Original Article

Association between body mass index and liver stiffness measurement using transient elastography in patients with non-alcoholic fatty liver disease in a hepatology clinic: a cross sectional study

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Background: Transient elastography (TE) is an FDA approved, non-invasive tool to estimate liver stiffness measurement (LSM) in patients with non-alcoholic fatty liver disease (NAFLD). Our aim was to analyze if body mass index (BMI) would predict the severity of liver stiffness using TE scores.

Methods: We performed a cross-sectional study of patients with NAFLD who presented to the hepatology clinic between January 2019 through January 2021. Fibrosis severity was divided into the following categories: F0 to F1 (2–7 kPa), F2 (>7 to 10 kPa), F3 (>10 to 14 kPa) and F4 (>14 kPa). We used ordered logistic regression models to determine the odds ratio (OR) and 95% confidence interval (CI) of having a higher LSM severity compared to lower associated with BMI. Models were adjusted for patient demographics and comorbidities.

Results: Among 284 patients, 56.7% were females, and the median (interquartile range, IQR) age was 62 [51–68] years and BMI 31.9 (28.1, 36.2) kg/m^2; 47% of patients were in the F0 to F1 stage, 24% F2, 16% F3, and 13% F4. The correlation between BMI and TE score was 0.31 (P<0.001). With 1 kg/m^2 increase in BMI there was 1.10 times higher odds of having a higher LSM severity (adjusted OR, 1.10; 95% CI: 1.05–1.14). Compared to patients with BMI <25 kg/m^2, the adjusted OR (95% CI) of having a higher fibrosis stage was 1.82 (0.61–5.44), 5.93 (2.05–17.13), and 8.56 (2.51–29.17) for patients with BMI of 25 to <30, 30 to <40, and ≥40 respectively.

Conclusions: BMI correlates with the severity of LSM using TE scores in NAFLD patients even after adjusting for potential confounding variables. This suggests TE as an appreciable study for liver stiffness even in obese individuals.

Keywords: Transient elastography (TE); non-alcoholic fatty liver disease (NAFLD); body mass index (BMI); obesity; liver stiffness measurement (LSM)

Received: 04 January 2022; Accepted: 08 April 2022; Published: 25 January 2023.

doi: 10.21037/tgh-22-1

View this article at: https://dx.doi.org/10.21037/tgh-22-1

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Introduction

Non-alcoholic fatty liver disease (NAFLD) is defined as the presence of ≥5% hepatic steatosis in the absence of significant alcohol consumption or alternative etiologies that cause fat accumulation in the liver. NAFLD is classified based on histology into non-alcoholic fatty liver (NAFL) without hepatocellular injury or non-alcoholic steatohepatitis (NASH) with hepatocellular injury and with or without fibrosis (1). Overall, the global prevalence of NAFLD is estimated to be around 25%, making it the most prevalent chronic liver disease worldwide. The prevalence of NASH is estimated to be around 3–4% (2). Currently, NAFLD is thought to be the third most common cause of hepatocellular cancer in the United States (3). NASH is now the second leading cause of liver transplantation and is soon expected to overtake Hepatitis C as the number one cause (4). NAFLD is associated with components of the metabolic syndrome, which includes obesity, glucose intolerance, dyslipidemia, and hypertension (5). Among metabolic syndrome, obesity in particular is associated with a higher risk of NAFLD, and the alarming rise in the prevalence of obesity parallels the steady rise in NAFLD globally (6). Among patients with diabetes the global prevalence of NAFLD and NASH is 55.5% and 37.3% respectively (7). The prevalence of ultrasonographic evidence of NAFLD in patients with type 2 diabetes can be as high as 70%, although this association is bidirectional (8). Liver biopsy is considered the gold standard for the diagnosis of NASH (9); however, it is an invasive procedure and is associated with sampling error for a variety of reasons including the length of the biopsy core, the presence of unfragmented core and the variability in interpretation among different pathologists (10). Transient elastography (FibroScan®, TE) is an FDA approved, non-invasive tool to estimate liver stiffness measurement (LSM) in patients with NAFLD (11). The optimal LSM cutoff for advanced fibrosis (stage 3 and 4) is estimated to be 9.9 kilopascals (kPa). TE can be used to rule out advanced fibrosis and avoid unnecessary biopsy in patients with LSM less than 7.9 kPa (12). The presence of fibrosis, especially stage 2 to 4 are important histologic features independently predictive of overall and liver related mortality in NAFLD patients (13). In patients with body mass index (BMI) between 27.1 to 40.1 kg/m^2, TE can be used for the estimation of LSM with a failure rate of less than 2.5% and reliability rate more than 95% (14). Studies have also shown that TE can be used as a reliable test for detection of advanced fibrosis even in severely obese patients with an average BMI of 43 kg/m^2 (15). Our aim was to analyze if BMI would predict the severity of LSM using TE scores. We hypothesized that higher BMI would be positively associated with a higher TE score. We present the following article in accordance with the STROBE reporting checklist (available at https://tgh.amegroups.com/article/view/10.21037/tgh-22-1/rc).

Methods

The study was a retrospective cross-sectional study of patients presenting to a Hepatology Clinic, Digestive Disease Associates in Baltimore, Maryland.

Study population

A total of 310 patients with known NAFLD attended the hepatology clinic at Digestive Disease Associates between January 2019 and January 2021. Among them, 284 patients who underwent TE were included in the study.

We excluded patients with age less than 18 years, significant alcohol use (defined as more than 21 standard drinks per week in men and more than 14 standard drinks per week in women over a 2-year period (16), fatty liver due to other pathology including chronic viral hepatitis, alcoholic liver disease, medication induced hepatic steatosis, autoimmune hepatitis, hemochromatosis, and Wilson disease. Patients without a TE were also excluded.

Data collection

The following variables were collected on each patient: age, gender, BMI (kg/m^2), ethnicity, LSM using TE (kPa), abdominal ultrasound findings, liver biopsy results (if available), comorbidities including hypertension, dyslipidemia, diabetes, and hypothyroidism.

BMI was classified into 4 categories: normal BMI <25 kg/m^2, overweight BMI 25 to <30 kg/m^2, obese BMI 30 to <40 kg/m^2 and severely obese BMI ≥40 kg/m^2 (17).

TE

FibroScan® model 502 V2 Touch (Echosens, Paris, France) containing medium (M) and extra-large (XL) probes was used to assess the liver stiffness. The FibroScan® used was equipped with an automatic probe selection tool that recommended the appropriate probe for each

Table 1 Fibrosis staging as per liver stiffness measurement

	Fibrosis stage			
	F0–F1	F2	F3	F4
Liver stiffness measurement (kPa)	2–7	>7–10	>10–14	>14

kPa, kilopascal.

patient according to real time assessment. The scans were performed by a single trained operator who has performed more than 500 determinations. The M probe was used initially unless the machine indicated the need for XL probe. Patients underwent fasting for at least 4 hours prior to the exam. At least 10 measurements with an interquartile range (IQR)/median of ≤30% was considered a requirement for a reliable test and the median measurement was used. LSM values were expressed in kPa.

TE scoring:

Based on the fibrosis scoring, the TE results were divided into four categories F0–F1, F2, F3, F4 (*Table 1*).

F3 and F4 represented advanced fibrosis.

Statistical analysis

We described baseline characteristics of included patients as medians and IQR for continuous variables and frequencies and percentages for categorical variables. Kruskal-Wallis and Chi-square tests were used as appropriate. We categorized LSM measurements into the fibrosis stages (F0–F1, F2, F3, and F4) as described above. For our main analysis, we used ordered logistic regression models to determine the odds ratio (OR) and 95% confidence interval (CI) of having a higher fibrosis stage compared to lower, associated with patient BMI. We ensured that the proportional odds assumption was not violated using the likelihood ratio test. We analyzed BMI as a categorical variable (25 to <30, 30 to <40, ≥40 compared to <25 and as ≥40 compared to <40 kg/m^2) and as a continuous variable (per 1 unit increment). We adjusted our models for age, sex, and race (model 2) and additional for diabetes, hypertension, hyperlipidemia, and hypothyroidism (model 3). Model 1 was unadjusted. We performed our analysis using Stata version 15 and considered a P value <0.05 to be statistically significant.

Ethical approval

This study was approved by the Institutional Review Board at Saint Agnes Healthcare (No. IORG0005451). All procedures in the study were done according to the ethical standards of the institutional review board. The study was exempted from needing consent as it was based on chart review. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Results

Baseline characteristics of the study population

The study included 284 patients with a median (IQR) age of 62 [51–68] years and BMI of 31.9 (28.1–36.2) kg/m^2. Twenty-six percent of the patients were overweight, 53.2% had class I & II obesity and 12.3% were severely obese (BMI ≥40). The median (IQR) LSM was 7.3 (5.5–10.8) kPa. The number of patients with fibrosis stage F0 to F1, F2, F3, and F4 was 134 (47.2%), 68 (23.9%), 45 (15.9%), and 37 (13.0%) respectively with 28.9% having advanced fibrosis (F3 or more). As shown in *Table 2*, 56.7% of the study population were females, 66.2% white, 78.2% were aged ≥50 years, 35.2% had diabetes, 62.7% hypertension, 60.9% hyperlipidemia, and 17.6% hypothyroidism. The median BMI and proportion of patients with diabetes and hypertension increased across the categories of fibrosis stage (*Table 2*). Tables S1,S2 show the baseline characteristics of patients stratified by BMI.

Association between BMI and fibrosis stage

There was a significant positive correlation between BMI and LSM (Spearman's rho =0.31, P<0.001). Compared to patients with BMI <25 kg/m^2, the unadjusted OR (95%) of having a higher fibrosis stage was 1.80 (0.65–4.98), 4.96 (1.90–12.94), and 7.43 (2.48–22.28) for patients with BMI of 25 to <30, 30 to <40, and ≥40 respectively. In our adjusted models, having a BMI 30 to <40, and ≥40 remained significantly associated with having a higher fibrosis stage (*Table 3*). Every 1 kg/m^2 increment in BMI was associated with an adjusted OR 1.10 (95% CI: 1.05–1.14) of having a higher fibrosis stage (*Table 3*). Similarly, patients with a BMI ≥40 kg/m^2 had higher odds of having a higher fibrosis stage compared with those <40 kg/m^2 with OR 2.05 (95% CI: 1.01–4.14) in a fully adjusted model (*Table 4*). The

Table 2 Baseline characteristics of patients by Fibrosis stage

Characteristics	Total	F0 to F1 (2–7 kPa)	F2 (>7 to 10 kPa)	F3 (>10 to 14 kPa)	F4 (>14 kPa)	P value*
N	284	134	68	45	37	–
Fibrosis score (kPa)	7.3 (5.5–10.8)	5.5 (4.6–6.3)	8.3 (7.7–9.3)	11.7 (10.8–12.5)	20.6 (16.6–26.4)	<0.001
Age (years)	62 [51–68]	60 [50–66]	61 [48.5–69]	62 [56–68]	63 [52–70]	0.28
BMI (kg/m^2)	31.9 (28.1–36.2)	30.3 (26.5–34.7)	32.6 (29.4–35.8)	33.4 (30.4–37.8)	34.3 (31.3–39.2)	<0.001
Age (years), n (%)						0.16
<50	62 (21.8)	33 (24.6)	18 (26.5)	5 (11.1)	6 (16.2)	
≥50	222 (78.2)	101 (75.4)	50 (73.5)	40 (88.9)	31 (83.8)	
Sex, n (%)						0.28
Female	161 (56.7)	83 (61.9)	33 (48.5)	26 (57.8)	19 (51.4)	
Male	123 (43.3)	51 (38.1)	35 (51.5)	19 (42.2)	18 (48.7)	
BMI, n (%)						0.001
<25	24 (8.5)	18 (13.4)	4 (5.9)	2 (4.4)	0 (0)	
25 to <30	74 (26)	47 (35.1)	15 (22.1)	7 (15.6)	5 (13.5)	
30 to <40	151 (53.2)	58 (43.3)	41 (60.3)	28 (62.2)	24 (64.9)	
≥40	35 (12.3)	11 (8.2)	8 (11.8)	8 (17.8)	8 (21.6)	
Race, n (%)						0.82
White	188 (66.2)	84 (62.7)	46 (67.7)	33 (73.3)	25 (67.6)	
Black	46 (16.2)	27 (20.2)	9 (13.2)	6 (13.3)	4 (10.8)	
Asian	25 (8.8)	10 (7.5)	7 (10.3)	3 (6.7)	5 (13.5)	
Others	25 (8.8)	13 (9.7)	6 (8.8)	3 (6.7)	3 (8.1)	
Diabetes, n (%)						<0.001
No	184 (64.8)	102 (76.1)	45 (66.2)	25 (55.6)	12 (32.4)	
Yes	100 (35.2)	32 (23.9)	23 (33.8)	20 (44.4)	25 (67.6)	
Hypertension, n (%)						0.04
No	106 (37.3)	56 (41.8)	29 (42.7)	9 (20)	12 (32.4)	
Yes	178 (62.7)	78 (58.2)	39 (57.4)	36 (80)	25 (67.6)	
Hyperlipidemia, n (%)						0.80
No	111 (39.1)	52 (38.8)	28 (41.2)	19 (42.2)	12 (32.4)	
Yes	173 (60.9)	82 (61.2)	40 (58.8)	26 (57.8)	25 (67.6)	
Hypothyroidism, n (%)						0.19
No	234 (82.4)	109 (81.3)	53 (77.9)	42 (93.3)	30 (81.1)	
Yes	50 (17.6)	25 (18.7)	15 (22.1)	3 (6.7)	7 (18.9)	

Values are medians (interquartile range) for continuous variables and frequency (percent) for categorical variables. *, P values are derived Kruskal-Wallis test for continuous variables and Chi-square test for categorical variables. kPa, kilopascal; BMI, body mass index.

Table 3 The association between categorized BMI and having a higher fibrosis stage

Model	BMI (kg/m^2)				Per 1 kg/m^2 increment in BMI
	<25	25 to <30	30 to <40	≥40	
Model 1	1 (reference)	1.80 (0.65–4.98)	4.96 (1.90–12.94)*	7.43 (2.48–22.28)*	1.10 (1.06–1.14)*
Model 2	1 (reference)	1.80 (0.63–5.20)	5.78 (2.10–15.91)*	11.9 (3.71–38.11)*	1.11 (1.07–1.16)*
Model 3	1 (reference)	1.82 (0.61–5.44)	5.93 (2.05–17.13)*	8.56 (2.51–29.17)*	1.10 (1.05–1.14)*

*, statistically significant. Model 1, unadjusted; model 2, adjusted for age, sex, and race; model 3, model 2 + diabetes, hypertension, hyperlipidemia, and hypothyroidism. BMI, body mass index.

Table 4 The association between having a BMI of 40 kg/m^2 or more and having a higher fibrosis stage

Model	BMI ≥40 *vs.* <40 kg/m^2 [odds ratios (95% CI)]	P value
Model 1	2.23 (1.17–4.24)*	0.02
Model 2	3.07 (1.56–6.06)*	0.001
Model 3	2.05 (1.01–4.14)*	0.046

*, are statistically significant. Model 1, unadjusted; model 2, adjusted for age, sex, and race; model 3, model 2 + diabetes, hypertension, hyperlipidemia, and hypothyroidism. BMI, body mass index; CI, confidence interval.

association between BMI and fibrosis stage did not differ by race (P>0.05).

Discussion

NAFLD is diagnosed by having evidence of hepatic steatosis on imaging or histology with no history of significant alcohol consumption and no other competing etiologies that can cause hepatic steatosis or coexisting causes of chronic liver disease (1). Components of metabolic syndrome, especially obesity and diabetes mellitus, are among the major risk factors for NAFLD (6,18). In a study done in China, obesity was found to be an independent and dose-dependent risk factor for fatty liver (19). In this study about 65.5% of patients were obese (BMI >30 kg/m^2) with a median BMI of 31.9 kg/m^2, 35.2% were diabetic and 62.7% were hypertensive. The prevalence of obesity in this study is almost the same as the one found in a large population-based study in Olmsted County, Minnesota, which showed the prevalence of obesity to be 68% with a median BMI of 33 kg/m^2 (20). The prevalence of metabolic comorbidities in this study is much higher than in the global epidemiology study done by Younossi *et al.*, in which among NAFLD patients the prevalence of obesity was 51.3%, diabetes 22.5% and hypertension 39.3% (2). This could be because about 78.2% of the study population was older than 49 years of age and may be partially related to the growing obesity epidemic.

Elevated BMI has strong and well-established associations with diabetes mellitus, hypertension and dyslipidemia (21-23), this study also showed a significant increase in the proportion of patients with diabetes, hypertension and hyperlipidemia as BMI increases. These associations make the worsening obesity epidemic a major public health concern (23), tackling this epidemic might be the biggest challenge in healthcare. NAFLD is not only seen in obesity, it also affects patients with normal BMI termed as lean NAFLD. According to a recent meta-analysis, the global prevalence of lean NAFLD is about 19.2% (24). In this study population only 8.5% of patients had normal BMI.

More than half (56.7%) of the population in this study were females which is nearly the same as the large population based NAFLD study done in Minnesota where 52% of the study population were females (20). Studies have shown that men are at a higher risk for NAFLD compared to women (25), but women with NAFLD have a higher risk of advanced fibrosis compared to men (26).

Liver biopsy is the gold standard in diagnosing NASH, but it is invasive and impractical to perform in all patients with a suspicion for NAFLD (10). Currently, specific blood tests are not available to differentiate NASH from simple steatosis (27); hence, non-invasive diagnostic methods such as TE or magnetic resonance elastography (MRE) should be considered. MRE is found to be more accurate in diagnosing liver fibrosis compared to TE (28); however, MRE is expensive and may not be widely available as compared to TE. TE is a reliable and rapid study which can be performed at the bedside to measure liver stiffness (29). Liver stiffness of 10 kPa and above was chosen in this study

to define advanced fibrosis (12). The presence of fibrosis stage 2 and above in histology is known to be predictive of mortality in NAFLD patients (13).

We found that there is a significant association between BMI and fibrosis score. This association remains significant even after adjusting for confounding variables including age, sex, race, diabetes, hypertension, and hyperlipidemia. The correlation between BMI and TE score is 0.31 (P<0.001). The reason for this positive correlation could be the fact that obesity is a known risk factor for NAFLD, especially NASH.

This study showed a significant increase in median BMI with increases in fibrosis stage and also significant increase in the median fibrosis score with increasing BMI. Compared to the group with normal BMI, there was a significant increase in the proportion of patients with advanced fibrosis (TE stage 3 and 4) in the obese and severely obese group. With every 1 kg/m^2 increase in BMI there is 1.10 (P<0.001) odds of increase in LSM by TE.

Strengths and limitations

Strengths

All patients diagnosed with NAFLD and who had TE during the specific time period were included in the study thereby avoiding selection bias. Possible confounding factors were adjusted using ordered logistic regression models. The fact that the positive correlation between BMI and TE score persisted even after adjusting for confounding factors is a strength for the study.

Limitations

Compared to the global lean NAFLD prevalence of 19.2%, the prevalence of lean NAFLD in this study population was only 8.5%. The difference in the cut offs for overweight and obesity among different Asian populations is not clearly defined; for this reason, we used the WHO general classification for BMI in this study (30). This is a single center study. Liver biopsy, which is the gold standard, was not available for comparison with the TE results.

Conclusions

The results of this study showed that among patients with NAFLD there is a positive correlation between BMI and TE score, even after adjusting for confounding variables. This suggests TE is an adequate tool for the evaluation of liver stiffness in obese individuals. With increasing BMI, worsening liver stiffness was seen on TE. Additionally, we found that with increasing BMI, there was an increase in the number of patients with diabetes, hypertension and hyperlipidemia which is expected to have a negative effect on health outcomes as all of these are individual risk factors for NAFLD and seem to be interdependent as well. This is more concrete evidence and a forewarning for the potential consequences of the growing obesity epidemic and its detrimental health effects.

Acknowledgments

The abstract has been presented for Abstract Presentation at the 2021 AASLD Liver Meeting.
Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tgh.amegroups.com/article/view/10.21037/tgh-22-1/rc

Data Sharing Statement: Available at https://tgh.amegroups.com/article/view/10.21037/tgh-22-1/dss

Peer Review File: Available at https://tgh.amegroups.com/article/view/10.21037/tgh-22-1/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tgh.amegroups.com/article/view/10.21037/tgh-22-1/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Institutional Review Board at Saint Agnes Healthcare (No. IORG0005451). All procedures in the study were done according to the ethical standards of the institutional review board. The study was exempted from needing consent as it was based on chart review.

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doi: 10.21037/tgh-22-1
Cite this article as: Gopalakrishna H, Fashanu OE, Nair GB, Ravendhran N. Association between body mass index and liver stiffness measurement using transient elastography in patients with non-alcoholic fatty liver disease in a hepatology clinic: a cross sectional study. Transl Gastroenterol Hepatol 2023;8:10.

Supplementary

Table S1 Baseline characteristics of patients by BMI

Characteristics	Total	BMI (kg/m^2)				P value*
		<25	25 to <30	30 to <40	¡Ý40	
N	284	24	74	151	35	
Fibrosis score (kPa)	7.35 (5.5–10.75)	5.35 (4.6–7.1)	6.2 (5.1–8.6)	8.3 (5.9–11.7)	9.5 (6.5–13.5)	<0.001
Age (years)	62 (51–68)	59.5 (51–67)	62 (52–69)	63 (51–68)	54 (38–64)	0.04
BMI (kg/m^2)	31.94 (28.1–36.2)	23.615 (22.88–24.365)	27.33 (26.5–28.7)	33.83 (31.7–35.84)	41.91 (41.03–44.15)	<0.001
Age (years)						
<50	62 (21.8%)	5 (20.8%)	15 (20.3%)	28 (18.5%)	14 (40%)	0.049
≥50	222 (78.2%)	19 (79.2%)	59 (79.7%)	123 (81.5%)	21 (60%)	
Sex						0.11
Female	161 (56.7%)	18 (75%)	44 (59.5%)	77 (51%)	22 (62.9%)	
Male	123 (43.3%)	6 (25%)	30 (40.5%)	74 (49%)	13 (37.1%)	
Race						0.02
White	188 (66.2%)	14 (58.3%)	40 (54.1%)	106 (70.2%)	28 (80%)	
Black	46 (16.2%)	4 (16.7%)	12 (16.2%)	27 (17.9%)	3 (8.6%)	
Asian	25 (8.8%)	5 (20.8%)	12 (16.2%)	7 (4.6%)	1 (2.9%)	
Others	25 (8.8%)	1 (4.2%)	10 (13.5%)	11 (7.3%)	3 (8.6%)	
Diabetes						<0.001
No	184 (64.8%)	21 (87.5%)	55 (74.3%)	95 (62.9%)	13 (37.1%)	
Yes	100 (35.2%)	3 (12.5%)	19 (25.7%)	56 (37.1%)	22 (62.9%)	
Hypertension						0.01
No	106 (37.3%)	14 (58.3%)	35 (47.3%)	43 (28.5%)	14 (40%)	
Yes	178 (62.7%)	10 (41.7%)	39 (52.7%)	108 (71.5%)	21 (60%)	
Hyperlipidemia						0.01
No	111 (39.1%)	11 (45.8%)	36 (48.6%)	46 (30.5%)	18 (51.4%)	
Yes	173 (60.9%)	13 (54.2%)	38 (51.4%)	105 (69.5%)	17 (48.6%)	
Hypothyroidism						0.55
No	234 (82.4%)	22 (91.7%)	61 (82.4%)	124 (82.1%)	27 (77.1%)	
Yes	50 (17.6%)	2 (8.3%)	13 (17.6%)	27 (17.9%)	8 (22.9%)	
Fibrosis stage**						0.001
F0 to F1	134 (47.2%)	18 (75%)	47 (63.5%)	58 (38.4%)	11 (31.3%)	
F2	68 (23.9%)	4 (16.7%)	15 (20.3%)	41 (27.2%)	8 (22.9%)	
F3	45 (15.9%)	2 (8.3%)	7 (9.5%)	28 (18.5%)	8 (22.9%)	
F4	37 (13.0%)	0 (0%)	5 (6.8%)	24 (15.9%)	8 (22.9%)	

Values are medians (interquartile range) for continuous variables and frequency (percent) for categorical variables. *, P values are derived Kruskal-Wallis test for continuous variables and Chi-square test for categorical variables; **, please refer to *Table 1*. BMI, body mass index; kPa, kilopascals.

https://dx.doi.org/10.21037/tgh-22-1

Table S2 Baseline characteristics of patients by BMI

Characteristics	Total	BMI (kg/m^2)		P value*
		<40	≥40	
N	284	249	35	
Fibrosis score (kPa)	7.3 (5.5–10.8)	7.2 (5.5–10.3)	9.5 (6.5–13.5)	0.01
Age (years)	62 (51–68)	62 (52–68)	54 (38–64)	0.01
BMI (kg/m^2)	31.94 (28.1–36.2)	31.3 (27.4–34.4)	41.9 (41–44.1)	<0.001
Age (years)				0.005
<50	5 (20.8%)	48 (19.28%)	14 (40%)	
≥50	19 (79.2%)	201 (80.72%)	21 (60%)	
Sex				0.43
Female	18 (75%)	139 (55.82%)	22 (62.86%)	
Male	6 (25%)	110 (44.18%)	13 (37.14%)	
Race				0.24
White	14 (58.3%)	160 (64.26%)	28 (80%)	
Black	4 (16.7%)	43 (17.27%)	3 (8.57%)	
Asian	5 (20.8%)	24 (9.64%)	1 (2.86%)	
Others	1 (4.2%)	22 (8.84%)	3 (8.57%)	
Diabetes				<0.001
No	21 (87.5%)	171 (68.67%)	13 (37.14%)	
Yes	3 (12.5%)	78 (31.33%)	22 (62.86%)	
Hypertension				0.73
No	14 (58.3%)	92 (36.95%)	14 (40%)	
Yes	10 (41.7%)	157 (63.05%)	21 (60%)	
Hyperlipidemia				0.11
No	11 (45.8%)	93 (37.4%)	18 (51.4%)	
Yes	13 (54.2%)	156 (62.6%)	17 (48.6%)	
Hypothyroidism				0.38
No	22 (91.7%)	207 (83.1%)	27 (77.1%)	
Yes	2 (8.3%)	42 (16.87%)	8 (22.9%)	
Fibrosis stage**				0.09
F0 to F1	18 (75%)	123 (49.4%)	11 (31.4%)	
F2	4 (16.7%)	60 (24.1%)	8 (22.9%)	
F3	2 (8.3%)	37 (14.9%)	8 (22.9%)	
F4	0 (0%)	29 (11.7%)	8 (22.9%)	

Values are medians (interquartile range) for continuous variables and frequency (percent) for categorical variables. *, P values are derived Kruskal-Wallis test for continuous variables and Chi-square test for categorical variables; **, please refer to Table 1. BMI, body mass index; kPa, kilopascal.

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