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Graphical abstract

Management of people with, or at risk of, NAFLD before the gastroenterology or liver clinic	UK results
1. Services should have an agreed local clinical pathway for the investigation of suspected liver disease that includes an assessment for liver fibrosis using available non-invasive liver fibrosis tests	85.3%
2. Individuals referred to secondary care with suspected NAFLD should have their non-invasive fibrosis staging (*e.g.* FIB-4 score or NAFLD fibrosis score) documented in the referral letter	27.9%
Investigations and management in secondary care	**UK results**
3. People with NAFLD should have their weight and BMI documented	73.2%
4. People with NAFLD should have an alcohol history documented and advice given, where appropriate	
a) Documented	77.6%
a) Advice given where appropriate	39.2%
5. People with NAFLD should have a smoking history documented and advice given, where appropriate	
a) Documented	54.90%
a) Advice given where appropriate	13.70%
6. People with NAFLD should undergo liver fibrosis staging using available non-invasive tests or liver biopsy	79.1%
7. Patients with NAFLD should be screened for Type 2 diabetes	33.0%
Diabetic patients advised on optimising diabetes control	38.3%
8. People with NAFLD should be screened for hypertension	19.3%
Patients with hypertension advised on optimising BP control	17.4%
9. Patients with NAFLD should have weight loss advice documented including objective goals for weight change and physical activity	
a) Assessment of physical activity	38.1%
a) Assessment of dietary habits	37.6%
a) Exercise advice given	55.1%
a) Weight loss target given	32.1%
a) Tailored dietary advice	35.7%
10. Patients who are at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) should be offered statin treatment in accordance with NICE guidelines	9.1%
11. Patients should be provided with written information about NAFLD and weight management and/or signposted to credible information sources	18.3%

Highlights

- This study identified significant variation in the management of NAFLD in the UK.
- Non-invasive fibrosis assessment was only performed in 27.9% of patients with suspected NAFLD.
- Greater emphasis on the management of associated cardiometabolic risk factors is warranted in individuals with NAFLD.
- Fibrosis evaluation and cardiometabolic risk management were more likely within hospitals with a multidisciplinary NAFLD service.
- Further work is needed to align guideline recommendations and real-world practice in NAFLD care.

Impact and implications

This study identified significant variation in the management of NAFLD in the UK. Only 27.9% of patients with suspected NAFLD had non-invasive fibrosis assessment performed to identify those at greater risk of advanced liver disease before specialist referral. Greater emphasis is needed on the management of associated cardiometabolic risk factors in individuals with NAFLD. Hospitals with multidisciplinary NAFLD service provision had higher rates of fibrosis evaluation and assessment and management of cardiometabolic risk than hospitals without multidisciplinary services. Further work is needed to align guideline recommendations and real-world practice in NAFLD care.

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Research article

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National study of NAFLD management identifies variation in delivery of care in the UK between 2019 to 2022

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Background & Aims: Non-alcoholic fatty liver disease (NAFLD) is associated with liver and cardiovascular morbidity and mortality. Recently published NAFLD Quality Standards include 11 key performance indicators (KPIs) of good clinical care. This national study, endorsed by British Association for the Study of the Liver (BASL) and British Society of Gastroenterology (BSG), aimed to benchmark NAFLD care in UK hospitals against these KPIs.

Methods: This study included all new patients with NAFLD reviewed in the outpatient clinic in the months of March 2019 and March 2022. Participating UK hospitals self-registered for the study through BASL/BSG. KPI outcomes were compared using Fisher's exact or Chi-square tests.

Results: Data from 776 patients with NAFLD attending 34 hospitals (England [25], Scotland [four], Wales [three], Northern Ireland [two]) were collected. A total of 85.3% of hospitals reported established local liver disease assessment pathways, yet only 27.9% of patients with suspected NAFLD had non-invasive fibrosis assessment documented at the point of referral to secondary care. In secondary care, 79.1% of patients had fibrosis assessment. Assessment of cardiometabolic risk factors including obesity, type 2 diabetes, hypertension, and smoking were conducted in 73.2%, 33.0%, 19.3%, and 54.9% of all patients, respectively. There was limited documentation of diet (35.7%) and exercise advice (55.1%). Excluding those on statins, only 9.1% of patients with NAFLD at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) had documented discussion of statin treatment. Significant KPI improvements from 2019 to 2022 were evident in use of non-invasive fibrosis assessment before secondary care referral, statin recommendations, and diet and exercise recommendations.

Conclusions: This national study identified substantial variation in NAFLD management in the UK with clear areas for improvement, particularly fibrosis risk assessment before secondary care referral and management of associated cardiometabolic risk factors.

Impact and implications: This study identified significant variation in the management of NAFLD in the UK. Only 27.9% of patients with suspected NAFLD had non-invasive fibrosis assessment performed to identify those at greater risk of advanced liver disease before specialist referral. Greater emphasis is needed on the management of associated cardiometabolic risk factors in individuals with NAFLD. Hospitals with multidisciplinary NAFLD service provision had higher rates of fibrosis evaluation and assessment and management of cardiometabolic risk than hospitals without multidisciplinary services. Further work is needed to align guideline recommendations and real-world practice in NAFLD care.

Introduction

Non-alcoholic fatty liver disease (NAFLD) is the most common chronic liver disease, with an estimated global prevalence of 30%[1] and represents a spectrum of liver disease that ranges from benign steatosis to the inflammatory form, non-alcoholic steatohepatitis (NASH),[2] which can result in liver fibrosis and eventual cirrhosis, leading to significantly increased morbidity and mortality.[3,4] Although NAFLD progression to NASH and fibrosis is associated with a range of liver-related sequelae including liver cirrhosis and hepatocellular carcinoma, the leading cause for mortality in patients diagnosed with NAFLD is cardiovascular disease.[5] NAFLD and cardiovascular disease share many modifiable cardiometabolic risk factors, including obesity, hypertension, and type 2 diabetes (T2DM). Therefore, assessing and addressing liver fibrosis progression and drivers of cardiovascular disease are critical for the holistic management of NAFLD. This is reflected universally in national and international

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guidelines on NAFLD management[6–8] as well as proposed models of care for NAFLD.[9–11] Despite this, two studies to date have demonstrated variations in NAFLD management and delivery of care. One study was conducted in the UK[12] and the other was a multinational study involving France, Germany, Italy, Spain, UK, Canada, United Arab Emirates, and Kingdom of Saudi Arabia.[13]

In 2016, a national qualitative survey of care standards in assessment and management of NAFLD was conducted in the UK involving secondary care specialists (Gastroenterologists and Hepatologists) from 84 hospitals.[14] The survey identified priority areas for service improvement and delivery of care including streamlining abnormal liver blood test referral pathways, defining non-invasive fibrosis assessment algorithms, and managing metabolic risk factors associated with NAFLD.[7] However, until recently, little practical guidance was available to support delivery of care and standardise evidence-based clinical management of patients with NAFLD. To address this unmet need, the British Association for the Study of the Liver (BASL) and British Society of Gastroenterology (BSG) NAFLD Special Interest Group (SIG) produced evidence-based quality standard recommendations, with the aim of standardising the implementation of good holistic care in people with NAFLD.[15] Outlined within the Quality Standards are 11 auditable key performance indicators (KPIs), which cover management of NAFLD patients before referral to secondary care (two KPIs) and management in secondary care (nine KPIs). Before secondary care referrals, KPIs address assessment of services with local clinical pathways for the investigation of suspected liver disease using available non-invasive liver fibrosis tests and documentation of fibrosis risk at the point of referral to secondary care outpatient clinic. The secondary care KPIs address assessments for weight/body mass index, alcohol and smoking history, liver fibrosis assessment using available non-invasive tests or liver biopsy, screening for T2DM and hypertension, cardiovascular risk assessment, and recorded patient advice including weight loss strategies and patient education resources.

The primary aim of this study is to assess clinical practice in NAFLD management across the UK and benchmark against the Quality Standards KPIs to identify actionable areas to improve future care of patients with NAFLD. The secondary aim is to describe the changes in service delivery and clinical practice in NAFLD across the UK since 2016.

Patients and methods

Study design

The BASL NAFLD SIG designed a web-based data collection proforma (https://docs.google.com/forms/d/1TeIdDjjBf3ed_MlXoelFMqCX6POs_1Lw5UQpRlLbAEE/prefill) which contained 23 questions focusing on service-related infrastructure, anonymised patient demographic and clinical information and KPI-related outcomes. Service-related data acquired for each hospital included type of hospital according to NHS-defined level of specialist hepatology service provision[16] (level 1 – district general hospital without specialist hepatology services; level 2 – hospitals with specialist hepatology services other than liver transplantation; level 3 – liver transplant unit), type of outpatient consultation (face-to-face or virtual consultation) and availability of multidisciplinary services to manage NAFLD (expertise in clinical hepatology, management of diabetes and cardiovascular risk factors, lifestyle intervention and health promotion [diet and exercise/physical activity]). Patient demographic and clinical information included age, sex, ethnicity (according to UK Census), metabolic comorbidities and management of liver disease and cardiometabolic risk factors. KPI-related outcomes were measured according to quality standards recommendations.[15]

This study was endorsed and publicised by BASL and BSG. Participating hospitals self-registered for the study through BSG and BASL websites (https://www.bsg.org.uk/news/non-alcoholic-fatty-liver-disease-nafld-national-audit/https://www.basl.org.uk/index.cfm/content/page/cid/40). Each participating hospital identified all new patients (first consultation) reviewed in gastroenterology and hepatology outpatient clinics in the months of March 2019 and March 2022 and collected anonymised outpatient healthcare record data through clinical records available from all patients referred with any of the following indications: (1) management of suspected or known clinical diagnosis of NAFLD; (2) radiological evidence of liver steatosis; (3) unexplained abnormal liver blood tests; (4) calculated non-invasive liver scores indicating indeterminate or high risk of liver fibrosis (Fibrosis-4 [FIB-4] score >1.30, NAFLD fibrosis score >-1.455, Enhanced Liver Fibrosis [ELF] score >9.5) according to BSG guideline.[7] Exclusion criteria were patients under the age of 18 years at time of review, documented history of excessive alcohol consumption or AUDIT-C score of ≥5, other non-NAFLD liver diagnoses, previous history of liver decompensation events, previous liver transplantation, current or previous history of hepatocellular carcinoma, active non-liver malignancy or known pregnancy at time of clinic visit. One electronic survey submission was made per patient. Data were collected between May and November 2022.

Data analysis

Categorical data were analysed using Fisher's exact tests (two groups) or Chi-square test (≥3 groups). Results were reported as number (%) and *p* value reported across subgroups. Data were analysed using SPSS version 25 (SPSS, Inc. Chicago, IL, USA) and GraphPad Prism version 9.1.1. (GraphPad Software, San Diego, CA, USA) Longitude and latitude coordinates of each participating site was plotted using QGIS version 3.24 to generate the study map.

Results

Data from 776 new patients with NAFLD patients were recorded (374 from 2019, 402 from 2022) from 34 UK hospitals (25 in England, three in Wales, two in Northern Ireland and four in Scotland) (Fig. 1). Seventeen out of 34 hospitals were level 1 centres (240 patients), 12 were level 2 centres (361 patients) and five were level 3 centres (175 patients). Twenty-one out of 34 hospitals had multidisciplinary services to manage patients with NAFLD.

The mean age of the population was 52.7 years (SD ± 14.4), 55.2% were male and the two largest ethnicities were White (63.4%) and Asian/Asian British (14.1%) (Fig. 2). A total of 84.9% of patients were overweight or obese, 40.5% had hypertension, 37.4% had T2DM and 35.3% had dyslipidaemia. The majority of referrals were from primary care (80.9%) and the most common indications for referral were unexplained abnormal liver blood tests (70.4%), radiological evidence of steatosis (49.6%) and raised non-invasive liver scores (17.7%) (Fig. 3). The majority of the patients were reviewed in clinic by consultant hepatologists or gastroenterologists (50.9% and 17.3%, respectively), doctors

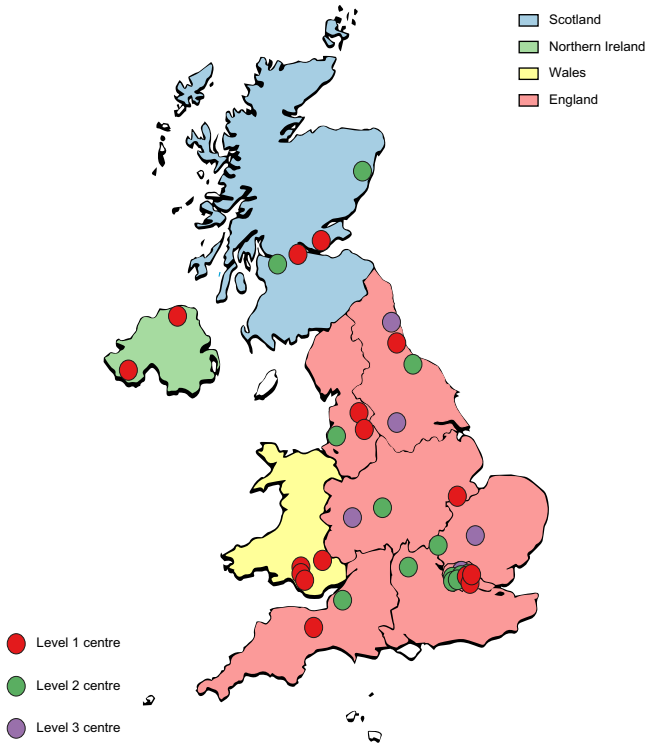


Fig. 1. Map of participating UK centres. Level 1 – district general hospital without specialist hepatology services; level 2 – hospitals with specialist hepatology services other than liver transplantation; level 3 – liver transplant unit.

in a training grade (24.2%) or nurse specialists (1%). A total of 78.7% of all consultations were conducted in person and the rest virtually. Of all virtual consultations, 96.5% occurred in 2022.

A total of 85.3% of services reported established local liver disease assessment pathways, yet only 27.9% of patients with suspected NAFLD had non-invasive fibrosis assessment documented at point of referral to secondary care (Table 1). Use of non-invasive fibrosis assessments were similar in both primary care and secondary care referrals (29.4% *vs.* 26.5% respectively, $p = 0.596$).

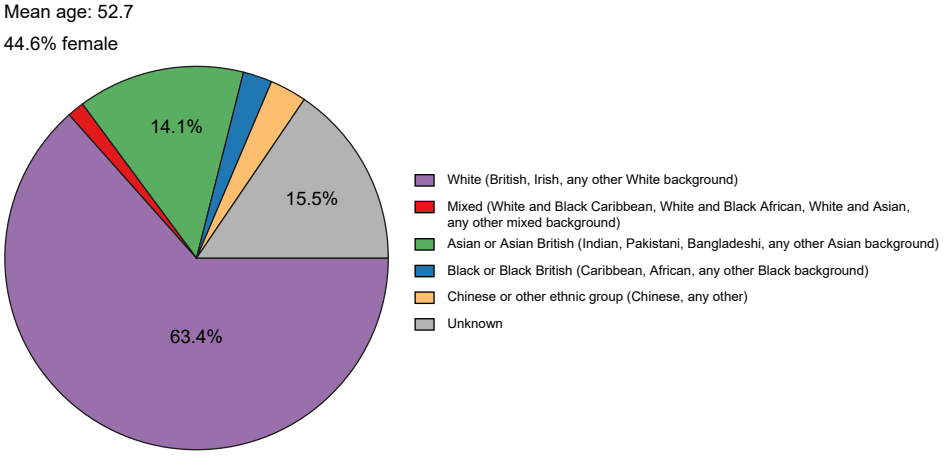
In patients without non-invasive liver fibrosis assessment, 79.0% were referred from areas with established local liver disease assessment pathways. The most widely used non-invasive fibrosis assessment used at point of referral was FIB-4 score (46.1%), followed by NAFLD Fibrosis Score (17.2%) and transient elastography (16.4%).

In secondary care, 79.1% of patients had fibrosis assessment with non-invasive fibrosis tests or liver biopsy. Overall, 30.7% of patients had low risk of advanced fibrosis (FIB-4 score <1.30 or NAFLD Fibrosis Score <-1.455, Fibroscan <8 kPa, absence of fibrosis on liver biopsy). In patients without non-invasive fibrosis assessment at point of referral to secondary care, 34.6% had low-risk of advanced fibrosis and therefore may not have required secondary care review. There was considerable variation in the assessment of cardiometabolic risk factors with only 73.2% having a documented BMI and 54.9% a smoking history, whereas screening for T2DM and hypertension was documented in 33.0% and 19.3%, respectively. Moreover, the documentation showed that appropriate advice to address cardiometabolic risk factors was given infrequently; 13.7% of people who smoke received smoking cessation advice; 38.3% of patients with diabetes received advice on optimising diabetes control and 17.4% of patients with hypertension received advice on blood pressure control. Documentation of lifestyle advice was also infrequent with 32.1% receiving weight loss target and 55.1% receiving exercise advice. Excluding patients already taking statins, only 9.1% of patients with NAFLD patients at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) were advised statin treatment in line with NICE (National Institute for Health and Care Excellence) guidelines.[17] Finally, alcohol history was documented in 77.6% of patients and appropriate advice was documented in 39.2% of patients.

In patients without evidence of fibrosis assessment in secondary care, assessments for metabolic risk factors were conducted in 19.6% for T2DM, 11.1% for hypertension, 47% for smoking, and 2.0% for cardiovascular risk. In addition, 30.7% and 25.8% were assessed for dietary habits and physical activity levels, respectively.

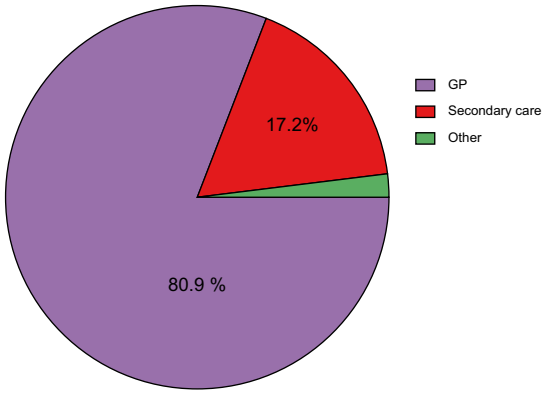
2019 *vs.* 2022

Significant improvements were observed in seven out of 11 KPIs between 2019 and 2022 (Table 2). Notably, non-invasive fibrosis



Comorbidities	
Type 2 diabetes	267 (37.4%)
Hypertension	289 (40.5%)
Dyslipidaemia	252 (35.3%)
Overweight or obese	605 (84.9%)

Fig. 2. Patient demographics.



Reasons for referral	
Unexplained abnormal LFTs	545 (70.4%)
Radiological evidence of steatosis	384 (49.6%)
Evidence of cirrhosis	38 (4.9%)
Non-invasive liver scores	137 (17.7%)
Fibrosis assessment from other speciality	23 (3%)
Other	70 (9%)

Fig. 3. Patient referral details.

assessment at referral increased from 20.8% to 35.1% (p <0.01), statin recommendations in patients with NAFLD patients at increased cardiovascular risk increased from 4.3% to 12.5% (p = 0.012) and providing patient information material regarding NAFLD increased from 11.6% to 24.5% (p <0.01). Improvements were also seen for assessment of physical activity (33.7–42.3%, p = 0.0147) and dietary habits (28.9–45.8%, p <0.01), and providing tailored dietary advice (25.9–44.7%, p <0.01). However, no significant changes were observed in the number of hospitals with established local liver referral pathways, documentation of weight/BMI, weight loss advice, alcohol history, and liver fibrosis assessments in secondary care.

Table 1. UK key performance indicator (KPI) results.

Management of people with, or at risk of, NAFLD before the gastroenterology or liver clinic	N	Overall (%)
1. Services should have an agreed local clinical pathway for the investigation of suspected liver disease that includes an assessment for liver fibrosis using available non-invasive liver fibrosis tests	34	85.3
2. Individuals referred to secondary care with suspected NAFLD should have their non-invasive fibrosis staging (*e.g.* FIB-4 score or NAFLD fibrosis score) documented in the referral letter.	776	27.9
Investigations and management in secondary care		
3. People with NAFLD should have their weight and BMI documented	776	73.2
4. People with NAFLD should have an alcohol history documented and advice given, where appropriate		
(a) Documented	776	77.6
(b) Advice given where appropriate	474	39.2
5. People with NAFLD should have a smoking history documented and advice given, where appropriate		
(a) Documented	776	54.9
(b) Advice given where appropriate	256	13.7
6. People with NAFLD should undergo liver fibrosis staging using available non- invasive tests or liver biopsy	776	79.1
Transient elastography/Fibroscan requested/performed	776	74.0
ELF requested	776	5.9
Ultrasound Acoustic Radiation Force Impulse (ARFI) requested	776	0.5
NFS score calculated	776	2.2
FIB-4 score calculated	776	17.7
Liver biopsy	776	6.4
7. Patients with NAFLD should be screened for type 2 diabetes	776	33.0
Diabetic patients advised on optimising diabetes control	334	38.3
8. People with NAFLD should be screened for hypertension	776	19.3
Patients with hypertension advised on optimising BP control	385	17.4
9. Patients with NAFLD should have weight loss advice documented including objective goals for weight change and physical activity.		
(a) Assessment of physical activity	776	38.1
(b) Assessment of dietary habits	776	37.6
(c) Exercise advice given	733	55.1
(d) Weight loss target given	728	32.1
(e) Tailored dietary advice	737	35.7
10. Patients who are at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) should be offered statin treatment in accordance with NICE guidelines	339	9.1
11. Patients should be provided with written information about NAFLD and weight management and/or signposted to credible information sources	717	18.3

ELF, Enhanced Liver Fibrosis; FIB-4, Fibrosis 4; N, total number of recorded responses for each KPI; NAFLD, non-alcoholic fatty liver disease; NFS, NAFLD fibrosis score; NICE, National Institute for Health and Care Excellence, Overall, percentage of positive responses for each KPI; T2DM, type 2 diabetes mellitus.

Table 2. UK key performance indicator (KPI) results comparing 2019 *vs.* 2022.

Management of people with, or at risk of, NAFLD before the gastroenterology or liver clinic	N	2019 (%)	N	2022 (%)	*p* value
1. Services should have an agreed local clinical pathway for the investigation of suspected liver disease that includes an assessment for liver fibrosis using available non-invasive liver fibrosis tests	34	85.3	34	88.2%	>0.99
2. Individuals referred to secondary care with suspected NAFLD should have their non-invasive fibrosis staging (e.g. FIB-4 score or NAFLD fibrosis score) documented in the referral letter	374	20.8	402	35.1%	**<0.01**
Investigations and management in secondary care					
3. People with NAFLD should have their weight and BMI documented	374	75.7	402	70.9	0.14
4. People with NAFLD should have an alcohol history documented and advice given, where appropriate					
(a) Documented	374	79.9	402	75.4	0.14
(b) Advice given where appropriate	223	32.3	251	45.4	**<0.01**
5. People with NAFLD should have a smoking history documented and advice given, where appropriate					
(a) Documented	374	61.0	402	49.3	**<0.01**
(b) Advice given where appropriate	111	10.8	145	15.9	0.27
6. People with NAFLD should undergo liver fibrosis staging using available non- invasive tests or liver biopsy	374	77.8	402	80.3	0.43
Transient elastography/Fibroscan requested/performed	374	72.5	402	75.4	0.37
ELF requested	374	5.3	402	6.5	0.55
Ultrasound Acoustic Radiation Force Impulse (ARFI) requested	374	0.5	402	0.5	>0.99
NFS score calculated	374	3.2	402	1.2	0.08
FIB-4 score calculated	374	17.1	402	18.2	0.71
Liver biopsy	374	7.5	402	5.5	0.31
7. Patients with NAFLD should be screened for T2DM	374	33.2	402	32.8	0.94
Diabetic patients advised on optimising diabetes control	160	33.8	174	42.5	0.11
8. People with NAFLD should be screened for hypertension	374	17.1	402	21.4	0.15
Patients with hypertension advised on optimising blood pressure control	188	11.7	197	22.8	**<0.01**
9. Patients with NAFLD should have weight loss advice documented including objective goals for weight change and physical activity					
(a) Assessment of physical activity	374	33.7	402	42.3	**0.01**
(b) Assessment of dietary habits	374	28.9	402	45.8	**<0.01**
(c) Exercise advice given	349	51.3	384	58.6	0.05
(d) Weight loss target given	352	29.0	376	35.1	0.08
(e) Tailored dietary advice	352	25.9	385	44.7	**<0.01**
10. Patients who are at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) should be offered statin treatment in accordance with NICE guidelines	139	4.3	200	12.5	**0.01**
11. Patients should be provided with written information about NAFLD and weight management and/or signposted to credible information sources	346	11.6	371	24.5	**<0.01**

Bold values signifies significant p <0.05.
2019, percentage of positive responses for each KPI in 2019; 2022, percentage of positive responses for each KPI in 2022.
ELF, Enhanced Liver Fibrosis; FIB-4, Fibrosis 4; N, total number of recorded responses for each KPI; NAFLD, non-alcoholic fatty liver disease; NFS, NAFLD fibrosis score; NICE, National Institute for Health and Care Excellence; T2DM, type 2 diabetes mellitus.

Presence *vs.* absence of multidisciplinary services for NAFLD care

Compared with hospitals without multidisciplinary services to manage patients with NAFLD, hospitals with multidisciplinary services were more likely to assess liver fibrosis by transient elastography (80.9% *vs.* 63.1%, p <0.01), screen for T2DM (39.1% *vs.* 23.2%, p <0.01), hypertension (21.4% *vs.* 15.4%, p = 0.05) and provide advice to address cardiometabolic risk including alcohol use, diabetes control, diet, exercise and weight loss target (Table 3). Greater proportion of patients in multidisciplinary services received advice about alcohol consumption (57.7% *vs.* 33.3%, p <0.01), optimising diabetes control (42.4% *vs.* 29.9%, p = 0.03), weight loss target (36.5% *vs.* 25.5%, p <0.01), diet (40.7% *vs.* 28.4%, p <0.01) and statin use (13.2% *vs.* 3.6%, p <0.01).

Comparisons between different levels of specialised hepatology service provided

Of the participating sites, 35.3% of level 1 centres, 66.7% of level 2 centres, and 60.0% of level 3 centres had a multidisciplinary NAFLD clinic. Documentation of non-invasive fibrosis scores at point of referral to secondary care clinics were highest in level 3 centres (50.0% level 3 *vs.* 26.4% level 2 *vs.* 20.4% level 1, p <0.01), as was fibrosis assessment (88.6% level 3 *vs.* 83.7% level 2 *vs.* 65.4% level 1, p <0.01) and review of cardiometabolic risk factors including obesity, alcohol, smoking, diabetes, hypertension, statin requirement (Table 4). However, greater proportions of patients outside level 3 centres received documented advice to address lifestyle risk factors such as alcohol consumption (52.5% level 1 *vs.* 32.8% level 2 *vs.* 32.0% level 3, p <0.01) and diet (38.4% level 1 *vs.* 38.7% level 2 *vs.* 16.5% level 3, p <0.01).

Comparisons between England, Scotland, Wales, and Northern Ireland

England had the highest proportion of total patients (81.4%), followed by Scotland (15.5%), Wales (2.3%) and Northern Ireland (0.8%). Comparing between the four countries, Wales had the highest proportion of patients that had liver fibrosis assessment before referral to secondary care (72.2% Wales *vs.* 29.0% England *vs.* 16.7% Northern Ireland *vs.* 15.8% Scotland, p <0.01) and in

Table 3. UK key performance indicator (KPI) results comparing centres with multidisciplinary services (MD) *vs.* centres without multidisciplinary services (no MD).

Management of people with, or at risk of, NAFLD before the gastroenterology or liver clinic	N	No MD (%)	N	MD (%)	*p* value
1. Services should have an agreed local clinical pathway for the investigation of suspected liver disease that includes an assessment for liver fibrosis using available non-invasive liver fibrosis tests	13	69.2	21	90.5	**0.02**
2. Individuals referred to secondary care with suspected NAFLD should have their non-invasive fibrosis staging (*e.g.* FIB-4 score or NAFLD fibrosis score) documented in the referral letter.	298	26.2	471	28.7	0.51
Investigations and management in secondary care					
3. People with NAFLD should have their weight and BMI documented	298	69.8	471	75.8	0.08
4. People with NAFLD should have an alcohol history documented and advice given, where appropriate					
a) Documented	298	88.9	471	91.5	0.26
b) Advice given where appropriate	165	33.3	307	57.7	**<0.01**
5. People with NAFLD should have a smoking history documented and advice given, where appropriate					
a) Documented	298	43.6	471	62.0	**<0.01**
b) Advice given where appropriate	92	12.0	161	14.3	0.70
6. People with NAFLD should undergo liver fibrosis staging using available non- invasive tests or liver biopsy	298	69.5	471	85.4	**<0.01**
Transient elastography/Fibroscan requested/performed	298	63.1	471	80.9	**<0.01**
ELF requested	298	3.4	471	7.6	**0.02**
Ultrasound Acoustic Radiation Force Impulse (ARFI) requested	298	0.3	471	0.6	>0.99
NFS score calculated	298	4.4	471	0.8	**<0.01**
FIB-4 score calculated	298	17.8	471	17.6	>0.99
Liver biopsy	298	6.4	471	6.8	0.88
7. Patients with NAFLD should be screened for T2DM	298	23.2	471	39.1	**<0.01**
Diabetic patients advised on optimising diabetes control	117	29.9	217	42.4	**0.03**
8. People with NAFLD should be screened for hypertension	298	15.4	471	21.4	**0.05**
Patients with hypertension advised on optimising blood pressure control	135	13.3	247	19.4	0.16
9. Patients with NAFLD should have weight loss advice documented including objective goals for weight change and physical activity.					
(a) Assessment of physical activity	298	28.2	471	44.8	**<0.01**
(b) Assessment of dietary habits	298	31.2	471	42.3	**<0.01**
(c) Exercise advice given	283	45.2	447	61.7	0.06
(d) Weight loss target given	278	25.5	444	36.5	**<0.01**
(e) Tailored dietary advice	278	28.4	452	40.7	**<0.01**
10. Patients who are at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) should be offered statin treatment in accordance with NICE guidelines.	137	3.6	197	13.2	**<0.01**
11. Patients should be provided with written information about NAFLD and weight management and/or signposted to credible information sources.	248	9.3	434	24.7	**<0.01**

Bold values signifies significant p <0.05.
ELF, Enhanced Liver Fibrosis; FIB-4, Fibrosis 4; MD, percentage of positive responses for each KPI in hospitals with multidisciplinary services; N, total number of recorded responses for each KPI; NAFLD, non-alcoholic fatty liver disease; NFS, NAFLD fibrosis score; NICE, National Institute for Health and Care Excellence; no MD (multidisciplinary services), percentage of positive responses for each KPI in hospitals without multidisciplinary services; T2DM, type 2 diabetes mellitus.

secondary care clinics (83.3% Wales *vs.* 80.9% England *vs.* 71.7% Scotland *vs.* 33.3% Northern Ireland, p <0.01).

In secondary care, Wales had the highest proportion of patients undergoing liver biopsy (22.2% Wales *vs.* 7.1% England *vs.* 1.7% Scotland *vs.* 0% Northern Ireland, p = 0.01) and Scotland had the highest proportion of patients with FIB-4 score calculated (30.8% Scotland *vs.* 15.8% England *vs.* 0% Wales *vs.* 0% Northern Ireland, p <0.01).

Assessment of cardiometabolic risk factors including alcohol, smoking, and obesity were highest in England (Table S1). However, a greater proportion of patients in Wales and Northern Ireland received documented advice to address risk factors including alcohol consumption (86.7% Wales *vs.* 75.0% Northern Ireland *vs.* 38.4% England *vs.* 32.5% Scotland, p <0.01), blood pressure control (60% Northern Ireland *vs.* 44.4% Wales *vs.* 17.6% England *vs.* 7.7% Scotland, p <0.01) and exercise (83.3% Northern Ireland *vs.* 75.0% Wales *vs.* 56.6% England *vs.* 42.9% Scotland, p = 0.01).

Face-to-face consultation *vs.* virtual consultation

In total, 78.2% of consultations were conducted in person (face-face) and the rest virtually (607 *vs.* 164). At virtual consultations, lifestyle change advice was more commonly documented, but cardiometabolic risk and fibrosis severity were less frequently assessed than at face-to-face consultations (Table S2). Compared with face-to-face consultations, virtual consultations were more likely to include appropriate advice in relation to alcohol consumption (50.5% *vs.* 36.7%, p = 0.02), optimising blood pressure control (27.0% *vs.* 15.0%, p = 0.02), dietary interventions (42.9% *vs.* 33.3%, p = 0.03) and provision of patient information material for NAFLD management (24.7% *vs.* 16.7%, p = 0.03). Face-to-face consultations were associated with greater proportions of patients having weight/BMI documentation (76.9% *vs.* 59.8%, p <0.01), T2DM screening (35.6% *vs.* 23.8%, p <0.01), hypertension screening (22.2% *vs.* 8.5%, p <0.01), smoking assessment (57.0% *vs.* 47.0%, p = 0.03) and fibrosis assessment (transient

Table 4. UK key performance indicator (KPI) results comparing centre types (level 1 – district general hospital; level 2 – hospitals with specialist Hepatology services other than liver transplantation; level 3 – liver transplant unit).

Management of people with, or at risk of, NAFLD before the gastroenterology or liver clinic	N	Level 1 (%)	N	Level 2 (%)	N	Level 3 (%)	*p* value
1. Services should have an agreed local clinical pathway for the investigation of suspected liver disease that includes an assessment for liver fibrosis using available non-invasive liver fibrosis tests	17	82.4	12	75	5	100	0.47
2. Individuals referred to secondary care with suspected NAFLD should have their non-invasive fibrosis staging (e.g. FIB-4 score or NAFLD fibrosis score) documented in the referral letter.	240	20.4	361	23.8	175	49.1	**<0.01**
Investigations and management in secondary care							
3. People with NAFLD should have their weight and BMI documented	240	63.3	361	74.2	175	84.6	**<0.01**
4. People with NAFLD should have an alcohol history documented and advice given, where appropriate							
(a) Documented	240	74.2	361	72.6	175	92.6	**<0.01**
(b) Advice given where appropriate	158	52.5	266	29.9	66	42.4	**<0.01**
5. People with NAFLD should have a smoking history documented and advice given, where appropriate							
(a) Documented	240	52.9	361	50.1	175	67.4	**<0.01**
(b) Advice given where appropriate	77	20.8	150	9.3	32	15.6	0.05
6. People with NAFLD should undergo liver fibrosis staging using available non- invasive tests or liver biopsy	240	65.4	361	83.7	175	88.6	**<0.01**
Transient elastography/Fibroscan requested/performed	240	59.6	361	79.2	175	82.9	**<0.01**
ELF requested	240	1.3	361	8.0	175	8.0	**<0.01**
Ultrasound Acoustic Radiation Force Impulse (ARFI) requested	240	0.8	361	0.6	175	0.0	0.50
NFS score calculated	240	2.1	361	0.8	175	5.1	**<0.01**
FIB-4 score calculated	240	5.4	361	18.6	175	32.6	**<0.01**
Liver biopsy	240	6.3	361	5.6	175	9.2	0.28
7. Patients with NAFLD should be screened for T2DM	240	18.8	361	38.2	175	41.7	**<0.01**
Diabetic patients advised on optimising diabetes control	107	47.7	185	28.7	55	49.1	**<0.01**
8. People with NAFLD should be screened for hypertension	240	14.2	361	13.6	175	38.3	**<0.01**
Patients with hypertension advised on optimising blood pressure control	139	23.0	199	12.1	49	22.4	**0.02**
9. Patients with NAFLD should have weight loss advice documented including objective goals for weight change and physical activity.							
(a) Assessment of physical activity	240	33.8	361	41.0	175	38.3	0.20
(b) Assessment of dietary habits	240	34.2	361	41.3	175	34.9	0.15
(c) Exercise advice given	227	58.1	338	55.3	171	50.9	0.35
(d) Weight loss target given	222	29.3	340	36.5	166	27.1	0.06
(e) Tailored dietary advice	229	38.4	337	42.4	171	18.7	**<0.01**
10. Patients who are at increased cardiovascular risk (T2DM and/or QRISK-3 >10%) should be offered statin treatment in accordance with NICE guidelines	125	4.0	171	9.4	46	21.7	**<0.01**
11. Patients should be provided with written information about NAFLD and weight management and/or signposted to credible information sources	219	30.1	324	9.6	174	19.5	**<0.01**

Bold values signifies significant p <0.05.
ELF, Enhanced Liver Fibrosis; FIB-4, Fibrosis 4; Level 1, percentage of positive responses for each KPI in level 1 hospitals; Level 2, percentage of positive responses for each KPI in level 2 hospitals; Level 3, percentage of positive responses for each KPI in level 3 hospitals; N, total number of recorded responses for each KPI; NAFLD, non-alcoholic fatty liver disease; NFS, NAFLD fibrosis score; NICE, National Institute for Health and Care Excellence; T2DM, type 2 diabetes mellitus.

Table 5. Comparisons with 2016 UK NAFLD Survey.

	Sheridan *et al.*[14]	Current study	
	2016	2019	2022
Local liver disease pathway	22%	85%	88%
Main indication for referral into secondary care	Abnormal LFTs	Abnormal LFTs	Abnormal LFTs
Non-invasive fibrosis assessment tools used in secondary care			
AST:ALT ratio	53%	Not captured	Not captured
Fib-4 score	16%	17%	18%
NAFLD fibrosis score	41%	3%	1%
APRI score	6%	Not captured	Not captured
ELF or other serum fibrosis markers	5%	5%	7%
Fibroscan	50%	72%	75%
BMI documentation*	83%	76%	71%
Alcohol history documentation*	79%	80%	75%
Alcohol advice*	71%	32%	45%
Dietary advice*	93%	26%	45%
Exercise advice*	94%	51%	59%
Weight loss target advice given*	50%	29%	35%

ALT, alanine aminotransferase; APRI, AST to Platelet Ratio Index; AST, aspartate aminotransferase; FIB-4, Fibrosis-4; NAFLD, non-alcoholic fatty liver disease.
* Metrics not directly comparable as 2016 study was a qualitative survey and current study measured practice.

elastography: 75.6% *vs.* 67.7%, $p = 0.04$, liver biopsy: 7.6% *vs.* 3.0%, $p = 0.03$).

Changes in service delivery and practice in NAFLD since 2016 in the UK

Compared with data extracted from the 2016 survey, which collected details about perceived practice rather than actual practice,[14] there was a four-fold increase in implementation of local liver disease pathways (Table 5). Transient elastography use increased and overtook other blood test-based scores to assess fibrosis risk in secondary care. Assessment of metabolic risk factors including weight/body mass index and alcohol history remained consistent. There were striking differences in provision of diet, exercise, and weight loss advice, with much lower rates of this advice being documented in the 2019/2022 compared with clinicians' perceptions of how they practice in the 2016 survey.

Discussion

This UK national study found significant variations in the management of individuals with NAFLD and identified areas requiring improvement, particularly in fibrosis risk assessment before secondary care referral and management of associated cardiometabolic risk factors. Compared with 2016, there have been significant improvements in the establishment of local liver disease referral and assessment pathways, which have increased from 22%[14] to 88% in 2022. Hospitals with multidisciplinary NAFLD service provision had higher rates of fibrosis evaluation and assessment and management of cardiometabolic risk than hospitals without multidisciplinary services.

The low utilisation of non-invasive fibrosis testing before secondary care referral despite increasing numbers of local services implementing liver disease assessment pathways emphasises the dissonance between guideline recommendations and delivery of care in real-world practice for NAFLD. This may be because of lack of awareness to use such pathways in primary care and highlights the need for ongoing education for healthcare professionals. The observation is not unique to the UK. *Anstee et al.*[13] recently reported similar dissonance from a study of 429 physicians managing 2,267 patients with NASH across Europe, Canada, and the Middle East. Despite the availability of test variables in 54% of patients, FIB-4 was calculated in only 5% of patients. In our study, 34.6% of patients who did not have fibrosis assessment before referral had low risk of advanced fibrosis and therefore could potentially have avoided referral to secondary care. It has been shown by different groups that automating pathways incorporating non-invasive liver fibrosis tests in primary care is clinically and cost effective.[18–20]

In secondary care, assessment of liver fibrosis was the best performing KPI, but there were significant variations in screening and management of cardiometabolic risk factors, as seen in other territories.[13] Variations in screening and management of cardiometabolic risk factors in our study may be influenced by several factors including outpatient clinic time constraints (not recorded in our study), practical issues such as weight and blood pressure recording during virtual consultations, perceived role of hepatology-trained professionals in managing cardiometabolic risk factors and availability of multidisciplinary services. Further work is needed to address the infrastructure necessary to deliver good quality care for NAFLD patients in outpatient setting.

Patient care bundles can be used to standardise good patient care and improve outcomes.[21–24] An outpatient NAFLD care bundle implemented in Newcastle, UK, resulted in significantly improved documentation and management of metabolic risk factors and lifestyle advice, and provision of NAFLD-specific patient advice material.[12] The care bundle provides a checklist approach to record and address NAFLD-related liver parameters and cardiometabolic risk factors. Wider adoption of an NAFLD care bundle approach is likely to help standardise and improve care, reducing unwarranted variation, irrespective of where patients are cared for.

Despite the disruptions caused by the COVID-19 pandemic, significant improvements in NAFLD care were observed between 2019 and 2022. During this period, many NAFLD services adopted virtual consultations for the majority of encounters. At virtual consultations, lifestyle change advice was more commonly documented, but cardiometabolic risk less frequently assessed than at face-to-face consultations. Further work is needed to develop tools to facilitate a more holistic care approach regardless of mode of consultation and to explore the role of an integrated care model that could incorporate both modes. This may be beneficial for patient care, reduce carbon footprint and improve sustainability in hepatology services.[25]

This study has several limitations. Firstly, the study was conducted through retrospective review of outpatient patient records and as such limited is to documentation at the time of outpatient clinic, which may not have been reflective of all discussions in the clinic appointment and given the 'real-world' nature of this study, exclusion of patients with alcohol-related liver diagnoses were based on documented patient clinical records if validated diagnostic criteria such as AUDIT-C scores were not available. Secondly, data collection within two single months may not be fully representative of care provision at each site. Thirdly, there is likely to be a selection bias, with services with clinicians interested in NAFLD being more likely to participate. In support of this, we found that a high proportion of services in the study had a multidisciplinary NAFLD clinic and the proportion of services with a primary care NAFLD pathway was much higher than seen in a recent national survey conducted by the British Liver Trust (85% *vs.* 40%).[26] Finally, the study population was skewed towards England (81.4% of the total population), which limited the interpretation of KPI comparisons with Scotland, Wales, and Northern Ireland. Future national studies involving more equal representation from England, Scotland, Wales, and Northern Ireland are needed to evaluate NAFLD care outcomes and standardise care.

Conclusions

This study assessed the management of patients with NAFLD in the UK and found significant variation in real-world practice and identified areas for improvement, particularly in fibrosis risk assessment before secondary care referral and management of associated cardiometabolic risk factors. Encouragingly improvements were seen in seven out of 11 key performance indicators

between 2019 and 2022, but further work is needed to align guideline recommendations and real-world practice in NAFLD care. A list of action points has been proposed to address this unmet need.

Action points

- Create multistakeholder groups involving hepatology, primary care and other secondary care services such as Endocrinology to incorporate non-invasive fibrosis tests into joint liver referral pathways.
- Encourage hospitals across the UK, other regions and countries to compare current practice and evaluate service provision against results from this study to improve delivery of care for patients with NAFLD.
- National study to evaluate the use of an NAFLD care bundle in outpatient clinics to standardise patient care.
- Promote education of metabolic health to all healthcare professionals caring for patients with NAFLD.
- Promote patient awareness of metabolic risk factors associated with NAFLD.

Abbreviations

ALT, alanine aminotransferase; APRI, AST to Platelet Ratio Index; AST, aspartate aminotransferase; BASL, British Association for the Study of the Liver; BSG, British Society of Gastroenterology; ELF, Enhanced Liver Fibrosis; FIB-4, Fibrosis-4; KPI, key performance indicator; NAFLD, non-alcoholic fatty liver disease; NASH, non-alcoholic steatohepatitis; NFS, NAFLD Fibrosis Score; NICE, National Institute for Health and Care Excellence; SIG, Special Interest Group; T2DM, type 2 diabetes mellitus.

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Conflicts of interest

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Authors' contributions

Concept and design: WL, DS, SM, WA. Data acquisition and analysis: WL. Initial drafting of manuscript: WL. Critical review and adaptation of the manuscript: DS, SM, WA. Approved the final version: all authors.

Data availability statement

Data, analytic methods, and study materials can be requested through the corresponding authors.

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Supplementary data

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