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The IBD-disk accurately assesses disability and psychological burden at IBD diagnosis and predicts adverse outcomes in both UC and Crohn's disease during the first year of treatment: a prospective observational cohort study

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Background: Inflammatory bowel disease (IBD) is linked with increased prevalence of mental health disorders (MHD), particularly anxiety and depression. How this influences treatment outcomes in the first year after diagnosis is poorly studied. The IBD disk is a patient-reported outcome measure that quantifies disease-associated disability. Our objectives were to determine if the disk can identify those at risk of adverse treatment outcomes during the first year after diagnosis and assess if it could accurately screen for significant mental health symptoms at IBD presentation.

Materials and methods: Patients with suspected IBD were seen in a rapid-access clinic. An IBD disk was completed upon first review, pre-diagnosis. A subgroup simultaneously completed the Hospital Anxiety and Depression scale (HADS). Repeat disks were completed after diagnosis, with 12-month outcomes collected prospectively.

Results: 188 patients completed a baseline IBD disk (97 Crohn's disease [CD], 91 Ulcerative colitis [UC]), 95 completed a simultaneous HADS and 82 completed a repeat disk after diagnosis and treatment. Pre-existing MHD were more frequent in CD. Pre-diagnosis, the IBD Disk 'Emotions' domain correlated with HADS depression ($r_s=0.607$ $p<.001$), anxiety ($r_s=0.586$ $p<.001$) and reliably identified HADS defined moderate-severe depression (Area under the curve [AUC] 0.873, 95% CI 0.804 – 0.942). An 'Emotions' domain score ≥ 7 identified all patients

meeting this HADS threshold (Sensitivity 100%, specificity 60.5%, Youden's index 0.601). The strength of discrimination fell post diagnosis (AUC 0.712, 95% CI 0.491 – 0.932), with ongoing high 'Emotions' domain scores strongly linked to disease activity in both CD and UC. Elevated baseline disk scores in UC predicted the subsequent need for advanced therapies ($p=0.019$), persistent active disease at 12 months ($p=0.023$) and need for inpatient treatment ($p<0.001$). In CD, elevated disk scores predicted need for advanced therapies ($p=0.014$) and persistent active disease ($p=0.015$), though an association with the need for surgical resection within 12 months was not statistically significant ($p=0.064$).

Conclusions: The IBD disk reliably screens for symptoms of depression and anxiety and identifies risk of adverse treatment outcomes at IBD presentation. Particularly in UC, higher disk scores at diagnosis could complement existing tools to better identify those who would benefit from early treatment escalation.

KEYWORDS

ulcerative colitis, Crohn's disease, patient report outcome measure (PRO), inflammatory bowel disease, IBD disk, disability, psychological distress, mental health disorder

Introduction

There is a high prevalence of mental health disorders (MHD) in those with established Inflammatory bowel disease (IBD). Two large meta-analyses have focussed on anxiety and depression, finding anxiety disorder present in 21% (but anxiety symptoms in up to 35%) and depressive disorder in 15% (with depressive symptoms in up to 25%) (1, 2). Comparatively, when last surveyed 17% of the United Kingdom (UK) general population met criteria for common mental health disorders (3). Both studies found a higher prevalence of depression and anxiety symptoms in those with Crohn's disease (CD) than Ulcerative colitis (UC) and those with active disease over remission. Links have also been established between IBD and broad range of other MHD including deliberate self-harm, eating disorders, bipolar disorder and post-traumatic stress disorder (4–6). The relationship between IBD and MHD can be viewed as bi-directional. Both anxiety and depression are associated with higher rates of treatment escalation, hospitalisation and emergency service utilisation amongst IBD patients, whilst active IBD is linked to the future development of anxiety or depression (7, 8). A large primary care study has highlighted this amongst UK IBD populations (9). It has been demonstrated that targeted psychological interventions, where a need is identified, can have a positive impact on IBD associated outcomes (10).

Though attempts at determining the prevalence of MHD at the first presentation of IBD have been limited, the UK IBD standards group make clear the need for psychological assessment in the initial management of patients newly diagnosed with IBD (11, 12). A 2023 review focussing on the practicality of delivering psychological support in established IBD patients highlighted the time constraints placed upon outpatient clinics (13). The authors recommended the use of psychometric questionnaires such as the Hospital Anxiety and Depression Scale (HADS), which can take up

to 5 minutes to complete (14). Time is often limited in new patient clinics and diagnostic uncertainty can increase the burden of anxiety. The option to utilise a tool that combines assessments of disease activity, disability and mental health burden is appealing. The IBD Disk ([Supplementary Appendix 1](#)) was first developed in 2017 (15). It represents a shortened self-administered version of the IBD Disability Index (IBD-DI) (16). The IBD-DI was developed as a multi-organisation cooperation based on four preparatory studies, a consensus conference and a subsequent operationalisation process (16). Conversely, the IBD disk followed an abridged development process and arose from an iterative Delphi consensus based upon opinion from selected gastroenterologists attending an industry funded training programme. Nonetheless, it was developed specifically with the 'busy outpatient clinic' in mind. It is deliberately broad in scope and employs a visual analogue scale. It has been validated as a measure for daily life burden in a large multicentre study (17). Disability as measured by the IBD disk has been shown to correlate well with the IBD-DI, as well as with C-reactive protein (CRP) and faecal calprotectin (FCP) (18). More recently, albeit on a smaller scale, multiple disk domains have been shown to correlate with disease activity in ileal CD, as measured by bowel wall thickness on abdominal ultrasound (19). Though it is reasonable to extrapolate these findings to disease onset, the utility of the IBD disk as a measure specifically of psychological disease burden, has not been validated. The HADS score is a long-established validated measure to screen for major depression and anxiety amongst individuals with physical health problems (20, 21). As such, it represents a suitable comparator for other scoring systems.

The primary objective for this work was to determine if disease associated disability at first presentation, as determined by the IBD disk, could be used to predict outcomes during the first year of

treatment. This included the need for treatment escalation, the presence of persistent disease activity and the need for inpatient admission. A secondary aim, carried out as a sub-study, was to determine if the IBD disk could be utilised at first presentation to screen for clinically significant mental health symptoms.

Materials and methods

Between February 2021 and June 2024, patients were triaged to a dedicated rapid access clinic for suspected IBD. Triage was based on having symptoms broadly compatible with IBD and an elevated (no mandated threshold) faecal calprotectin (FCP) level. The collection of the established and validated clinical indices and patient reported outcome measures (PROM) employed in this study took place as part of a wider prospective observational cohort study to which patients provided informed consent (IRAS 287279, approved by Bloomsbury Research Ethics Committee [REC reference 21/PR/0515]). During the first outpatient appointment, prior to the establishment of a diagnosis, patients were asked to complete an IBD disk score. This was completed in the clinic room, following discussion regarding the suspected diagnosis and investigative plan. A subgroup of patients were also asked to complete a simultaneous HADS score. Traditional clinical and biochemical indices, symptom duration and longitudinal treatment outcomes were collected prospectively. Repeat scores were taken at follow up attendances. Treatment was not protocolised for this study, but all patients were managed by the same multi-disciplinary group of IBD clinicians within a single hospital and treatment commenced on the day of colonoscopy where endoscopic findings were supportive. Pre-existing mental health diagnoses were obtained from clinical history taking and coded primary care diagnoses. IBD disk scores from patients in whom IBD was subsequently excluded have been omitted from the analysis.

At each follow-up visit, current treatments were recorded and an assessment of disease activity undertaken. Diagnoses of IBD were established in line with European Crohn's and Colitis Organisation guidelines (22). The criteria utilised to define 'Inactive' disease are shown in [Supplementary Appendix 2](#). A hierarchy of importance was employed in decision making. Where clinical indices alone were available these were used. If both CRP and FCP were available, these were preferred over clinical symptoms. If an endoscopic or radiological assessment had been performed, it superseded both clinical and biochemical indices.

Presented statistical analyses were primarily undertaken in JASP version 0.183 (23). Non-parametric tests were undertaken for all IBD disk related analyses as both the total IBD disk score (Shapiro-Wilk W 0.981 $p=0.012$) and each individual domain score did not follow a normal distribution. The Mann-Whitney U (U) test has been utilised for grouped differences in continuous variables. A chi-squared (X^2) test is employed to determine proportional difference in categorical variables. For receiver operating characteristic (ROC) curves and logistic regression modelling, Jamovi version 2.6.26 was utilised alongside a dedicated R package and integrated modules (24–27).

Results

IBD disk scores were collected from 188 patients (97 CD, 91 UC) at their first outpatient appointment, prior to diagnosis. 95 (45 CD, 50 UC) completed a simultaneous HADS score. 128 patients seen via this pathway completed an IBD disk and subsequently had IBD excluded. Follow up IBD disk scores were collected post treatment (median interval 117 days) from 82 patients, of whom 37 completed a paired post-treatment HADS score. The cohorts contributing to each analysis are shown in [Table 1](#).

The CD cohort was characterised by a significantly higher proportion of pre-existing MHD than those with UC (CD 22% [21/97], UC 11% [10/91], X^2 3.88 $p=0.049$). Including those with multiple diagnoses; depression, anxiety disorder and mixed anxiety and depression were the most frequent MHD, accounting for 73% (27/37) of all pre-existing MHD. The most frequent anti-depressant prescribed was Sertraline (9 [41% of all antidepressants]) followed by Citalopram (4 [18%]).

Quantifying disability and psychological disturbance at baseline

The overall IBD disk score was higher in those subsequently diagnosed with CD (median 56, IQR 30), relative to UC (median 45, IQR 36.5, Mann-Whitney $p=0.002$). The individual scores for each domain are presented, split by diagnosis, in [Table 2](#). This increase in disease-associated disability was driven by significantly higher scores across multiple IBD Disk domains including 'Abdominal pain' ($p<.001$), 'Interpersonal interactions' ($p=0.04$), 'Energy' ($p<.001$), 'Emotions' ($p=0.02$) and 'Body image' ($p<.001$). A binomial logistic regression was performed to identify the key drivers of the differences observed. The association of all 10 IBD disk domains with a CD or UC diagnosis was modelled, with UC coded as 'Class 1'. The overall model was significant (Overall model test X^2 29.9 $p<.001$). The only factor significantly associated with a UC diagnosis was 'Regulating Defecation' (Odds ratio 1.179 95% CI 1.055 – 1.318), whilst 'Abdominal pain' (Odds ratio 0.878 95% CI 0.788 – 0.978) and 'Body Image' (Odds ratio 0.874 95% CI 0.775 – 0.985) significantly favoured CD. Pre-existing MHD did associate with a higher baseline IBD disk score across IBD (Median, MHD=59, no MHD=49, $U=1762$ $p=0.015$). However, IBD subtype ($t=2.8$ $p=0.006$) had a far greater impact on total IBD Disk score than the presence of a MHD ($t=1.86$ $p=0.064$) when modelled together in a linear regression (overall model R 0.257, F 6.54, $p=0.002$).

The impact of symptom duration at diagnosis on psychological disease burden

The presence of a pre-existing MHD did not associate with a different length of historical symptoms prior to first clinical assessment in CD ($U=865$ $p=0.43$) or UC ($U=393$ $p=0.97$).

TABLE 1 Cohort descriptions for each subgroup contributing to presented analyses.

Total IBD disk visit 1 cohort			
	Crohn's	UC	Global test
N	97	91	
Age median (IQR)	28 (15)	33 (17)	U=3716 p=0.06 ¹
Sex (% male)	41%	58%	X ² 5.43 p=0.020 ²
Baseline FCP, median (IQR), ug/g	791 (1341)	1479 (1342)	U=2731 p=0.001 ¹
Disease extent/location/non-IBD type (%)	Ileal: 47 (48)	Proctitis: 25 (27)	
	Colonic: 20 (21)	Left sided: 28 (31)	
	Ileocolonic: 30 (31)	Extensive: 38 (42)	
Pre-existing MHD (% yes)	22%	11%	X ² 3.88 p=0.049 ²
Current antidepressants (% yes)	16%	7%	X ² 4.45 p=0.035 ²
Current antipsychotics (% yes)	3%	0%	X ² 2.86 p=0.091 ²
Cohort providing a paired HADS at visit 1			
N	45	50	
Age median (IQR)	28 (12)	31.5 (17.75)	U=1025 p=0.46 ¹
Sex (% male)	38%	56%	X ² 3.15 p=0.076 ²
Baseline FCP, median (IQR), ug/g	721 (1276)	1480 (1714)	U=756 p=0.039 ¹
Disease extent/location/non-IBD type (%)	Ileal: 22 (49)	Proctitis: 16 (32)	
	Colonic: 11 (24)	Left sided: 15 (30)	
	Ileocolonic: 12 (27)	Extensive: 19 (38)	
Pre-existing MHD (% yes)	27%	14%	X ² 2.38 p=0.123 ²
Current antidepressants (% yes)	22%	12%	X ² 1.76 p=0.18 ²
Current antipsychotics (% yes)	4%	0%	X ² 2.27 p=0.13 ²
Cohort providing a repeat IBD Disk			
N	49	33	
Age median (IQR)	27 (12)	33 (11)	U=561 p=0.020 ¹
Sex (% male)	40%	60%	X ² 3.76 p=0.052 ²
Baseline FCP, median (IQR), ug/g	720.5 (852.75)	1949 (1338)	U=376 p<.001 ¹
Disease extent/location/non-IBD type (%)	Ileal: 23 (47)	Proctitis: 5 (15)	
	Colonic: 10 (20)	Left sided: 14 (42)	
	Ileocolonic: 16 (33)	Extensive: 14 (42)	
Pre-existing MHD (% yes)	24.5%	12%	X ² 1.92 p=0.166 ²
Current antidepressants (% yes)	16%	6%	X ² 1.94 p=0.164 ²
Current antipsychotics (% yes)	4%	0%	X ² 1.38 p=0.240 ²
Visit 2 FCP median (IQR), ug/g	218 (644)	211.5 (272.75)	U=335 p=0.444 ¹
Duration between visits (days)	114 (124)	118 (119)	U=725 p=0.628 ¹

¹Mann-Whitney ²Chi-Squared X².

However, across IBD subtypes, a longer symptom duration positively correlated with overall IBD disk score (Spearman's $r_2 = 0.153$ $p=0.039$). Looking at individual IBD disk domains, IBD patients with an 'Emotions' domain score of ≥ 7 (out of 10) had a

significantly longer symptom duration than those that did not ($n=183$, median 5 vs 9.5 months, $U=5044$ $p=0.016$). This is more pronounced in CD ($n=95$, median 6 vs 18 months, Mann-Whitney $p=0.04$). In CD, differences in symptom duration for those

TABLE 2 Median (interquartile range) IBD disk domain scores (entire cohort) at baseline, split by final diagnosis, with the HADS scores from the relevant subgroup at the end of the table.

Domain	Crohn's	UC	Mann-Whitney U
IBD disk domains (n=188)			
Abdominal Pain	8 (4)	6 (5.5)	p<.001
Regulating Defecation	5 (7)	6 (8)	p=0.52
Interpersonal Interactions	3 (6)	2 (4.5)	p=0.04
Education and Work	6 (6)	4 (7)	p=0.11
Sleep	7 (5)	5 (7)	p=0.05
Energy	9 (3)	8 (4)	p<.001
Emotions	7 (4)	6 (5)	p=0.02
Body Image	6 (6)	3 (5)	p<.001
Sexual Functions	2 (7)	2 (6)	p=0.21
Joint Pain	5 (7)	2 (5.5)	P=0.04
HADS domains (n=95)			
Anxiety	8 (8)	7 (6)	p=0.58
Depression	6 (7)	4.5 (6.75)	p=0.17

presenting with stricturing and penetrating complications did not reach significance (Montreal B1 n=80 median=9 months, B2/B3 n=15 median=24 months, Mann-Whitney p=0.08).

The IBD Disk as a screening tool for significant mental health symptoms

Across IBD, strong correlations were seen between individual IBD disk domains and HADS scores for both depression and anxiety. For both HADS anxiety and depression scores, the 'Emotions' domain outperformed all others (Figure 1). Post treatment, during the second visit, IBD disk 'Emotions' scores remained most strongly associated with HADS Depression scores (n=36 $r_s = 0.579$ p<.001).

To validate the IBD disk, specifically the 'Emotions' domain, as a viable screening tool for clinically significant psychological symptoms, an appropriate cut off had to be sought. At least moderate HADS determined symptoms of depression and anxiety (score ≥ 11 for each) were thus sought. 15% (14/95) of patients met this threshold for HADS depression, of whom 36% (5/14) had an existing MHD. The 'Emotions' domain scores when plotted on a receiver operating characteristic (ROC) curve carried an area under the curve (AUC) of 0.873 (95% CI 0.804 – 0.942) for the HADS depression score cut-off. Statistically, the optimal cut point was a

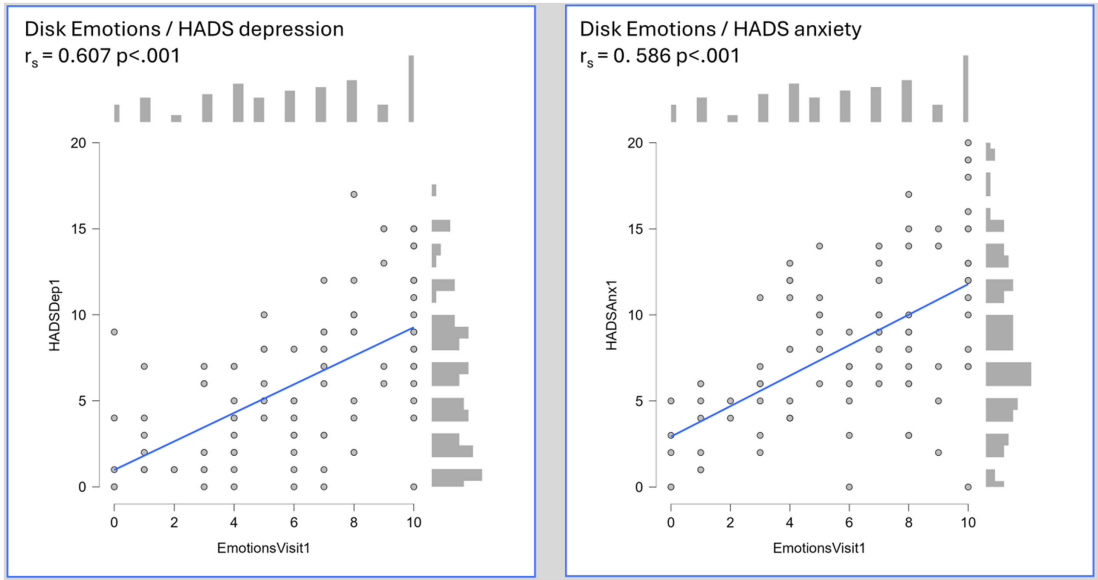


FIGURE 1 Heatmap of Spearman's rank coefficients for correlation between individual disk domains and HADS anxiety and depression scores amongst 95 patients presenting with IBD (45 CD, 50 UC). Individual scatter plots are shown for the 'Emotions' domain.- An individual scatter plot of paired HADS depression and IBD disk 'Emotions' scores, with a histogram of score frequency around the outside of the plot. The correlation, as measured by Spearman's rho, is highly statistically significant (HADS depression r_s 0.607 p<.001).- An individual scatter plot of paired HADS anxiety and IBD disk 'Emotions' scores, with a histogram of score frequency around the outside of the plot. The correlation, as measured by Spearman's rho, is highly statistically significant (HADS anxiety r_s 0.586 p<.001).

score of ≥ 8 (Sensitivity, 92.86%, specificity 71.6%, Youden's index 0.645), though a score of ≥ 7 captured all of those with significant depression scores (Sensitivity 100%, specificity 60.49%, Youden's index 0.605). For HADS anxiety, 30.5% (29/95) met the specified threshold, of whom 34% (10/29) had an existing MHD. The accuracy of the 'Emotions' domain was lower, with an overall AUC of 0.774 (95% CI 0.671 – 0.877). The optimal cut-point statistically was an 'Emotions' score of 9 (Sensitivity 55.17%, specificity 87.88%, Youden's index 0.431) though a lower threshold of ≥ 7 again carried greater clinical relevance as a screening tool (Sensitivity 75.86%, specificity 63.64%, Youden's index 0.395). The individual ROC plots of this data are shown in Figure 2. A binomial logistic regression model was developed to assess the predictive capacity of the 'Emotions' domain when adjusting for baseline patient and disease characteristics including age, sex, presence of an existing mental health diagnosis, haemoglobin, CRP and baseline faecal calprotectin. Due to missing FCP data, this model included 78 patients. The model for moderate depression scores was significant (Overall model test X^2 25.3 $p=0.003$) with an overall AUC of 0.910. The 'Emotions' domain score was the only independently significant predictor within the model (odds ratio 2.84 95% CI 1.38 – 5.85). Whilst model performance deteriorated for moderate anxiety scores, it remained significant (Overall model test X^2 24.2 $p=0.004$) with an overall AUC of 0.797. The 'Emotions' remained the only independently significant predictor (odds ratio 1.40 95% CI 1.09 – 1.78) within the model.

The utility of IBD Disk after diagnosis and treatment was interrogated in the 37 patients who went on the complete a further, post-diagnosis IBD Disk and HADS. This cohort was too

small for modelling. Nonetheless, the unadjusted AUC fell to 0.712 (95% CI 0.491 – 0.932) for the depression cut-off and 0.707 (95% CI 0.463 – 0.952) for the anxiety cut off. The ≥ 7 threshold demonstrated inferior performance across both depression and anxiety scores (Sensitivity 57%, Specificity 70%, Youden's index 0.271 for both).

Drivers of ongoing disability and psychological symptoms after IBD diagnosis and treatment

Once the diagnosis has been confirmed and treatment initiated, the burden of symptoms for patients attending their first follow-up clinic was quantified. Across the cohort, this took place a median of 117 (IQR 126.25) days after the first pre-diagnosis clinic visit. In both CD and UC, the key driver of difference in the IBD disk score at the follow-up clinic was disease activity. As demonstrated in our earlier linear regression, unequal contribution across IBD subtypes drove the higher baseline disk scores in those with a pre-existing mental health diagnosis. Indeed, upon repeat completion of an IBD disk at the follow up clinic, presence of an existing MHD did not associate with differences in total disk score (No MHD = median IBD disk score 41 MHD present = median 50. Mann-Whitney $p=0.31$). Furthermore, there was no proportional difference in patients reaching an inactive disease state by first follow-up when stratified by the presence or absence of a MHD (X^2 0.047 $p=0.828$).

When patients were stratified by whether they have reached an inactive disease state at first follow-up, a clear pattern emerges. Those with active disease carry a far higher overall IBD disk score in

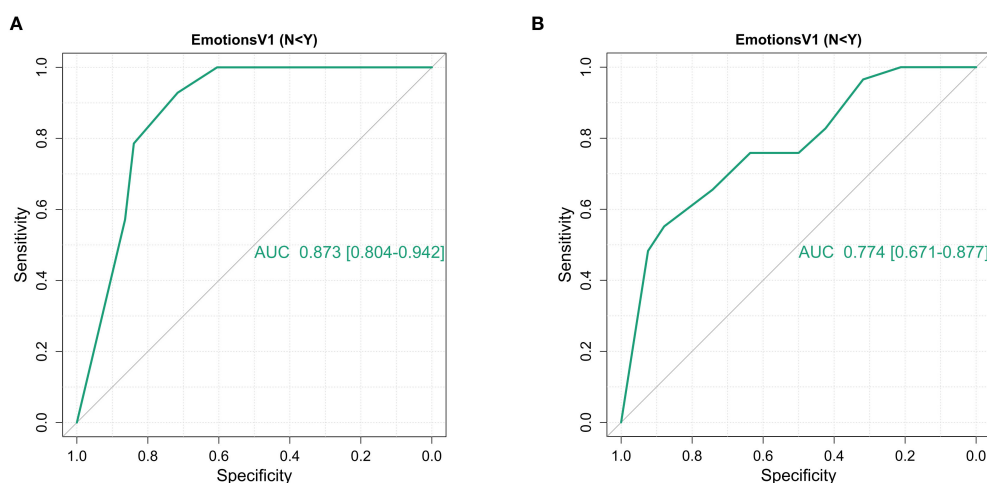


FIGURE 2

Receiver operating characteristic curves of the ability of the IBD disk 'Emotions' domain to identify HADS depression and anxiety scores of moderate severity (≥ 11) amongst 95 patients at first presentation of inflammatory bowel disease. (A) Overall, the 'Emotions' domain had an AUC of 0.873 [95% CI 0.804 – 0.942] for HADS depression scores ≥ 11 . An 'Emotions' domain score ≥ 8 had the highest Youden's index (0.645) but in a screening situation, a cut off ≥ 7 identified all individuals meeting the HADS cut off whilst retaining a high Youden's index (Sensitivity 100%, specificity 60.5%, Youden's index 0.605). (B) The 'Emotions' domain performed less well, both overall and at pre-specified cut offs for HADS anxiety, with an AUC of 0.774 [95% CI 0.671 – 0.877] for HADS anxiety scores ≥ 11 . Here the optimal cut-off statistically was 9 (Youden's index 0.431) but again a score of ≥ 7 would be favoured as it missed far few patients meeting the cut-off (Youden's index 0.395 but sensitivity 75.8%, specificity 63.6%).

addition to scores across multiple domains (Post treatment IBD disk 'active' = 55 [median], Post treatment IBD disk 'inactive' = 27. Mann-Whitney $p < .001$). The median values at baseline and at the first post treatment follow up clinic, split by disease activity state, are shown for Crohn's disease (Figure 3) and Ulcerative colitis (Figure 4). Additional focus is placed in these figures on the stark differences in the 'Emotions' domain. The cohort completing a repeat HADS score was underpowered ($n=37$), though scores were significantly higher in those with ongoing active disease compared to those in remission (HADS anxiety 'active' = 8 [median], 'inactive' = 6, Mann-Whitney $p=0.02$. HADS depression 'active' = 8, 'inactive' = 3, $p=0.01$).

The IBD disk as a predictor of outcomes during the first 12 months of treatment

A total of 179 IBD patients (95 CD, 84 UC) had complete 12-month outcomes available. First, the impact of pre-existing MHD was quantified. CD patients with a pre-existing MHD received double the number of courses of oral steroids during this first year (MHD yes median=2, MHD no median=1, $U=465.5$ $p=0.006$). This did not reach significance in the smaller UC cohort of 8 patients with pre-existing MHDs (MHD yes median=1, MHD no median=0,

$U=238$ $p=0.312$). Despite this, patients with pre-existing MHDs were no more likely to have ongoing disease activity at 12 months (overall X^2 2.87 $p=0.09$, UC X^2 1.12 $p=0.29$, CD X^2 0.77 $p=0.38$), progress to an advanced therapy (AT) within 12 months (overall X^2 = 0.23 $p=0.63$, UC X^2 1.35 $p=0.24$, CD X^2 0.82 $p=0.37$) or require inpatient care in the first 12 months (overall X^2 = 0.12 $p=0.73$, UC X^2 0.07 $p=0.79$, CD X^2 0.21 $p=0.64$).

Secondly the impact of baseline IBD disk scores and one-year outcomes was analysed. This is shown in Table 3 with traditional clinical activity scores for comparison. A higher overall IBD disk score at baseline predicted an increased likelihood of progression to advanced therapy (AT) and having persistently active disease in both CD and UC. In UC, higher baseline IBD disk scores also predicted the need for inpatient IBD treatment during the following 12 months (Figure 5). In the underpowered cohort requiring bowel resection surgery, a trend was observed towards higher baseline IBD disk score being associated with needing a surgical resection within 12 months of CD diagnosis ($U=177.5$ $p=0.06$). This trend was not observed using the Harvey-Bradshaw index ($U=246.5$ $p=0.51$). Nonetheless, in both CD and UC, the disk had a lower AUC than traditional activity indices for detecting the need for AT, likelihood of persistent active disease and need for inpatient care (Partial mayo score and Harvey-Bradshaw index respectively). Finally, the total IBD disk score was observed to correlate with referral FCP in UC

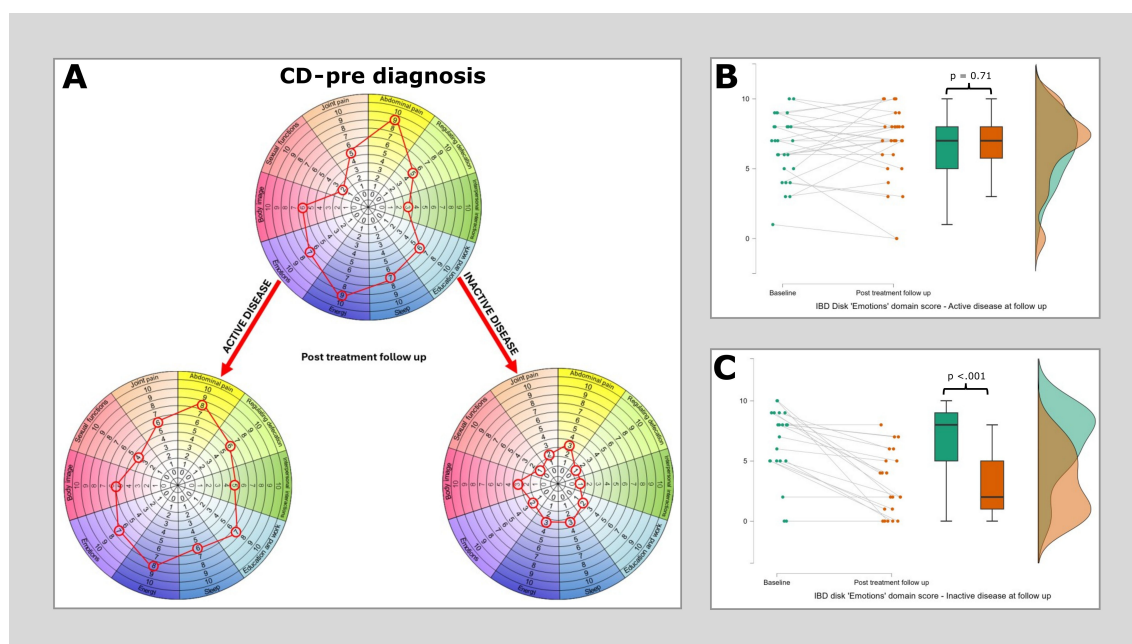


FIGURE 3

Median IBD disk scores for each domain in Crohn's disease at baseline and then at post treatment follow-up, stratified according to disease state. (A) plots median IBD disk scores at baseline and post treatment follow up for 49 patients with CD, of whom 28 had active disease at follow up and 21 were inactive. Scores are plotted on the grid as would be aim when interpreting these on an individual patient basis in clinic. The only significant reduction identified in the 'active' disease group was in the 'Energy' domain (Pre diagnosis median 9, post diagnosis median 8, Wilcoxon 170 $p=0.015$). All observed differences in the 'inactive' disease group reached statistical significance. (B) shows a raincloud plot of IBD disk 'Emotions' domain scores at baseline and at first follow up in those with persistent disease activity. There is no significant difference observed (Pre diagnosis median 7, post diagnosis median 7, Wilcoxon 148.5 $p=0.71$). (C) shows a raincloud plot of IBD disk 'Emotions' domain scores at baseline and at first follow up in those who reached an inactive disease state at this time point. A highly significant reduction is observed in this cohort (Pre diagnosis median 7, post diagnosis median 2, Wilcoxon 153 $p<.001$).

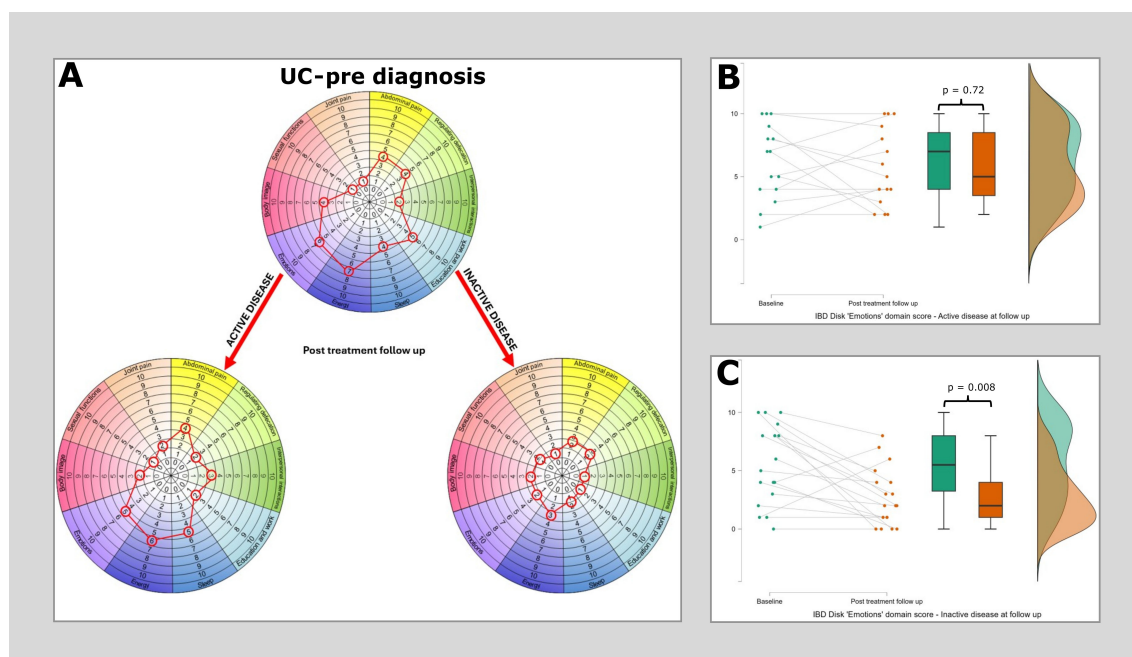


FIGURE 4

Median IBD disk scores for each domain in Ulcerative colitis at baseline and then at post treatment follow-up, stratified according to disease state. (A) plots median IBD disk scores at baseline and post treatment follow up for 33 patients with UC, of whom 15 had active disease at follow up and 18 were inactive. Scores are plotted on the grid as would be aim when interpreting these on an individual patient basis in clinic. The only significant reduction identified in the 'active' disease group was again in the 'Energy' domain (Pre diagnosis median 7, post diagnosis median 6, Wilcoxon 56 $p=0.044$). In the 'Inactive' disease group differences in the 'Emotions', 'Abdominal pain', 'Regulated defecation', 'Education & work', 'Sleep' and 'Body image' displayed statistically significant differences. (B) shows a raincloud plot of IBD disk 'Emotions' domain scores at baseline and at first follow up in those with persistent disease activity. There is no significant difference observed (Pre diagnosis median 7, post diagnosis median 7, Wilcoxon 37.5 $p=0.72$). (C) shows a raincloud plot of IBD disk 'Emotions' domain scores at baseline and at first follow up in those who reached an inactive disease state at this time point. A highly significant reduction is observed in this cohort (Pre diagnosis median 7, post diagnosis median 2, Wilcoxon 119.5 $p=0.008$).

($r_s=0.328$ $p=0.002$) but not CD ($r_s=-0.02$ $p=0.74$) and subsequent endoscopic severity at UC diagnosis (UCEIS $r_s=0.352$ $p=0.004$) but not CD diagnosis (SESCD $r_s=0.157$ $p=0.16$).

In grouped IBD, a number of these trends can also be seen when looking at the 'Emotions' domain alone. If the previously discussed baseline threshold of an 'Emotions' score of ≥ 7 is again chosen, patients who met this received more oral steroid courses ($U=4448$ $p=0.035$), were more likely to progress to an advanced therapy within 12 months (X^2 3.96 $p=0.047$) and were more likely to require inpatient care during the first 12 months (X^2 7.21 $p=0.007$). There was a non-significant trend for higher baseline 'Emotions' scores in those with persisting disease activity at 12 months (X^2 3.67 $p=0.055$).

Discussion

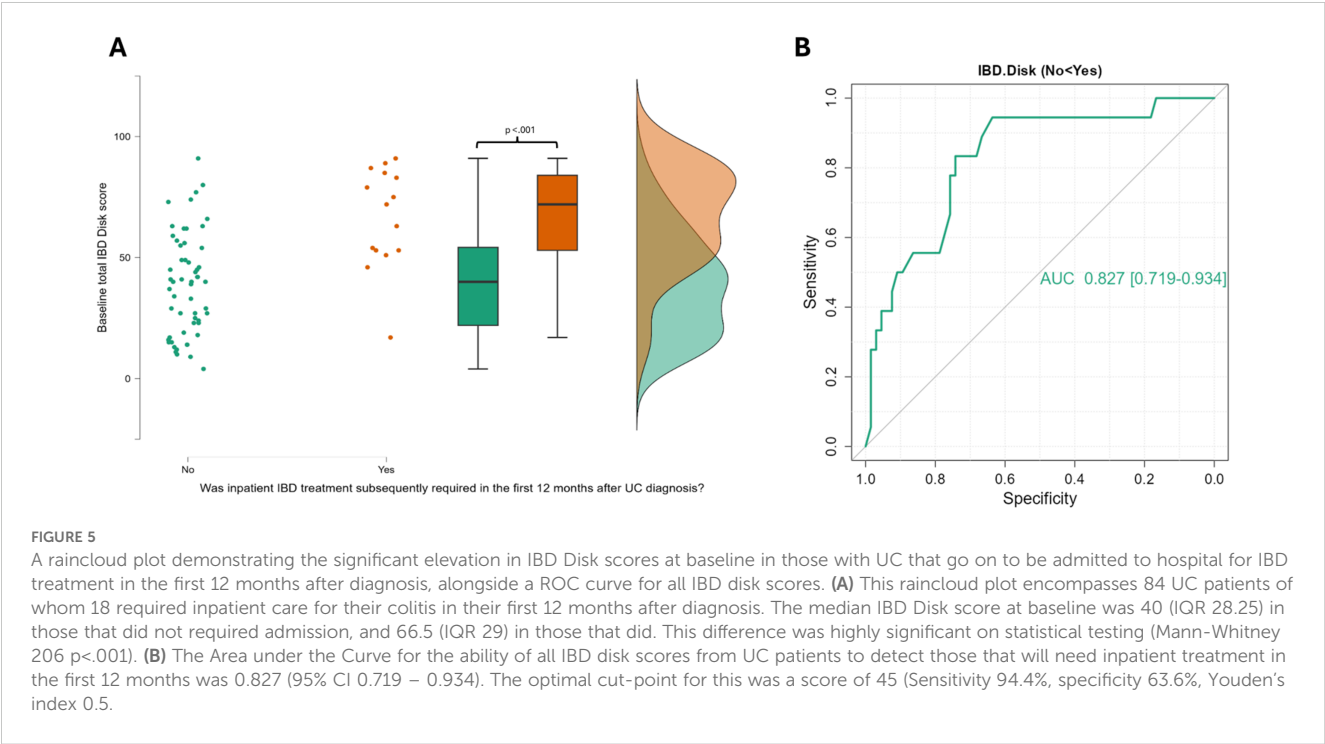
The data presented signifies a novel evaluation of the IBD disk in a cohort of IBD patients assessed at the point of first presentation, prior to diagnosis. Whilst it is acknowledged that obtaining disk scores when diagnostic uncertainty remained may have heightened factors such as anxiety, our approach allowed for the quantification of baseline disease associated disability prior to any treatment being commenced and uninfluenced by any preconceptions about a given IBD type (28).

In IBD, disease associated disability has been shown to negatively impact upon health-related quality of life and socioeconomic productivity (29, 30). Disability determined by other PROM including the IBD-DI has been linked to adverse future treatment outcomes in both established and newly diagnosed IBD cohorts (31, 32). Moreover, normalised quality of life and the absence of disability now forms a long-term treatment target listed in STRIDE 2 (33). For the first time we have demonstrated that disability determined by the IBD disk can help identify both UC and CD patients at an increased risk adverse treatment outcomes in the first 12 months after diagnosis. The strength of association, particularly within UC where IBD disk scores also correlated with biochemical and endoscopic disease activity, highlights disability as an important marker of disease severity and treatment outcome. Whilst overall predictive capacity was not superior to traditional disease activity indices, our data supports the complementary role of the IBD disk as a PROM at IBD diagnosis across disease subtypes. Alongside these established markers, higher IBD disk scores at presentation should prompt consideration of a more aggressive therapeutic approach with earlier treatment escalation. In CD, whilst the cohort proceeding to surgical resection within 12 months was small, the disk was more able to identify these patients than the Harvey-Bradshaw index.

We have been able to demonstrate the high prevalence of significant psychological symptoms across IBD patients at

TABLE 3 Median (interquartile range), Mann-Whitney derived p values and AUC (95% CI) for all plotted values comparing the ability of the IBD disk and traditional disease activity index to differentiate CD and UC patients who will/will not require advanced therapies, surgical resections or inpatient care within the first 12 months, in addition to the rates of persistent disease activity at the 12-month timepoint.

Treatment Outcome	UC (n=84)		CD (n=95)	
	Partial mayo	IBD disk	Harvey bradshaw index	IBD disk
Advanced therapy within 12m <i>UC AT 18/84 (21%)</i> <i>CD AT 49/95 (52%)</i>	No AT: 4 (2)	No AT: 40 (31.5)	No AT: 6 (4)	No AT: 53 (29.25)
	AT: 7 (2)	AT: 54.5 (24.5)	AT: 9 (4)	AT: 65 (29)
	p<.001	p=0.019	p=<.001	p=0.014
	AUC 0.853 (0.744-0.962)	AUC 0.681 (0.539–0.824)	AUC 0.760 (0.658–0.862)	AUC 0.646 (0.534–0.758)
Active disease at 12m <i>UC Active 19/84 (23%)</i> <i>CD Active 37/95 (39%)</i>	Inactive: 4 (3)	Inactive 41 (33)	Inactive: 7 (5)	Inactive: 54 (32)
	Active: 6 (3)	Active: 54 (31.5)	Active: 9 (5)	Active: 62 (27)
	p=0.013	p=0.023	p=0.014	p=0.015
	AUC 0.689 (0.559 – 0.819)	AUC 0.672 (0.527–0.817)	AUC 0.653 (0.541–0.765)	AUC 0.649 (0.537–0.761)
Inpatient care during first 12m <i>UC IP care 18/84 (21%)</i> <i>CD IP care 15/95 (16%)</i>	No IP care: 3 (2)	No IP care: 40 (28.25)	No IP care: 7 (4)	No IP care: 56 (26.75)
	IP care: 7 (1)	IP care: 66.5 (29)	IP care: 9 (3.5)	IP care: 58 (26.5)
	p<.001	p<.001	p=0.199	p=0.366
	AUC 0.937 (0.885 – 0.989)	AUC 0.827 (0.719 – 0.934)	AUC 0.605 (0.466 – 0.744)	AUC 0.574 (0.412 – 0.736)
Resection within 12m <i>UC resection 2/84 (2%)</i> <i>CD resection 7/95 (7%)</i>	No resection: 4 (3)	No resection: 42 (34)	No resection: 8 (4)	No resection: 56 (26.75)
	Resection: 7 (0)	Resection: 59 (4)	Resection: 7 (4.5)	Resection: 77 (26.5)
			p=0.510	p=0.064
	Only 2 patients	Only 2 patients	AUC 0.576	AUC 0.712



presentation. This is particularly the case in patients subsequently diagnosed with CD, aligning with studies in those with established disease (1, 2). IBD disk scores, particularly in the 'Emotions' domain, strongly associated with HADS anxiety and depression scores. An 'Emotions' score of ≥ 7 identified all patients with HADS determined moderate or severe depressive symptoms at IBD presentation, but in many these symptoms appear driven by disease behaviour with longitudinal scores highlighting a greater psychological burden enduring in those with persisting disease activity at follow up appointments. Whilst the IBD standards emphasise the importance of holistic psychological assessment at IBD diagnosis, separating psychiatric illness from a psychological response to severe physical symptoms is not possible at first presentation, with prompt establishment of disease control through shared treatment plans that prioritise health related quality of life the key first step to be taken (12, 34). In those with persisting disability and psychological disease burden over and above other markers of disease activity, targeted psychological intervention might then be considered, as has been shown to be effective in those with established disease (10, 35, 36). Though the strength of specific IBD disk cut-offs for predicting moderate-severe depression and anxiety symptoms fell in our underpowered post-treatment cohort, IBD disk 'Emotions' scores and HADS scores remained strongly linked. In our work, patients identified with persisting moderate depression or anxiety symptoms did not receive targeted intervention, but this data will be used to support service expansion to facilitate such measures being available in future.

Though longer symptom durations prior to diagnosis associated with increased psychological symptoms, a pre-existing MHD was not associated with delayed diagnosis in our cohort. The framework of our study does not allow for the contribution of recall bias to these differences. However, patients with pre-existing MHDs were more likely to receive courses of oral corticosteroids, despite being no more likely to progress to advanced therapies or have ongoing disease activity after a year of treatment. Whilst this finding has been previously noted in active IBD and may relate to increased service utilisation amongst these patients, it remains noteworthy given the long-established potential for steroids to cause neuropsychiatric complications (37–40).

The difference in size of the cohorts for each analysis, in particular the longitudinal cohort being less than half the size of the overall cohort (and consequently underpowered for validation) is a key limitation. Furthermore, all scores are also derived from a single IBD centre and whilst patients were managed by a single MDT, post diagnosis treatment was not protocolised. Additionally, whilst data was gathered regarding pre-existing MHD, no data on other confounding socioeconomic factors were collected. Modelling relating to psychological burden was adjusted for baseline characteristics, but this was not the case in analyses relating to 12-month outcome, increasing the risk of uncontrolled confounding.

Utilisation of the IBD disk is not time consuming and whilst we opted to complete it in the clinic room given our pre-diagnosis setting, it can be completed electronically or in the waiting room prior to consultation (41). Implementing it as a PROM at IBD

presentation can help in the early identification of those who are likely to require more aggressive IBD treatment to obtain disease control. Moreover, it can reliably detect clinically relevant depressive symptoms. Whilst these may represent a reaction to physical symptoms at IBD presentation, use of the IBD disk during longitudinal follow-up may help identify those with a persisting psychological symptom burden beyond that attributable to disease activity alone.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Bloomsbury Research Ethics Committee (REC reference 21/PR/0515, IRAS 287279), with the collection of established and validated clinical indices and patient reported outcome measures (PROM) occurring as part of a wider prospective observational cohort study. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

PR: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. VS: Data curation, Investigation, Validation, Writing – review & editing. MI: Data curation, Investigation, Writing – review & editing. AJ: Data curation, Investigation, Writing – review & editing. KH: Data curation, Investigation, Writing – review & editing. MO: Data curation, Investigation, Project administration, Writing – review & editing. DR-K: Conceptualization, Funding acquisition, Resources, Supervision, Writing – review & editing. RC: Data curation, Investigation, Supervision, Validation, Writing – review & editing. AI: Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review & editing. IC: Funding acquisition, Methodology, Supervision, Writing – review & editing. PH: Conceptualization, Formal Analysis, Methodology, Writing – review & editing. TI: Conceptualization, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Visualization, Writing – review & editing.

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Conflict of interest

Author DR-K was employed by F. Hoffmann-La Roche. PR and TI have received research grants from F. Hoffman La Roche. PR has received speaker fees or educational grants from Abbvie, Janssen Cilag, Bristol Myers Squibb and Ferring. TI has received honoraria from Pharmacosmos. RC has received advisory or speaker fees from Abbvie, Galapagos, Bristol Myers Squibb and Celltrion.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fgstr.2025.1642061/full#supplementary-material>

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