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Original Article

Association of visible fat intake with serum liver enzymes in obese individuals

Ashni Sangappan Jayakumar [1], **Anuradha Ganesan** [1] *

[1] Department of Biochemistry, Chettinad Academy of Research and Education, Chettinad Hospital and Research Institute, Kelambakkam, Chengalpattu District, Tamil Nadu, India

* Correspondence to: Anuradha Ganesan, Department of Biochemistry, Chettinad Academy of Research and Education, Chettinad Hospital and Research Institute, Kelambakkam, Chengalpattu District, Tamil Nadu, India. E-mail: anuradhasankar79@gmail.com

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Abstract

Visible fat intake may adversely influence hepatic function and lipid metabolism. This study aimed to assess the association between visible fat consumption, liver enzyme biomarkers, and lipid profile in obese and non-obese individuals. A cross-sectional study was conducted from July to December 2023 in the Department of Biochemistry, Chettinad Hospital and Research Institute, Kelambakkam, India. One hundred subjects (20–70 years, both genders) were enrolled and stratified by BMI. Dietary visible fat intake, liver enzymes (ALT, AST, ALP, GGT), and lipid profile were analysed. Among obese males, AST (P=0.037) showed a significant correlation with visible fat, while ALP (P=0.01) correlated in obese females. Lipid analysis revealed associations in obese males with triglycerides (P=0.001), HDL (P=0.004), VLDL (P=0.001), and in obese females with triglycerides (P=0.003), HDL (P=0.043), LDL (P=0.039), and VLDL (P=0.003). Age-wise, ALT (P=0.048) and GGT (P=0.020) were significant in the 20–40 year group, ALP (P=0.000) in the 41–60 year group, and cholesterol, triglycerides, and VLDL in individuals over 60 years. ROC curve analysis revealed AST (AUC=0.95) and ALT (AUC=0.76) as accurate predictors. Visible fat intake is significantly linked with altered liver enzymes and lipid profile in obese individuals, highlighting dietary fat as a modifiable risk factor for hepatic and metabolic health.

Keywords: body mass index, obese, non obese, liver disease

Introduction

The rising occurrence of obesity is emerging as a significant global concern, with forecasts suggesting that by the year 2030, approximately 40% of the world's population will be overweight, and 20% will be classified as obese. Obesity is a widely acknowledged contributor to metabolic syndrome, a condition associated with severe chronic disorders like cardiovascular diseases, diabetes, and non-alcoholic fatty liver disease (NAFLD) [1, 2]. Recent investigations have proposed a potential connection between obesity and liver disease. Furthermore, obesity has the potential to adversely affect liver function through diverse pathways [3, 4].

The assessment of liver function often involves measuring the levels of four enzymes in the serum: alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), and γ-glutamyl transferase (GGT). ALT and AST, being primarily located in the liver, serve as specific indicators of liver dysfunction. GGT, found in various tissue cell membranes, exhibits its highest activity in biliary epithelial cells, pancreatic acinar cells, and renal tubular epithelial cells. ALP, an enzyme present in the liver, bones, intestine, and kidneys, is also part of this evaluation [5–7]. Elevated levels of ALP, AST, ALT, and GGT have been documented in various illnesses, and individuals with obesity frequently exhibit heightened concentrations of these enzymes [8].

Fats are a crucial part of our diet and have significant implications for both health and illness. Consuming excessive amounts of fats, particularly those derived from animal sources, raises blood cholesterol levels, which in turn can cause atherosclerosis and

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contribute to cardiovascular and other related diseases. Research has shown that Asian Indians exhibit among the highest rates of coronary artery disease and type 2 diabetes mellitus in comparison to other global populations [9]. Visible fats, such as ghee and butter, are derived from animal sources, while liquid fats, like those found in groundnut, mustard, sunflower, and safflower oils, are obtained from vegetable sources. Vanaspati oil, which is derived from vegetables, becomes a solid, visible fat after undergoing a process called "hydrogenation". Despite its popularity in India, it is highly harmful to one's health [10].

Obesity is linked to an abnormal lipid profile, which consists of total cholesterol, triglycerides, LDL cholesterol, and HDL cholesterol. These factors are modifiable and can be influenced by obesity. Research suggests that dyslipidemia, a condition characterized by high total cholesterol and LDL, low HDL, and high triglycerides, may increase the risk of prostate cancer. Additionally, dyslipidemia may also be connected to a higher tumour grade, as proven by abnormal low HDL levels being a strong predictor of high-risk disease. This association is particularly strong in liver cancer [11].

The relationship between visible fat and serum markers of liver enzymes in obese individuals, independent of dietary intake, remains unclear. Given the impact of altered liver enzymes on metabolic processes in the body, establishing a connection between visible fat and serum levels of liver enzymes in this study could provide insights into a potential mechanism by which obesity contributes to an elevated risk of various diseases, including fatty liver disease, diabetes, and cancer. Hence, the primary objective of this study was to explore the link between visible fat and serum levels of liver enzymes (AST, ALT, ALP, and GGT) in obese individuals. Additionally, the study aimed to investigate the correlation between serum lipid profiles, BMI, and liver enzymes in the obese population [12]. The study aimed to explore whether there is a slight association between visible fat and elevated levels of liver enzymes in obese individuals.

Material and methods

It was an age and sex matched cross sectional study. It was done among individuals who come for a Master health check-up at Chettinad Hospital and Research Institute, Kelambakkam. A total of 100 subjects, including both males and females aged between 20 and 70 years, were enrolled in the study. The participants were categorized as obese and non-obese individuals based on their BMI. Accordingly, 50 were obese individuals and 50 were non-obese individuals.

Exclusion criteria

Those suffering from systemic disorders (diabetes mellitus, hypothyroidism), pregnant women, lactating women, and those who consume alcohol were excluded from the study.

The study participants' dietary habits, including visible fat intake and demographic details, were collected using a semi-structured questionnaire. Anthropometric measurements like height and weight were measured through standard procedures, and BMI was computed using the formula (weight in kilograms divided by the square of height in meters). A 5 mL fasting blood sample was collected under sterile conditions for analysis of the lipid profile and liver enzymes, followed by automated processing using a Siemens chemistry analyzer.

Statistical analysis

Data analysis was performed using SPSS version 29 software. Descriptive statistics, including mean and standard deviation, were computed, and correlation analysis, specifically linear regression analysis, was conducted. A p-value below 0.05 was regarded as statistically significant. The independent t-test was employed to determine the significance between the groups. To compare the visible fat with LFT and lipid profiles in both genders, Pearson's correlation analysis was used.

Results

The general characteristics of the participants are presented in Table 1. A comparison of visible fat intake between obese and non-obese individuals revealed a significant p-value of 0.02. Serum total cholesterol showed a significant p-value of 0.00 on comparison between the two groups. There was no significant difference with respect to age, height, weight, BMI, and liver enzymes.

Correlation between visible fat intake and liver function test in both males and females is presented in Table 2. In Males, AST showed a significant correlation with visible fat intake (P-value=0.03), and in females, ALP showed a significant correlation (P-value=0.01).

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Table 1: Common characteristics of the participants.

	Obese (n=50)	Non-obese (n=50)	P-value
Age (year)	50.16±11.70	49.58±14.30	0.27
Height (m)	158.60±4.57	158.86±4.30	0.26
Weight (kg)	74.04±5.36	58.70±4.55	0.31
BMI (kg/m²)	29.25±1.94	22.68±1.27	0.63
Visible fat intake (g)	76.60±15.08	43.38±12.50	**0.02** *
Liver profile			
AST	68.62±23.73	23.28±9.89	0.64
ALT	49.58±18.83	31.92±15.10	0.88
ALP	100.54±46.71	75.78±19.79	0.68
GGT	44.74±37.04	36.76±29.46	0.76
Lipid profile			
Total Cholesterol (mg/dl)	221.58±18.57	157.02±26.07	**0.00** *
Triglycerides (mg/dl)	136.24±71.26	114.38±55.67	0.25
HDL(mg/dl)	41.98±9.51	39.80±9.54	0.82
LDL (mg/dl)	148.0±25.57	93.21±24.75	0.11
VLDL (mg/dl)	27.72±14.18	22.90±11.27	0.24

Note: * – P-value less than 0.05 level is significantly correlate. AST – Aspartate aminotransferase; ALT – Alanine aminotransferase; ALP – alkaline phosphatase; GGT – Gamma-glutamyl transferase; HDL – High-density lipoprotein; LDL – Low-density lipoprotein; VLDL – very low-density lipoprotein.

Table 3 shows the correlation between visible fat intake and lipid profile in both genders. In Males, Serum triglycerides and VLDL showed significant positive correlation, and HDL showed negative correlation with visible fat intake. In Females, serum triglycerides, LDL, and VLDL showed significant positive correlation, and HDL showed negative correlation with visible fat intake.

Pearson correlation between visible fat intake and LFT in different age groups is presented in Table 4. In the age group between 20 and 40, ALT showed a significant correlation with visible fat intake. ALP showed a significant correlation in the 41–60 age group.

Pearson correlation between visible fat intake and Lipid profile in different age groups is presented in Table 5. In the age group between 20 and 40, triglycerides,

Table 2: Correlation between visible fat intake and LFT with gender (male and female).

Liver enzymes	Male			Female		
	Mean±SD	P-value	r-value	Mean±SD	P-value	r-value
AST	41.16 ±16.27	**0.03** *	0.419	0.170±14.48	0.80	0.052
Visible fat intake	70.0±15.27	**0.03** *	0.419	78.07±14.70	0.80	0.052
ALT	48.96±24.36	0.09	0.338	50.38±11.10	0.08	0.345
Visible fat intake	70.0±15.27	0.09	0.338	78.07±14.70	0.08	0.345
ALP	78.76±25.16	0.23	0.246	122.1±52.16	**0.01** *	0.449
Visible fat intake	70.0±15.27	0.23	0.246	78.07±14.70	**0.01** *	0.449
GGT	52.72±44.91	0.07	0.363	36.23±25.14	0.11	0.317
Visible fat intake	70.0±15.27	0.07	0.363	78.07±14.70	0.11	0.317

Note: * – P-value less than 0.05 level is significantly correlate. AST – Aspartate aminotransferase; ALT – Alanine aminotransferase; ALP – alkaline phosphatase; GGT – Gamma-glutamyl transferase.

Table 3: Correlation between visible fat intake and lipid profile with gender (male and female).

Lipid profile	Male			Female		
	Mean±SD	P-value	r-value	Mean±SD	P-value	r-value
Total cholesterol	221.36±15.34	0.57	0.119	220.96±21.63	0.11	0.280
visible fat intake	70.0±15.27	0.57	0.119	78.07±14.70	0.11	0.280
Triglycerides	145.20±74.26	**0.00** *	0.602	128.63±67.45	**0.00** *	0.565
visible fat intake	70.0±15.27	**0.00** *	0.602	78.07±14.70	**0.00** *	0.565
HDL	41.80±8.63	**0.00** *	- 0.556	41.92±10.35	**0.04** *	-0.400
visible fat intake	70.0±15.27	**0.00** *	-0.556	78.07±14.70	**0.04** *	-0.400
LDL	145.32±25.47	0.12	-0.314	149.92±25.66	**0.03** *	0.408
visible fat intake	70.0±15.27	0.12	-0.314	78.07±14.70	**0.03** *	0.408
VLDL	29.12±14.80	**0.00** *	0.601	26.57±13.48	**0.00** *	0.567
visible fat intake	70.0±15.27	**0.00** *	0.601	78.07±14.70	**0.00** *	0.567

Note: * – P-value less than 0.05 level is significantly correlate. HDL – High-density lipoprotein; LDL – Low-density lipoprotein; VLDL – very low-density lipoprotein.

Table 4: Correlation between visible fat and LFT with age groups.

Liver enzymes	Age groups								
	20–40 (n=11)			41–60 (n=30)			>60 (n=10)		
	Mean±SD	P-value	r-value	Mean±SD	P-value	r-value	Mean±SD	P-value	r-value
AST	37.72±20.02	0.11	0.500	42.20±14.75	0.76	0.057	51.70±6.46	0.73	0.739
visible fat	70.90±19.21	0.11	0.500	72.66±13.37	0.76	0.057	82.00±15.49	0.73	0.739
ALT	57.45±31.94	**0.04** *	0.607	46.30±13.02	0.64	0.088	51.30±11.75	0.48	0.253
visible fat	70.90±19.21	**0.04** *	0.607	72.66±13.37	0.64	0.088	82.00±15.49	0.48	0.253
ALP	86.18±40.75	0.65	0.154	103.03±47.71	**0.00** *	0.611	110.50±48.43	0.27	0.386
visible fat	70.90±19.21	0.65	0.154	72.66±13.37	**0.00** *	0.611	82.00±15.49	0.27	0.386
GGT	48.72±38.21	**0.02** *	0.687	43.73±39.87	0.66	0.083	38.20±26.61	0.23	0.414
visible fat	70.90±19.21	**0.02** *	0.687	72.66±13.37	0.66	0.083	82.00±15.49	0.23	0.414

Note: * – P-value less than 0.05 level is significantly correlate. AST – Aspartate aminotransferase; ALT – Alanine aminotransferase; ALP – alkaline phosphatase; GGT – Gamma-glutamyl transferase.

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Table 5: Correlation between visible fat and lipid profile with age group.

Lipid enzymes	Age groups								
	20–40 (n=11)			41–60 (n=30)			>60 (n=10)		
	Mean±SD	P-value	r-value	Mean±SD	P-value	r-value	Mean±SD	P-value	r-value
Total cholesterol	217.54±16.65	0.59	0.183	221.70±18.04	0.93	-0.17	232.50±23.42	**0.04** *	0.643
visible fat	70.90±19.21	0.59	0.183	72.66±13.37	0.93	-0.17	82.00±15.49	**0.04** *	0.643
Triglycerides	134.45±94.78	**0.02** *	0.664	129.60±51.72	0.28	0.201	160.90±91.13	**0.00** *	0.808
visible fat	70.90±19.21	**0.02** *	0.664	72.66±13.37	0.28	0.201	82.00±15.49	**0.00** *	0.808
HDL	40.81±8.56	**0.02** *	-0.676	42.6±8.73	0.68	-0.338	41.30±12.79	0.09	-0.558
visible fat	70.90±19.21	**0.02** *	-0.676	72.66±13.37	0.68	-0.338	82.00±15.49	0.09	-0.558
VDL	140.72±32.38	0.52	-0.213	151.0±24.48	0.50	0.125	145.30±19.79	0.07	0.585
visible fat	70.90±19.21	0.52	-0.213	72.66±13.37	0.50	0.125	82.00±15.49	0.07	0.585
VLDL	26.90±18.87	**0.02** *	0.660	26.73±10.35	0.21	0.234	32.10±18.24	**0.00** *	0.809
visible fat	70.90±19.21	**0.02** *	0.660	72.66±13.37	0.21	0.234	82.00±15.49	**0.00** *	0.809

Note: * – P-value less than 0.05 level is significantly correlate. HDL – High-density lipoprotein; LDL – Low-density lipoprotein; VLDL – very low-density lipoprotein.

Table 6: Independent t-test association between age group with obese and non-obese (BMI).

Age group	BMI					
	Mean±SD		t-value		P-value	
	Obese	Non-obese	Obese	Non-obese	Obese	Non-obese
20–40 **Obese (n=11)** **Non-obese (n=16)**	32.36±4.96	32.96±6.49	0.86	0.86	0.93	0.93
41–60 **Obese (n=30)** **Non-obese (n=19)**	52.36±5.57	51.15±5.71	0.732	0.732	0.46	0.46
>60 **Obese (n=9)** **Non-obese (n=15)**	64.55±3.08	65.73±3.86	0.776	0.776	0.44	0.44

Note: * – P-value less than 0.05 level is significantly correlate.

Table 7: Independent t-test association between visible fat intake and obese and non-obese (BMI).

	BMI					
	Mean±SD		t-value		P-value	
	Obese N=50	Non-obese N=50	Obese N=50	Non-obese N=50	Obese N=50	Non-obese N=50
Visible fat intake	73.60±15.08	43.38±12.50	10.90	10.90	**0.00** *	**0.00** *

Note: * – P-value less than 0.05 level is significantly correlate.

Table 8: Independent t-test association between LFT and obese and non-obese (BMI).

Liver enzymes	BMI					
	Mean±SD		t-value		P-value	
	Obese N=50	Non-obese N=50	Obese N=50	Non-obese N=50	Obese N=50	Non-obese N=50
AST	68.62±23.73	23.28±9.89	12.46	12.46	0.00	0.00
ALT	49.58±18.83	31.92±15.10	5.17	5.17	0.00	0.00
ALP	100.54±46.71	75.58±19.79	3.47	3.47	0.01	0.01
GGT	44.74±37.04	33.76±29.46	1.640	1.640	0.10	0.10

Note: * – P-value less than 0.05 level is significantly correlate. AST – Aspartate aminotransferase; ALT – Alanine aminotransferase; ALP – alkaline phosphatase; GGT – Gamma-glutamyl transferase

Table 9: Independent t-test association between lipid profile and obese and non-obese (BMI).

Lipid profile	BMI					
	Mean±SD		t-value		P-value	
	Obese N=50	Non-obese N=50	Obese N=50	Non-obese N=50	Obese N=50	Non-obese N=50
Total cholesterol	221.58±18.57	157.02±26.07	14.25	14.25	**0.00** *	**0.00** *
Triglycerides	136.24±71.26	114.38±55.67	1.709	1.709	0.09	0.09
HDL	41.98±9.51	39.80±9.54	1.144	1.144	0.25	0.25
LDL	148.0±25.57	93.12±24.72	10.91	10.91	**0.00** *	**0.00** *
VLDL	27.27±14.18	22.90±11.27	1.880	1.880	0.63	0.63

Note: * – P-value less than 0.05 level is significantly correlate. HDL – High-density lipoprotein; LDL – Low-density lipoprotein; VLDL – very low-density lipoprotein.

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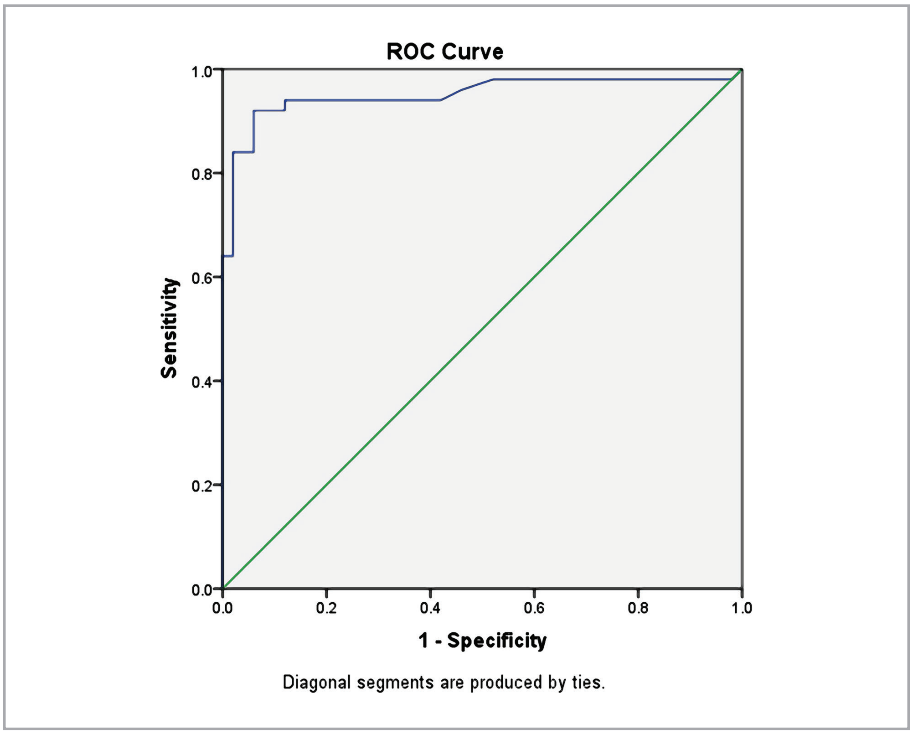

Figure 1: ROC curve – AST with visible fat (obese and non-obese). AST – Aspartate aminotransferase.

Table 10: ROC curve – AST with visible fat (obese and non-obese). AST – Aspartate aminotransferase.

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower bound	Upper bound
.950	.024	.000	.903	.998

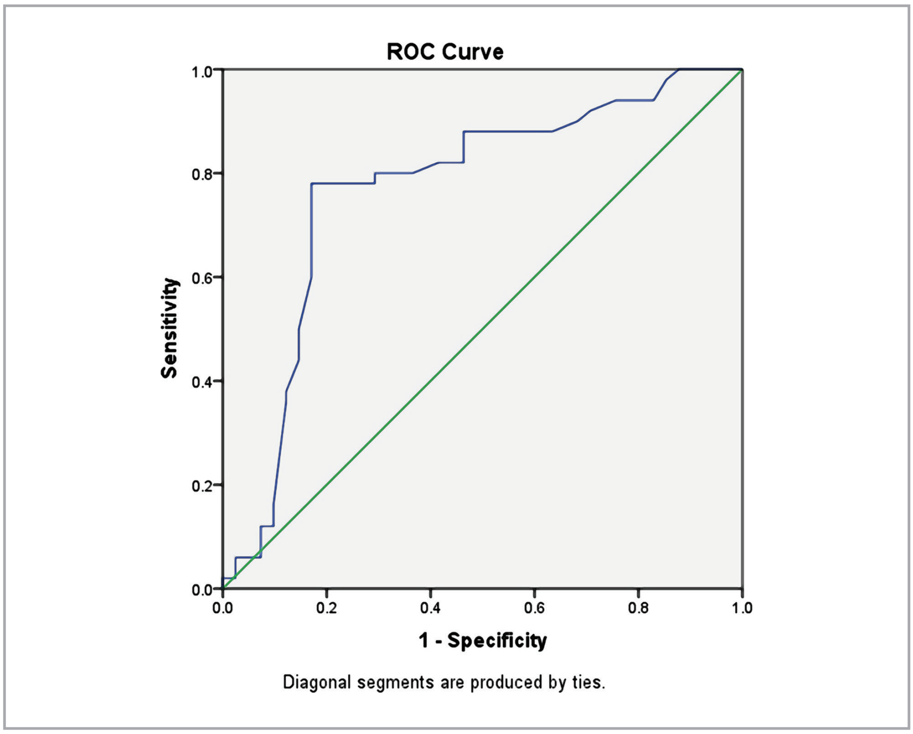

Figure 2: ROC curve – ALT with visible fat (obese and non-obese). ALT – Alanine aminotransferase.

Table 11: ROC curve – ALT with visible fat (obese and non-obese). ALT – Alanine aminotransferase.

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower bound	Upper bound
.769	.053	.000	.664	.873

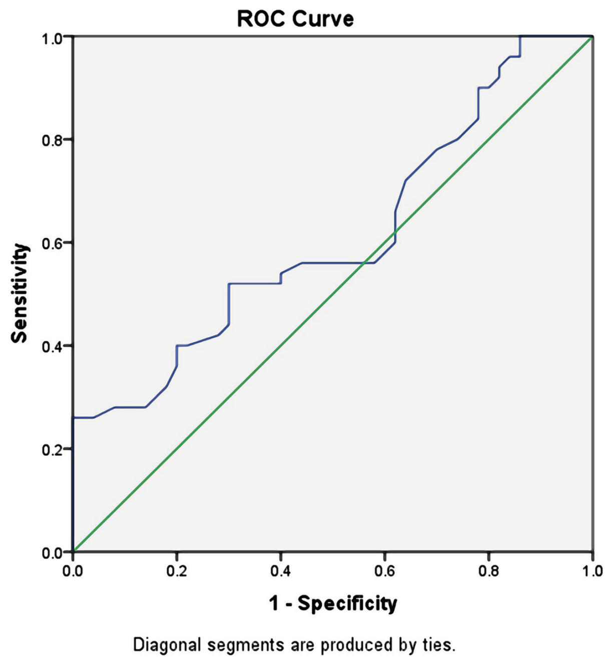

Figure 3: ROC curve – ALP with visible fat (obese and non-obese). ALP – alkaline phosphatase.

HDL, and VLDL showed significant correlation with visible fat intake. Total cholesterol, triglycerides, and VLDL showed a significant correlation in the group aged more than 60 years.

By an independent t-test, the BMI of obese and non-obese individuals was compared with different age groups in Table 6, visible fat intake in Table 7, LFT in Table 8, and lipid profile in Table 9. Liver enzymes, including AST, ALT, and ALP, showed a significant association, as did the lipid profile, specifically total cholesterol and LDL. Table 6 shows the Independent t-test association between age groups and obese and non-obese individuals (BMI).

Table 7 shows the Independent t-test association between visible fat intake and obesity and non-obesity (BMI). Table 8 shows the Independent t-test association between the LFT profile and obese and non-obese individuals (as indicated by BMI). Table 9 shows the Independent t-test association between lipid profile and obesity (BMI). Figure 1 and Table 10 show an AUC of 0.950 for AST, indicating a high level of accuracy for the test. Figure 2 and Table 11 show an AUC of 0.769 for ALT, implying significant accuracy of the test. Figure 3 and Table 12 show an AUC of 0.611for ALP, implying significant accuracy of the test. Figure 4 and Table 13 show an AUC of 0.626 for GGT, implying significant accuracy of the test.

Table 12: ROC curve – ALP with visible fat (obese and non-obese). ALP – alkaline phosphatase.

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower bound	Upper bound
.611	.057	.055	.500	.722

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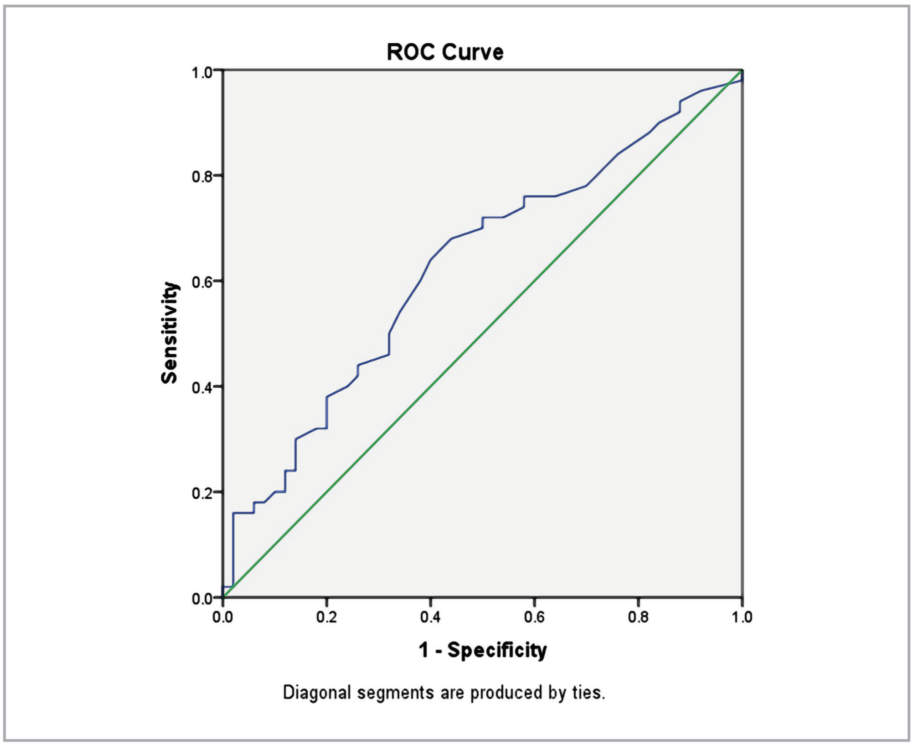

Figure 4: ROC curve – GGT with visible fat (obese and non-obese). GGT – Gamma-glutamyl transferase.

Discussion

The present study was conducted to study the effects of visible fat intake on liver function. A considerable relationship was found between liver enzymes (AST, ALT, and ALP) and BMI, indicating that obesity can deteriorate liver function. These findings are in accordance with the study conducted by Marchesini *et al.* [13].

The reason behind this association is not yet very clear. Liver tissues may be subjected to increased oxidative stress, and hence, DNA methylation occurs when individuals become obese. Moreover, in obesity, several inflammatory markers, such as adipokines and tumor necrosis factor-alpha, are secreted. This, in turn, triggers liver inflammation. In addition, obese individuals are at increased risk of steatosis, hence liver injury leading to abnormal liver enzyme levels in the serum [14].

Interestingly, the findings of the present study were more pronounced in females than in males, possibly due to hormonal variations. However, unlike Nurshad *et al.* [15], our study did not find a significant association between obesity and GGT levels.

Few studies have found a significant association between liver enzymes and HOMA-IR (Homeostatic Model Assessment for Insulin Resistance) [16]. Hence, obese individuals with abnormal liver enzymes are more prone to metabolic disorders like diabetes mellitus later in life. Regular monitoring of liver function tests in individuals with obesity may help reduce mortality and morbidity.

The study's limitations include its relatively small sample size, which may have impacted the accuracy and generalizability of the findings. A larger sample size could have provided more robust and reliable results. Additionally, the study did not collect data on other macronutrients, such as carbohydrates and proteins. Including these measurements would have allowed for a more comprehensive and detailed analysis of the outcomes.

Table 13: ROC curve – GGT with visible fat (obese and non-obese). GGT – Gamma-glutamyl transferase.

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower bound	Upper bound
.626	.056	.030	.516	.736

Conclusion

The findings of this study demonstrate a clear and significant association between visible fat intake and alterations in serum liver enzyme levels as well as lipid profile parameters among obese individuals aged 20 to 70 years in the Kelambakkam population. Elevated intake of visible fat was particularly associated with abnormal levels of AST, ALT, ALP, and GGT, as well as disturbances in triglycerides, HDL, LDL, VLDL, and total cholesterol, with variations observed across gender and age groups. The strong predictive value shown by ROC curve analysis, especially for AST and ALT, further underscores the relevance of visible fat consumption as a determinant of hepatic and metabolic health. These results highlight the importance of dietary fat quality and quantity as modifiable risk factors that could be targeted to prevent or mitigate liver dysfunction and dyslipidemia in obese individuals. Therefore, lifestyle interventions that focus on reducing visible fat intake may play a vital role in promoting long-term metabolic well-being.

Conflict of interest

The authors declare no conflict of interest.

Ethics approval

The approval for this study was obtained from the Ethics Committee of Chettinad. Academy of Research and Education (CARE IHEC I) (Approval ID: IHEC-I/2075/23).

Consent to participate

Written informed consent was obtained from all the participants.

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