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1 **Validation of the IMPACT-III questionnaire in French children with inflammatory bowel**
2 **disease**

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49 All authors contributed significantly to the study. JV, LB, DL, FG, SC, and DT designed the
50 research; JV, LB, and SC conducted the research; JV and ED analyzed the data; ED analyzed
51 the data and performed the statistical analysis; JV, FG, and DT wrote the paper; JV had
52 primary responsibility for the final content. All authors read and approved the final
53 manuscript.

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56

ABSTRACT

Objectives: This study assessed the reliability and validity of the IMPACT-III questionnaire, a health-related quality of life (HRQoL) instrument, in French children with inflammatory bowel disease (IBD).

Methods: Eighty-four children and adolescents (45 boys, aged 14.3 ± 2.7 years) were included in a validation study of the IMPACT-III questionnaire. Patients completed two questionnaires for measuring HRQoL: the IMPACT-III and the Pediatric Quality of Life Inventory 4.0 Generic Core Scale (PedsQL™). Internal consistency was assessed using Cronbach's α . Factor analysis was performed on data from the IMPACT-III to help construct domains. Concurrent validity was assessed by calculating Spearman correlation coefficients.

Results: Cronbach's α for the PedsQL™ total score was good (0.89). The most robust factor solution was a three-domain structure: a) Concerns, b) Body Image and Physical Condition, and c) Symptoms and Socializing. All domains had good reliability (0.674 to 0.863). Only two items had to be removed. Discriminant validity was demonstrated by significant differences ($p < 0.001$) in median IMPACT-III scores between inactive and active disease for the total score (83.3 vs. 72.0), and for Concerns ($p < 0.002$) and Symptoms and Socializing ($p < 0.001$).

Conclusions: These results suggest that IMPACT-III appears to be a useful instrument for measuring HRQoL in French children with IBD.

Keywords: Crohn disease; ulcerative colitis; pediatric; quality of life.

22 **What is Known:**

- 23 • IMPACT-III questionnaire is an important tool for assessing health-related quality of
24 life (HRQoL) in pediatric patients with inflammatory bowel disease (IBD).
- 25 • Studies have examined the validity of this questionnaire for measuring HRQoL in
26 European pediatric patients with IBD.
- 27 • No studies have examined the validity of this questionnaire in French children.

28 **What is New:**

- 29 • Our study is the first to assess the validity of this questionnaire in French children with
30 IBD.
- 31 • IMPACT-III is a valid and reliable instrument for assessing HRQoL in French pediatric
32 patients with IBD.
- 33 • Future studies in French children and adolescents with IBD should be able to use the
34 IMPACT-III to assess the effects of intervention programs on quality of life.

35 **Introduction**

36 Inflammatory bowel diseases (IBD) encompass Crohn's disease (CD), ulcerative colitis (UC),
37 and IBD-unclassified (IBD-U). These diseases are characterized by chronic inflammation of
38 the gastrointestinal tract and represent a worldwide health-care problem. Several IBD
39 symptoms, such as abdominal pain, diarrhea, and fatigue, as well as poor nutritional status and
40 depression affect the quality of life in pediatric patients with IBD (1). In addition, regular visits
41 to hospitals, constraints caused by treatment, disruption of schooling, complications of the
42 disease, social and functional disability, and an uncertainty about the future may also
43 compromise the quality of life of these children.

44 It is important to assess health-related quality of life (HRQoL) in pediatric patients with
45 IBD to determine the consequences of these chronic diseases. HRQoL encompasses physical,
46 mental, and social well-being. The Pediatric Quality of Life Inventory 4.0 Generic Core Scale
47 (PedsQL™) is a widely used instrument to measure generic HRQoL in children and adolescents.
48 The first instrument for assessing HRQoL in children with IBD was the IMPACT Questionnaire
49 (IMPACT-I) (2-3). This questionnaire was developed after adaptation of the adult version of
50 IBD disease-specific HRQoL questionnaire (2-4). This pediatric IBD-specific HRQoL
51 instrument has since been modified by adding questions and changing the modality for answers,
52 and is called the IMPACT-III questionnaire (5). Studies have examined the validity of this
53 questionnaire for measuring HRQoL in pediatric patients with IBD (6-8). However, no studies
54 have examined the validity of this questionnaire in French children.

55 The aim of this study was to assess the reliability and validity of the IMPACT-III
56 questionnaire for measuring HRQoL in French children with IBD.

57 **Materials and methods**

58 *Study design*

59 The present study was an ancillary study of previous work assessing the associations between
60 physical activity, bone health, and quality of life (9). Pediatric patients with IBD who were
61 followed up in two hospitals in Northern France were invited to participate in this prospective
62 study. Eighty-four children aged between 6 and 18 years with confirmed IBD at least 6 months
63 before were included in this study from October 2014 to March 2017.

64 Before beginning the study, its aims and objectives were carefully explained to all
65 participants and their parents/guardians. Written informed consent was obtained from the
66 participant and consent from the parents/guardians by the study physician. The study was
67 approved by the Research Ethical Committee (Comité de Protection des Personnes, Nord-Ouest
68 IV, Lille, France) and French research competent authority (Agence Nationale de Sécurité du
69 Médicament et des Produits de Santé, Paris, France). All procedures were performed according
70 to the ethical standards of the 1975 Declaration of Helsinki as revised in 2013, and the European
71 Union's Guidelines for Good Clinical Practice. According to the General Data Protection
72 Regulation, data collection was approved by the French personal informatics competent
73 authority (Commission Nationale de l'Informatique et des Libertés).

74

75 *Measurements*

76 *Clinical assessment*

77 Each patient was required to pass a physical examination with a pediatric gastroenterologist
78 (clinical investigator) before being included in the study. During the inclusion visit,
79 anthropometric data (weight, height, and body mass index) were collected. Pubertal status was
80 assessed by direct observation according to Tanner and Whitehouse (10).

81 A blood sample was collected from each patient and used for measurement of inflammatory

82 status (hematocrit, C-reactive protein and albumin concentrations, and erythrocyte
83 sedimentation rate) and to calculate disease activity. Disease activity was assessed using a
84 specific scale according to the type of IBD (11-12). The Pediatric CD Activity Index (PCDAI)
85 was used for patients with CD (11). The Pediatric Ulcerative Colitis Activity Index (PUCAI)
86 was used for patients with UC (12). Remission was defined as a score <10 and mild activity as
87 10–27.5 on the PCDAI and as 10–34 on the PUCAI. Values >27.5 on the PCDAI and >34 on
88 the PUCAI indicated moderate to severe activity. **No IBD-U score was used as there is no**
89 **validated scale available**

90

91 *HRQoL*

92 HRQoL was assessed by self-report using the PedsQL™ and the IBD-specific IMPACT-III
93 questionnaire. Patients were asked to complete the two questionnaires during the same visit. A
94 clinical investigator was present during the completion of questionnaires to help the children
95 understand the questions if needed.

96

97 *PedsQL™*

98 The questionnaire is aimed at three age groups: 5–7 years, 8–12 years, and 13–18 years. For
99 each age group, the questionnaire includes 23 questions comprising four dimensions: (i)
100 physical functioning; (ii) emotional functioning; (iii) social functioning; and (iv) school
101 functioning. The PedsQL™ provides a total score and two subscale dimensions: (i) physical
102 health (physical functioning scale score) and (ii) psychosocial health (emotional, social, and
103 school functioning scale scores). For children aged 8–18 years, each question was scored using
104 a five-point Likert scale ranging from 0 (never) to 4 (almost/always). Appropriate items were
105 reverse scored and total scores were linearly transformed to a 0–100 scale where 0 = 100, 1 =

106 75, 2 = 50, 3 = 25, and 4 = 0. For children aged 5–7 years, each question was scored using a
107 three-point Likert scale of 0 (not at all), 2 (sometimes), and 4 (a lot).

108

109 *IMPACT-III Questionnaire*

110 The IMPACT-III questionnaire comprises 35 closed questions about the frequency and
111 intensity of the effects of IBD on various aspects of health. The questionnaire encompasses six
112 specific domains: bowel symptoms (seven items), systemic symptoms (three items), emotional
113 functioning (seven items), social functioning (12 items), body image (three items), and
114 treatment/interventions (three items). The IMPACT-III uses a five-point Likert response scale
115 ranging from 1 to 5 for all answers. The outcome score ranges from 35 to 175. To obtain a
116 measure of overall HRQoL, a total score was calculated by summing all 35 items. A final open
117 question allows patients to describe anything else they feel is important to their health. Because
118 forward and backward translations were previously conducted, cross-cultural adaptation was
119 not required (5). In the present paper, we studied the validity and reliability of this
120 questionnaire.

121

122 *Statistical analysis*

123 Qualitative variables are reported as frequency (percentage) and continuous variables as mean
124 \pm standard deviation in cases of normal distribution or median (interquartile range [IQR] = first
125 quartile – third quartile) for nonnormal distribution. Normality was assessed graphically and
126 using the Shapiro–Wilk test. Internal consistency was assessed using Cronbach’s α , which was
127 expected to be >0.70 (13).

128 Factor analysis was performed on data from the IMPACT-III to help construct domains. The
129 number of components was checked by examination of the scree plot of eigenvalues using
130 Horn’s procedure and parallel analysis of 200 random simulations (14). Principal component

131 analysis was conducted for three-factor (domain) structures using varimax rotation. Items were
132 included in a domain when factor loadings (correlation between the item and the overall factor
133 or domain) was >0.3 .

134 Concurrent validity was assessed by calculating Spearman correlation coefficients to assess
135 concurrence between domains of the PedsQL™ and IMPACT-III questionnaires. A strong
136 correlation was defined as $r \geq 0.5$, a moderate correlation as $r = 0.3-0.5$, and a mild or weak
137 correlation as $r < 0.3$.

138 IMPACT-III scores were compared between different disease groups using the Kruskal–Wallis
139 test and between different disease activities using the Wilcoxon U test. All statistical tests were
140 performed at the two-tailed α level of 0.05 using SAS software (release 9.4; SAS Institute,
141 Cary, NC) and R 3.6.2 ('psy' packages).

142

143 **Results**

144 *Participants' characteristics*

145 For all patients, there were no missing answers for any items of both questionnaires. The
146 patients' demographic and disease characteristics are shown in Table 1. The sample ($n=84$)
147 included more boys ($n = 45, 54\%$) and patients with CD ($n = 37, 64\%$); 10 patients had IBD-U.
148 Most of the patients (77%) had inactive disease activity.

149

150 *Reliability*

151 The mean values and reliability coefficients for the total and original domains scores of the
152 IMPACT-III and PedsQL™ are shown in Table 2. The internal consistency (Cronbach's α) was
153 0.90 for the IMPACT-III total score. A good Cronbach's α was also found (0.89) for the
154 PedsQL™ total score.

155

156 ***Factor structure of the IMPACT-III questionnaire domains***

157 A factor analysis was performed to explore the domains in the IMPACT-III questionnaire
158 (Table 3). The most statistically robust solution of the principal component analysis was a three-
159 factor structure, which was confirmed by the scree plot of eigenvalues (Suppl Figure 1). The
160 three domain titles chosen according to their Cronbach's α coefficients for each item are shown
161 in Table 3. The three domain titles chosen were a) Concerns ($\alpha = 0.863$), b) Body Image and
162 Physical Condition ($\alpha = 0.840$) and c) Symptoms and Socializing ($\alpha = 0.674$) (Table 3).
163 Questions 31 ("How often did you have to pass wind in the last 2 weeks?") and 33 ("How do
164 you feel about your height?") were loaded into specific domains, but their factor loadings were
165 <0.3 .

166

167 ***Concurrent validity***

168 The results of the correlational analysis between the IMPACT-III and PedsQL™ scores are
169 presented in Table 4. Significant correlations were found in the cross-statistical analysis ($p <$
170 0.01). The strongest correlations were for the domains Concerns, Body Image and Physical
171 Condition, and Symptoms and Socializing emotional functioning ($r = 0.58$), physical health (r
172 $= 0.49$), and emotional functioning ($r = 0.44$) (Table 4). The domain Body Image and Physical
173 Condition correlated only moderately with social functioning ($r = 0.33$) in the PedsQL™. The
174 domain Body Image and Physical Condition also correlated only moderately with physical
175 health ($r = 0.39$) and school functioning ($r = 0.25$) in the PedsQL™.

176

177 ***Discriminant validity***

178 The total and domain IMPACT-III scale scores in the overall population analyzed according to
179 the type of disease and disease activity are presented in Supplementary Table 1. These scores
180 did not differ significantly between disease type. The total score was higher in patients with

181 inactive disease (median 83.3 (IQR, 76.5 to 90.2); $n = 62$) than in those with active disease
182 (median 72.0 (IQR, 60.6 to 82.6); $n = 19$) ($p < 0.001$). The IMPACT-III scores differed
183 significantly between active and inactive disease for Concerns ($p < 0.002$) and for Symptoms
184 and Socializing ($p < 0.001$) (Supp Table 1).

185

186 **Discussion**

187 In addition to disease history and physical examination, use of HRQoL instruments may help
188 give health-care providers a more comprehensive picture of the health status of a patient with
189 IBD. IMPACT-III is a specific questionnaire for children with IBD that has been validated in
190 many countries (Croatia, England, United States, Netherlands, Canada) (2,3,6,7,15,16). The
191 results of our study show that the French version of IMPACT-III is suitable for assessing
192 HRQoL in children and adolescents with inactive or mildly active IBD. The significant
193 correlations between similar domains of the IMPACT-III (French version) and the PedsQL™
194 questionnaires confirm good concurrent validity of the French IMPACT-III questionnaire.

195 The factor analysis suggested that a three-factor structure was more appropriate for the French
196 version of IMPACT-III and that two items seemed not be relevant in our model. Our results do
197 not concur with previous studies that have assessed IMPACT-III in other countries, (i.e., in
198 other languages) (2,3,6,7,8,15,16). However, the results of previous studies also do not agree
199 with each other. A five-factor structure has been suggested by validations of British and
200 Croatian versions of IMPACT-III, a four-factor structure by a study of young people in the
201 United States and Switzerland, and a six-domain structure by studies of Dutch and Canadian
202 versions (2,3,6,7,8,15,16). The differences reported for the three studies that assessed the
203 Canadian and Dutch versions may be explained by differences in the methodologic approaches
204 for assessing the domains (2,3,16).

205 The structures developed by previous authors were based on clinical relevance and judgmental

206 processes, whereas we used a statistical approach with factor analysis (2,3,16).
207 This difference in approach has also been mentioned by other authors who used factor analysis,
208 which is more robust (6,7,8,15). Despite the similar use of factor analysis, it is difficult to
209 compare our findings with those of the study of Perrin et al. (2008) in United States children
210 and adolescents because of the different questionnaires used (15). The study by Perrin et al.
211 analyzed the validity of an older version of the IMPACT questionnaire (Version II) which
212 differs from the French version of IMPACT-III, which now includes a 10-cm visual analogue
213 scale and more items (35 vs. 33 questions). Only studies using the Croatian, Swiss, and British
214 versions used the same methodology as in our study (6-8). Differences between our results and
215 those of these three studies may reflect differences in cultures between where the studies were
216 performed.

217 Another possible explanation for differences between our results and those of earlier studies is
218 the low statistical power in our study of 84 children compared with 104, 106, and 146 children
219 for Croatian, British, and Swiss studies, respectively (6-8). The psychometric evaluation using
220 Cronbach's α in our study showed good internal reliability for the three structural factors.
221 Therefore, we conclude that the three-factor structure of the French version of the IMPACT-III
222 questionnaire seems to be appropriate for measuring HRQoL in French children and adolescents
223 with IBD. However, further study is needed with larger samples to confirm our conclusions.
224 Disparities found in the number of domains between studies make it difficult to interpret the
225 assessment of HRQoL in multicentric international studies.

226 Concurrent validity was tested in our study by comparing scores between the three-factor
227 structure and the PedsQL™ results. The patients in our study with a low HRQoL score assessed
228 using the PedsQL™ scale also had a low score on the French version of the IMPACT-III
229 questionnaire ($r = 0.709$). Our results of the discriminant validity also showed that the
230 IMPACT-III questionnaire may be affected by patients' health status (total score $p < 0.001$).

231 For example, patients with active disease had a lower total HRQoL score than patients with
232 inactive disease ($p < 0.001$). These results have been reported in previous studies (2,6,7). In
233 contrast to previous work, our study did not include patients with severe disease, and future
234 studies with larger samples across the range of disease activity are needed to assess the overall
235 discriminant validity. The discriminant validating testing also showed no significant difference
236 according to the type of disease (CD vs UC and IBD-U). Patients with CD had a similar mean
237 total HRQoL score as patients with UC or IBD-U. This suggests that the French version of the
238 IMPACT-III can be used to assess QoL in patients with CD or UC.

239 Our study has some strengths and limitations. First, as suggested above, the recruitment of our
240 study sample was limited by inclusion criteria linked to the main objective of this study and
241 patients with a severe IBD activity were not included (9). There was an overrepresentation of
242 pediatric patients with inactive or mild IBD and no representation of those with a moderate to
243 severe disease. Therefore, our results may not apply generally to all young people with IBD.
244 Another limitation is the small sample size and the unequal representation of disease types (i.e.,
245 more CD than UC patients). However, the incidence rate is higher for CD than UC in French
246 pediatric IBD patients (17), and we believe that our sample may reflect the population of
247 pediatric IBD patients in France (73% and 27% for CD and UC patients, respectively). Third,
248 no test–retest reliability was assessed because this was an ancillary study that was not designed
249 to examine this parameter. The first strength of the study is the multicentric study design, which
250 should have limited shared method bias. The second strength in the use of standardized and
251 validated methods for assessing IBD activity and HRQoL (PedsQL™). A third strength is the
252 excellent response rate (100%) for completion of the two HRQoL questionnaires because this
253 was an ancillary study to a clinical intervention study. Finally, the robust statistical
254 psychometric analysis is another strength of our study.

255 In summary, our findings suggest that the IMPACT-III is a valid and reliable instrument for
256 assessing HRQoL in French pediatric patients with IBD. The development of the French version
257 of this questionnaire seems to be useful for assessing the impact of IBD on the HRQoL of
258 patients with CD or UC. Future studies in French in children and adolescents with IBD should
259 be able to use the IMPACT-III to assess the effects of intervention programs on QoL.
260

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263

264

265

References

1. Sawczenko A, Sandhu BK. Presenting features of inflammatory bowel disease in Great Britain and Ireland. *Arch Dis Child* 2003; 88: 995-1000.
2. Otley A, Smith C, Nicholas D, et al. The IMPACT questionnaire: a valid measure of health-related quality of life in pediatric inflammatory bowel disease. *J Pediatr Gastroenterol Nutr* 2002; 35: 557-63.
3. Griffiths AM, Nicholas D, Smith C, et al. Development of a quality-of-life index for pediatric inflammatory bowel disease: dealing with differences related to age and IBD type. *J Pediatr Gastroenterol Nutr* 1999; 28: S46-52.
4. Guyatt G, Mitchell A, Irvine EJ, et al. A new measure of health status for clinical trials in inflammatory bowel disease. *Gastroenterology* 1989; 96: 804-10.
5. Otley A. Measurement of quality of life in pediatric inflammatory bowel disease. In: Mamula P, Markowitz JE, Baldassano RN, editors. *Pediatric Inflammatory Bowel Disease*. 1st edition. New York: Springer; 2008. p. 565–80.
6. Abdovic S, Mocic Pavic A, Milosevic M, et al. The IMPACT-III (HR) questionnaire: a valid measure of health-related quality of life in Croatian children with inflammatory bowel disease. *J Crohns Colitis* 2013; 7: 908-15.
7. Ogden CA, Akobeng AK, Abbott J, et al. Validation of an instrument to measure quality of life in British children with inflammatory bowel disease. *J Pediatr Gastroenterol Nutr* 2011; 53: 280-6.
8. Werner H, Landolt MA, Buehr P, et al. Validation of the IMPACT-III quality of life questionnaire in Swiss children with inflammatory bowel disease. *J Crohns Colitis* 2014; 8: 641-8.
9. Vanhelst J, Vidal F, Turck D, et al. Physical activity is associated with improved bone health in children with inflammatory bowel disease. *Clin Nutr* 2020; 39: 1793-8.

10. Tanner JM, Whitehouse RH. Clinical longitudinal standards for height, weight, height velocity, weight velocity, and stages of puberty. *Arch Dis Child* 1976; 51:170-9.
11. Hyams JS, Ferry GD, Mandel FS, et al. Development and validation of a pediatric Crohn's disease activity index. *J Pediatr Gastroenterol Nutr* 1991; 12: 439-47.
12. Turner D, Otley AR, Mack D, et al. Development, validation, and evaluation of a pediatric ulcerative colitis activity index: a prospective multicenter study. *Gastroenterology* 2007; 133: 423-32.
13. Streiner DL, Norman GR. *Health measurement scales. A practical guide to their development and use.* 2nd edition, Oxford: Oxford University; 1995.
14. Horn JL. A rationale and test for the number of factors in factor analysis. *Psychometrika* 1965; 30: 179-85.
15. Perrin JM, Kuhlthau K, Chughtai A, et al. Measuring quality of life in pediatric patients with inflammatory bowel disease: psychometric and clinical characteristics. *J Pediatr Gastroenterol Nutr* 2008; 46: 164-71.
16. Loonen HJ, Grootenhuis MA, Last BF, et al. Measuring quality of life in children with inflammatory bowel disease: the impact-II (NL). *Qual Life Res* 2002; 11: 47-56.
17. Ghione S, Sarter H, Fumery M, et al. Dramatic Increase in Incidence of Ulcerative Colitis and Crohn's Disease (1988-2011): A Population-Based Study of French Adolescents. *Am J Gastroenterol* 2018; 113:265-272.

Table 1. Patient demographic and disease characteristics.

	Overall (n=84)	CD (n=58)	UC (n=16)	IBD-U (n=10)
Age (years)	14.3 ± 2.7	14.5 ± 2.6	13.6 ± 3.1	14.5 ± 2.5
Male	45 (53.6)	37 (63.8)	6 (37.5)	2 (20.0)
Disease duration (months)	34.3 (16.6 to 64.8)	29.0 (15.3 to 58.5)	47.2 (33.5 to 61.6)	50.9 (14.8 to 74.4)
Weight (kg)	50.3 ± 14.7	51.6 ± 14.2	45.1 ± 18.2	50.8 ± 10.2
Height (cm)	159.8 ± 14.6	161.4 ± 14.1	154.3 ± 17.9	159.5 ± 10.6
BMI	19.5 ± 3.4	19.8 ± 3.5	18.2 ± 3.6	19.9 ± 2.7
Disease activity				
Inactive	59 (79.7)	49 (84.5)	10 (62.5)	-
Mild	14 (18.9)	9 (15.5)	5 (31.3)	-
Moderately-Severe	1 (1.4)	0	1 (6.2)	-
PUCAI	5.0 (2.5 to 15.0)	-	5.0 (0.0 to 10.0)	-
PCDAI	3.0 (0.0 to 6.5)	3.0 (0.0 to 5.0)	-	-
Corticosteroids	49 (58.3)	34 (58.6)	8 (50.0)	7 (70.0)
Anti-inflammatory	75 (89.3)	54 (93.1)	14 (87.5)	7 (70.0)

Values are presented as count (percentage), mean ± standard deviation or median (interquartile range).

CD, Crohn's disease; UC, Ulcerative colitis; IBD-unclassified, IBD-U

Table 2. Mean values and reliability coefficients for total and original domains scores of IMPACT-III and PedsQL™ (n=84).

Scale	No. of items	Score range	Mean ± SD	Cronbach's alpha
IMPACT-III total score	35	0-100	81.1 ± 13.5	0.896
Social functioning	12	0-100	70.3 ± 17.9	0.662
Emotional functioning	7	0-100	85.7 ± 9.8	0.839
Bowel symptoms	7	0-100	73.3 ± 19.6	0.644
Systemic symptoms	3	0-100	75.8 ± 20.3	0.786
Body image	3	0-100	68.5 ± 23.5	0.626
Treatment interventions	3	0-100	78.8 ± 11.6	0.652
PedsQL™ Total Score	23	0-100	81.6 ± 13.4	0.892
Physical health	8	0-100	84.3 ± 13.5	0.733
Psychosocial health	15	0-100	80.2 ± 15.0	0.866
Emotional functioning	5	0-100	76.6 ± 20.0	0.777
Social functioning	5	0-100	90.8 ± 15.3	0.837
School functioning	5	0-100	73.2 ± 19.4	0.735

SD = standard deviation

Table 3. Proposed factor structure for IMPACT-III (HR) with factors and item loading, indicating original domains for each question

IMPACT-III item	Rotated factor loadings			Original IMPACT-III domain
	Factor 1	Factor 2	Factor 3	
Factor 1: Concerns (14 items)				
5: How much does it bother you that you have an illness that doesn't just go away?	0.775	0.151	0.273	Emotional functioning
12: How often do you think it's unfair that you have IBD?	0.710	0.037	0.326	Emotional functioning
13: During the last 2 weeks, were you ever angry that you have IBD?	0.672	0.174	0.343	Emotional functioning
19: How often do you worry about stool containing blood?	0.658	-0.002	0.009	Bowel symptoms
11: How much do you worry about health problems that you might have in the future?	0.629	0.248	0.222	Emotional functioning
22: How do you feel about the tests you have to go through?	0.596	0.039	0.144	Treatment interventions
24: How often do you worry about having an operation?	0.587	0.336	-0.088	Treatment interventions
8: How has your IBD affected your family?	0.536	-0.047	0.224	Social functioning
4: How much have you been worrying about having a flare up (increase in symptoms) in the last 2 weeks?	0.497	0.366	0.143	Emotional functioning
2: Taking medicines or tablets bothers you?	0.487	0.146	0.107	Treatment interventions
20: Are you worried you cannot have a girlfriend or boyfriend because of your IBD?	0.471	0.092	-0.079	Social functioning
14: Do you think too many rules or restrictions are placed on you because of your IBD?	0.447	0.347	0.305	Social functioning
27: Does your IBD make it difficult to travel or go on holiday?	0.436	0.176	0.126	Social functioning
18: Is it harder to make friends because of your IBD?	0.322	0.039	-0.133	Social functioning
Factor 2: Body image & physical condition (12 items)				
35: How often are you able to go to school?	0.110	0.726	0.028	Social functioning
17: Did you have fun during the last 2 weeks?	0.189	0.692	-0.092	Social functioning
32: How tired have you felt in the last 2 weeks?	0.019	0.669	0.195	Systemic symptoms
29: Are you happy with your life?	0.219	0.602	0.186	Emotional functioning
6: How much energy did you have during the last 2 weeks?	-0.040	0.578	0.496	Systemic symptoms
9: How often did you miss out certain things because of your IBD?	0.233	0.578	0.093	Social functioning
34: Despite your IBD can you take part in as much sport as you would like?	-0.020	0.565	0.242	Social functioning
28: How did you feel in the last two weeks?	0.046	0.554	0.551	Systemic symptoms
15: How do you feel about the way you look?	0.114	0.540	-0.332	Body image

3: Has your IBD prevented you from eating what you like in the last 2 weeks?	0.073	0.503	0.347	Bowel symptoms
30: Do you feel there is someone you can talk to about your IBD?	0.289	0.499	-0.378	Social functioning
7: How do you feel about your weight?	0.284	0.479	-0.084	Body image
Factor 3: Symptoms & socializing (7 items)				
16: Are you embarrassed because of your bowel condition?	0.359	0.042	0.712	Emotional functioning
1: How much has your stomach been hurting in the last 2 weeks?	0.054	0.204	0.649	Bowel symptoms
21: How often did you feel sick in the last 2 weeks?	0.105	0.423	0.513	Bowel symptoms
26: Do you try and hide your IBD?	0.051	-0.107	0.478	Social functioning
23: Do other children bully you or leave you out of things because of your IBD or its treatment?	0.161	0.058	0.472	Social functioning
25: How often are you afraid you may have an accident (not get to the toilet on time)?	0.413	0.283	0.467	Bowel symptoms
10: How often have you been bothered by diarrhea in the last 2 weeks?	0.194	0.276	0.344	Bowel symptoms
Items that did not load well				
31: How often did you have to pass wind in the last 2 weeks?	0.227	-0.039	0.282	Bowel symptoms
33: How do you feel about your height?	0.243	0.088	0.169	Body image

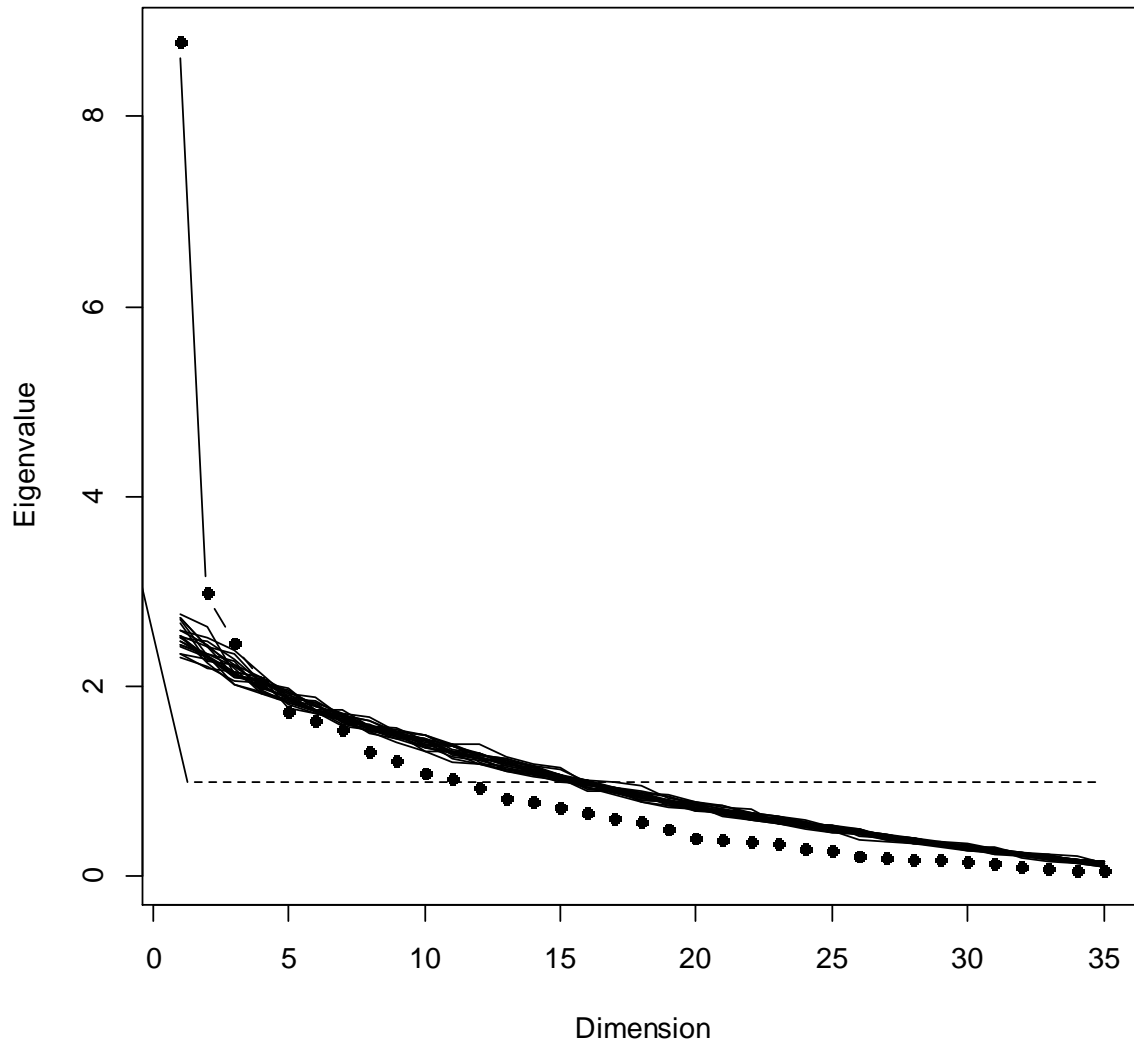
Bold indicates factors on which each item loaded.

Table 4. Correlation between the IMPACT-III scales and PedsQL™ (n=84)

IMPACT-III	PedsQL™				
	Physical health	Emotional functioning	Social functioning	School functioning	Total score
Factor 1: Concerns	0.492 ***	0.567 ***	0.438 ***	0.403 **	0.601 ***
Factor 2: Body image & physical condition	0.487 ***	0.427 ***	0.333 **	0.491 ***	0.561 ***
Factor 3: Symptoms & socializing	0.393 ***	0.440 ***	0.355 **	0.254 **	0.458 ***
Total score	0.599 ***	0.638 ***	0.497 ***	0.508 ***	0.709 ***

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.0001$

Suppl Figure 1. Scree plot of eigenvalues from principal component analysis on 35 items through the IMPACT-III questionnaire (n=84).



A scree plot displays the eigenvalues associated with each factor in descending order. Point line represents the plot of observed eigenvalues obtained from the 84 patients included in this study. Plain lines represent plots of eigenvalues obtained from 200 random samples (parallel analysis). Only factors with eigenvalues that are greater than simulated values are interpreted. Here, three eigenvalues are above simulated values.

Suppl Table 1. Total and domain IMPACT-III scale score in overall population, according to disease and according to disease's activity

IMPACT-III	Subgroups	Median (interquartile range)	p-value
Factor 1: Concerns	Overall	80.4 (66.1 to 90.2)	0.25
	Disease		
	CD (n=58)	83.9 (69.2 to 91.1)	
	UC (n=16)	77.7 (57.4 to 92.9)	
	IBD-U (n=10)	73.2 (64.6 to 78.6)	
	Disease's activity		
Inactive (n=59)	83.9 (71.4 to 91.1)		
Active (n=15)	64.6 (48.2 to 78.6)		
Factor 2: Body image & physical condition	Overall	83.3 (75.0 to 89.6)	0.43
	Disease		
	Crohn (n=58)	83.3 (75.0 to 89.6)	
	UC (n=16)	84.4 (80.2 to 89.6)	
	IBD-U (n=10)	78.1 (70.8 to 83.3)	
	Disease's activity		
Inactive (n=59)	83.3 (75.0 to 91.7)		
Active (n=15)	79.2 (64.6 to 85.4)		
Factor 3: Symptoms & socializing	Overall	89.3 (78.6 to 96.4)	0.67
	Disease		
	Crohn (n=58)	89.3 (82.1 to 96.4)	
	UC (n=16)	85.7 (75.0 to 98.2)	
	IBD-U (n=10)	83.9 (75.0 to 93.9)	
	Disease's activity		
Inactive (n=59)	91.1 (83.3 to 96.4)		
Active (n=15)	78.6 (67.9 to 85.7)		
Total score	Overall	83.0 (72.0 to 88.6)	0.44
	Disease		
	Crohn (n=58)	83.3 (73.5 to 89.4)	
	UC (n=16)	83.7 (72.3 to 88.3)	
	IBD-U (n=10)	77.7 (71.1 to 84.1)	
	Disease's activity		
Inactive (n=59)	83.3 (76.5 to 90.2)		
Active (n=15)	72.0 (60.6 to 82.6)		

CD, Crohn's disease; UC, Ulcerative colitis; IBD-unclassified, IBD-U