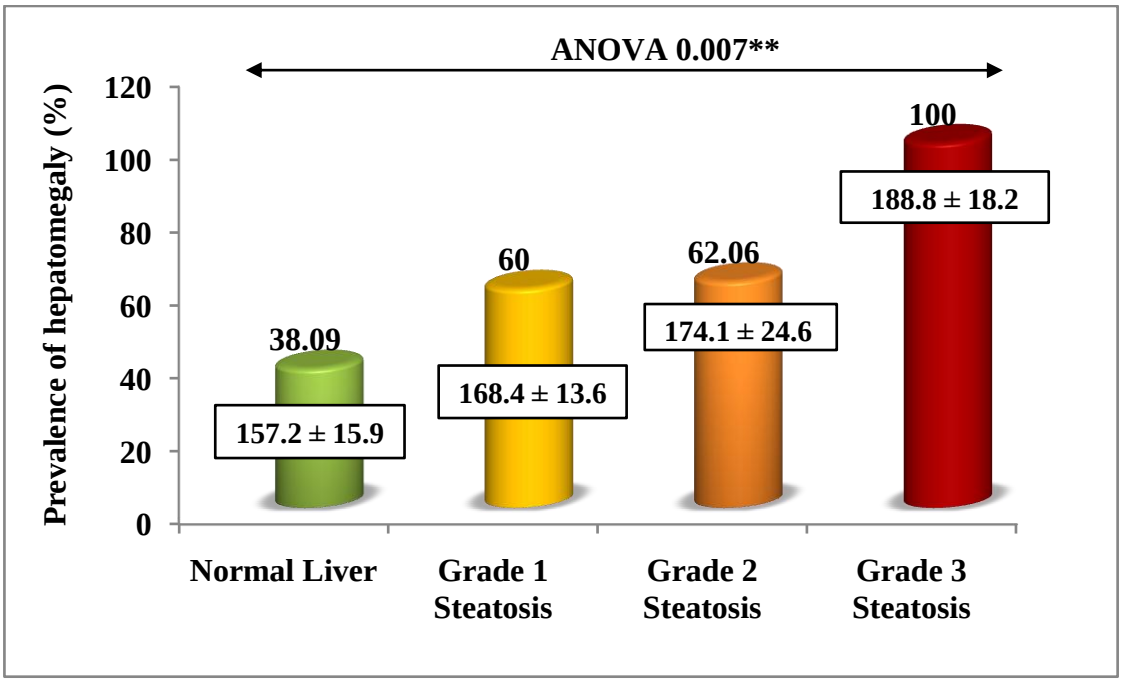


TABLE 4.34: DIFFERENCES IN LIVER SPAN ACROSS HEPATIC STATUS

Groups	P value liver span
Normal liver vs. Grade 1	0.067
Normal liver vs. Grade 2	**0.032***
Normal liver vs. Grade 3	**0.0003*****
Grade 1 vs. Grade 2	0.8
Grade 1 vs. Grade 3	**0.045***
Grade 2 vs. Grade 3	**0.029***

P<0.05*, P<0.01**, P<0.001***

Metabolic Syndrome (IDF) among Type 2 Diabetes Patients with NAFLD and Normal Liver

Elevated blood pressure had similar prevalence among NAFLD and normal liver group. Hypertriglyceridemia or those undergoing specific treatment for the said condition, was more prevalent in the NAFLD subjects (51.35%). Lower HDL-C levels were more prevalent among the NAFLD group. Abdominal obesity was present in epidemic proportions in the NAFLD group (87.3%). Thus, with the presence of abdominal obesity along with two or more risk factors, 72.97% of the NAFLD subjects had MS as against 33.33% prevalence in the normal liver group (P 0.008) (fig 4.22). The ODDs of having a fatty liver was 5.43 times higher in type 2 diabetic men if they have MS (P 0.019, 95% CI; 1.03-53.03). Similarly, type 2 diabetic women are predisposed to having a fatty liver if they are cases of MS (P 0.044, OR: 4.25, 95% CI; 0.8-23.44).

Frequency of Features of Metabolic Syndrome among Type 2 Diabetes Patients with NAFLD and Normal Liver

Lower frequencies of the number of features of MS were more prevalent in normal liver subjects and as the presence of number of features of MS increased, the NAFLD group overtook the normal liver group (table 4.35). It demonstrates that more features of MS were present amongst the NAFLD subjects than those with a normal liver (3.3 vs. 2.7, P 0.036). The NAFLD group marked a higher prevalence of the number of features of MS from the stage of presence of three features of metabolic syndrome.

Association of Metabolic Syndrome with NAFLD in Type 2 Diabetes

Prevalence of NAFLD and grade of hepatic steatosis increased steadily (P 0.023) as the number of features of MS increased, peaked at 94.11% prevalence with 4 features of MS (fig 4.23). Mean grade of hepatic steatosis was significantly higher in those with 3 (1.65 vs. 1.16, P 0.048) and 4 (1.94 vs. 1.16, P 0.006) features of MS compared to those with 2 features of MS, respectively (table 4.36).

FIG 4.22: PREVALENCE OF METABOLIC SYNDROME (IDF) AMONG TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (%)

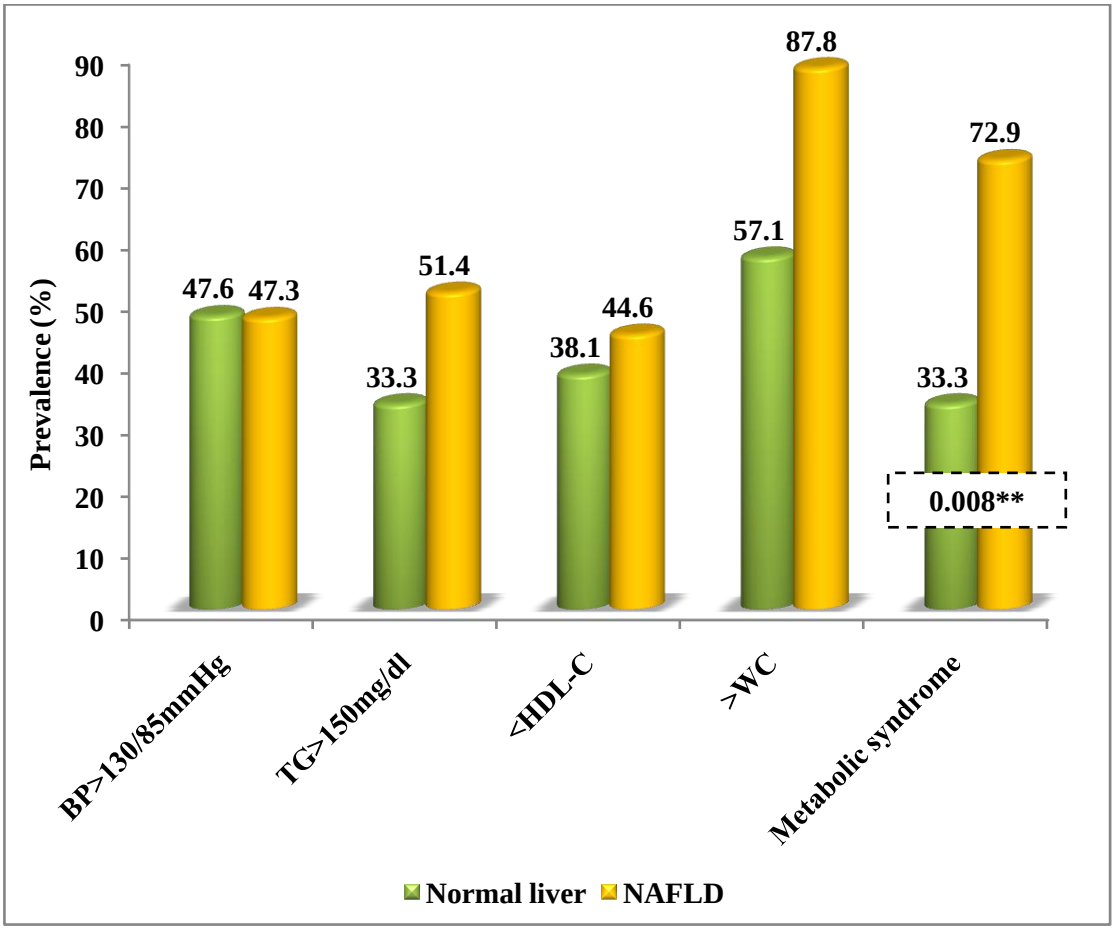


TABLE 4.35: PREVALENCE OF FREQUENCY OF FEATURES OF METABOLIC SYNDROME AMONG TYPE 2 DIABETES PATIENTS WITH NAFLD AND NORMAL LIVER (MEAN ± SD, N, %)

No. of features of metabolic syndrome	Normal Liver (N=21)		NAFLD (N=74)	
	Total N (%)	95% CI	Total N (%)	95% CI
One	2 (9.52)	-3.2-22.3	2 (2.7)	-1-6.4
Two	9 (42.85)	21.2-64.4	15 (20.27)	10.9-29.6
Three	6 (28.57)	8.8-48.2	29 (39.18)	27.8-50.5
Four	1 (4.76)	-4.5-14	16 (21.62)	12-31.1
Five	3 (14.28)	-0.9-29.5	12 (16.21)	7.6-24.7
No. of features*	2.7 ± 1.1		3.3 ± 1.0	

Values in parenthesis indicate percentage, p value = 0.036*

FIG 4.23: ASSOCIATION OF METABOLIC SYNDROME WITH NAFLD IN TYPE 2 DIABETICS (%)

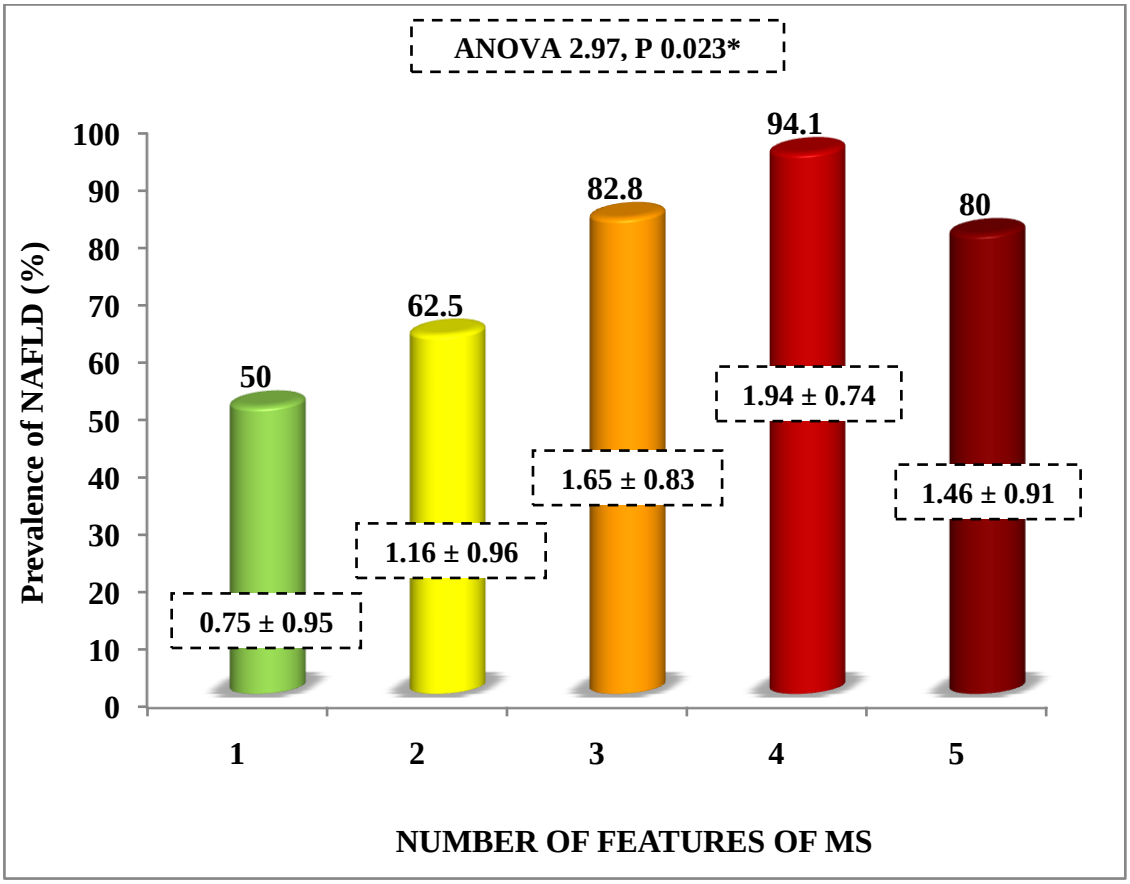


TABLE 4.36: HEPATIC STEATOSIS GRADE BASED ON NUMBER OF FEATURES OF METABOLIC SYNDROME

Categories of frequency of features of MS	P value
One vs. two	0.43
One vs. three	0.14
One vs. four	0.08
One vs. five	0.23
Two vs. three	**0.048***
Two vs. four	**0.006****
Two vs. five	0.33
Three vs. four	0.22
Three vs. five	0.49
Four vs. five	0.12

P<0.05*, P<0.01**, P<0.001***

Prevalence of Metabolic Syndrome (IDF) among Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

Since all had confirmed type 2 diabetes, all of the patients met the criteria of feature of fasting glucose for MS. The highest prevalence of elevated blood pressure was among the patients with grade 3 hepatic steatosis (66.7%). Hypertriglyceridemia or its specific medication was least prevalent in the normal liver subjects (33.33%) and the highest among grade 2 hepatic steatosis patients (51.72%). Lower HDL-C concentrations had the least prevalence in the normal liver group (38.09%) and the highest prevalence in grade 3 hepatic steatosis patients (66.7%). A steady and a sharp rise in the prevalence of abdominal obesity was observed as 57.14% of the normal liver subjects had increased WC and it became 100% in those with grade 3 hepatic steatosis. Similarly, the prevalence of MS saw an escalating trend as 33.33% in the normal liver group, 60% in grade 1 hepatic steatosis, 72.41% in grade 2 hepatic steatosis and all in grade 3 hepatic steatosis had MS (fig 4.24).

Frequency of Features of Metabolic Syndrome among Type 2 Diabetes Patients with Normal Liver and Different Grades of Hepatic Steatosis

A single feature of MS was present in 4.76% of the normal liver subjects, 10% in grade 1 hepatic steatosis, 1.72% in grade 2 hepatic steatosis and none in the grade 3 hepatic steatosis category (table 4.37). Presence of two features of MS was the highest in the normal liver group and in none in the stage of grade 3 hepatic steatosis. Three features of MS were present the least in grade 1 hepatic steatosis and were the highest in grade 2 hepatic steatosis patients. The grade 3 hepatic steatosis patients had the highest proportion of patients with four features of MS (50%) and the least in normal liver group (4.76%). Five features of MS were present in 14.28% of the type 2 diabetic patients having a normal liver, 30% of those with grade 1 hepatic steatosis, 13.79% of grade 2 hepatic steatosis patients and 16.7% of those with grade 3 hepatic steatosis. However, the average number of features of MS differed non-significantly across the various hepatic stages (P 0.09).

FIG 4.24: PREVALENCE OF METABOLIC SYNDROME (IDF) AMONG TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (%)

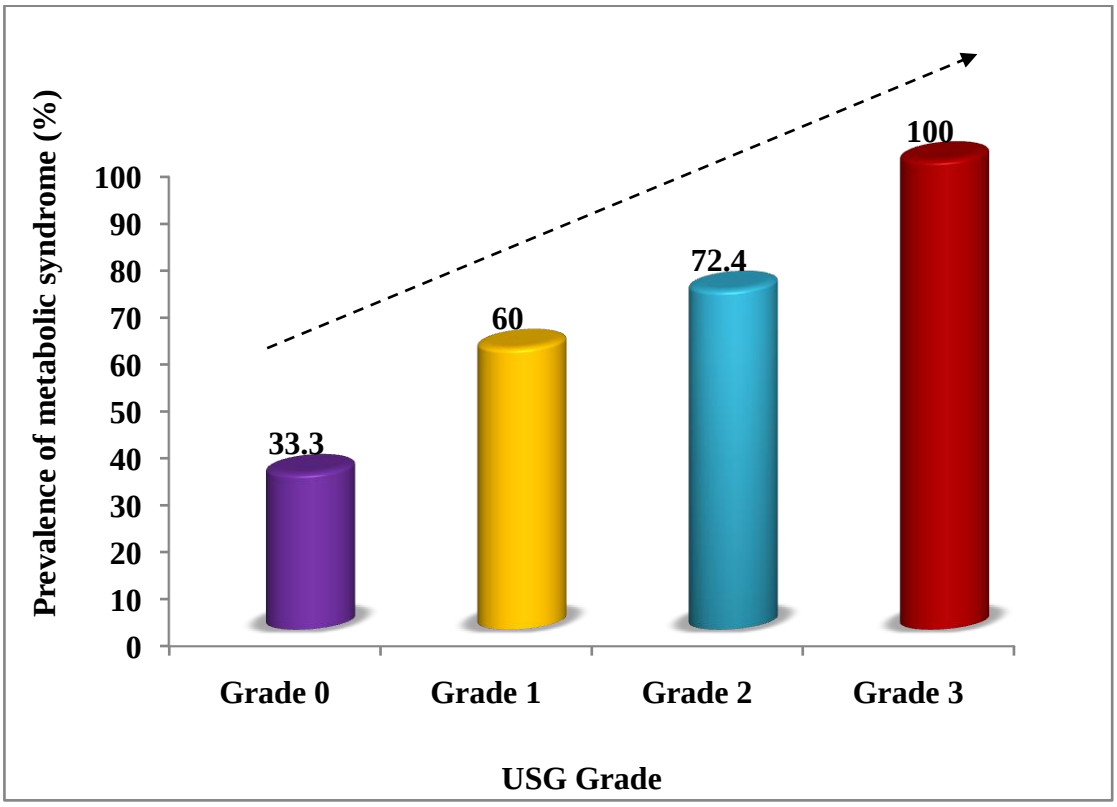


TABLE 4.37: PREVALENCE OF FREQUENCY OF FEATURES OF METABOLIC SYNDROME AMONG TYPE 2 DIABETES PATIENTS WITH NORMAL LIVER AND DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD, N, %)

No. of features MS	NAFLD Absent (N=21)	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
One	1 (4.76)	1 (10)	1 (1.72)	0 (0)
Two	10 (47.61)	2 (20)	13 (22.41)	0 (0)
Three	6 (28.57)	2 (20)	25 (43.1)	2 (33.33)
Four	1 (4.76)	2 (20)	11 (18.96)	3 (50)
Five	3 (14.28)	3 (30)	8 (13.79)	1 (16.66)
Avg.	2.7 ± 1.1	3.4 ± 1.4	3.2 ± 1.0	3.8 ± 0.75

Values in parenthesis indicate percentage, ANOVA = 0.09

Risk Factors for NAFLD in Type 2 Diabetics

GGT was significantly elevated amongst those with NAFLD (28.37% vs. 4.76%, P 0.036) and the ODDs of having NAFLD was 7.92 times higher (CI: 1.01-168.34) among the type 2 diabetics if they had GGT >35U/L (table 4.38).

Abdominal obesity (WC, WSR) was more prevalent in NAFLD subjects (87.83% vs. 57.14%, P 0.0016). The probability of having NAFLD in type 2 diabetic patients was 5.42 times more (CI: 1.57-19.09) if they had abdominal obesity.

NAFLD emerged to be the hepatic expression of the MS among the type 2 diabetic patients in the present study. Those with NAFLD had an alarmingly high prevalence of MS (72.97%) as compared to those with a normal liver (33.33%, P 0.008). MS was a significant risk factor for the development of NAFLD, with a possibility of 5.4 times higher (CI: 1.71-17.54) occurrence if a type 2 diabetic patient had MS.

Cottonseed oil was consumed more by NAFLD patients (45.94%) than those with a normal liver (14.28%) and this difference was significant (P 0.008). Its consumption emerged to be a risk factor for occurrence of NAFLD among type 2 diabetics with an increased probability of 5.1 times (CI: 1.26-23.92) among those incorporating cottonseed oil in cooking practices.

Elevated non-HDL-C was more prevalent among NAFLD patients than those with a normal liver (33.78% vs. 9.52%, P 0.03, CI: 0.96-32.76). The odds of having NAFLD were 4.85 times higher amongst type 2 diabetics who had elevated non HDL-C than those with normal non HDL-C.

Yoga was found to be a protective factor against NAFLD as more normal liver group patients practiced yoga than the NAFLD patients and the probability of having NAFLD was 4.7 times higher amongst type 2 diabetics who did not practice yoga (P 0.0027, CI: 1.4-15.4).

AVI was higher in the type 2 diabetic patients with NAFLD (79.72%) as compared to those who had a normal liver (47.61%, P 0.003) and type 2 diabetics who had an increased AVI, were 4.33 times more prone (CI: 1.38-13.74) to having NAFLD.

Obesity (BMI >25kg/m^2) was significantly higher (P 0.006) in those with NAFLD (74.32%) than those with a normal liver (42.85%). The ODDs of having NAFLD was 3.86 times higher (CI: 1.26-11.99) if a type 2 diabetic patient was a case of obesity.

AIP also emerged as a risk factor for NAFLD among type 2 diabetic patients (P 0.015, CI: 1.09-11.46). More NAFLD patients had high risk of CVD based on AIP as compared to those with a normal liver (82.43% vs. 57.14%). The odds of having NAFLD were 3.52 times higher among type 2 diabetics who had AIP levels above 0.21 compared to type 2 diabetics who had AIP <0.21.

Hs-CRP was significantly elevated (P 0.017) in patients with NAFLD (58.1%) than those with a normal liver (28.57%). Also, the ODDs of having NAFLD was 3.47 times more in type 2 diabetic patients if they have hs-CRP levels above 3mg/l. This depicts the role of cardiac derangement in having a significant contribution in the development and pathogenesis of NAFLD among the type 2 diabetes patients.

Liver span above 160 mm in type 2 diabetic patients was more prevalent among the NAFLD patients (64.86%) than the normal liver patients (38.09%, P 0.028). Type 2 diabetes patients with liver spans above 160mm had 3 times higher probability (CI: 1.0-9.22) of having NAFLD.

TABLE 4.38: RISK FACTOR ASSESSMENT FOR NAFLD AMONG TYPE 2 DIABETES PATIENTS (N, %)

Risk factors	NAFLD Present (N=74)	Normal Liver (N=21)	χ^2	P value	OR	95% CI
FHDM	51 (68.91)	14 (66.66)	0.04	0.84	1.11	0.35-3.46
BMI >25 kg/m^2	55 (74.32)	9 (42.85)	7.29	**0.006****	3.86	1.26-11.99
WC >80cm (f), 90cm (m)	65 (87.83)	12 (57.14)	9.93	**0.0016****	5.42	1.57-19.09
WSR >0.53 (f), >0.55 (m)	65 (87.83)	12 (57.14)	9.93	**0.0016****	5.42	1.57-19.09
AVI >16	59 (79.72)	10 (47.61)	8.4	**0.003****	4.33	1.38-13.74
HbA1c >7%	53 (71.62)	17 (80.95)	0.73	0.39	0.59	0.15-2.2
Cottonseed oil consumption	34 (45.94)	3 (14.28)	6.82	**0.008****	5.1	1.26-23.92
GGT >35U/L	21 (28.37)	1 (4.76)	5.07	**0.036***	7.92	1.01-168.34
AP >125 U/L	19 (25.67)	1 (4.76)	4.26	0.064	6.91	0.87-147.32
TC >200 mg/dl	24 (32.43)	3 (14.28)	2.62	0.105	2.88	0.7-13.66
TG>150 mg/dl	25 (33.78)	5 (23.8)	0.75	0.38	1.63	0.48-5.8
LDL>100 mg/dl	43 (58.1)	9 (42.85)	1.52	0.21	1.85	0.63-5.51
HDL <50 (f), <40 (m)	33 (44.59)	8 (38.09)	0.28	0.59	1.31	0.44-3.96
Hs-CRP >3mg/l	43 (58.1)	6 (28.57)	5.65	**0.017***	3.47	1.09-11.41
Metabolic Syndrome	54 (72.97)	7 (33.33)	11.07	**0.008****	5.4	1.71-17.54
Liver span >160 mm	48 (64.86)	8 (38.09)	4.79	**0.028***	3	1.0-9.22

Figures in parenthesis represent percentage, Chi square significant at P<0.05*, P<0.01**, P<0.001***

TABLE 4.38: RISK FACTORS ASSESSMENT FOR NAFLD AMONG TYPE 2 DIABETES PATIENTS (N, %)

Risk factors	NAFLD Present (N=74)	Normal Liver (N=21)	χ^2	P value	OR	95% CI
Low Physical Activity	42 (56.75)	7 (33.33)	3.56	0.059	2.63	0.86-8.23
Hyperuricemia	5 (6.75)	1 (4.76)	0.11	1	1.45	0.15-34.72
Elevated Non-HDL-C	25 (33.78)	2 (9.52)	4.68	**0.03***	4.85	0.96-32.76
AIP > 0.21	61 (82.43)	12 (57.14)	5.82	**0.015***	3.52	1.09-11.46
No yoga	62 (83.78)	11 (52.38)	8.97	**0.0027****	4.7	1.45-15.47

Figures in parenthesis represent percentage, Chi square significant at P<0.05*, P<0.01**, P<0.001***

Impact of Cottonseed Oil on Health Status of Type 2 Diabetics: The consumption of cottonseed oil by the type 2 diabetics was linked to significantly higher weight (73.9 vs. 68.9kg, P 0.044), WC (99.9 vs. 94.7cm, P 0.032), WSR (0.63 vs. 0.58, P 0.008), BMI (29.5 vs. 26.5kg/m^2, P 0.0019), LDL-C (113.3 vs. 99.3mg/dl, P 0.043), TC/HDL (4.2 vs. 3.6, P 0.015), LDL/HDL (2.59 vs. 2.09, P 0.012), HbA1c (8.5 vs. 7.8%, P 0.050) and liver span (173.7 vs. 161.6mm, P 0.004) (table 4.39). It was a risk factor for NAFLD as 91.8% of those who consumed cottonseed oil had NAFLD (P 0.008; OR: 5.1; CI: 1.2-23.9).

TABLE 4.39: IMPACT OF COTTONSEED OIL ON HEALTH STATUS OF PATIENTS WITH TYPE 2 DIABETES (MEAN ± SD)

Variables	Cottonseed oil consumption		P value
	Yes (N= 37)	No (N= 58)	
Weight (kg)	73.9 ± 12.3	68.9 ± 11.2	**0.044***
WC (cm)	99.9 ± 13.8	94.7 ± 9.7	**0.032***
WSR	0.63 ± 0.09	0.58 ± 0.06	**0.008****
BMI (kg/m^2)	29.5 ± 5.1	26.5 ± 4.05	**0.0019****
SBP (mmHg)	139.6 ± 18.1	135.07 ± 14.8	0.18
DBP (mmHg)	86.2 ± 6.4	85 ± 8.5	0.46
Total cholesterol (mg/dl)	186.8 ± 35.9	174.8 ± 41.1	0.14
Triglycerides (mg/dl)	140.2 ± 73.6	134.6 ± 62.4	0.70
LDL-C (mg/dl)	113.3 ± 29.8	99.28 ± 36.6	**0.043***
HDL-C (mg/dl)	45.4 ± 8.2	48.64 ± 11.1	0.13
Non HDL (mg/dl)	141.3 ± 36.7	126.2 ± 39.2	0.061
Hs-CRP (mg/l)	4.12 ± 3.24	4.54 ± 3.79	0.58
AIP	0.44 ± 0.27	0.41 ± 0.24	0.58
TC/HDL	4.2 ± 1.2	3.6 ± 1	**0.015***
LDL/HDL	2.59 ± 0.86	2.09 ± 0.94	**0.012***
GGT (U/L)	31.76 ± 16.15	25.6 ± 15.2	0.064
Vitamin D (ng/ml)	16.5 ± 7.2	18.08 ± 11.6	0.43
HbA1c (%)	8.5 ± 1.7	7.85 ± 1.46	**0.050***
Liver span (mm)	173.7 ± 20.2	161.6 ± 19.4	**0.004****

p<0.05*, p<0.01**, p<0.001***

Predictors of NAFLD in Type 2 Diabetes Patients

Forward regression analysis was carried out to arrive at the predictor variables for non-alcoholic fatty liver disease among those with type 2 diabetes mellitus. All the variables that were fed into the univariate analysis model were also fed into the regression model with status of liver, either normal or fatty, as the dependent variable (table 4.40). The forward regression yielded metabolic syndrome as the strongest predictor for NAFLD in type 2 diabetics (P .002, OR 5.4, CI: 1.9-15.3). It was followed by GGT emerging as the second most powerful predictor variable for the determination of presence of NAFLD amongst the type 2 diabetic population (P 0.047, OR: 8.6, CI: 1.03-71.7).

TABLE 4.40: FORWARD STEPWISE LOGISTIC REGRESSION FOR DERIVING PREDICTOR VARIABLES FOR NAFLD IN TYPE 2 DIABETES

Variables in the Equation									
Steps		**B**	**S.E.**	**Wald**	**Df**	**Sig.**	**OR**	**95% CI**	
								Lower	**Upper**
Step 1[a]	**MS**	1.686	.532	10.056	1	**.002****	5.400	1.904	15.313
	Constant	.357	.348	1.048	1	.306	1.429		
Step 2[b]	**GGT**	2.153	1.082	3.960	1	**.047***	8.612	1.033	71.794
	MS	1.737	.551	9.943	1	**.002****	5.679	1.929	16.715
	Constant	.031	.380	.007	1	.935	1.031		

a. Variable(s) entered on step 1: MS: Metabolic syndrome

b. Variable(s) entered on step 2: GGT: Gamma glutamyl transaminase

PREDICTORS OF SEVERITY OF HEPATIC STEATOSIS IN TYPE 2 DIABETES PATIENTS WITH NAFLD

To arrive at the independent predictor variables to determine the severity of hepatic steatosis in type 2 diabetic patients, following variables were fed into the forward regression model; age, duration of diabetes, weight, waist circumference, abdominal volume index, waist hip ratio, waist stature ratio, SBP, DBP, consumption of cottonseed oil, total platelet count, hs-CRP, TC, TG, HDL-C, LDL-C, non-HDL-C, SGPT, SGOT, GGT, alkaline phosphatase, albumin, total protein, liver span, HbA1c, vitamin D, uric acid and ferritin as independent variables and grade of fatty liver as the dependent variable. The most powerful predictor of severity of NAFLD in type 2 diabetics was found to be WSR (P 0.002). In the second model, WSR and GGT together defined the severity of NAFLD (P 0.040) (table 4.41, table 4.42 and table 4.43).

TABLE 4.41: FORWARD REGRESSION FOR ARRIVING AT PREDICTOR VARIABLES FOR SEVERITY OF HEPATIC STEATOSIS IN NAFLD IN TYPE 2 DIABETES MELLITUS

Model	R	R^2	Adjusted R^2	SE	Change Statistics				
					R^2 Change	F Change	df1	df2	Sig. F Change
1	.356(a)	.127	.114	.50456	.127	10.436	1	72	**.002****
2	.421(b)	.177	.154	.49318	.051	4.360	1	71	**.040***

a Predictors: (Constant), WSR, b Predictors: (Constant), WSR, GGT

TABLE 4.42: ANOVA OF PREDICTOR VARIABLES FOR SEVERITY OF NAFLD (c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.657	1	2.657	10.436	**.002(a)****
	Residual	18.330	72	.255		
	Total	20.986	73			
2	Regression	3.717	2	1.859	7.642	**.001(b)****
	Residual	17.269	71	.243		
	Total	20.986	73			

a Predictors: (Constant), WSR, b Predictors: (Constant), WSR, GGT, c Dependent Variable: GradeFL

TABLE 4.43: COEFFICIENTS OF PREDICTORS OF SEVERITY OF NAFLD IN TYPE 2 DIABETES (a)

Model		95% Confidence Interval for B	
		Lower bound	Upper Bound
1	(Constant)	-.420	1.446
	WSR	.925	3.908
2	(Constant)	-.490	1.342
	WSR	.715	3.663
	GGT	.000	.015

a Dependent Variable: Grade of fatty liver

PROBABILITY OF ADVANCED NAFLD IN PATIENTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS

The NAFLD Fibrosis Score of Type 2 Diabetes Patients from the Gender Perspective and Different Grades of Hepatic Steatosis

From the gender perspective, there was a non-significant difference in NAFLD fibrosis score from the gender perspective. Males were found to have a lesser probability of fibrosis compared to the females. However, males had a higher intermediate probability of fibrosis compared to the females. The highest probability of fibrosis was observed amongst the females (fig 4.25).

There was a steady increase in NAFLD Fibrosis Score across the different grades of hepatic steatosis, but it was not statistically different. All the grades of hepatic steatosis had their NAFLD Fibrosis Score in the category depicting intermediate probability of having fibrosis. The highest probability of fibrosis was found in grade 3 hepatic steatosis patients (16.7%) and 6.89% in grade 2 hepatic steatosis (fig 4.26). Intermediate probability of fibrosis was prevalent in 66.7% of the patients in grade 3 hepatic steatosis, followed by 60% in grade 1 hepatic steatosis and 41.37% in grade 2 hepatic steatosis.

The FIB-4 Score of Type 2 Diabetes Patients from the Gender Perspective and Different Grades of Hepatic Steatosis

NAFLD males had a non-significantly higher FIB-4 score. Majority of the NAFLD patients had a <1.45 FIB-4 score, depicting probability of early bridging fibrosis. Amongst the 13.68% NAFLD cases who may have had moderate fibrosis, more males had a moderate FIB-4 score than the females. However, the probability of significant fibrosis was found in a single female NAFLD case (fig 4.27).

There was a non-significant rise in FIB-4 score from grade 1 to grade 3 hepatic steatosis. The possibility of early bridging fibrosis was the highest in grade 2 hepatic steatosis. The risk of moderate fibrosis was most evident in patients with grade 3 hepatic steatosis. However, the possibility of significant fibrosis was observed in only a single patient who had grade 2 hepatic steatosis (fig 4.28).

FIG 4.25: NAFLD FIBROSIS SCORE OF TYPE 2 DIABETICS WITH NAFLD FROM THE GENDER PERSPECTIVE (MEAN ± SD, N, %)

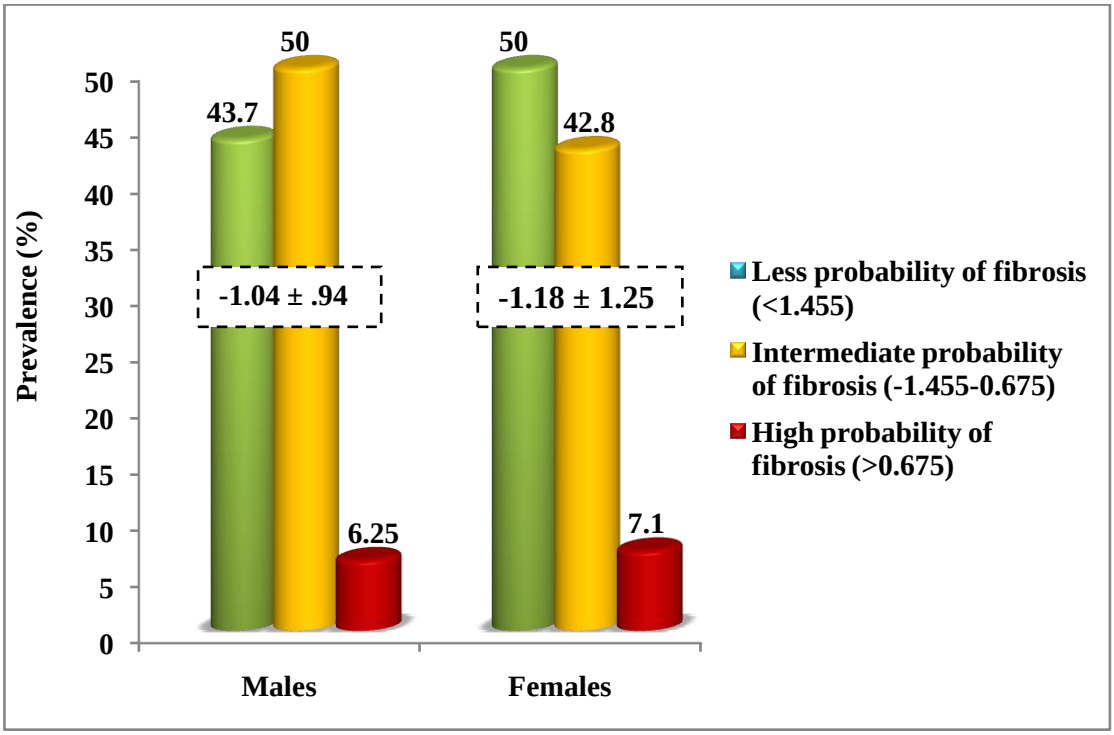


FIG 4.26: NAFLD FIBROSIS SCORE OF TYPE 2 DIABETICS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD, N, %)

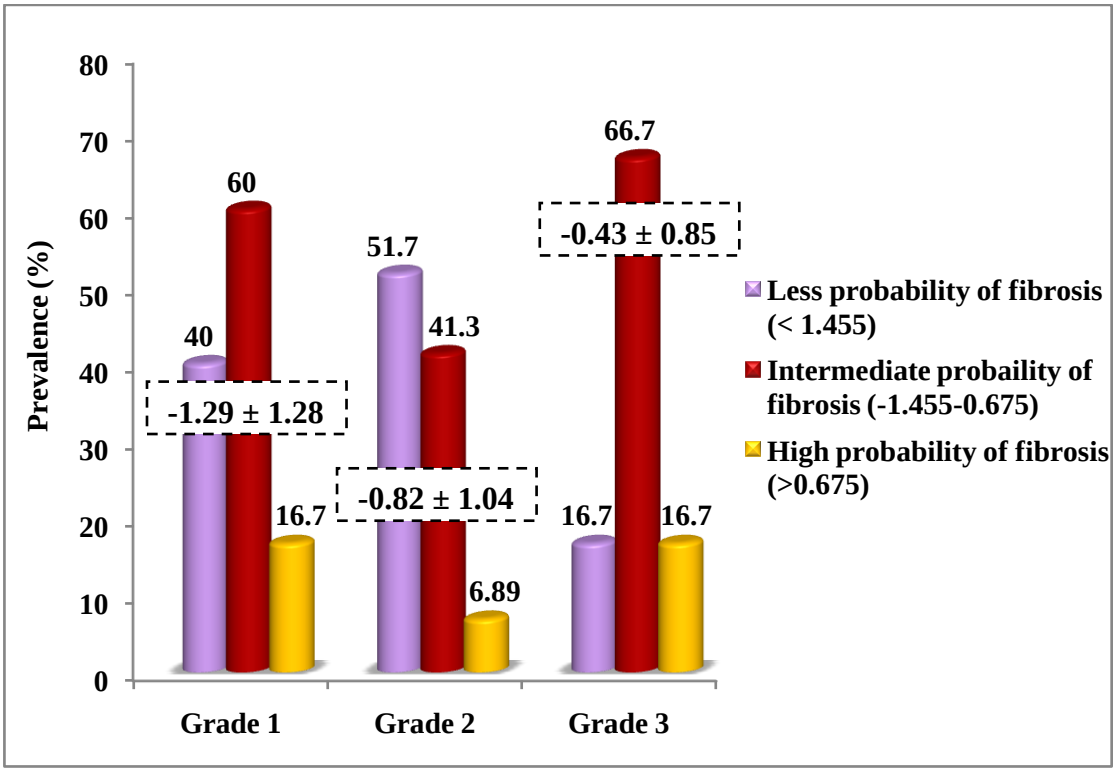


FIG 4.27: FIB-4 SCORE OF NAFLD PATIENTS WITH TYPE 2 DIABETES FROM GENDER PERSPECTIVE (MEAN ± SD, N, %)

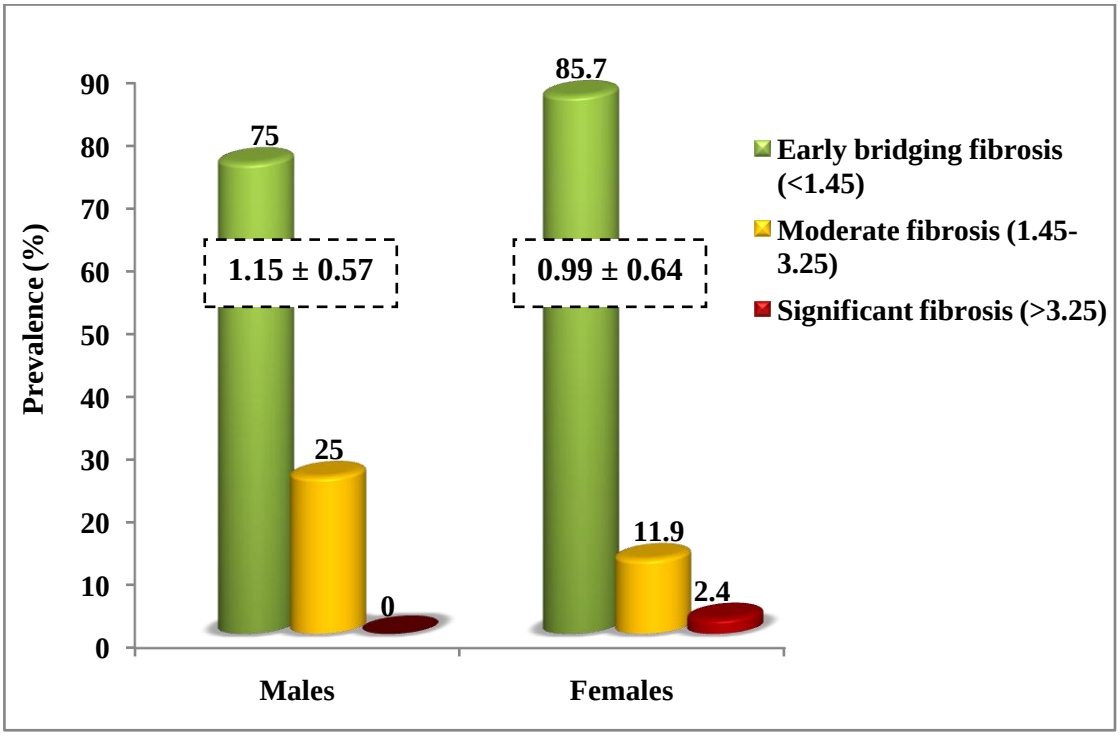
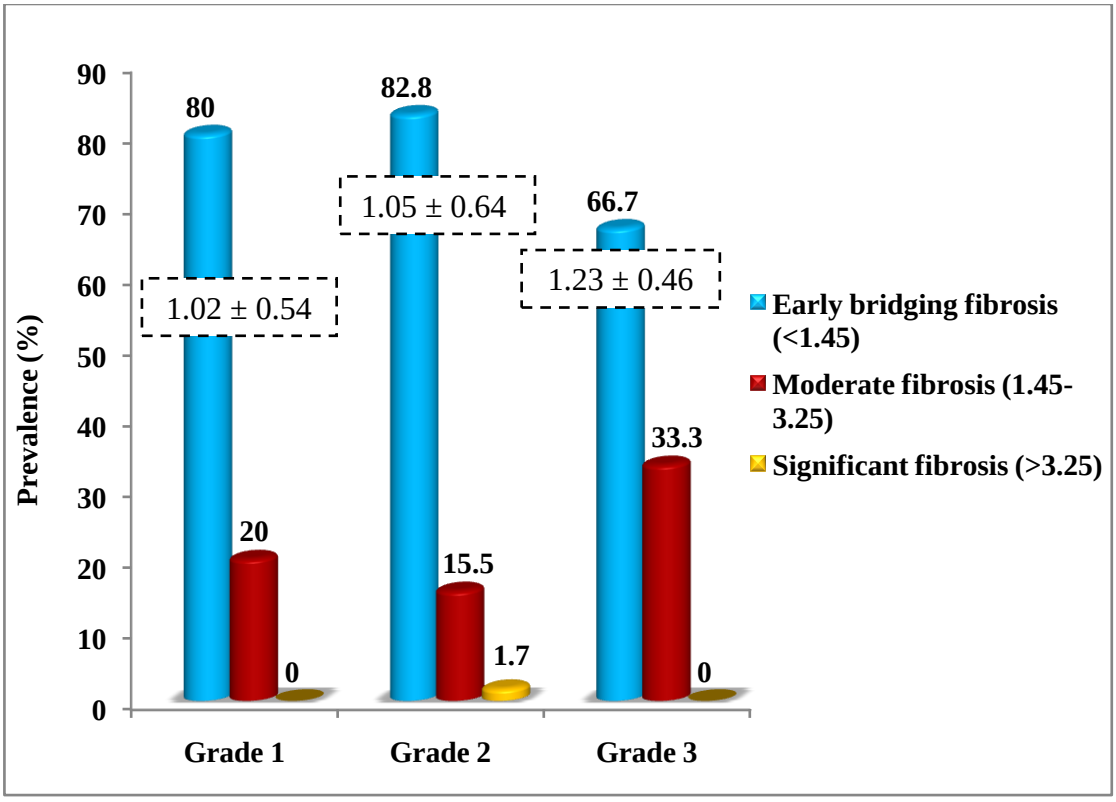


FIG 4.28: FIB-4 SCORE OF TYPE 2 DIABETICS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD, N, %)



DISCUSSION

Background

It is postulated that NAFLD stems from IR, which is a universal phenomenon in those with NAFLD (Bugianesi et al., 2006), be it the obese, non-obese, diabetic or non-diabetic (Caceaune, 2012). Hence, fatty liver is also taken as a marker of IR (Alavian, 2010). NAFLD is also associated with diabetes (Chalasani et al., 2012). The link between the two diseased conditions is corroborated by the presence of IR and that of hyperglycemia (Sattar et al., 2014).

IR gives rise to increased lipolysis that increases the concentration of FFA (Marchesini et al., 1999), which are diverted to the liver (Kim and Younossi, 2008). They are taken up by the hepatocytes as a source of energy (Angulo, 2002). Hence, IR increases the flux of FFA to the liver by decreasing the inhibition of lipolysis and increasing the DNL in the hepatocytes (Utzschneider and Kahn, 2006). This creates a condition of overload of FFA for hepatic mitochondrial β oxidation. Eventually, accumulation of fatty acids occurs in the liver (Angulo, 2002).

Asians develop NAFLD at lower degrees of obesity (Puri and Sanyal, 2012). Of the Asians, the risk of developing NAFLD is higher among those hailing from the Indian subcontinent (Dharel and Fuchs, 2014). The plausible relationship behind this association could be the development of central obesity instead of general obesity, which makes the Asian Indians more susceptible to NAFLD (Sawant et al., 2011). Genetic predisposition to type 2 diabetes makes the possibility of having NAFLD very high in the Indian population (Duseja et al., 2010).

The data on NAFLD has been lacking in the Indian context especially with regard to type 2 diabetics. The cardio-metabolic derangements that occur with this diseased condition and its association with MS require further elucidation. Therefore, the study was planned with the broad objective of mapping the prevalence of NAFLD in type 2 diabetics and identifying the predictor variables. A total of 105 type 2 diabetics were enrolled from a diabetic clinic. Of them, two tested positive for hepatitis B surface antigen and one for hepatitis C antibody, and were excluded. Another seven refused to appear for ultrasound scan citing vague reasons. Hence, the total data was presented for 95 type 2 diabetic individuals who underwent abdominal ultrasound liver scan.

Prevalence of NAFLD in type 2 diabetics

Ultrasound diagnosis revealed the prevalence of NAFLD to be 77.89% (CI 69.4-86.4) in the study population. Needless to say, it reflects significant burden of NAFLD in type 2 diabetics that was unrecognised and undiagnosed so far. Surprisingly, all those who were diagnosed with gallstones during the ultrasound (3.15%), also had fatty liver. This is suggestive of abnormal cholesterol metabolism in NAFLD patients as hepatic cholesterol is rich in PUFA and SFA (Blooomgarden, 2007).

Although it is said that NAFLD affects men and women alike, irrespective of the gender differences in prevalence of risk factors (Dharel and Fuchs, 2014), in the present study females were found to be having marginally higher prevalence of NAFLD. This could possibly be due to the higher prevalence of risk factors for NAFLD among females in the study population. Data on type 2 diabetics with NAFLD in India, has found an equal prevalence in both the genders (Krishnan and Venkataraman, 2011) and male preponderance has also been reported (Agarwal et al., 2011).

Comparing with international data on prevalence of NAFLD in type 2 diabetics, the prevalence in the present study is on the upper side of the prevalence range reported globally. This strongly reflects that the Indian type 2 diabetic population is as much burdened by NAFLD as the other countries are. Infact, the burden seems to be on the higher side compared to 55.8% prevalence that was reported from Iran (Merat et al., 2009), 69.5% from Italy (Targher et al., 2007), 56.9% from Scotland (Williamson et al., 2011) and a 69% prevalence of USG diagnosed NAFLD in type 2 diabetics (Leite et al., 2009). However, the findings are comparable to Valpolicella Heart Study, wherein a cohort of type 2 diabetics free of CVD at baseline, had a 75% prevalence of NAFLD (Targher et al., 2005). In another study with type 2 diabetic patients, a prevalence of 78% NASH was diagnosed based on histology (Leite et al., 2011). In a study using MRS, a 76% prevalence of NAFLD was reported amongst the type 2 diabetics (Chen et al., 2009). The prevalence of NAFLD in the present study is lower than one reported in Iran, wherein 82.9% type 2 diabetics had USG diagnosed NAFLD (Hosseinpanah et al., 2007) and also another study wherein upto 85% type 2 diabetics had histological evidence of NASH (Silverman et al., 1989).

With respect to data on the prevalence of NAFLD in type 2 diabetics in India, the prevalence reported in the present study is again on the higher side of the range. When comparing with data from USG studies conducted in Chennai, wherein 64.7% had NAFLD (Krishnan and Venkataraman, 2011), in Nagpur with 56.6% prevalence of NAFLD (Somalwar and Raut, 2014), in New Delhi with 57.2% NAFLD (Agarwal et al., 2011), in Mumbai with 49% NAFLD (Gupte et al., 2004), the prevalence in the present study is indeed a cause of concern. Though another Indian USG study reported an alarming 88% prevalence of NAFLD in type 2 diabetics, it needs to be kept in mind that it was conducted on those who had been recently diagnosed with type 2 diabetes (Duseja et al., 2004). The histological data in India on NAFLD in type 2 diabetics has revealed 87% prevalence of NAFLD, wherein 62.6% had steatohepatitis and 37.3% had fibrosis (Prashanth et al., 2009). Another study found 40% prevalence of NASH and 23% had advanced disease (Banerjee et al., 2008).

Recent findings report that the prevalence of NAFLD can be upto 70% in those with type 2 diabetes (Chalasani et al., 2012). In the present study, the prevalence is indeed alarming as almost every three out of four type 2 diabetic screened had NAFLD. Not surprisingly, NAFLD was found to be asymptomatic in the study population. Evidence has to it that signs of liver failure become visible only when progression to cirrhosis or HCC occurs (Duseja, 2010). Hence, it calls for making screening of NAFLD mandatory for those with type 2 diabetes. Unfortunately, screening for NAFLD for high risk groups attending primary care clinics has not been advised owing to uncertainties surrounding the diagnostic tests, treatment options and lack of knowledge related to long term benefits and cost effectiveness of screening (Chalasani et al., 2012). However, if diagnosis of NAFLD in type 2 diabetics is presently not paid heed to, the prediction that the future public health costs on management of NAFLD will pose a huge burden (Bhatia et al., 2012), will turn out to be true.

NAFLD and age and duration of diabetes

There was no association of NAFLD with the age and the duration of diabetes in the present study. Similar findings have also been reported from other research works on NAFLD in type 2 diabetics in India (Krishnan and Venkataraman, 2011; Prashanth et al., 2009). In fact, in the present study, the duration of diabetes was non-significantly lower amongst those with NAFLD. Similar findings were obtained from a study done

on type 2 diabetics with and without NAFLD (Trojak et al., 2013). It is postulated that the presence or severity of NAFLD may not be related to the age of the patient but with the duration of NAFLD itself (Vernon et al., 2011).

NAFLD and family history of type 2 diabetes and NAFLD

Though family history of diabetes is implicated to be a risk factor for the development of NAFLD and NASH at any given BMI (Loomba et al., 2012), no association of NAFLD with family history of diabetes could be established in the present study. Similar findings were obtained from a histological study involving diagnosis of NASH in type 2 diabetics (Prashanth et al., 2009). Also, no data was available on family history of NAFLD.

NAFLD with hypertension

No association of NAFLD with hypertension was established even though the NAFLD group had marginally higher prevalence of hypertension in the study. It is reported that that hypertension maybe seen in 70% of the patients with NAFLD (Marchesini et al., 2003). However, in the present study, the prevalence of hypertension in NAFLD was lower (58.1%).

NAFLD with diet

The NAFLD subjects had non-significantly higher intake of energy, fat and carbohydrates than the normal liver subjects. However, the protein intake was non-significantly lower among the NAFLD subjects. The subjects with NAFLD had significantly lower intake of crude fibre that also differed significantly with the hepatic status along with the intake of soluble fibre. Reduced intake of crude and soluble fibre was found in the NAFLD subjects. It is depictive of lower intake of whole grains, fruits and vegetables, which act as a protective factor against NAFLD (Fan and Cao, 2013).

The NAFLD subjects had only 10.9% of the energy coming from protein which was significantly lower from that of the normal liver subjects. Moreover, the grade 1, grade 2 and grade 3 hepatic steatosis subjects had significantly lower proportion of energy from proteins than those with a normal liver. Although there is no evidence to

elucidate the role of dietary proteins in NAFLD, but, protein deficiency is taken to be a risk factor for NASH (Colak et al., 2012), as evidently the NAFLD subjects in the present study had a low protein intake.

Cottonseed oil as a risk factor for NAFLD in type 2 diabetics

Cottonseed oil was the most commonly consumed cooking oil by the study subjects, irrespective of their liver status. It was a risk factor for the occurrence of NAFLD in type 2 diabetics, holding a 5.1 times probability. Though no data is available for comparison, as a prophylactic word of caution it should be advised to type 2 diabetics to avoid consuming cottonseed oil, which comprises of 51.9% PUFAs (more of n-6) and 25.9% SFAs. Eicosanoids from n-6 PUFA are pro-inflammatory and pro-thrombotic (Mouzaki and Allard, 2012) in nature and lead to occurrence of chronic inflammatory diseases (Patterson et al., 2012). Moreover, care needs to be taken as an excess of n-6 PUFA is implicated in the promotion of necro-inflammation (Cortez-Pinto et al., 2006). However, for further extrapolation of the cottonseed oil findings to become a generalisation, it should be subject to more research.

NAFLD and obesity

General obesity and central obesity, which are major risk factors for NAFLD (Chalasani et al., 2012; Finelli and Tarantino, 2012), were rampant in those with NAFLD. Therefore, BMI and WC were established as risk factors for NAFLD in type 2 diabetes, with a 3.86 and 5.42 higher risk of having NAFLD, respectively. This was further corroborated by the presence of significantly higher abdominal fat and subcutaneous abdominal adipose tissue in NAFLD cases. The findings are in tune with the evidence from other studies wherein obesity was established as a risk factor for NAFLD in type 2 diabetics (Trojak et al., 2013; Merat et al., 2009; Williamson et al., 2011; Hosseinpanah et al., 2007; Vishwanathan et al., 2010; Somalwar and Raut, 2014; Agarwal et al., 2011). The danger of progression to fibrosis lurks in these subjects as evidence points that in type 2 diabetics, elevated BMI is a major risk factor for progression to fibrosis (Adams et al., 2005). Elevated BMI in the study subjects could also be indicative of progression and pathogenesis of NASH (Caceaune, 2012; Banerjee et al., 2008).

Though WHR is said to be strongly associated with NAFLD (Chitturi et al., 2002; Marchesini et al., 2001; Rocha et al., 2005; Krishnan and Venkataraman, 2011; Agarwal et al., 2011), in the present study no link could be established between WHR and NAFLD, very similar to the findings reported by Trojak et al., 2013 wherein NAFLD and WHR showed no association with each other.

Talking about grade wise prevalence of obesity; weight, BMI, WC, HC, WSR, AVI were significantly higher across the three stages of hepatic steatosis, reflective of increasing general obesity and abdominal obesity with each grade of steatosis. NAFLD patients with grade 3 steatosis had the worst anthropometric profile. It supports the evidence that there is a linear relationship between an increase in the BMI and an increase in the prevalence of NAFLD, resulting in higher prevalence of NAFLD among those with increasing BMI (Ahmed et al., 2012). Obesity is known to strongly correlate with the prevalence of NAFLD and its severity (Palekar et al., 2006; Luyckx et al., 1998; Park et al., 2007; Marchesini et al., 2001; Ruderman et al., 1998; Singh et al., 2008; Kral et al., 1993), as was also established in the present study. The most powerful predictor of severity of NAFLD in type 2 diabetics was WSR.

Amongst the NAFLD patients with a normal BMI; abdominal obesity, reflected through WC, WSR and AVI were significantly higher than those with the normal liver normal BMI counterparts. It establishes the temporal relationship that visceral fat accumulation leads to IR, which maybe an important pathogenic factor in the development of NAFLD in those with a normal BMI (Chitturi et al., 2002; Pagano et al., 2002).

Studies have supported that NAFLD in type 2 diabetics is linked to visceral obesity (Trojak et al., 2013; Somalwar and Raut, 2014; Agarwal et al., 2011) as was also observed in the present research. This could be because visceral adipocytes are more resistant to insulin (Angulo, 2006). Lipolysis of the visceral adipose tissue due to IR leads to elevated FFA flux into the portal vein for direct transport to the liver, thereby providing an insight into the role of visceral adipocytes in the development of liver fat content (Bjorntorp, 1990). Moreover, liver fat correlates with visceral adiposity (Kotronen et al., 2008; Perseghin et al., 2000). In these NAFLD subjects, the stored hepatic triglycerides may contribute further to visceral fat accumulation (Caceaune, 2012) and the accumulated hepatic fat may lead to hepatic IR (Marchesini et al., 2001;

Marchesini et al., 2003; Marchesini et al., 1999; Petersen and Shulman, 2006), which may pave the way for further progression of NAFLD in them. Moreover, visceral fat accumulation is implicated to be elevated in those with MS and type 2 diabetes (Caceaune, 2012), as was also observed in the present study. Given the high prevalence of central obesity along with diabetes in the subjects with NAFLD, it may also mediate a relationship between NAFLD and CVD (Byrne, 2012).

NAFLD and renal system

Renal profile was similar in NAFLD patients as well as normal liver type 2 diabetic patients, although the eGFR was non-significantly lower in NAFLD. Recent evidence points towards an increased risk and severity of CKD based on the presence and severity of NAFLD (Musso et al., 2014). Care needs to be taken as in type 2 diabetics, NAFLD is independently associated with an increased prevalence of CKD as well as retinopathy (Targher et al., 2008).

The serum creatinine levels amongst those with NAFLD were non-significantly lower than those with a normal liver. Similar results were obtained from a research on type 2 diabetics with and without NAFLD wherein the serum concentrations of creatinine of NAFLD patients were found to be lower than the normal liver patients. The reason behind this could possibly be that NAFLD patients maybe having lower body muscle mass because creatinine strongly correlates with total body muscle mass (Trojak et al., 2013). Creatinine is also dependent on age, gender and renal haemodynamics.

NAFLD and lipid profile, dyslipidemia

None of the lipid fractions emerged as risk factors for NAFLD even though they were more altered in NAFLD cases along with lower HDL-C. Although low HDL-C fraction was more prevalent among NAFLD patients than those with a normal liver and studies have established that low HDL-C is a risk factor for NAFLD in type 2 diabetics (Trojak et al., 2013; Leite et al., 2011; Somalwar and Raut, 2014; Agarwal et al., 2011), the same association could not be established here.

Even though hypercholesterolemia and hypertriglyceridemia were more prevalent in the patients with NAFLD, both didn't emerge as risk factors for developing NAFLD

among type 2 diabetics. The findings are contrary to some of the available evidence that points towards elevated cholesterol and triglycerides levels in type 2 diabetics with NAFLD (Krishnan and Venkataraman, 2011; Somalwar and Raut, 2014). In other studies also, the TC and triglyceride levels were found to be higher among NAFLD patients than the controls (Sathiaraj et al., 2011; Bajaj et al., 2009) and some also report only elevated TG as a risk factor in type 2 diabetics (Merat et al., 2009; Williamson et al., 2011; Leite et al., 2011; Agarwal et al., 2011). However, it was only non-HDL-C fraction that significantly correlated with the presence of NAFLD in type 2 diabetics. Being a surrogate marker of apo B (NCEP ATP III), it is depictive of risk of atherogenicity in these NAFLD subjects. The most common lipid aberration noticed in the NAFLD group was elevated LDL-C, but it was not found to be a risk factor for NAFLD in type 2 diabetics. Evidence points that other than a high TG and low HDL profile of lipids, a LDL-C fraction and lower LDL particle size are being observed in NAFLD patients (DeFilippis et al., 2013).

A possible reason why fasting lipemic status showed no association with NAFLD could be because liver fat content correlates with post prandial lipids (Ahmed et al., 2012). This is intriguing because postprandial hyperlipidemia is also a risk factor for pathogenesis of CVD (Ahmed et al., 2012; Matikainen et al., 2007).

Lipid aberrations were better reflected through lipid ratios as non HDL/HDL and LDL/HDL were significantly higher in the NAFLD patients, depicting the cholesterol carried by potentially pro-atherogenic particles (Tangvarasittichai et al., 2010). The elevated non-HDL/HDL is explanatory of the cardiovascular risk in these diabetic subjects with NAFLD (Hermans et al., 2007). The elevated LDL/HDL is depictive of greater cardiovascular risk owing to the imbalance between the cholesterol carried by atherogenic and protective lipoproteins (Millán et al., 2009). AIP also emerged as a risk factor for NAFLD among type 2 diabetic patients. It is reflective of high risk of atherogenicity in the NAFLD subjects. In female type 2 diabetic NAFLD subjects, it is also indicative of poor glycemic control (Hermans et al., 2012), which is evident from poor HbA1c value of the females in the NAFLD group. In type 2 diabetic NAFLD males, it reflects beta cell function status in addition to cardio-metabolic risk (Hermans et al., 2010).

Dyslipidemia is commonly reported in patients with NAFLD (Chalasani et al., 2012) and is seen along with other features of MS (Chatrath et al., 2012). In India, an average 50% prevalence of dyslipidemia is reported (Duseja et al., 2007; Duseja et al., 2007). In the present study, the prevalence of dyslipidemia in NAFLD subjects was 20.27%, whereas that of hypertriglyceridemia was 33.8% and of low HD-C was 44.6%. When comparing with the evidence available (Day and James, 1998), the prevalence of dyslipidemia and hypertriglyceridemia was low and that of low HDL-C was high. It could be possibly because HDL-C is small, dense and dysfunctional in type 2 diabetics (Mazzone et al., 2008).

In totality, dyslipidemia and lipid profile aberrations were more prevalent in those with a fatty liver; however they didn't differ significantly from those with a normal liver. Grade wise as well, subjects with grade 3 hepatic steatosis had the highest prevalence of non-significant altered lipid profile and dyslipidemia. In a steatotic liver, liver responds to the elevated FFA by enhancing cholesterol ester synthesis, VLDL production, and DNL (Sniderman et al., 2001; Rector et al., 2008). Under such circumstances, dyslipidemia is only going to worsen in the NAFLD subjects.

NAFLD and inflammatory markers; hs-CRP and ferritin

In the present study, hs-CRP was established as a risk factor for type 2 diabetics with NAFLD. Supporting the available evidence that CRP is present in 25% of controls compared to 60% of NAFLD patients (Brea et al., 2005), in the present study, 58.1% of the NAFLD subjects and 28.5% of the normal liver subjects had elevated CRP. Highest risk of CVD was evident among grade 3 hepatic steatosis patients. Hs-CRP is an acute phase protein which is produced by the liver in response to inflammation (Pfützner and Forst, 2006; Bhatia et al., 2012). This depicts that inflammation was significantly present in the type 2 diabetic subjects with NAFLD. This could be because NAFLD patients have significantly higher oxidative stress and inflammation in their system partly due to the already damaged and diseased liver that may cause systemic inflammation (Chalasani et al., 2004; Targher et al., 2006). Further support for role of inflammation comes from studies on NAFLD (Sung et al., 2009) and NASH wherein CRP was found to be elevated (Yoneda et al., 2007; Targher, 2006).

Presence of inflammation in these type 2 subjects with NAFLD will further stimulate IR leading to increased NEFA uptake by the hepatocytes and increased DNL in the liver, triggering an imbalance between DNL and export of VLDL which will further deposit triglycerides in the hepatocytes. This abnormality may cause insulin signalling derangement in the liver (Samuel et al., 2004; Cai et al., 2005) and in the long run predispose these subjects to hepatic IR and CVD (Ahmed et al., 2012), which may manifest in the form of myocardial infarction, stroke, peripheral arterial disease and peripheral vascular disease (Ridker et al., 2001).

Although ferritin has been associated with IR and hepatic inflammation in those with NAFLD (Bugianesi et al., 2004) and is an independent predictor of advanced fibrosis (Kowdley et al., 2012), no association of NAFLD with ferritin was found in the present study, although it was non-significantly higher in those with NAFLD.

NAFLD and the liver enzymes

Though within the reference range, SGPT, GGT and alkaline phosphatase were significantly higher in NAFLD patients than the normal liver type 2 diabetic patients. Although elevated SGPT has been associated with the presence of NAFLD in type 2 diabetics (Krishnan and Venkataraman, 2011; Somalwar and Raut, 2014; Trojak et al., 2013), higher risk of NASH (Leite et al., 2011), and liver fibrosis in NAFLD (Ratziu et al., 2000), it needs to be noted that SGPT cannot be relied upon to make judgements about the presence or absence of NAFLD in those with type 2 diabetes or those having hepatomegaly (Amarapurkar et al., 2004). Hence, relying on ALT as a surrogate marker won't be reliable to either diagnose or stage NAFLD (Perlemuter et al., 2007; Westphal, 2008).

Data suggests that liver enzyme elevations are seen to the tune of 7.8% to 22.9% among those with type 2 diabetes (Harris, 2005). The scenario didn't differ in the present study, as only 14.86% with NAFLD had elevated SGPT and 6.75% had elevated SGOT. Hence, transaminases can be misleading. They can be within the normal range in individuals having NAFLD (Vernon et al., 2011; Chen et al., 2009) and also in advanced disease (Mofrad et al., 2003; Ruhl et al., 2003; Gupte et al., 2004). Thus, normal aminotransferases do not guarantee absence of NAFLD or of advanced liver disease.

Because NAFLD is primarily an asymptomatic disease (Kim and Younossi, 2008) and it may remain so for years (WGO, 2014), its impact remains highly underestimated (Kim and Younossi, 2008). As the type 2 diabetic NAFLD study subjects displayed no symptoms of NAFLD and the transaminases were also in the normal range for most of them, the diagnosis of NAFLD was overlooked in them so far as has also been pointed out by previous studies (Browning et al., 2004; Targher et al., 2007).

The only marker of liver status that emerged to be a risk factor and the second most powerful predictor for NAFLD among type 2 diabetics was GGT. It was significantly elevated amongst those with NAFLD and also increased steadily across the three stages of hepatic steatosis. Elevated GGT is not only a marker of fatty liver but is also indicative of oxidative stress (Gohel and Chacko, 2013; Kotronen et al., 2008; de Alwis and Day, 2008; Targher et al., 2008). As oxidative stress is a known marker for progression of NAFLD (Narasimhan et al., 2010), the subjects with elevated GGT and NAFLD are at an increased risk of developing progressive form of NAFLD. The elevated GGT in these NAFLD subjects may lead to enhanced deposition of fat in the hepatocytes, which will eventually lead to hepatic IR, development of systemic IR and a state of hyperinsulinemia (Marchesini et al., 2001), thereby contributing to progression of NAFLD. It is a vicious cycle as hepatic fat deposition would favour hepatic IR which would favour development of oxidative stress (Fan and Peng, 2007). Those with increased GGT could also be having low but persistent increase in oxidative and other cellular stresses (Gohel and Chacko, 2013).

From the cardiac perspective, NAFLD subjects with elevated GGT are at risk of developing adverse cardiac events as prospective studies implicate GGT for the occurrence of CVD (Jousilahti et al., 2000; Wannamethee et al., 1995) and is associated with the development of atherosclerotic plaques in individuals with NAFLD (McCullough, 2004; Tolman et al., 2004). This may possibly link fatty liver with the development of early atherosclerosis (Kozakova et al., 2012). Thus, elevated GGT aids in NAFLD identification and cardiovascular risk stratification (Haring et al., 2009). There is also a possibility that GGT mediated redox reactions maybe playing a direct role in the pathogenesis of atherogenic dyslipidemia and poor glycemic control, possibly through chronic inflammation and IR, independently of the presence of fatty liver (Dandona et al., 2005) in these subjects.

Elevated GGT levels in the study NAFLD subjects maybe a risk factor for CKD as well, as the presence of the same has also implicated to be independently associated with increased prevalence of CKD (Targher et al., 2010).

NAFLD and vitamin D deficiency

Rampant vitamin D deficiency among NAFLD patients was observed, though normal liver type 2 diabetic patients had a higher prevalence of VDD. Other studies have also found VDD highly prevalent amongst NAFLD patients (Schuppan and Schattenberg, 2013; Targher et al., 2013; Eliades et al., 2013). It is even more detrimental in NAFLD as VDD may have a negative impact on glycemic status (Pittas et al., 2007).

NAFLD and HbA1c

HbA1c was reflective of poor glycemic control in NAFLD and normal liver type 2 diabetic patients. No association of NAFLD with HbA1c was observed. The glycated hemoglobin was similar for both the groups which maybe apparently because further and sequential estimations of glycated hemoglobin maybe required to estimate the effect of poor prolonged periods of glycemic control, the inference of which cant be drawn from a single measurement (Prasanth et al., 2009) and it may highlight a possible association between NAFLD and glycemic control of an indirect nature (Hosseinpanah et al., 2007). Similar results were also obtained from studies on type 2 diabetics with NAFLD wherein HbA1c showed no association with NAFLD (Trojak et al., 2013; Prashanth et al., 2009; Hosseinpanah et al., 2007). However, there is also some evidence that points towards HbA1c as an independent predictor of NAFLD in type 2 diabetes (Williamson et al., 2011; Somalwar and Raut, 2014; Agarwal et al., 2011). Grade 3 hepatic steatosis patients had the worst glycemic status. Despite pharmacological treatment, hyperglycemia was evident in both the groups. It could be possibly due to irregular adherence to drug regime, poor self monitoring of blood glucose, poor exercise and faulty diet. Moreover, since NAFLD is associated with IR even in extra hepatic tissues, achieving a good glycemic control becomes difficult in type 2 diabetics with NAFLD (Byrne, 2012).

Despite pharmacological treatment, hyperglycemia was evident in both the groups. It could be possibly due to irregular adherence to drug regime, poor self monitoring of

blood glucose (data presented on a subset of NAFLD subjects in the KAP section), low physical activity levels and diet.

MS was rampant in those with NAFLD. It could be a possible reason why HbA1c was elevated in the NAFLD subjects, as in those with MS and NAFLD, hepatic IR sets in. It ceases the power of insulin to inhibit glycogenolysis and gluconeogenesis and hence leads to unabated endogenous hepatic glucose production (Rector et al., 2008). Irrespective of the liver status, the subjects in the present study are at a very high risk of CVD owing to a high prevalence of dyslipidemia along with elevated HbA1c (Bodhe et al., 2011).

Type 2 diabetics are resistant to the peripheral action of insulin (Raz et al., 2005). A poor HbA1c level of the NAFLD subjects is a marker of impaired glucose metabolism (Alavian, 2010). The liver is involved in glucose reuptake and glycogenolysis. The condition of IR in the hepatic tissue disturbs the normal glucose metabolism (Alavian, 2010). A deficiency of insulin promotes lipolysis in type 2 diabetics with poor glycemic control. Enhanced lipolysis mobilizes the FFA to the hepatocytes further leading to a favourable environment for triglyceride deposition in the hepatocytes. The damage caused along with inflammation may pave the way for fibrosis and hepatic apoptosis (Sharma et al., 2014). Moreover, in type 2 diabetics, hyperglycemia significantly increases lipid profile, oxidative stress markers and inflammatory mediators in patients with NAFLD and normal liver enzyme profile (Shams et al., 2011). Thus, those with type 2 diabetes and NAFLD have higher hepatic and peripheral IR and poor glycemic control. Eventually they end up having higher HbA1c levels compared to those without NAFLD (Perseghin, 2009).

NAFLD and liver span

Liver span was above the reference range and significantly higher in NAFLD than in those with a normal liver. Similar results were obtained from studies that found elevated liver span in type 2 diabetics with NAFLD (Jayarama and Sudha, 2012; Krishnan and Venkataraman, 2011). More of males had liver span abnormalities than the females in the NAFLD patients. Liver span of grade 3 hepatic steatosis patients was significantly higher than all other categories and had elevated liver span.

NAFLD and Metabolic Syndrome

NAFLD occurs mostly as a result of the impact of MS on the hepatic metabolism (Kneeman et al., 2012), because both have IR as the common pathogenic factor (Marchesini et al., 2001; Kotronen et al., 2007; Bugianesi et al., 2005). Chronic low grade inflammation seen in MS is associated with the development of hepatic steatosis (Diehl, 2001; Diehl, 2004).

Ultrasound diagnosis of NAFLD was strongly associated with the presence of MS, much alike the evidence reported about type 2 diabetics with NAFLD by Hosseinpanah et al., 2007. MS turned out to be the strongest predictor of NAFLD in type 2 diabetics in the present study. Those with MS have 5.4 times higher probability of developing NAFLD. Put simply, three out of four NAFLD subjects had MS vs. one out of three with normal liver had MS. Consequently, higher numbers of features of MS were present in NAFLD subjects. This may predispose the subjects to development of carotid atherosclerosis (Kim et al., 2009). Mean grade of hepatic steatosis increased significantly as the number of features of MS increased and so did the prevalence of NAFLD. The findings are similar to multi-ethnic study of atherosclerosis, wherein risk of NAFLD increased with increasing number of the features of MS (Zeb et al., 2013). The findings are contrary to those reported by Hosseinpanah et al., 2007 wherein the mean grade of steatosis showed a non-significant increase with the addition of each component of MS. However, with the addition of each component of MS, the probability of having NAFLD went up in type 2 diabetics (Hosseinpanah et al., 2007) much alike the finding in the present study. It further supports the evidence that with the addition of each component of MS, the probability of having NAFLD goes up (Caceaune, 2012). A steady rise in prevalence of MS was observed from normal liver to grade 3 hepatic steatosis wherein all the subjects had MS. In another study on type 2 diabetics, all with severe fibrosis had MS (Prashanth et al., 2009).

There is a possibility of hepatic IR setting in the subjects with NAFLD and MS as hepatic IR is taken to be a common factor in both the diseased conditions (Marchesini et al., 2001), it will be detrimental because it will cease the power of insulin to inhibit glycogenolysis and gluconeogenesis and lead to unabated endogenous hepatic glucose production (Rector et al., 2008). Hence, MS also contributes to liver damage in

NAFLD (Diehl, 2001; Diehl, 2004). MS is also associated with oxidative stress and inflammation (Wellen and Hotamisligil, 2005), which can be triangulated by the presence of elevated GGT and hs-CRP, respectively in the subjects with NAFLD. From the cardiac perspective, NAFLD and MS together are lethal because they predict high risk of future CVD events (Ahmed and Byrne, 2007). In totality, in those with NAFLD and MS, the ground is fertile for progressive NAFLD and adverse cardiac events to occur.

It maybe a possibility that many of the subjects with NAFLD may already be having NASH as evidence points towards an increased likelihood of the presence of NASH (Fan and Peng, 2007), especially on liver biopsy amongst those with MS and diabetes (Williams et al., 2011). Those who might not be having NASH as yet, are at a great risk as the presence of MS in NAFLD is a strong predictor of NASH (Vuppalanchi and Chalasani, 2009; Gambino et al., 2011; Marchesini et al., 2003; Kang et al., 2006; Ryan et al., 2005).

To the evidence that NAFLD is the hepatic expression of the MS (Ahmed et al., 2012; Ahmed and Byrne, 2005; Bellentani et al., 2000; Ahmed and Byrne, 2007; Bedogni et al., 2005), findings of the present study state that even the same can be said in context of type 2 diabetes.

MS is said to be prevalent in 60% of females with NAFLD and 30% of males with NAFLD (Caceaune, 2012), whereas in the present study, MS was prevalent in 80.95% of the females with NAFLD and in 62.5% males with NAFLD.

Seeing the association between MS and NAFLD, researches done previously have come up with the recommendation that features of MS in type 2 diabetics could be used for screening of NAFLD (Williamson et al., 2011) and that clinicians should look for NAFLD in type 2 diabetics, more so in the case of presence of MS (Agarwal et al., 2011). However, the findings of the present study call for screening all the type 2 diabetics who have MS along with elevated GGT.

NAFLD and physical activity

Evidence has to it that NAFLD patients are engaged in lesser physical activity than those without NAFLD (Zelber-Sagi et al., 2008). Though low physical activity was

more prevalent amongst the NAFLD group than the normal liver group and they also had significantly lower physical activity profile, it did not turn out to be a risk factor for NAFLD in the present study. However, being more physically active was associated with lesser severe steatosis, which demonstrates findings similar to those reported by Perseghin et al., 2007. Moreover, as the stage of hepatic steatosis increased, the METminutes/week declined. Grade 3 hepatic steatosis patients had the worst physical activity profile supporting the evidence that lower levels of fitness are implicated with increased severity of NAFLD (Krasnoff et al., 2008).

Yoga was found to be a protective factor against NAFLD as more normal liver group patients practiced yoga than the NAFLD patients. While there is an extreme dearth of data to link yoga with NAFLD as a prophylactic measure, evidence comes from a population based study wherein habitual leisure time physical activity was found to play a protective role against NAFLD (Zelber-Sagi et al., 2008).

Hepatic Risk

Type 2 diabetes is associated with more severe and progressive forms of NASH (Dyson et al., 2014; Oprea-Călin et al., 2014) and the study subjects are at an increased risk of developing cirrhosis (Oprea-Călin et al., 2014; Angulo et al., 1999; Younossi et al., 2004). The risk of developing fibrosis and eventual liver complications is also present in these subjects (Neuschwander-Tetri and Caldwell, 2003; Younossi et al., 2004).

In the NAFLD subjects, the steatotic liver is unable to impair further production of endogenous glucose because of the inability of the insulin to do so. Thus, hyperglycemia and hyperinsulinemia may result as a consequence of hepatic triglyceride deposition (Oprea-Călin et al., 2014). Prolonged hyperinsulinemia may predispose them to develop steatohepatitis (Palekar et al., 2006; Ruhl and Everhart, 2004). Moreover, accepting steatosis as a benign state is difficult (Chalasani, 2008) owing to the shorter duration of cohorts and their small sample sizes (Dam-Larsen et al., 2004; Teli et al., 1995). Evidence states that of those with NAFLD, one third may already be having NASH which may eventually progress onto cirrhosis, hepatic failure and HCC (Serfaty and Lemoine, 2008; Pais et al., 2011; Kawai et al., 2011).

The factors that are known to stimulate progression of NAFLD are; presence of diabetes, obesity, hypertension, dyslipidemia (Marchesini and Marzocchi, 2007; Bellentani et al., 2000; Puri and Sanyal, 2012). If observed carefully, when clustered together, they define MS, which along with its features is a risk factor for advanced NAFLD (Pagadala et al., 2009; Puri and Sanyal, 2012). As previously stated, type 2 diabetics with NAFLD in the present study had a very high prevalence of MS. Hence, there is a very likely possibility that those with benign steatosis may progress onto NASH owing to the high prevalence of risk factors.

Since majority of the cases of cryptogenic cirrhosis are found to be diabetic (Maheshwari et al., 2006; Caldwell and Lee, 2008) and NASH related cirrhosis is the second most common cause of age related mortality in type 2 diabetics (Das et al., 2006) the need of the hour is to identify those at high risk. Type 2 diabetes and NASH is also a lethal combination that may predispose an individual to HCC (Bugianesi et al., 2007). Of the type 2 diabetics with NAFLD who were on insulin, they are predisposed to HCC because of risk of severe hyperinsulinemia (Donadon et al., 2008). Thus, a close monitoring of the liver status is required for those with type 2 diabetes and NAFLD (Oprea-Călin et al., 2014).

Amongst the type 2 diabetics, the presence of NAFLD is associated with increase in total mortality independent of the classical risk factors (Soderberg et al., 2010), wherein liver related mortality accounts for 19% of the deaths (Adams et al., 2010). The risk of liver related mortality is about 22 fold (Younossi et al., 2004) much greater than those without diabetes (Rafiq et al., 2009). In this group, hepatic causes of mortality are actually masked by those caused due to CV events (Gaede et al., 2003; Sasaki et al., 1989), which is the leading cause of mortality in them. However, liver failure is also a potent threat that is unrealised and neglected (Bugianesi et al., 2007; Younossi et al., 2004).

Cardiac risk

Irrespective of the other classical risk factors, NAFLD subjects in the present study are at an increased risk of CVD morbidity (Targher et al., 2007; Takeuchi et al., 2012; Targher et al., 2005, Targher et al., 2010) and mortality (Targher et al., 2007; Takeuchi et al., 2012; Targher et al., 2005, Chalasani et al., 2012; Targher et al.,

2010). Even simple steatosis is associated with silent carotid atherosclerosis (Ramilli et al., 2009). Needless to say, occurrence of adverse cardiac events is an imminent danger for the subjects of the present study having NAFLD (Targher et al., 2006). This is because the combination of type 2 diabetes and NAFLD may be linked to increased CVD, independent of the components of MS (Targher et al., 2005; Targher et al., 2007). The presence of NAFLD may also be linked to reduced myocardial perfusion in these subjects, independent of traditional risk factors, visceral fat mass, and insulin sensitivity (Lautamaki et al., 2006). Corroborating that further, NAFLD has also been found to be a surrogate and a fairly reliable marker of CAD in type 2 diabetics, wherein NAFLD was associated with a cluster of traditional coronary risk factors (Agarwal et al., 2011).

Though prospective studies have documented an increased incidence of CVD among the NAFLD patients, it is unclear whether NAFLD is simply a risk factor that coexists in people at high risk of CVD or is an independent risk factor in itself for the occurrence of NAFLD (Ekstedt et al., 2006; Targher et al., 2007; Soderberg et al., 2010; Haring et al., 2009; Adams et al., 2005). However, given the data trends about the congregation of three major risk factors; type 2 diabetes, NAFLD, MS which are partners of the same disease process (Mavrogiannaki and Migdalis, 2013), there is an increased risk of adverse cardiac events related morbidity and mortality in the study subjects.

Advantages and drawbacks of the study

A major advantage of the study was non-reliance on liver enzymes for the diagnosis of NAFLD. Though liver biopsy is the gold standard for the diagnosis and the staging of NAFLD (Noureddin and Loomba, 2012), it has many disadvantages to it because of which it was not used in the present study. It is painful (Castera et al., 1999), invasive in nature and the risk of infection and possibility of biliary leakage runs high (Roldan-Valadez et al., 2008). It requires the patient to undergo atleast 6-8 hours of bed rest (Grant and Neuberger, 1999) because of which the acceptance is low. There is a possibility of bleeding and even a low mortality risk (Ryan et al., 2002), which doesn't warrant for its use in the routine clinical practice (Chalasani et al., 2012). The possibility of sampling error in liver biopsy remains because less than $1/50{,}000^{th}$ of the liver is available for histological analysis (Mehta et al., 2008). It may lead to

misdiagnosis or staging inaccuracies (Ratziu et al., 2005; Merriman et al., 2006) because NAFLD is a patchy disease (Byrne, 2012). The futility of conducting a liver biopsy arises from the fact that there are no established and evidence based guidelines for the treatment of NAFLD (WGO, 2014). Also, the possibility of intra and inter observer variability in the analysis of liver biopsy samples remains as the radiologist may interpret in his or her own way depending on their knowledge and expertise (Kleiner et al., 2005; Younossi et al., 1998). Hence, liver biopsy is not a viable screening tool to diagnose NAFLD even in a clinical setting. With the literature based alarming prevalence of NAFLD in type 2 diabetics, it is not practical to subject an asymptomatic population with normal transaminases to liver biopsy. Moreover, it is equally important to note that the primary approach is not to recommend the patients for liver biopsy on first referral (Farrell, 2003).

Ultrasound was used as a gold standard for diagnosis of NAFLD in the present study because it is recommended as the first line of investigation to diagnose fatty liver (Festi et al., 2013; Ratziu et al., 2010). It is the most preferred and commonly used modality for the diagnosis as it is inexpensive, has no side effects (Roldan-Valadez et al., 2008), is radiation free and non-invasive (Singh et al., 2013). USG has a good sensitivity and specificity in detecting moderate and severe steatosis (Bhatia et al., 2012). Another advantage of the study was that there was no scope of inter-observer bias as the ultrasound was performed by a single radiologist who was blinded to the profile of the subjects. However, a significant disadvantage of the study was that owing to the restricted sensitivity and specificity (Saadeh et al., 2002), a few true positive cases of NAFLD may have been missed out (true negative) and a few false negative cases may have been classified as NAFLD (false positive).

The study also had other significant advantages to it. Cases of type 2 diabetes who confirmed complete abstinence of alcohol were enrolled for the study to be accurate with the non-alcoholic profile of the subjects for the diagnosis of NAFLD. However, possibility of misreporting alcohol consumption remains in a self reported data. Also, type 2 diabetics who tested positive for hepatitis B surface antigen and hepatitis C antibody were excluded from the study. Another advantage of the study was the use of IDF classification for the diagnosis of MS as it has the highest sensitivity for predicting NAFLD (Seo et al., 2012).

Due to the cross sectional nature of the study, a biologically plausible relationship of NAFLD with other variables could not be established, though an attempt was made to identify the predictor variables, wherein the presence of MS emerged as the most powerful predictive variable, followed by GGT. The study also fails to establish the temporal relationship and leaves the question unanswered as to who came first, diabetes or NAFLD. However, it is postulated that the pathogenesis of NAFLD may have started prior to the diagnosis of type 2 diabetes as IR is a common pathogenic factor (Prashanth et al., 2009). There is also a possibility of weakening of the association of specific nutrients in relation to diet (Zelber-Sagi et al., 2011) owing to the flat slope syndrome and recall bias.

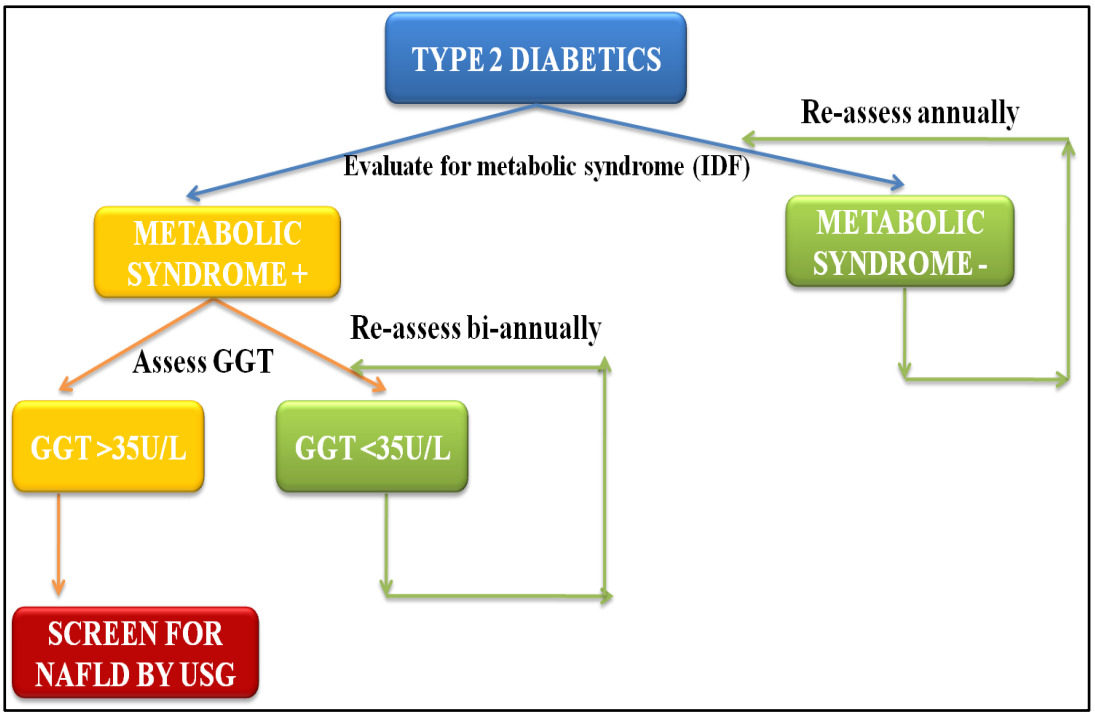
CONCLUSIONS

The prevalence of NAFLD was alarmingly high in the type 2 diabetics. NAFLD subjects had an unfavourable cardio-metabolic profile, lower physical activity status and a close association with metabolic syndrome. WSR was the most powerful predictor of severity of NAFLD in type 2 diabetics.

In terms of diet, NAFLD subjects need to be wary of the consequences of cottonseed oil consumption, enhance protein intake and include as much as fibre possible in the form of whole grains, fruits and vegetables in the diet.

The ADA in 2013 highlighted the relevance of diagnosing NAFLD by recommending that assessment of NAFLD should be incorporated into the routine clinical assessment of diabetic patients so as to implement lifestyle changes and implement pharmaceutical interventions. However, going by the ADA recommendation may not be a practical approach in the Indian set up, which is so hugely burdened by type 2 diabetes. In order to identify those at high risk of NAFLD and its progressive forms, assessment of MS and GGT will help to filter out type 2 diabetics at high risk as shown in the algorithm (fig 4.29). Should the type 2 diabetics be having metabolic syndrome according to the IDF classification, they should be subjected for GGT assessment. If the GGT is >35U/L, these subjects should then be screened for NAFLD by ultrasonography.

FIG 4.29: ALGORITHM FOR SCREENING OF TYPE 2 DIABETICS FOR NAFLD



PHASE I (B): QUALITY OF LIFE OF TYPE 2 DIABETES PATIENTS WITH NON-ALCOHOLIC FATTY LIVER DISEASE

1. ROLE LIMITATION DUE TO PHYSICAL HEALTH

a) Gender Perspective

In the aspect of missing on work due to diabetes, majority of the NAFLD subjects (58.1%) sometimes only missed their work because of their diabetic condition; with more females than the males (61.9 vs. 53.1%) in the said category. About 22.9% of NAFLD subjects never missed their work owing to diabetes and males (37.5%) formed the major chunk (11.9%) (table 4.44).

About 52.7% of the NAFLD subjects found their diabetic regime affecting their work sometimes only; with more males (65.6%) than females (42.8%). Of the 29.7% NAFLD subjects who often found their diabetic regime affecting their work, females formed larger segment than the males (40.5% vs. 15.6%).

About 70.3% of the NAFLD subjects opined that owing to diabetes, their efficiency at work did get affected sometimes; males responding in greater proportion than the females (78.1% vs. 64.3%). However, more females (30.9%) than the males (3.1%) often found their efficiency at work being affected owing to their diabetic condition.

Most of the NAFLD subjects (71.6%) opined that diabetes sometimes did affect their social life with no major difference in perceptions of males and females. A quarter of the males and 14.3% females said that diabetes never affected their social life.

About 66.2% of the NAFLD subjects sometimes avoided travelling due to diabetes, of whom were more females than the males (71.4% vs. 59.4%). More males than the females (34.4% vs. 11.9%) reported never skipping travelling owing to diabetes.

Most of the NAFLD subjects (70.3%) opined that diabetes limited their social activities and more females agreed than the males (80.9% vs. 56.3%). More of the NAFLD males than the females (34.4% vs. 7.1%) had an opinion that diabetes never limited their social activities as compared to others of their age.

b) Different Grades of Hepatic Steatosis Perspective

The highest proportion of NAFLD subjects who never missed on their work belonged to grade 1 hepatic steatosis (30%). Of the NAFLD subjects who sometimes missed on their work owing to diabetes, were 60% grade 1 hepatic steatosis, 58.6% grade 2 hepatic steatosis and 50% grade 3 hepatic steatosis subjects. Half of the grade 3 hepatic steatosis subjects missed on their work on an often basis owing to their diabetic status, followed by a decline to 13.79% in grade 2 hepatic steatosis and 10% in grade 1 hepatic steatosis (table 4.45).

Alarmingly, 66.7% of the grade 3 hepatic steatosis subjects found their diabetic regime to be affecting their work often as against 27.58% in grade 2 hepatic steatosis and 20% in grade 1 hepatic steatosis. Half of the grade 1 hepatic steatosis subjects and 55.2% of the grade 2 hepatic steatosis subjects reported that sticking to the strict diabetic regime sometimes affected their work vs. 33.3% in grade 3 steatosis.

Diabetes affecting the work efficiency of NAFLD subjects was most prevalent among the grade 3 hepatic steatosis subjects (50%), followed by 17.2% in grade 2 hepatic steatosis.

About 20% grade 1 and 20.7% grade 2 hepatic steatosis opined that diabetes never limited their social life. All of the type 2 diabetics with grade 3 hepatic steatosis were of the opinion that diabetes sometimes limited their social life, followed by 80% in grade 1 hepatic steatosis.

All the subjects with grade 1 hepatic steatosis, 60.3% in grade 2 hepatic steatosis and 66.7% in grade 3 hepatic steatosis sometimes avoided travelling because of diabetes. More of the grade 3 hepatic steatosis subjects compared to the grade 2 hepatic steatosis subjects (16.7% vs. 13.8%) often avoided travelling because of diabetes.

About 90% of the grade 1 hepatic steatosis subjects and 63.8% of the grade 2 hepatic steatosis subjects and all the grade 3 hepatic steatosis subjects were of the opinion that diabetes limited their social activities as compared to the others of their age. However, 22.4% of the grade 2 hepatic steatosis subjects and 10% of the grade 1 hepatic steatosis subjects never found diabetes affecting their social activities.

TABLE 4.44: ROLE LIMITATION DUE TO PHYSICAL HEALTH AMONG TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Role Limitation Due To Physical Health	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How often do you miss work because of your diabetes?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	2 (4.8)	2 (2.7)
3	Often	3 (9.4)	9 (21.4)	12 (16.2)
4	Sometimes	17 (53.1)	26 (61.9)	43 (58.1)
5	Never	12 (37.5)	5 (11.9)	17 (22.9)
A person with diabetes has the requirement of adhering to a schedule for eating and taking regular medication. How often does this affect your work?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (2.4)	1 (1.4)
3	Often	5 (15.6)	17 (40.5)	22 (29.7)
4	Sometimes	21 (65.6)	18 (42.9)	39 (52.7)
5	Never	6 (18.8)	6 (14.3)	12 (16.2)
How often does diabetes affect your efficiency at work?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	1 (3.1)	13 (30.9)	14 (18.9)
4	Sometimes	25 (78.1)	27 (64.3)	52 (70.3)
5	Never	6 (18.8)	2 (4.8)	8 (10.8)
How often do you find diabetes limiting your social life?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	1 (3.1)	6 (14.3)	7 (16.7)
4	Sometimes	23 (71.9)	30 (71.4)	53 (71.6)
5	Never	8 (25)	6 (14.3)	14 (18.9)

Values in parenthesis indicate percentage

TABLE 4.44: ROLE LIMITATION DUE TO PHYSICAL HEALTH AMONG TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Role Limitation Due To Physical Health	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
To what extent do you avoid travelling because of your diabetes?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	2 (6.3)	7 (16.7)	9 (12.2)
4	Sometimes	19 (59.4)	30 (71.4)	49 (66.2)
5	Never	11 (34.4)	5 (11.9)	16 (21.6)
Compared to others of your age are your social activities limited because of your diabetes?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (2.4)	1 (1.4)
3	Often	3 (9.4)	4 (9.5)	7 (9.5)
4	Sometimes	18 (56.3)	34 (80.9)	52 (70.3)
5	Never	11 (34.4)	3 (7.1)	14 (18.9)

Values in parenthesis indicate percentage

TABLE 4.45: ROLE LIMITATION DUE TO PHYSICAL HEALTH AMONG TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Role Limitation Due To Physical Health	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
How often do you miss work because of your diabetes?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	2 (3.4)	0 (0)
3	Often	1 (10)	8 (13.8)	3 (50)
4	Sometimes	6 (60)	34 (58.6)	3 (50)
5	Never	3 (30)	14 (24.1)	0 (0)
A person with diabetes has the requirement of adhering to a schedule for eating and taking regular medication. How often does this affect your work?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (1.7)	0 (0)
3	Often	2 (20)	16 (27.6)	4 (66.7)
4	Sometimes	5 (50)	32 (55.2)	2 (33.3)
5	Never	3 (30)	9 (15.5)	0 (0)
How often does diabetes affect your efficiency at work?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	1 (10)	10 (17.2)	3 (50)
4	Sometimes	8 (80)	41 (70.7)	3 (50)
5	Never	1 (10)	7 (12.1)	0 (0)
How often do you find diabetes limiting your social life?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	0 (0)	7 (12.1)	0 (0)
4	Sometimes	8 (80)	39 (67.2)	6 (100)
5	Never	2 (20)	12 (20.7)	0 (0)

Values in parenthesis indicate percentage

TABLE 4.45: ROLE LIMITATION DUE TO PHYSICAL HEALTH AMONG TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Role Limitation Due To Physical Health	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
To what extent do you avoid travelling because of your diabetes?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	0 (0)	8 (13.8)	1 (16.7)
4	Sometimes	10 (100)	35 (60.3)	4 (66.7)
5	Never	0 (0)	15 (25.9)	1 (16.7)
Compared to others of your age are your social activities limited because of your diabetes?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (1.7)	0 (0)
3	Often	0 (0)	7 (12.1)	0 (0)
4	Sometimes	9 (90)	37 (63.8)	6 (100)
5	Never	1 (10)	13 (22.4)	0 (0)

Values in parenthesis indicate percentage

2. PHYSICAL ENDURANCE

a) Gender Perspective

Vigorous activities were better tolerated by the males than the females (table 4.46). Of the 35.1% of the NAFLD subjects who reported that their vigorous activities were limited frequently owing to their overall health problems, more females agreed with this than the males (38.1% vs. 31.3%). Vigorous activities getting affected sometimes only owing to overall health problems' was cited more by the males than the females (46.9% vs. 4.8%).

Moderate activities were better tolerated than the vigorous activities but, males scored better than the females. A majority of 59.5% of the NAFLD subjects found their moderate activities being limited sometimes only with females higher in proportion than the males (69.1% vs. 46.9%). Half of the males and 11.9% of the females never had any trouble while doing the moderate activities because of their overall health problems.

The frequency of only 'sometimes' in trouble walking uphill or climbing floors was the highest among the males than females (68.8% vs. 28.6%). Similarly, more females than the males (38.1% vs. 15.6%) often had the problem.

A majority of 47.3% of the NAFLD subjects only sometimes were unable to walk 1-2 km at a stretch owing to their overall health problems, of which 65.6% were males and 33.3% females. Of the 17.5% NAFLD subjects who often had a problem walking a couple of kilometres at a stretch, females formed a bigger proportion than the males (23.8% vs. 9.4%). More males (21.8%) than the females (14.3%) never had any problem while walking 1-2 kilometer at a stretch due to their overall health problems.

Males formed a higher proportion than the females (62.5% vs. 38.1%) who only sometimes had problem in bending, squatting and turning. Females more often had problems (21.4% vs. 9.4%) and males outperformed them as a quarter (25%) never had any problem in bending, squatting and turning vs. 7.1% females.

Most of the NAFLD subjects (67.6%) never had any problem in eating, dressing, bathing or using the toilet owing to their overall health problems with more males (81.3%) than the females (57.1%) who opined so.

b) Different Grades of Hepatic Steatosis Perspective

Half of the grade 3 hepatic steatosis subjects always had a problem in doing vigorous activities. Further, 40% of the grade 1 hepatic steatosis subjects frequently and often couldn't perform vigorous activities owing to their overall health problems vs. 24.1% and 34.4% in grade 2 hepatic steatosis (table 4.47).

There was better tolerance for moderate activities as 30% of the grade 1 hepatic steatosis subjects and 31.1% in grade 2 hepatic steatosis never had any problem in moving a table, carrying groceries or utensils, owing to their overall health problems. Majority of the type 2 diabetics sometimes had a problem in doing moderate activities with 60% in grade 1 hepatic steatosis, 56.9% in grade 2 hepatic steatosis and 83.3% in grade 3 hepatic steatosis.

Majority of the subjects in grade 1 hepatic steatosis (80%) and grade 2 hepatic steatosis (43.1%) sometimes had a problem in walking uphill or climbing floors. Often as a response was reported by 33.3% of the subjects in grade 3 hepatic steatosis, followed by 31.1% in grade 2 hepatic steatosis. About 16.7% of the grade 3 hepatic steatosis subjects always had a problem in walking uphill and climbing 1-2 floors.

Majority of the grade 1 (40%) and grade 2 hepatic steatosis subjects (51.7%) only sometimes had problem in walking at a stretch. Also, 33.3% of grade 3 hepatic steatosis subjects, 20% in grade 1 hepatic steatosis and 8.6% grade 2 hepatic steatosis subjects frequently had problem in walking at a stretch. Alarmingly, 33.3% of the grade 3 hepatic steatosis subjects always had issues walking at a stretch.

About 16.7% of the grade 3 hepatic steatosis subjects always had a problem in bending, squatting and turning. Shockingly, 50% of the grade 3 hepatic steatosis subjects frequently had a problem in doing the said activities vs. 17.2% in grade 2 hepatic steatosis and 10% in grade 1 hepatic steatosis.

Majority of the subjects in grade 1 hepatic steatosis (90%) and grade 2 hepatic steatosis (68.9%) never had problems in dressing, eating, bathing or using the toilet. Sometimes, 66.7% of the grade 3 hepatic steatosis subjects had problems in doing these basic activities.

TABLE 4.46: PHYSICAL ENDURANCE OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Physical Endurance	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How often has your overall health problems limited the kind of vigorous activities you can do like lifting heavy bags/objects, running, skipping, jumping.				
1	Always	0 (0)	10 (23.8)	10 (13.5)
2	Frequently	6 (18.8)	13 (30.9)	19 (25.7)
3	Often	10 (31.3)	16 (38.1)	26 (35.1)
4	Sometimes	15 (46.9)	2 (4.8)	17 (22.9)
5	Never	1 (3.1)	1 (2.4)	2 (2.7)
How often has your overall health problems limited the kind of moderate activities you can do like moving a table, carrying groceries or utensils.				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	2 (4.8)	2 (2.7)
3	Often	1 (3.1)	6 (14.3)	7 (9.5)
4	Sometimes	15 (46.9)	29 (69)	44 (59.5)
5	Never	16 (50)	5 (11.9)	21 (28.4)
How often has your overall health problems limited you from walking uphill or climbing 1-2 floors.				
1	Always	0 (0)	2 (4.8)	2 (2.7)
2	Frequently	2 (6.3)	10 (23.8)	12 (16.2)
3	Often	5 (15.6)	16 (38.1)	21 (28.4)
4	Sometimes	22 (68.8)	12 (28.6)	34 (45.9)
5	Never	3 (9.4)	2 (4.8)	5 (6.8)
How often has your overall health problems limited you from walking 1-2 km at a stretch.				
1	Always	0 (0)	4 (9.5)	4 (5.4)
2	Frequently	1 (3.1)	8 (19)	9 (12.2)
3	Often	3 (9.4)	10 (23.8)	13 (17.6)
4	Sometimes	21 (65.6)	14 (33.3)	35 (47.3)
5	Never	7 (21.9)	6 (14.3)	13 (17.6)

Values in parenthesis indicate percentage

TABLE 4.46: PHYSICAL ENDURANCE OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Physical Endurance	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How often has your overall health problems limited you from bending, squatting, or turning.				
1	Always	0 (0)	1 (2.4)	1 (1.4)
2	Frequently	1 (3.1)	13 (30.9)	14 (18.9)
3	Often	3 (9.4)	9 (21.4)	12 (16.2)
4	Sometimes	20 (62.5)	16 (38.1)	36 (48.6)
5	Never	8 (25)	3 (7.1)	11 (14.9)
How often has your overall health problems limited you from eating, dressing, bathing, or using the toilet				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (2.4)	1 (1.4)
3	Often	0 (0)	0 (0)	0 (0)
4	Sometimes	6 (18.8)	17 (40.5)	23 (31.1)
5	Never	26 (81.3)	24 (57.1)	50 (67.6)

Values in parenthesis indicate percentage

TABLE 4.47: PHYSICAL ENDURANCE OF TYPE 2 DIABETES SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Physical Endurance	Grade 1 steatosis (N=10)	Grade 2 steatosis (N=58)	Grade 3 steatosis (N=6)
How often has your overall health problems limited the kind of vigorous activities you can do like lifting heavy bags/objects, running, skipping, jumping.				
1	Always	2 (20)	5 (8.6)	3 (50)
2	Frequently	4 (40)	14 (24.1)	1 (16.7)
3	Often	4 (40)	20 (34.5)	2 (33.3)
4	Sometimes	0 (0)	17 (29.3)	0 (0)
5	Never	0 (0)	2 (3.4)	0 (0)
How often has your overall health problems limited the kind of moderate activities you can do like moving a table, carrying groceries or utensils.				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	2 (3.4)	0 (0)
3	Often	1 (10)	5 (8.6)	1 (16.7)
4	Sometimes	6 (60)	33 (56.9)	5 (83.3)
5	Never	3 (30)	18 (31.1)	0 (0)
How often has your overall health problems limited you from walking uphill or climbing 1-2 floors.				
1	Always	0 (0)	1 (1.7)	1 (16.7)
2	Frequently	1 (10)	9 (15.5)	2 (33.3)
3	Often	1 (10)	18 (31)	2 (33.3)
4	Sometimes	8 (80)	25 (43.1)	1 (16.7)
5	Never	0 (0)	5 (8.6)	0 (0)

Values in parenthesis indicate percentage

TABLE 4.47: PHYSICAL ENDURANCE OF TYPE 2 DIABETES SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Physical Endurance	Grade 1 steatosis (N=10)	Grade 2 steatosis (N=58)	Grade 3 steatosis (N=6)
How often has your overall health problems limited you from walking 1-2 km at a stretch.				
1	Always	0 (0)	2 (3.4)	2 (33.3)
2	Frequently	2 (20)	5 (8.6)	2 (33.3)
3	Often	1 (10)	11 (18.9)	1 (16.7)
4	Sometimes	4 (40)	30 (51.7)	1 (16.7)
5	Never	3 (30)	10 (17.2)	0 (0)
How often has your overall health problems limited you from bending, squatting, or turning.				
1	Always	0 (0)	0 (0)	1 (16.7)
2	Frequently	1 (10)	10 (17.2)	3 (50)
3	Often	1 (10)	10 (17.2)	1 (16.7)
4	Sometimes	7 (70)	28 (48.3)	1 (16.7)
5	Never	1 (10)	10 (17.2)	0 (0)
How often has your overall health problems limited you from eating, dressing, bathing, or using the toilet				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (1.7)	0 (0)
3	Often	0 (0)	0 (0)	0 (0)
4	Sometimes	1 (10)	17 (29.3)	4 (66.7)
5	Never	9 (90)	40 (68.9)	2 (33.3)

Values in parenthesis indicate percentage

3. SYMPTOMS BOTHERNESS

a) Gender Perspective: Of the 21.6% NAFLD subjects who never experienced polydipsia in the last 3 months were 34.4% males and 11.9% females. More males (62.5%) than the females (54.7%) had polydipsia sometimes in the last 3 months. Females more often had polydipsia than the males (30.9% vs. 3.1%) (table 4.48). More males than the females (56.3% vs. 33.3%) never had polyphagia in the last three months. However, half of the females (50%) and 37.5% males sometimes experienced polyphagia in the last three months. More females than the males (16.6% vs. 3.1%) often have had polyphagia in the last three months. Only males reported frequent occurrence of polyphagia in the last three months. Majority of the males never had polyuria in the last three months vs. 23.8% of the females. Half of the NAFLD subjects sometimes experienced polyuria in the last three months of which were 59.5% females and 37.5% males. Only female type 2 diabetic NAFLD subjects reported often occurrence of polyuria in the last three months.

b) Different Grades of Hepatic Steatosis Perspective: Only 20% in grade 1 hepatic steatosis, 24.1% in grade 2 hepatic steatosis never had polydipsia in last 3 months. However, half of the grade 1 and grade 3 hepatic steatosis subjects, 60.3% in grade 2 hepatic steatosis sometimes had polydipsia in the last 3 months. Half in grade 3 hepatic steatosis often had polydipsia in the last 3 months. Frequent polydipsia was reported only by grade 2 hepatic steatosis subjects (1.7%) (table 4.49). Majority of grade 2 hepatic steatosis subjects (46.5%), 40% in grade 1 hepatic steatosis and 16.6% in grade 3 hepatic steatosis never had polyphagia in the last 3 months. But, 60% in grade 1 hepatic steatosis, 83.4% in grade 3 hepatic steatosis and 37.9% in grade 2 hepatic steatosis sometimes had polyphagia in the last 3 months. Only grade 2 hepatic steatosis subjects reported often and frequent occurrence of polyphagia in the last 3 months. Half of the grade 1 hepatic steatosis subjects, 48.3% in grade 2 hepatic steatosis and 66.6% in grade 3 hepatic steatosis sometimes experienced polyuria in the last 3 months. Those who often had a problem of polyuria were 16.6% in grade 3 hepatic steatosis, 10% in grade 1 hepatic steatosis and 8.6% in grade 2 hepatic steatosis. Of those who never had the problem of polyuria were 43.1% in grade 2 hepatic steatosis, 40% in grade 1 hepatic steatosis.

TABLE 4.48: SYMPTOMS BOTHERNESS OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Symptoms botherness	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How many times in the past three months have you had thirst/dry mouth?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (2.4)	1 (1.4)
3	Often	1 (3.1)	13 (30.9)	14 (18.9)
4	Sometimes	20 (62.5)	23 (54.8)	43 (58.1)
5	Never	11 (34.4)	5 (11.9)	16 (21.6)
How many times in the past three months have you felt excessive hunger?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	1 (3.1)	0 (0)	1 (1.4)
3	Often	1 (3.1)	7 (16.7)	8 (10.8)
4	Sometimes	12 (37.5)	21 (50)	33 (44.6)
5	Never	18 (56.3)	14 (33.3)	32 (43.2)
How many times in the past three months have you had frequent urination related to diabetes management?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	0 (0)	7 (16.7)	7 (9.5)
4	Sometimes	12 (37.5)	25 (59.5)	37 (50)
5	Never	20 (62.5)	10 (23.8)	30 (40.5)

Values in parenthesis indicate percentage

TABLE 4.49: SYMPTOMS BOTHERNESS OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Symptoms botherness	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
How many times in the past three months have you had thirst/dry mouth?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (1.7)	0 (0)
3	Often	3 (30)	8 (13.8)	3 (50)
4	Sometimes	5 (50)	35 (60.3)	3 (50)
5	Never	2 (20)	14 (24.1)	0 (0)
How many times in the past three months have you felt excessive hunger?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (1.7)	0 (0)
3	Often	0 (0)	8 (13.8)	0 (0)
4	Sometimes	6 (60)	22 (37.9)	5 (83.3)
5	Never	4 (40)	27 (46.6)	1 (16.7)
How many times in the past three months have you had frequent urination related to diabetes management?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	0 (0)	0 (0)
3	Often	1 (10)	5 (8.6)	1 (16.7)
4	Sometimes	5 (50)	28 (48.3)	4 (66.7)
5	Never	4 (40)	25 (43.1)	1 (16.7)

Values in parenthesis indicate percentage

4. GENERAL HEALTH

a) Gender Perspective

Majority of the males (53.1%) were of the opinion that their health was very good vs. 28.6% of the females. Those who thought their health to be good were 46.8% males and a majority of 38.1% females. Males were found to be having a better opinion about their health compared to the females (table 4.50).

Majority of the males (68.8%) were able to very much concentrate in working, driving and reading vs. 40.5% of the females. Moderate levels of concentration in doing these activities were reported by 47.61% females and 15.62% males.

Majority of the NAFLD subjects (47.3%) sometimes experienced fatigue in the last three months of which were 56.3% males and 40.5% females. More females often had the problem of fatigue in the last three months compared to the males (47.6% vs. 18.7%).

b) Different Grades of Hepatic Steatosis Perspective

A very good health status was opined by 43.1% in grade 2 hepatic steatosis, followed by 30% in grade 1 hepatic steatosis and 16.7% in grade 3 hepatic steatosis. Majority of the grade 1 hepatic steatosis subjects (60%) opined that their health was good, so did half of the grade 3 hepatic steatosis subjects and 37.9% of the grade 2 hepatic steatosis subjects (table 4.51).

Majority of the subjects in grade 1 hepatic steatosis (80%) and grade 2 hepatic steatosis subjects (50%) and 33.3% in grade 3 hepatic steatosis reported that they were very much able to concentrate in working, driving and reading. Moderate levels of concentration in doing these activities were reported to be the highest amongst grade 3 hepatic steatosis subjects (66.7%).

Half of the grade 2 hepatic steatosis subjects, followed by 40% in grade 1 hepatic steatosis and 33.3% in grade 3 hepatic steatosis sometimes experienced fatigue in the last three months. Surprisingly, 66.7% of the grade 3 hepatic steatosis subjects, 50% of the grade 1 hepatic steatosis subjects and 29.3% of the grade 2 hepatic steatosis subjects often had fatigue in the last three months.

TABLE 4.50: GENERAL HEALTH OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	General health	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
In general would you say your health is				
1	Poor	0 (0)	1 (2.4)	1 (1.4)
2	Fair	0 (0)	13 (30.9)	13 (17.6)
3	Good	15 (46.9)	16 (38.1)	31 (41.9)
4	Very Good	17 (53.1)	12 (28.6)	29 (39.2)
5	Excellent	0 (0)	0 (0)	0 (0)
How well are you able to concentrate in everything like working, driving, reading etc?				
1	Not at all	0 (0)	0 (0)	0 (0)
2	A little	0 (0)	4 (9.5)	4 (5.4)
3	Moderate	5 (15.6)	20 (47.6)	25 (33.8)
4	Very much	22 (68.8)	17 (40.5)	39 (52.7)
5	Extremely well	5 (15.6)	1 (2.4)	6 (8.1)
How many times in the past three months have you had fatigue/ felt very tired?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	3 (7.1)	3 (4.1)
3	Often	6 (18.8)	20 (47.6)	26 (35.1)
4	Sometimes	18 (56.3)	17 (40.5)	35 (47.3)
5	Never	8 (25)	2 (4.8)	10 (13.5)

Values in parenthesis indicate percentage

TABLE 4.51: GENERAL HEALTH OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	General health	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
In general would you say your health is				
1	Poor	0 (0)	1 (1.72)	0 (0)
2	Fair	1 (10)	10 (17.2)	2 (33.3)
3	Good	6 (60)	22 (37.9)	3(50)
4	Very Good	3 (30)	25 (43.1)	1 (16.7)
5	Excellent	0 (0)	0 (0)	0 (0)
How well are you able to concentrate in everything like working, driving, reading etc?				
1	Not at all	0 (0)	0 (0)	0 (0)
2	A little	0 (0)	4 (6.9)	0 (0)
3	Moderate	2 (20)	19 (32.8)	4 (66.7)
4	Very much	8 (80)	29 (50)	2 (33.3)
5	Extremely well	0 (0)	6 (10.3)	0 (0)
How many times in the past three months have you had fatigue/ felt very tired?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	3 (5.2)	0 (0)
3	Often	5 (50)	17 (29.3)	4 (66.7)
4	Sometimes	4 (40)	29 (50)	2 (33.3)
5	Never	1 (10)	9 (15.5)	0 (0)

Values in parenthesis indicate percentage

5. TREATMENT SATISFACTION

a) Gender Perspective

Majority of the males were moderately satisfied with their current diabetes treatment along with 26.2% of the females. Most of the females (47.6%) and 15.6% males were neither dissatisfied nor satisfied with their current diabetes treatment. Of the 12.2% NAFLD subjects who were very satisfied with their current diabetes treatment were 21.8% males and 4.7% females. More females were moderately dissatisfied as compared to the males (19.1% vs. 6.3%) with their current diabetes treatment (table 4.52).

More males than the females (15.6% vs. 4.7%) were very satisfied with the quantum of time it took them to manage their diabetes. Moderate levels of satisfaction were more prevalent amongst the males (56.3%) than the females (26.2%). More females than the males (45.2% vs. 28.1%) were neither dissatisfied nor satisfied with the time it took them to manage their diabetes. Again, females were the only ones (23.8%) who reported moderate levels of dissatisfaction in terms of the time it took them to manage their diabetes.

Majority of the NAFLD subjects (52.7%) were moderately satisfied with the amount of time it took them to get their regular checkups done every 3 months, of which were; 56.3% males and 50% females. However, 42.8% of the females and 31.3% males were neither satisfied or dissatisfied with the said aspect. Only female NAFLD subjects (4.7%) were moderately dissatisfied. More males than the females (12.5% vs. 2.4%) were very satisfied with the amount of time spent in getting regular health check ups done.

Of the 10.8% NAFLD subjects who were very satisfied with the time they spend in doing exercise were more of males than the females (12.5% vs. 9.5%). Moderate levels of satisfaction with their exercise regime were reported by half of the male NAFLD subjects vs. 21.4% females. More females than the males (33.3% vs. 21.8%) were neither satisfied nor dissatisfied with the exercise regime they follow. More females were moderately dissatisfied with the exercise routine they follow compared to the males (28.5% vs. 15.6%). Only the female NAFLD subjects (7.1%) reported that they were very dissatisfied with the quantum of time they spend in exercising.

b) Different Grades of Hepatic Steatosis Perspective

Very few were very satisfied with their current diabetes treatment. Majority of the grade 2 hepatic steatosis subjects (41.4%) followed by 33.3% of the grade 3 hepatic steatosis subjects and 30% grade 1 hepatic steatosis subjects were moderately satisfied with their current diabetes treatment. Half of the grade 1 hepatic steatosis subjects, 33.3% of the grade 3 hepatic steatosis subjects and 31.03% of the grade 2 hepatic steatosis subjects were neither dissatisfied nor satisfied. Moderate levels of dissatisfaction were reported by 33.3% in grade 3 hepatic steatosis, 12.06% in grade 2 hepatic steatosis and 10% in grade 1 hepatic steatosis subjects. Only grade 2 hepatic steatosis subjects reported being very dissatisfied with the current diabetes treatment (table 4.53).

Only a few grade 2 and grade 1 hepatic steatosis subjects were very satisfied with the time taken to manage diabetes. Majority of the grade 1 hepatic steatosis subjects (50%), 39.7% in grade 2 hepatic steatosis and 16.7% in grade 3 hepatic steatosis were moderately satisfied. Most in grade 3 hepatic steatosis (66.7%), 37.9% in grade 2 hepatic steatosis and 20% in grade 1 hepatic steatosis were neither dissatisfied or satisfied.

Only 8.6% grade 2 hepatic steatosis subjects were very satisfied with the time they spend in getting regular health check ups done once in 3 months. Majority of the grade 1 (70%) and grade 2 hepatic steatosis subjects (51.7%) were moderately satisfied. Most of the grade 3 hepatic steatosis subjects, 36.2% grade 2 hepatic steatosis subjects and 30% in grade 1 hepatic steatosis were neither satisfied or dissatisfied.

Most of the grade 1 hepatic steatosis subjects (40%) were very satisfied with the exercise regime they undertook for diabetes management. Moderate levels of satisfaction were reported by 36.2% grade 2 hepatic steatosis, 30% grade 1 hepatic steatosis and 16.7% grade 3 hepatic steatosis subjects. About 33.3% grade 3 hepatic steatosis subjects, 29.3% in grade 2 hepatic steatosis and 20% in grade 1 hepatic steatosis were neither dissatisfied nor satisfied. However, half of the grade 3 hepatic steatosis subjects were moderately dissatisfied.

TABLE 4.52: TREATMENT SATISFACTION OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Treatment Satisfaction	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How satisfied are you with your current diabetes treatment?				
1	Very dissatisfied	0 (0)	1 (2.4)	1 (1.4)
2	Moderately dissatisfied	2 (6.3)	8 (19)	10 (13.5)
3	Neither dissatisfied or satisfied	5 (15.6)	20 (47.6)	25 (33.8)
4	Moderately Satisfied	18 (56.3)	11 (26.2)	29 (39.2)
5	Very satisfied	7 (21.9)	2 (4.8)	9 (12.2)
How satisfied are you with amount of time it takes to manage your diabetes?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	10 (23.8)	10 (13.5)
3	Neither dissatisfied or satisfied	9 (28.1)	19 (45.2)	28 (37.8)
4	Moderately Satisfied	18 (56.3)	11 (26.2)	29 (39.2)
5	Very satisfied	5 (15.6)	2 (4.8)	7 (9.5)
How satisfied are you with the amount of time you spend getting regular checkups (once in 3 months)?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	2 (4.8)	2 (2.7)
3	Neither dissatisfied or satisfied	10 (31.3)	18 (42.9)	28 (37.8)
4	Moderately Satisfied	18 (56.3)	21 (50)	39 (52.7)
5	Very satisfied	4 (12.5)	1 (2.4)	5 (6.8)
A person with diabetes needs to exercise for 35-45 min, 4 times a week. Keeping this in mind how satisfied are you with the time you spend exercising?				
1	Very dissatisfied	0 (0)	3 (7.1)	3 (4.1)
2	Moderately dissatisfied	5 (15.6)	12 (28.6)	17 (22.9)
3	Neither dissatisfied or satisfied	7 (21.9)	14 (33.3)	21 (28.4)
4	Moderately Satisfied	16 (50)	9 (21.4)	25 (33.8)
5	Very satisfied	4 (12.5)	4 (9.5)	8 (10.8)

Values in parenthesis indicate percentage

TABLE 4.53: TREATMENT SATISFACTION OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Treatment Satisfaction	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
How satisfied are you with your current diabetes treatment?				
1	Very dissatisfied	0 (0)	1 (1.7)	0 (0)
2	Moderately dissatisfied	1 (10)	7 (12.1)	2 (33.3)
3	Neither dissatisfied or satisfied	5 (50)	18 (31)	2 (33.3)
4	Moderately Satisfied	3 (30)	24 (41.4)	2 (33.3)
5	Very satisfied	1 (10)	8 (13.8)	0 (0)
How satisfied are you with amount of time it takes to manage your diabetes?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	2 (20)	7 (12.1)	1 (16.7)
3	Neither dissatisfied or satisfied	2 (20)	22 (37.9)	4 (66.7)
4	Moderately Satisfied	5 (50)	23 (39.7)	1 (16.7)
5	Very satisfied	1 (10)	6 (10.3)	0 (0)
How satisfied are you with the amount of time you spend getting regular checkups (once in 3 months)?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	2 (3.4)	0 (0)
3	Neither dissatisfied or satisfied	3 (30)	21 (36.2)	4 (66.7)
4	Moderately Satisfied	7 (70)	30 (51.7)	2 (33.3)
5	Very satisfied	0 (0)	5 (8.6)	0 (0)
A person with diabetes needs to exercise for 35-45 min, 4 times a week. Keeping this in mind how satisfied are you with the time you spend exercising?				
1	Very dissatisfied	0 (0)	3 (5.2)	0 (0)
2	Moderately dissatisfied	1 (10)	13 (22.4)	3 (50)
3	Neither dissatisfied or satisfied	2 (20)	17 (29.3)	2 (33.3)
4	Moderately Satisfied	3 (30)	21 (36.2)	1 (16.7)
5	Very satisfied	4 (40)	4 (6.9)	0 (0)

Values in parenthesis indicate percentage

6. FINANCIAL WORRIES

a) Gender Perspective

Most of the male NAFLD subjects (53.1%) found the cost involved in diabetes management to be not at all expensive vs. 30.9% females. The cost being reasonable was reported by 46.9% males and 42.9% females. Only female NAFLD subjects reported the cost in diabetes management to be a little expensive (19.04%) and very expensive (7.1%) (table 4.54).

More males than the females (34.4% vs. 7.1%) were of the opinion that their priority of expenditure has not shifted at all towards diabetes management. However; a very little shift in expenditure was reported by 35.7% females and 34.4% males. A little shift in expenditure was reported by more females than the males (33.3% vs. 31.3%). Only female NAFLD subjects found that their priority of expenditure had shifted highly (23.8%) towards diabetes management.

Most of the males (43.8%) and 16.7% females said that their family budget didn't get affected at all because of the expenses related to diabetes management. A very little extent of family budget getting affected was reported by 40.5% females and 40.6% males. A little shift in budget owing to diabetes management was reported by more females than the males (35.7% vs. 15.6%). Only 7.1% females opined that their family budget got highly affected because of the expenditure incurred on diabetes management.

More of the males (43.8%) were of the opinion that diabetes has not at all limited their expenditure on other aspects of life vs. 26.2% females who also opined so. Majority of the males (46.9%) and females (35.7%) cited a very little impact of diabetes expenditure on other aspects of life. A little impact on other expenditure aspects was reported by 26.2% females and 9.4% males. Only female NAFLD subjects reported that because of their expenses on diabetes management, there has been a high impact on other aspects of expenditure.

b) Different Grades of Hepatic Steatosis Perspective

Majority of the grade 2 hepatic steatosis subjects (46.6%) found the cost involved in diabetes management to be not at all expensive. However, most of the grade 1 hepatic steatosis subjects (80%), followed by 66.6% in grade 3 hepatic steatosis found the cost involved to be reasonable. Only grade 2 hepatic steatosis subjects found the cost involved being very expensive (5.2%) and a little expensive was cited by 16.6% in grade 3 hepatic steatosis and 12.06% in grade 2 hepatic steatosis (table 4.55).

Most of the subjects in grade 1 hepatic steatosis, 50% in grade 3 hepatic steatosis and 24.1% in grade 2 hepatic steatosis opined a little shift in priority of expenditure owing to diabetes management. About 22.4% in grade 2 hepatic steatosis and 16.6% in grade 3 hepatic steatosis found the priority of expenditure to be not shifted at all. A very little extent of shift was reported by 37.9% in grade 2 hepatic steatosis, 30% in grade 1 hepatic steatosis and 16.6% in grade 3 hepatic steatosis. A high impact on shift in expenditure was reported by 16.6% of the grade 3 hepatic steatosis subjects and 15.5% of the grade 2 hepatic steatosis subjects.

Most of the grade 1 hepatic steatosis subjects (80%), 34.4% in grade 2 hepatic steatosis reported a very little impact on family budget in relation to diabetes management. About 50% in grade 3 hepatic steatosis, 27.5% in grade 2 hepatic steatosis and 10% of the grade 1 hepatic steatosis subjects opined that their family budget got affected a little because of the expenses incurred on diabetes management. Only 5.2% in grade 2 hepatic steatosis found high impact on family budget because of expenses on diabetes management.

A high impact on limitation on expenditure on other aspects of life owing to diabetes management was reported only by 6.9% in grade 2 hepatic steatosis. Most of the grade 1 hepatic steatosis subjects and 50% grade 3 hepatic steatosis subjects opined a little limitation on spending in other aspects of life because of expenses on diabetes management. A very little shift in expenses on other aspects of life was reported by 37.9% in grade 2 hepatic steatosis, 33.3% in grade 3 hepatic steatosis and 30% in grade 1 hepatic steatosis. However, the expenditure on diabetes having no impact on spending on other aspects of life was cited by 36.2% in grade 2 hepatic steatosis and 16.6% in grade 3 hepatic steatosis.

TABLE 4.54: FINANCIAL WORRIES OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Financial worries	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
What do you think about the cost involved in your management of diabetes?				
1	Very expensive	0 (0)	3 (7.1)	3 (4.1)
2	Little expensive	0 (0)	8 (19)	8 (10.8)
3	Reasonable	15 (46.9)	18 (42.9)	33 (44.6)
4	Not at all expensive	17 (53.1)	13 (30.9)	30 (40.5)
To what extent has your priority of expenditure shifted towards diabetes management?				
1	A lot	0 (0)	0 (0)	0 (0)
2	Highly	0 (0)	10 (23.8)	10 (13.5)
3	Little	10 (31.3)	14 (33.3)	24 (32.4)
4	Very little	11 (34.4)	15 (35.7)	26 (35.1)
5	Not at all	11 (34.4)	3 (7.1)	14 (18.9)
To what extent has your family budget got affected by the expenses related to the management of diabetes?				
1	A lot	0 (0)	0 (0)	0 (0)
2	Highly	0 (0)	3 (7.1)	3 (4.1)
3	Little	5 (15.6)	15 (35.7)	20 (27)
4	Very little	13 (40.6)	17 (40.5)	30 (40.5)
5	Not at all	14 (43.8)	7 (16.7)	21 (28.4)
To what extent has your diabetes limited your expenditure on other aspects of life?				
1	A lot	0 (0)	0 (0)	0 (0)
2	Highly	0 (0)	5 (11.9)	5 (6.8)
3	Little	3 (9.4)	11 (26.2)	14 (18.9)
4	Very little	15 (46.9)	15 (35.7)	30 (40.5)
5	Not at all	14 (43.8)	11 (26.2)	25 (33.8)

Values in parenthesis indicate percentage

TABLE 4.55: FINANCIAL WORRIES OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Financial worries	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)
What do you think about the cost involved in your management of diabetes?				
1	Very expensive	0 (0)	3 (5.2)	0 (0)
2	Little expensive	0 (0)	7 (12.1)	1 (16.7)
3	Reasonable	8 (80)	21 (36.2)	4 (66.7)
4	Not at all expensive	2 (20)	27 (46.6)	1 (16.7)
To what extent has your priority of expenditure shifted towards diabetes management?				
1	A lot	0 (0)	0 (0)	0 (0)
2	Highly	0 (0)	9 (15.5)	1 (16.7)
3	Little	7 (70)	14 (24.1)	3 (50)
4	Very little	3 (30)	22 (37.9)	1 (16.7)
5	Not at all	0 (0)	13 (22.4)	1 (16.7)
To what extent has your family budget got affected by the expenses related to the management of diabetes?				
1	A lot	0 (0)	0 (0)	0 (0)
2	Highly	0 (0)	3 (5.2)	0 (0)
3	Little	1 (10)	16 (27.6)	3 (50)
4	Very little	8 (80)	20 (34.5)	2 (33.3)
5	Not at all	1 (10)	19 (32.8)	1 (16.7)
To what extent has your diabetes limited your expenditure on other aspects of life?				
1	A lot	0 (0)	0 (0)	0 (0)
2	Highly	1 (10)	4 (6.9)	0 (0)
3	Little	6 (60)	11 (18.9)	3 (50)
4	Very little	3 (30)	22 (37.9)	2 (33.3)
5	Not at all	0 (0)	21 (36.2)	1 (16.7)

Values in parenthesis indicate percentage

7. EMOTIONAL / MENTAL HEALTH

a) Gender Perspective

More males than the females (28.1% vs. 9.5%) reported that they were moderately satisfied with themselves. Most of the males (62.5%) and 35.7% females were moderately satisfied with themselves. Of the 27.02% of the NAFLD subjects who were neither dissatisfied nor satisfied with themselves were 40.5% females and 9.4% males (14.3%) (table 456.).

Males were more satisfied with their personal relationships (40.6%) compared to females (30.9%). Most of the males (59.4%) and females (61.9%) were moderately satisfied with their personal relationships. Only the female NAFLD subjects (7.14%) were neither dissatisfied nor satisfied with their personal relationships.

More males than the females (46.9% vs. 30.9%) were more satisfied with the emotional support that they get from their family and friends. Half of the males and 47.6% females reported that they were moderately satisfied with the said aspect. More females compared to the males (21.4% vs. 3.1%) were neither dissatisfied nor satisfied with the emotional support they get from family and friends.

Amongst those who were never discouraged by their health problems, were 46.9% males and only 9.5% females. However, 46.9% males and 42.9% females were sometimes discouraged by their health problems. Females more often were discouraged by their health problems than the males (45.2% vs. 6.3%).

More males than the females (34.4% vs. 9.5%) opined that they have been able to lead their lives in a purposeful manner. Most of the males (65.6%) and females (52.4%) said that they have been able to lead their lives in a very much purposeful manner.

b) Different Grades of Hepatic Steatosis Perspective

Only 20% in grade 1 hepatic steatosis and 18.9% in grade 2 hepatic steatosis were very satisfied with themselves. Half of the grade 1 hepatic steatosis subjects, 66.6% in grade 3 hepatic steatosis were moderately satisfied with themselves. A little above one

third of the grade 3 hepatic steatosis subjects, 27.58% in grade 2 hepatic steatosis were neither dissatisfied or satisfied with themselves (table 4.57).

Half of the grade 1 hepatic steatosis subjects, 36.2% in grade 2 hepatic steatosis were very satisfied with their personal relationships. All the subjects in grade 3 hepatic steatosis, 58.6% subjects in grade 2 hepatic steatosis and half of the subjects in grade 1 hepatic steatosis were moderately satisfied with their personal relationships. Only grade 2 hepatic steatosis subjects (5.2%) were neither dissatisfied nor satisfied with their personal relationships.

Half of the grade 1 hepatic steatosis subjects, 37.9% in grade 2 hepatic steatosis were very satisfied with the emotional support from their family and friends. Most of the grade 3 hepatic steatosis subjects (83.3%), 48.27% in grade 2 hepatic steatosis were moderately satisfied with the emotional support. However, 20% of the grade 1 hepatic steatosis subjects and 13.79% in grade 2 hepatic steatosis were neither dissatisfied nor satisfied.

Half of the grade 3 hepatic steatosis subjects, 46.5% in grade 2 hepatic steatosis were sometimes discouraged by their health problems. Most of the grade 1 hepatic steatosis subjects (40%), followed by 33.3% in grade 3 hepatic steatosis often were discouraged by their health problems. Amongst those who were never discouraged by their health problems were 30% in grade 1 hepatic steatosis, 25.8% in grade 2 hepatic steatosis. Only grade 2 hepatic steatosis subjects (1.7%) were frequently discouraged by their health problems.

About 83.3% in grade 3 hepatic steatosis, 60% in grade 1 hepatic steatosis and 55.2% in grade 2 hepatic steatosis opined that they were able to lead their life in a very much purposeful way. Those with moderate intensity of leading their life purposefully were 20.6% in grade 2 hepatic steatosis, 20% in grade 1 hepatic steatosis and 16.6% in grade 3 hepatic steatosis. Only grade 2 hepatic steatosis subjects reported leading their lives in a little purposeful way. However, 22.4% in grade 2 hepatic steatosis and 20% in grade 1 hepatic steatosis said they have been able to lead their lives in an extremely well purposeful way.

TABLE 4.56: EMOTIONAL / MENTAL HEALTH OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Emotional / mental health	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How satisfied are you with yourself?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	6 (14.3)	6 (8.1)
3	Neither dissatisfied or satisfied	3 (9.4)	17 (40.5)	20 (27)
4	Moderately Satisfied	20 (62.5)	15 (35.7)	35 (47.3)
5	Very satisfied	9 (28.1)	4 (9.5)	13 (17.6)
How satisfied are you with your personal relationships?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	0 (0)	0 (0)
3	Neither dissatisfied or satisfied	0 (0)	3 (7.1)	3 (4.1)
4	Moderately Satisfied	19 (59.4)	26 (61.9)	45 (60.8)
5	Very satisfied	13 (40.6)	13 (30.9)	26 (35.1)
How satisfied are you with the emotional support you get from your friends and family?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	0 (0)	0 (0)
3	Neither dissatisfied or satisfied	1 (3.1)	9 (21.4)	10 (13.5)
4	Moderately Satisfied	16 (50)	20 (47.6)	36 (48.6)
5	Very satisfied	15 (46.9)	13 (30.9)	28 (37.8)
How often are you discouraged by your health problems?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (2.4)	1 (1.4)
3	Often	2 (6.3)	19 (45.2)	21 (28.4)
4	Sometimes	15 (46.9)	18 (42.9)	33 (44.6)
5	Never	15 (46.9)	4 (9.5)	19 (25.7)

Values in parenthesis indicate percentage

TABLE 4.56: EMOTIONAL / MENTAL HEALTH OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Emotional / mental health	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
All people want to fulfill certain roles and lead their lives in a purposeful manner. To what extent do you feel that you have been able to lead your life in the same way?				
1	Not at all	0 (0)	0 (0)	0 (0)
2	A little	0 (0)	1 (2.4)	1 (1.4)
3	Moderate	0 (0)	15 (35.7)	15 (20.3)
4	Very much	21 (65.6)	22 (52.4)	43 (58.1)
5	Extremely well	11 (34.4)	4 (9.5)	15 (20.3)

Values in parenthesis indicate percentage

TABLE 4.57: EMOTIONAL / MENTAL HEALTH OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Emotional / mental health	Grade 1 steatosis (N=10)	Grade 2 steatosis (N=58)	Grade 3 steatosis (N=6)
How satisfied are you with yourself?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	1 (10)	5 (8.6)	0 (0)
3	Neither dissatisfied or satisfied	2 (20)	16 (27.6)	2 (33.3)
4	Moderately Satisfied	5 (50)	26 (44.8)	4 (66.7)
5	Very satisfied	2 (20)	11 (18.9)	0 (0)
How satisfied are you with your personal relationships?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	0 (0)	0 (0)
3	Neither dissatisfied or satisfied	0 (0)	3 (5.2)	0 (0)
4	Moderately Satisfied	5 (50)	34 (58.6)	6 (100)
5	Very satisfied	5(50)	21 (36.2)	0 (0)

TABLE 4.57: EMOTIONAL / MENTAL HEALTH OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)				
Likert Scale	**Emotional / mental health**	**Grade 1 steatosis (N=10)**	**Grade 2 steatosis (N=58)**	**Grade 3 steatosis (N=6)**
How satisfied are you with the emotional support you get from your friends and family?				
1	Very dissatisfied	0 (0)	0 (0)	0 (0)
2	Moderately dissatisfied	0 (0)	0 (0)	0 (0)
3	Neither dissatisfied or satisfied	2 (20)	8 (13.8)	0 (0)
4	Moderately Satisfied	3 (30)	28 (48.3)	5 (83.3)
5	Very satisfied	5(50)	22 (37.9)	1 (16.7)
How often are you discouraged by your health problems?				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	1 (1.7)	0 (0)
3	Often	4 (40)	15 (25.9)	2 (33.3)
4	Sometimes	3 (30)	27 (46.6)	3(50)
5	Never	3 (30)	15 (25.9)	1 (16.7)
All people want to fulfill certain roles and lead their lives in a purposeful manner. To what extent do you feel that you have been able to lead your life in the same way?				
1	Not at all	0 (0)	0 (0)	0 (0)
2	A little	0 (0)	1 (1.7)	0 (0)
3	Moderate	2(20)	12 (20.7)	1 (16.7)
4	Very much	6 (60)	32 (55.2)	5 (83.3)
5	Extremely well	2(20)	13 (22.4)	0 (0)

Values in parenthesis indicate percentage

8. DIET SATISFACTION

a) Gender Perspective

While eating out, more female NAFLD subjects than the male NAFLD subjects (7.1% vs. 6.3%) 'always' cited a restriction in choosing foods. Those who frequently (24.3%) encountered restrictions while choosing foods when eating out, comprised of more males than the females (28.1% vs. 21.4%). Majority of the females (45.2%) and 28.12% males often had a problem in choosing foods while eating out owing to the diabetic restrictions. Of the 29.7% NAFLD subjects who sometimes felt restriction in choosing foods while eating out, 37.5% were males and 23.8% females. Only female NAFLD subjects opined that they never had a problem in choosing foods while eating out (table 4.58).

Most of the NAFLD subjects (52.7%) said that they sometimes ate food items that they shouldn't to hide that they are diabetic, of which were 59.4% males and 47.6% females. Of the 25.7% NAFLD subjects who often ate the prohibited foods, 28.6% were females and 21.9% males. More females (11.9%) than the males (6.3%) frequently ate foods that are not prescribed for a diabetic diet. More males than the females (12.5% vs. 11.9%) never ate foods that they shouldn't in order to control their sugar levels.

None of the NAFLD subjects agreed with the fact that they have a lot of choice while eating away from home. About 14.9% of the NAFLD subjects cited that they have enough choices while eating out and of them, 18.8% were males and 11.9% females. Half of the males and most of the females (42.3%) opined that they had little choice when they ate away from home. Amongst those who said that they had very little choice when eating away from home were 35.7% females and 31.3% males. Only the female NAFLD subjects said that they had no choice when they ate out.

b) Different Grades of Hepatic Steatosis Perspective

Amongst those who often had a problem in choosing foods when they went to eat out were, half of the grade 3 hepatic steatosis subjects, 40% in grade 1 hepatic steatosis and 36.2% of the grade 2 hepatic steatosis subjects. Half of the subjects in grade 1 hepatic steatosis subjects, 33.3% of the grade 3 hepatic steatosis subjects and 25.9%

of the grade 2 hepatic steatosis subjects sometimes felt a restriction in choosing foods when they ate out. Those who frequently had a problem in choosing foods while eating out were 29.3% of the grade 2 hepatic steatosis subjects and 10% of the grade 1 hepatic steatosis subjects. A few of the grade 3 hepatic steatosis subjects (16.7%) and grade 2 hepatic steatosis subjects (6.9%) always had a problem while eating out owing to the restriction over foods (table 4.59).

Majority of the grade 2 hepatic steatosis subjects (56.9%) and grade 1 hepatic steatosis subjects (40%) sometimes ate the prohibited foods in order to hide that they are diabetic. A little above one third of the grade 3 hepatic steatosis subjects, 30% of the grade 1 hepatic steatosis subjects and 24.1% of the grade 2 hepatic steatosis subjects often ate foodstuffs that they shouldn't. Only 12.06% of the grade 2 hepatic steatosis subjects reported that they frequently ate food items that they shouldn't be eating. About 33.3% of the grade 3 hepatic steatosis subjects, 30% of the grade 1 hepatic steatosis subjects and 6.9% of the grade 2 hepatic steatosis subjects never ate any foodstuff that is prohibited.

Half of the grade 1 hepatic steatosis subjects, 46.5% of the grade 2 hepatic steatosis subjects and 33.3% of the grade 3 hepatic steatosis subjects had a little choice in eating meals or snacks away from home. A very little choice in eating out was reported by 36.2% of the grade 2 hepatic steatosis subjects, 30% of the grade 1 hepatic steatosis subjects and 16.6% of the grade 3 hepatic steatosis subjects. Only 5.2% of the grade 2 hepatic steatosis subjects felt that they had no choice while eating out. An enough choice in eating meals and snacks while eating out was opined by 33.3% of the grade 3 hepatic steatosis subjects, 20% of the grade 1 hepatic steatosis subjects and 12.06% of the grade 2 hepatic steatosis subjects.

TABLE 4.58: DIET SATISFACTION OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (N, %)

Likert Scale	Diet Satisfaction	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)
How often do you feel because of your diabetes a restriction in choosing your food when eating out?				
1	Always	2 (6.3)	3 (7.1)	5 (6.8)
2	Frequently	9 (28.1)	9 (21.4)	18 (24.3)
3	Often	9 (28.1)	19 (45.2)	28 (37.8)
4	Sometimes	12 (37.5)	10 (23.8)	22 (29.7)
5	Never	0 (0)	1 (2.4)	1 (1.4)
How often do you eat the food items that you shouldn't, in order to hide the fact that you are having diabetes.				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	2 (6.3)	5 (11.9)	7 (9.5)
3	Often	7 (21.9)	12 (28.6)	19 (25.7)
4	Sometimes	19 (59.4)	20 (47.6)	39 (52.7)
5	Never	4 (12.5)	5 (11.9)	9 (12.2)
As you have diabetes, how much choice do you feel you have in eating your meals or snacks away from home e.g. if you go in a party and there is a buffet where there are also a lot of fried snacks and desserts would you be able to make enough choice?				
1	No choice	0 (0)	4 (9.5)	4 (5.4)
2	Very little	10 (31.3)	15 (35.7)	25 (33.8)
3	Little	16 (50)	18 (42.9)	34 (45.9)
4	Enough	6 (18.8)	5 (11.9)	11 (14.9)
5	A lot	0 (0)	0 (0)	0 (0)

Values in parenthesis indicate percentage

TABLE 4.59: DIET SATISFACTION OF TYPE 2 DIABETIC SUBJECTS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (N, %)

Likert Scale	Diet Satisfaction	Grade 1 steatosis (N=10)	Grade 2 steatosis (N=58)	Grade 3 steatosis (N=6)
How often do you feel because of your diabetes a restriction in choosing your food when eating out?				
1	Always	0 (0)	4 (6.9)	1 (16.7)
2	Frequently	1 (10)	17 (29.3)	0 (0)
3	Often	4 (40)	21 (36.2)	3(50)
4	Sometimes	5 (50)	15 (25.9)	2 (33.3)
5	Never	0 (0)	1 (1.7)	0 (0)
How often do you eat the food items that you shouldn't, in order to hide the fact that you are having diabetes.				
1	Always	0 (0)	0 (0)	0 (0)
2	Frequently	0 (0)	7 (12.1)	0 (0)
3	Often	3 (30)	14 (24.1)	2 (33.3)
4	Sometimes	4 (40)	33 (56.9)	2 (33.3)
5	Never	3 (30)	4 (6.9)	2 (33.3)
As you have diabetes, how much choice do you feel you have in eating your meals or snacks away from home e.g. if you go in a party and there is a buffet where there are also a lot of fried snacks and desserts would you be able to make enough choice?				
1	No choice	0 (0)	3 (5.2)	1 (16.7)
2	Very little	3 (30)	21 (36.2)	1 (16.7)
3	Little	5 (50)	27 (46.6)	2 (33.3)
4	Enough	2 (20)	7 (12.1)	2 (33.3)
5	A lot	0 (0)	0 (0)	0 (0)

Values in parenthesis indicate percentage

Quality of Life of Type 2 Diabetics with NAFLD from Gender Perspective

The male NAFLD subjects had a significantly higher (P 1.49E) mean score than the female NAFLD subjects (4.2 vs. 3.8) on the aspect of role limitation due to physical health. In the domain of physical endurance, males scored better than the females (4.09 vs. 3.3, P 1.62E). Males scored better than the females (4.4 vs. 4, P 1.72E) in the domain of symptom botherness. Perceptions regrading general health were better amongst the male NAFLD subjects than the female NAFLD subjects (3.8 vs. 3.2, P 2.12E). In the aspect of treatment satisfaction, males were more satisfied than the females (3.8 vs. 3.1, P 3.09E). More females had financial worries than the males (4.07 vs. 3.4, P 2.91E). Emotional and mental health was better in the male NAFLD subjects compared to the female NAFLD subjects (4.3 vs. 3.8, P 4.05E). Though males scored better than the females in the domain of dietary satisfaction (3.2 vs. 3.03), yet the difference was not significant (table 4.60). Diet satisfaction was the lowest scoring domain among type 2 diabetics with NAFLD, followed by treatment satisfaction, general health, physical endurance, financial worries, role limitation due to physical health, emotional health and the best scoring domain was symptom botherness (fig 4.30).

Quality of Life of Type 2 Diabetics with Different Grades of Hepatic Steatosis

A significant reduction (P 0.009) in role limitation due to physical health was observed from grade 1 hepatic steatosis to grade 3 hepatic steatosis (table 4.61). The grade 3 hepatic steatosis subjects had significantly lower scores than the grade 1 hepatic steatosis subjects (P 0.0024) and grade 2 hepatic steatosis subjects (P 0.0024) (table 4.62). The scores of physical endurance were same for grade 1 hepatic steatosis subjects and grade 2 hepatic subjects and were lowest for the grade 3 hepatic steatosis subjects (P 4.41E). The grade 3 hepatic steatosis scores of physical endurance were significantly lower than that of the grade 1 hepatic steatosis (P 0.0005) scores and grade 2 hepatic steatosis (P 0.0001) scores and it was the least scoring domain among them. Diet satisfaction was the least scoring domain in subjects with grade 1 and grade 2 hepatic steatosis and symptom botherness was the best scoring domain among them. In scores of treatment satisfaction (P 0.016), the grade 3 hepatic steatosis had significantly lower scores of treatment satisfaction as compared to grade 1 hepatic steatosis subjects (P 0.002) and grade 2 hepatic steatosis subjects (P 0.0067).

TABLE 4.60: QUALITY OF LIFE OF TYPE 2 DIABETIC SUBJECTS WITH NAFLD FROM GENDER PERSPECTIVE (MEAN±SD)

Domains	Maximum Score	NAFLD Males (N=32)	NAFLD Females (N=42)	Total (N=74)	P value
Role limitation due to physical health	5	4.2 ± 0.56	3.8 ± 0.61	4.0 ± 0.58	**1.49E*** **
Physical endurance	5	4.09 ± 0.79	3.3 ± 1.1	3.6 ± 0.94	**1.62E*** **
Symptom botherness	5	4.4 ± 0.59	4.0 ± 0.69	4.2 ± 0.64	**1.72E*** **
General health	5	3.8 ± 0.62	3.2 ± 0.77	3.5 ± 1.39	**2.12E*** **
Treatment satisfaction	5	3.8 ± 0.76	3.1 ± 0.88	3.4 ± 0.82	**3.09E*** **
Financial worries	4.75	4.07 ± 0.76	3.4 ± 0.95	3.7 ± 0.85	**2.91E*** **
Emotional / mental health	5	4.3 ± 0.55	3.8 ± 0.77	4.05 ± 0.66	**1.74E*** **
Diet satisfaction	5	3.2 ± 0.9	3.03 ± 0.96	3.1 ± 0.93	0.16

P<0.05*, p<0.01**, p<0.001***

FIG 4.30: PREVALENCE OF SATISFACTION IN DIFFERENT DOMAINS OF QUALITY OF LIFE IN TYPE 2 DIABETICS WITH NAFLD FROM GENDER PERSPECTIVE (%)

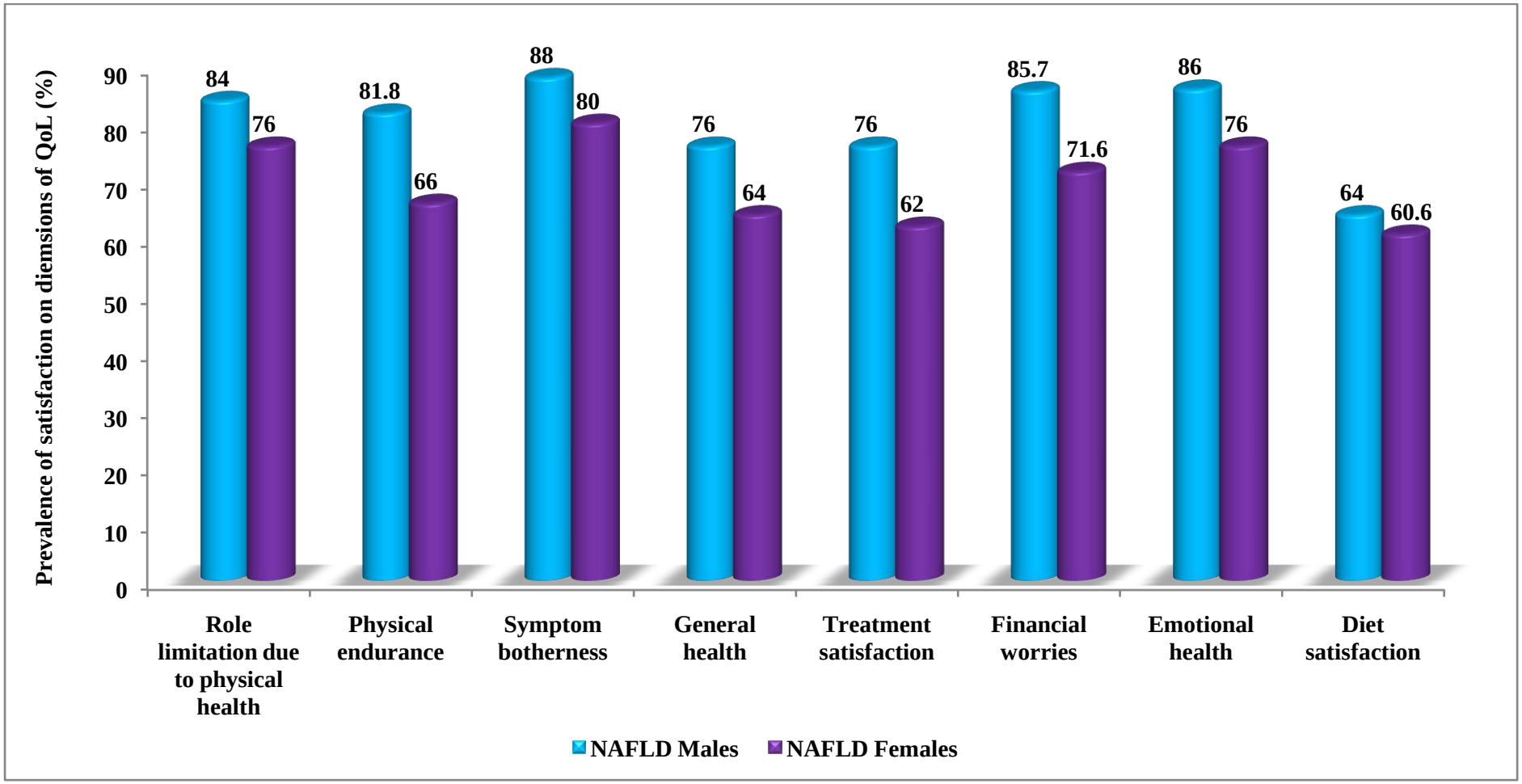


TABLE 4.61: QUALITY OF LIFE OF TYPE 2 DIABETICS WITH DIFFERENT GRADES OF HEPATIC STEATOSIS (MEAN ± SD)

Domains	Maximum Score	Grade 1 Steatosis (N=10)	Grade 2 Steatosis (N=58)	Grade 3 Steatosis (N=6)	F value	ANOVA P value
Role limitation due to physical health	5	4.1 ± 0.47	4.01 ± 0.63	3.72 ± 0.51	4.65	**0.009*** **
Physical endurance	5	3.75 ± 1.08	3.75± 1.02	2.83 ± 1.25	12.68	**4.41E*** **
Symptom botherness	5	4.2 ± 0.66	4.23 ± 0.7	3.88 ± 0.58	2.06	0.12
General health	5	3.53 ± 0.62	3.54 ± 0.8	3.16 ± 0.61	1.91	0.14
Treatment satisfaction	5	3.65 ± 0.86	3.46 ± 0.89	3.0 ± 0.72	4.19	**0.016***
Financial worries	4.75	3.65 ± 0.69	3.72 ± 0.96	3.41 ± 0.82	1.24	0.29
Emotional/mental health	5	4.1 ± 0.78	4.04 ± 0.75	3.9 ± 0.48	0.71	0.48
Diet satisfaction	5	3.43 ± 0.85	3.03 ± 0.92	3.2 ± 1.12	2.66	0.07

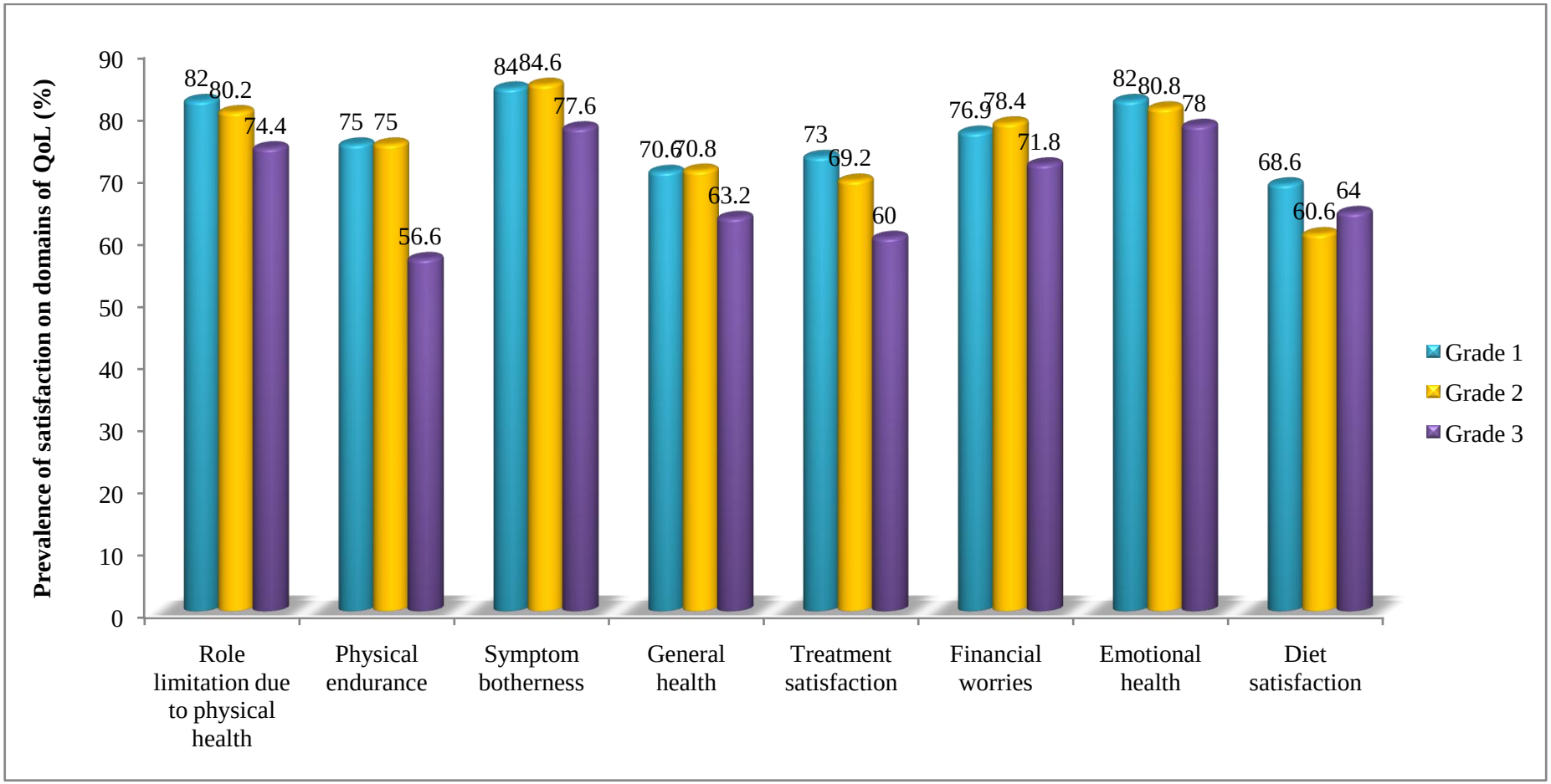
P<0.05*, p<0.01**, p<0.001***

TABLE 4.62: DIFFERENCES IN DOMAINS OF QUALITY OF LIFE BETWEEN GRADES OF HEPATIC STEATOSIS

Domains	P value		
	Grade 1 vs. Grade 2	Grade 1 vs. Grade 3	Grade 2 vs. Grade 3
Role limitation due to physical health	0.23	**0.0024****	**0.0024****
Physical endurance	0.96	**0.0005*****	**0.0001*****
Treatment satisfaction	0.21	**0.002****	**0.0067****

P<0.05*, p<0.01**,p<0.001***

FIG 4.31: PREVALENCE OF SATISFACTION IN DIFFERENT DOMAINS OF QUALITY OF LIFE IN TYPE 2 DIABETICS WITH NAFLD FROM GRADES OF HEPATIC STEATOSIS PERSPECTIVE (%)



DISCUSSION

The term ‘quality of life’ (QoL) is defined as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. The concept encompasses a broad sphere with factors like a person's physical health, psychological state, level of independence, social relationships, relationship to salient features of the environment, having an impact (Skevington et al., 2004). It is an individual perception (Glasgow and Osteen, 1992) and is influenced by a person’s ethnicity, culture, education and income (Nagpal et al., 2010).

Type 2 diabetic patients have to address several barriers while managing their disease, which, in turn, has an impact on self care behaviour, long term glycemic control, predisposition to developing long term complications and QoL (Rubin and Peyrot, 1999). A co-morbidity that is yet to get its share of recognition as an epidemic, having a major impact on the QoL of type 2 diabetics is NAFLD. There is a dearth of research to provide an insight into the QoL of type 2 diabetes patients with newly diagnosed NAFLD. Thus, the study was conducted with an attempt to assess the QoL of type 2 diabetes patients with newly confirmed NAFLD with the help of the quality of life instrument for Indian diabetes patients (QOLID) (Roy and Iyer, 2014).

The study found the physical endurance of the NAFLD patients compromised, especially among those with grade 3 hepatic steatosis. Needless to say, the ramifications would emerge in terms of productivity losses, mortality (David et al., 2009), significant increases in medical costs and health care utilization over time (Baumeister et al., 2008). It also highlights the potent effect of psychosocial factors on physical health outcomes (Rubin and Peyrot, 1999). The dietary domain was the second sphere that came under the lens of concern as it was the least scoring domain among the type 2 diabetic NAFLD subjects, especially among those with grade 1 and grade 2 hepatic steatosis. It is challenging enough for nutritionists and health care practitioners to deliver healthy eating alternatives with the available resources and meagre food choices while eating out. Also, lesser acceptance for healthy alternatives among diabetics, to opt for dietary diversification to suit and meet the nutritional needs, further adds to the problem (Roy and Iyer, 2014).

Compromised QoL in the present study further corroborates the evidence that NAFLD patients score poorly on QoL and especially health related QoL (Younossi et al., 2001; Younossi et al., 2001; Dan et al., 2007) and as the severity of the disease increases, there is a further decline in the QoL (Younossi et al., 2001; Younossi et al., 2001). Such trends ask for inclusion of strategies to improve QOL within the framework of treatment (David et al., 2009).

Evaluations of QoL as a significant technique for clinical research (Testa and Simonson, 1996; Thier, 1992), has led to the emergence of management strategies targeting the modifiable factors. Interventions focusing on improving the physical health status of type 2 diabetic patients have shown to have positive impacts on HbA1c, FBG, weight and BMI along with improvement in daily physical activity, mental health, subjective wellbeing and QoL (Thier, 1992). Improvements in physical health have also been observed regardless of the training modality (Myers et al., 2013). Thus, identification and intervention on modifiable factors associated with decreased QOL, may hold promise to improve QOL (David et al., 2009). From the health care delivery standpoint, there is a need to increase the capacity to deliver more intensive patient friendly management, utilize the exiting health care resources in the community to cater to the ever increasing numbers of type 2 diabetics (Krass and Dhippayom, 2013).

From the gender perspective, role limitation due to physical health was more evident amongst the females and males had a better tolerance in terms of physical endurance. Symptoms bothered the females more than the males. General health perceptions were found to be more favourable in males than the females. Males had better treatment satisfaction rates than the females. Finances involved in the management of diabetes caused more worries to the females than the males. Emotional and mental health scores reflected better status of males than the females. The above mentioned associations of gender differences were statistically significant. Diet satisfaction in totality, was found to be poor in both the genders. Restrictions while eating out, choosing foods that aren't diabetic friendly and while eating out were the common reported troubles.

To the best of knowledge, this is the first research that has documented QoL of type 2 diabetic patients with newly diagnosed NAFLD. In this study, diet and physical activity, emerged to be the core components wherein the QoL of these patients was found to be compromised. Being the elements of lifestyle modification, these issues can be addressed to bring about a favourable change in the QoL of these patients. Thus, integration of QOL along with the standard care protocol may improve many psychosocial elements, which, in turn, play a significant role in the holistic management of chronic disease (Roy and Iyer, 2014).

NAFLD is associated with impaired QOL (Younossi et al., 2001; Younossi et al., 2001; Dan et al., 2007; Afendy et al., 2009) as has also been corroborated in the present study. As the role played by psychosocial factors on self care, acceptance of therapeutic regimens and treatment success is being increasingly recognised (Bott et al., 1994; Dunn, 1986). Hence, induction of assessment of QoL as a core strategy for the management of diabetes and its subsequent co-morbidities like NAFLD, will help to enhance patient's health-related QoL and thereby potentially improve treatment compliance and hence their metabolic profile (Nagpal et al., 2010).

However, the study had its own sets of limitations. Type 2 diabetes patients who had a normal liver were excluded from this phase of the study. Hence, an analytical difference between the QoL of those with NAFLD and normal liver could not be derived. Moreover, QoL assessment was not a part of the post treatment lifestyle modification therapy assessment. Hence, the impact of LMT over QOL could not be derived.

CONCLUSIONS

The quality of life of type 2 diabetes patients with NAFLD is compromised. Diet satisfaction was the most compromised domain of QoL among these subjects. Males had a better QoL than the females. QoL assessment aids in identifying the modifiable factors that can be improved in order to provide holistic management of NAFLD or any other diseased condition.