






Health-related quality of life aspects of the ‘Periodontitis prevalence in ulcerative colitis and Crohn's disease’ (PPCC) cohort

Kristina Bertl^{1,2}  | Georgios Tsakos³  | Nikolaos Pandis⁴  | Anna Bogren⁵ |
Johan Burisch^{6,7}  | Andreas Stavropoulos^{2,8} 

¹Department of Periodontology, Dental Clinic, Faculty of Medicine, Sigmund Freud University, Vienna, Austria

²Department of Periodontology, Faculty of Odontology, University of Malmö, Malmö, Sweden

³Department of Epidemiology and Public Health, University College London, London, UK

⁴Department of Orthodontics and Dentofacial Orthopedics, School of Dental Medicine, University of Bern, Bern, Switzerland

⁵Department of Odontology, Section of Molecular Periodontology, Umeå University, Umeå, Sweden

⁶Gastrounit, Medical Division, Copenhagen University Hospital - Amager and Hvidovre, Hvidovre, Denmark

⁷Copenhagen Center for Inflammatory Bowel Disease in Children, Adolescents and Adults, Copenhagen University Hospital - Amager and Hvidovre, Hvidovre, Denmark

⁸Division of Conservative Dentistry and Periodontology, University Clinic of Dentistry, Medical University of Vienna, Vienna, Austria

Correspondence

Andreas Stavropoulos, Department of Periodontology, Faculty of Odontology, University of Malmö, Malmö, Sweden.
Email: andreas.stavropoulos@mau.se

Funding information

Eklund Foundation

Abstract

Aim: To assess whether oral health problems affect disease-specific quality of life (QoL) of inflammatory bowel disease (IBD) patients, and vice versa, whether IBD affects oral-health-related QoL.

Materials and Methods: Individuals reporting IBD and matched controls were surveyed on general anamnestic information, oral-health-related questions and the Oral Health Impact Profile (OHIP)-5. IBD patients were additionally surveyed on years since diagnosis, disease activity and severity as well as health-related QoL (Short Inflammatory Bowel Disease Questionnaire, sIBDQ). OHIP-5 and sIBDQ were defined as primary outcome parameters, and several predictors and confounders were used in adjusted univariable and multivariable regression analyses.

Results: Answers from 1108 IBD patients and 3429 controls were analysed. Compared with controls, IBD patients reported significantly more frequently an oral impact on daily life and worse oral-health-related QoL, with Crohn's disease (CD) patients being more severely affected than ulcerative colitis (UC) patients. The diagnosis of UC and CD, having <20 teeth, severe periodontitis and stressful daily-life experience were associated with a higher prevalence of poor oral-health-related QoL. Among IBD patients, an impaired IBD-specific, health-related QoL was significantly associated with the diagnosis of CD and depression, IBD activity and severity, having <20 teeth, presence of oral lesions and stressful daily-life experience, while a longer time since diagnosis was significantly associated with an improved IBD-specific, health-related QoL.

Conclusions: The results of the present study indicate, for the first time, that oral health problems are associated with an impairment of IBD-specific health-related QoL, and vice versa, IBD is associated with an impaired oral health-related QoL. This emphasizes the potential advantages of including dental professionals in the multi-disciplinary treatment teams of IBD patients.

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2023 The Authors. *Journal of Clinical Periodontology* published by John Wiley & Sons Ltd.

KEYWORDS

case-control study, inflammatory bowel disease, oral health problems, quality of life, questionnaire

Clinical Relevance

Scientific rationale for study: There is no information on the association between oral health problems, including periodontitis, and inflammatory bowel disease (IBD) on IBD-specific and/or oral health-related quality of life (QoL).

Principal findings: IBD patients reported significantly more frequently an oral impact on daily life and worse oral-health-related QoL compared with controls. In adjusted multivariable models, the diagnosis of ulcerative colitis (UC) and Crohn's disease (CD), having <20 teeth and severe periodontitis were associated with a higher prevalence of poor oral-health-related QoL, while the diagnosis of CD, having <20 teeth and problems with oral lesions were significantly associated with an impaired IBD-specific health-related QoL.

Practical implications: The fact that both oral health problems and IBD were associated with an impairment of IBD-specific and oral-health-related QoL, respectively, emphasizes the potential benefit of including dental professionals in the multi-disciplinary treatment teams of IBD patients.

1 | INTRODUCTION

Inflammatory bowel disease (IBD) affects—depending on the disease entity (i.e., ulcerative colitis [UC] or Crohn's disease [CD])—parts of or the entire gastrointestinal tract, and often has extra-intestinal manifestations (EIM) involving the joints, eyes, skin, and/or the oral cavity. Additionally, IBD is associated with oral conditions such as caries and periodontitis (see for reviews Agossa et al., 2017, 2021; Domokos et al., 2022; Lorenzo-Pouso et al., 2021; Nijakowski et al., 2021; Papageorgiou et al., 2017; She et al., 2020; Zhang et al., 2021). In a recent large-scale, questionnaire-based, case-control study in Denmark, the association between IBD and oral health was further investigated based on answers of over 1100 IBD patients and more than 3400 matched controls. In summary, IBD patients reported significantly worse self-perceived oral health, more periodontal problems and fewer teeth (Bertl et al., 2022), which resulted in higher expenses towards professional dental care for the IBD patients compared with controls (Bertl et al., 2023). In addition, about 30% of the IBD patients reported having problems with oral lesions but these were rarely addressed by the medical or dental team and/or hardly any treatment was provided (Bertl et al., 2023). Furthermore, having fewer teeth and severe periodontitis were associated with a significantly higher IBD disability index and disease activity in the preceding 12 months (Madsen et al., 2023).

It is well known that various diseases, including IBD and oral conditions, can negatively affect the health-related quality of life (QoL). To be able to assess the extent of this negative effect but also the potential effect of any treatment, various tools evaluating overall health-related QoL and disease-specific QoL have been developed. In terms of oral health problems, frequently applied and validated tools are the Oral Health Impact Profile (OHIP) (Slade & Spencer, 1994a, 1994b) and the Oral Impacts on Daily Performances (Tsakos et al., 2001, 2010). For instance, a significant impact of periodontitis and tooth loss on oral health-related QoL has been previously shown. Specifically, a 'dose-dependent' relation was reported for periodontitis (i.e., more severe

periodontitis was associated with poorer oral-health-related QoL), while periodontal treatment improved patients' QoL (Graziani & Tsakos, 2020; Shanbhag et al., 2012). Regarding tooth loss, the severity of QoL impairment appears to be dependent on the location and distribution of tooth loss (Gerritsen et al., 2010). Similarly, various tools exist to assess disease-specific health-related QoL in IBD patients; the Inflammatory Bowel Disease Questionnaire (Guyatt et al., 1989; Irvine, 1993) and shorter versions of it (Alcalá et al., 2004; Irvine, Feagan, et al., 1996; Irvine, Zhou, et al., 1996) are the most frequently used (Alrubaiy et al., 2015; Chen et al., 2017). Based on these tools, an association between IBD activity and impaired health-related QoL has been reported in several studies (Cao et al., 2019; Christiansen et al., 2019; Min Ho et al., 2019).

Previous publications have reported on the risk of additional impairment of IBD patients' health-related QoL in the presence of comorbidities such as arthritis, heart disease, hypertension, depression/anxiety and rheumatic symptoms (Bernklev et al., 2004; Pizzi et al., 2006). However, to the best of our knowledge, no study has assessed whether the co-occurrence of oral health problems, for example, periodontitis, in IBD patients causes an additional impairment in IBD-specific health-related QoL; and vice versa, whether IBD has an impact on oral-health-related QoL. Hence, the present analysis used information collected in the above-mentioned, large-scale, Danish case-control study to assess whether oral health problems affect disease-specific health-related QoL of IBD patients, and vice versa, whether IBD affects oral-health-related QoL.

2 | MATERIALS AND METHODS

2.1 | Population details and distribution of the questionnaire

The present analysis is based on the data collected in the first large-scale, questionnaire-based, case-control study involving a European

population, assessing self-perceived overall health of teeth and gums, severe periodontitis and tooth loss in self-reported IBD patients, Periodontitis Prevalence in Ulcerative Colitis & Crohn's Disease Patients: the PPCC study (Bertl et al., 2022). Individuals reporting diagnosis of IBD (i.e., cases) were matched with individuals without IBD (i.e., controls) in a ratio of 1:3. Both groups were recruited in Denmark and surveyed by means of a web-based tool (Sunet Survey). Members of the Danish Colitis-Crohn Association (CCF; www.ccf.dk) were informed and reminded three times about the study via email, the association's home page and social media. Answers were collected for a period of 6 months from November 2018 to April 2019. Potential controls were identified from the database of Statistics Denmark (www.dst.dk), a governmental organization under the Ministry of the Interior and Housing, being matched according to gender, age (± 2 years within the same decade of age), education (up to high school/higher education up to 3 years /higher education >3 years), income after taxes (<10,000 DKK/ $\geq 10,000$ DKK) and living area (city/non-city) and after excluding citizens with a UC or CD diagnosis based on the National Patient Registry of the public Danish healthcare system. Based on experience of Statistics Denmark in similar types of surveys, an age-dependent response rate of 25%–33% was expected, and therefore 9–12 controls were matched to each IBD case. The identified controls received information about the study directly via email in an official communication platform (www.e-boks.com), but their answers were treated anonymously. Answers were again collected for a period of 6 months from July 2020 to December 2020, with three reminders sent in total. No ethical approval is required for this type of study in Denmark, and reporting here complies with the STROBE guidelines.

2.2 | Content of the questionnaire

Details on the content of the questionnaire have been previously described (Bertl et al., 2022). Here, the analyses included general information (i.e., age, gender, body height and weight for calculation of the body mass index [BMI], smoking status, comorbidities, living area, education, income after taxes, family status and daily-life experience), information on oral health questions (i.e., number of teeth, presence of self-reported severe periodontitis based on the Periodontal Screening Score, or PESS, with a score ≥ 5 being indicative for severe periodontitis) (Carra et al., 2018), presence of oral lesions, parts of the World Health Organization (WHO) Oral Health Questionnaire (for details see Table 2) (World Health Organization, 2013) and the OHIP-5, which includes five questions on functional limitation, pain, psychological discomfort, physical disability and handicap (John et al., 2006; Wide & Hakeberg, 2018). For the OHIP-5, the total sum (ranging from 0 to 20) was used, as well as the following dichotomous discrimination between good and poor oral-health-related QoL; if up to one oral impact was experienced 'fairly often' or 'very often', the participant was judged as having a good oral health-related QoL, while two or more oral impacts reported 'fairly often' or 'very often' indicated a poor oral-health-related QoL (Wide & Hakeberg, 2018).

Patients answering a question as 'I don't know' were not considered as having 'fairly often' or 'very often' a problem with the specific question. However, these patients were excluded when calculating the OHIP-5 sum. Furthermore, the analyses included information on IBD-related characteristics (i.e., diagnosis [CD, UC, or unclassified IBD], years since diagnosis, history of surgery, intake of biological therapy and disease activity based for CD patients on the Harvey & Bradshaw's Activity Index [HBI] [Harvey & Bradshaw, 1980] with a sum >5 indicating active disease, and for UC patients on the Simple Clinical Colitis Activity Index [SCCAI] [Walmsley et al., 1998] with a sum >2 indicating active disease), and the Short Inflammatory Bowel Disease Questionnaire (sIBDQ) for assessment of disease-specific health-related QoL (Christiansen et al., 2019; Irvine, Zhou, et al., 1996; Jowett et al., 2001). IBD severity was defined as a composite parameter based on a history of surgery due to IBD and/or intake of biological therapy, indicating a higher severity. For the sIBDQ, the sum of each dimension (i.e., bowel symptoms, emotional functioning, social functioning and systemic symptoms) and the overall sum were calculated; a sum of 50 or higher was judged as indicative of a good health-related QoL (Christiansen et al., 2019). All information and questions were provided in Danish.

2.3 | Statistical analysis

Frequency distribution for categorical variables and mean (standard deviation), median and interquartile range for continuous variables are reported for IBD patients and controls and separately for UC and CD patients. Patients indicating that they had unclassified IBD were grouped with UC, while patients reporting to be diagnosed with both UC and CD were included in comparisons between IBD patients and controls but excluded from any secondary analyses regarding comparisons within or between UC and CD patients, as it was not possible to allocate those cases knowledgeably in one or the other category. To test any differences between controls and IBD patients or between UC and CD patients, either Fisher's exact test or the chi-squared test was applied for categorical parameters and either an independent *t*-test (for normally distributed data) or a Mann-Whitney *U* test (for non-normally distributed data) for continuous variables. Normality of the data was controlled graphically by Q-Q plots and by the Shapiro-Wilk test.

For the main analysis, the following two variables were defined as primary outcomes (and analysed statistically accordingly): (i) prevalence of poor oral-health-related QoL (dichotomous outcome, i.e., good vs. poor; binary logistic regression analysis), and (ii) sIBDQ overall sum (continuous outcome parameter; quantile regression analysis). Further, the following predictors were included: (i) patient group (control/UC/CD for the prevalence of poor oral-health-related QoL; UC/CD for sIBDQ); (ii) tooth number (<20 teeth/ ≥ 20 teeth); (iii) PESS (<5/ ≥ 5); and (iv) oral lesions as EIM (absent/present; for sIBDQ), as well as the following confounders: (i) systemic diseases (absent/present); (ii) family status (no current relationship/relationship); (iii) daily-life experience (not stressful at all/a little stressful/average

TABLE 1 Self-reported general characteristics of the IBD patients ($n = 1108$) and controls ($n = 3429$).

Parameter		IBD patients	Controls	<i>p</i> -Value ^a
Age	Mean (SD)	48.0 (14.8)	48.9 (13.3)	.068 ^b
	Median (Q1; Q3)	49 (37; 59)	50 (40; 57)	
Gender (n [%])	Female	825 (74.5)	2714 (79.1)	.001
	Male	283 (25.5)	715 (20.9)	
BMI	Mean (SD)	26.2 (5.4)	26.3 (5.4)	.761 ^c
	Median (Q1; Q3)	25.3 (22.4; 29.1)	25.2 (22.6; 29.0)	
Smoking (n [%])	Never	465 (42.0)	1820 (53.1)	<.001
	Former	460 (41.5)	1129 (32.9)	
	Current	183 (16.5)	480 (14.0)	
Systemic diseases (present; n [%])	Diabetes	40 (3.6)	89 (2.6)	.077
	Osteoporosis	75 (6.8)	53 (1.6)	<.001
	Rheumatoid arthritis	49 (4.4)	45 (1.3)	<.001
	Ankylosing spondylitis	30 (2.7)	11 (0.3)	<.001
	Psoriasis	64 (5.8)	80 (2.3)	<.001
	Depression	89 (8.0)	157 (4.6)	<.001
	High cholesterol	73 (6.6)	147 (4.3)	.002
	Cardiovascular disease	143 (12.9)	262 (7.6)	<.001
	Asthma	92 (8.3)	190 (5.5)	.001
	COPD	15 (1.4)	26 (0.8)	.069
Living area (n [%])	City	535 (48.3)	980 (28.6)	<.001
	Suburban area	370 (33.4)	905 (26.4)	
	Countryside	203 (18.3)	1544 (45.0)	
Education (n [%])	No school	1 (0.1)	19 (0.5)	<.001^d
	Primary school	157 (14.2)	410 (12.0)	
	High school	108 (9.8)	260 (7.6)	
	Higher education up to 3 years	501 (45.2)	1454 (42.4)	
	Higher education up to 6 years	324 (29.2)	1219 (35.5)	
	PhD	17 (1.5)	67 (2.0)	
Income (n [%])	<5,000 DKK	130 (11.7)	352 (10.2)	.274
	5,000 to <10,000 DKK	303 (27.3)	980 (28.6)	
	10,000 to <20,000 DKK	413 (37.3)	1223 (35.7)	
	≥20,000 DKK	262 (23.7)	874 (25.5)	
Family status (n [%])	Single	188 (17.0)	424 (12.4)	.001
	Relationship (not living together)	55 (5.0)	183 (5.3)	
	Relationship (living together)	788 (71.1)	2629 (76.7)	
	Divorced	57 (5.1)	140 (4.1)	
	Widow/widower	20 (1.8)	53 (1.5)	
Daily life experience (n [%])	Not stressful at all	230 (20.8)	948 (27.6)	<.001
	A little stressful	500 (45.1)	1509 (44.0)	
	Average stressful	303 (27.3)	812 (23.7)	
	Very stressful	75 (6.8)	160 (4.7)	

Note: Bold values indicate statistical significance.

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; DKK, Danish krone; IBD, inflammatory bowel disease; Q1/Q3, first/third quartile; SD, standard deviation.

^aNo adjustment for confounders was performed.

^b*p*-Value relates to the mean values and independent *t*-test was applied.

^c*p*-Value relates to the median values and Mann Whitney-*U* test was applied.

^dCalculation of the Fisher's exact test was not possible for these data, and *p*-value is based on chi-squared test.

TABLE 2 Self-reported dental characteristics and oral-health-related quality of life aspects of the IBD patients ($n = 1108$) and controls ($n = 3429$).

Parameter		IBD patients	Controls	p-Value ^a	
Tooth number (n [%])	Edentulous	6 (0.5)	23 (0.7)	<.001	
	1–9 teeth	14 (1.3)	59 (1.7)		
	10–19 teeth	154 (13.9)	251 (7.3)		
	≥20 teeth	934 (84.3)	3096 (90.3)		
PESS ≥ 5 ^b	Yes (n [%])	352 (31.8)	681 (19.9)	<.001	
Problems with oral lesions as EIM	Yes (n [%])	323 (29.2)	-	-	
Because of the state of your teeth or mouth, how often have you experienced any of the following problems during the past 12 months? ^c	Difficulty in biting foods (n [%])	Very often	40 (3.6)	40 (1.2)	<.001
		Fairly often	73 (6.6)	41 (1.2)	
		Sometimes	218 (19.7)	372 (10.8)	
		No	757 (68.3)	2918 (85.1)	
		Do not know	20 (1.8)	58 (1.7)	
	Difficulty chewing foods (n [%])	Very often	32 (2.9)	34 (1.0)	<.001
		Fairly often	60 (5.4)	49 (1.4)	
		Sometimes	242 (21.9)	364 (10.6)	
		No	758 (68.4)	2942 (85.8)	
		Do not know	16 (1.4)	40 (1.2)	
	Difficulty with speech/trouble pronouncing words (n [%])	Very often	16 (1.4)	17 (0.5)	<.001
		Fairly often	25 (2.3)	25 (0.7)	
		Sometimes	144 (13.0)	300 (8.8)	
		No	882 (79.6)	3015 (87.9)	
		Do not know	41 (3.7)	72 (2.1)	
	Dry mouth (n [%])	Very often	106 (9.6)	93 (2.7)	<.001
		Fairly often	129 (11.6)	154 (4.5)	
		Sometimes	385 (34.7)	955 (27.8)	
		No	476 (43.0)	2132 (62.2)	
		Do not know	12 (1.1)	95 (2.8)	
Felt embarrassed due to appearance of teeth (n [%])	Very often	48 (4.3)	63 (1.8)	<.001	
	Fairly often	52 (4.7)	73 (2.1)		
	Sometimes	179 (16.2)	431 (12.6)		
	No	818 (73.8)	2797 (81.6)		
	Do not know	11 (1.0)	65 (1.9)		
Felt tense because of problems with teeth or mouth (n [%])	Very often	44 (4.0)	48 (1.4)	<.001	
	Fairly often	72 (6.5)	84 (2.5)		
	Sometimes	261 (23.6)	474 (13.8)		
	No	705 (63.6)	2736 (79.8)		
	Do not know	26 (2.3)	87 (2.5)		
Have avoided smiling because of teeth (n [%])	Very often	33 (3.0)	44 (1.3)	<.001	
	Fairly often	44 (4.0)	65 (1.9)		
	Sometimes	144 (13.0)	282 (8.2)		
	No	872 (78.7)	2994 (87.3)		
	Do not know	15 (1.3)	44 (1.3)		
Had sleep that is often interrupted (n [%])	Very often	77 (6.9)	128 (3.7)	<.001	
	Fairly often	113 (10.2)	208 (6.1)		
	Sometimes	249 (22.5)	592 (17.2)		
	No	636 (57.4)	2396 (69.9)		
	Do not know	33 (3.0)	105 (3.1)		

(Continues)

TABLE 2 (Continued)

Parameter		IBD patients	Controls	p-Value ^a	
Have taken days off work (n [%])	Very often	6 (0.5)	5 (0.2)	<.001 ^d	
	Fairly often	10 (0.9)	13 (0.4)		
	Sometimes	115 (10.4)	197 (5.7)		
	No	897 (81.0)	3072 (89.6)		
	Do not know	80 (7.2)	142 (4.1)		
Difficulty doing usual activities (n [%])	Very often	21 (1.9)	29 (0.9)	<.001	
	Fairly often	31 (2.8)	31 (0.9)		
	Sometimes	160 (14.4)	230 (6.7)		
	No	864 (78.0)	3069 (89.5)		
	Do not know	32 (2.9)	70 (2.0)		
Felt less tolerant of spouse or people who are close to you (n [%])	Very often	15 (1.3)	22 (0.7)	<.001	
	Fairly often	47 (4.2)	42 (1.2)		
	Sometimes	268 (24.2)	490 (14.3)		
	No	722 (65.2)	2744 (80.0)		
	Do not know	56 (5.1)	131 (3.8)		
Have reduced participation in social activities (n [%])	Very often	32 (2.9)	42 (1.2)	<.001	
	Fairly often	44 (3.9)	61 (1.8)		
	Sometimes	197 (17.8)	292 (8.5)		
	No	802 (72.4)	2940 (85.7)		
	Do not know	33 (3.0)	94 (2.8)		
Within the last 7 days...	...have you had difficulty chewing any food because of problems with your teeth, mouth, dentures or jaws?	Very often	23 (2.1)	25 (0.7)	<.001
		Fairly often	61 (5.5)	48 (1.4)	
		Occasionally	216 (19.5)	301 (8.8)	
		Hardly ever	228 (20.6)	742 (21.6)	
		Never	572 (51.6)	2287 (66.7)	
	...have you had painful aching in your mouth?	Very often	27 (2.4)	25 (0.7)	<.001
		Fairly often	75 (6.8)	57 (1.7)	
		Occasionally	349 (31.5)	470 (13.7)	
		Hardly ever	352 (31.8)	1479 (43.1)	
		Never	295 (26.6)	1359 (39.6)	
...have you felt uncomfortable about the appearance of your teeth or dentures?	Very often	26 (2.4)	33 (1.0)	<.001	
	Fairly often	42 (3.8)	60 (1.8)		
	Occasionally	124 (11.2)	217 (6.3)		
	Hardly ever	141 (12.7)	379 (11.0)		
	Never	768 (69.3)	2709 (79.0)		
...have you felt that there has been less flavour in your food because of problems with your teeth, mouth, dentures or jaws?	Very often	5 (0.5)	5 (0.2)	<.001 ^d	
	Fairly often	18 (1.6)	18 (0.5)		
	Occasionally	65 (5.9)	56 (1.6)		
	Hardly ever	98 (8.8)	149 (4.3)		
	Never	847 (76.4)	3106 (90.6)		
...have you had difficulty doing your usual jobs because of problems with your teeth, mouth, dentures or jaws?	Very often	0 (0.0)	1 (0.0)	<.001 ^e	
	Fairly often	3 (0.3)	3 (0.1)		
	Occasionally	35 (3.2)	37 (1.1)		
	Hardly ever	60 (5.4)	123 (3.6)		
	Never	982 (88.6)	3220 (93.9)		
	Do not know	28 (2.5)	45 (1.3)		

TABLE 2 (Continued)

Parameter		IBD patients	Controls	p-Value ^a
Oral health-related QoL (OHIP) (n [%])	Poor	72 (6.5)	64 (1.9)	<.001
OHIP sum ^f	Mean (SD)	2.9 (3.0)	1.7 (2.2)	<.001 ^g
	Median (Q1; Q3)	2 (1; 4)	1 (0; 2)	

Note: Bold values indicate statistical significance.

Abbreviations: EIM, extra-intestinal manifestations; IBD, inflammatory bowel disease; OHIP, oral health impact profile; PESS, periodontal screening score; Q1/Q3, first/third quartile; QoL, quality of life; SD, standard deviation.

^aNo adjustment for confounders was performed.

^bBased on 3419 controls and 1107 cases.

^cQuestions were derived from the World Health Organization (WHO) Oral Health Questionnaire.

^dCalculation of the Fisher's exact test was not possible for these data, and *p*-value is based on chi-squared test.

^eFisher's exact test was applied.

^fBased on 3242 controls and 996 cases.

^g*p*-Value relates to the median values and Mann–Whitney *U* test was applied.

stressful/very stressful); (iv) BMI; and for the sIBDQ also (i) years since diagnosis; (ii) disease activity, based on the SCCAI for UC patients and on the HBI for CD patients (remission/inactive disease/active disease); and (iii) disease severity. In a first step, each predictor and confounder was assessed in a univariable analysis, which was adjusted for age, gender, living area (city/suburban area/countryside), education (no school or primary school/high school/higher education up to 3 years/higher education up to 6 years and/or PhD), income after taxes (<5000 DKK/5000 to <10,000 DKK/10,000 to <20,000 DKK/≥20,000 DKK) and smoking status (never/former/current). In a second step, all predictors and confounders presenting a *p*-value <.2 in the adjusted univariable analysis were combined in a multivariable analysis, which was again adjusted for age, gender, living area, education, income and smoking status. Statistical analysis was performed with STATA/IC 17.0 for Mac, and a *p*-value of ≤.05 was considered statistically significant.

3 | RESULTS

3.1 | Response rate

Within 6 months, 1108 IBD patients responded to the survey (response rate based on the known number of CCF member: 26.4%): 538 with UC, 527 with CD, 28 with unclassified IBD and 15 indicating to be diagnosed with UC and CD. Based on the characteristics of this sample, 12,949 potential controls were contacted, and 3429 eligible answers were received (response rate: 26.5%) within 6 months.

3.2 | General characteristics

Significant differences between IBD patients and controls were detected regarding gender, smoking status, living area, education, family status and daily-life experience. IBD patients comprised fewer females, never smokers and participants with a higher education up to 6 years and/or PhD, but with more participants living in a city, and being singles, compared with controls. Despite the fact that the invited non-IBD individuals (*n* = 12,949) were

matched to the IBD patients, because of the nature of the study, namely voluntarily answering a questionnaire, statistically significant differences between IBD patients and controls were observed regarding gender, education (both <8% difference) and living area (~20% difference). Further, IBD patients experienced their daily life significantly less often as 'not stressful at all' compared with the controls: that is, 20.8% of IBD patients versus 27.6% of controls. Finally, IBD patients presented a significantly higher percentage for most of the assessed systemic diseases. For details see Table 1.

3.3 | Self-reported dental characteristics and oral health-related QoL aspects

IBD patients had significantly fewer teeth and higher prevalence of severe periodontitis; additionally, about 29% of the IBD patients indicated having problems with oral lesions. Furthermore, IBD patients reported for all questions of the WHO Oral Health Questionnaire (for details see Table 2) a significantly higher prevalence of problems in various daily-life activities due to the state of their teeth or mouth in the last 12 months compared with the controls. The prevalence of reporting problems occurring 'fairly often' or 'very often' was 1.7–4.4 times higher for IBD patients compared with the controls. Similarly, all questions of the OHIP-5 questionnaire indicated a significantly higher impact on the QoL of IBD patients compared with the controls. The prevalence of reporting problems occurring 'fairly often' or 'very often' was 2.2–3.8 times higher for IBD patients compared with the controls: that is, while the prevalence of 'fairly often' or 'very often' ranged between 0.1% and 2.8% for controls, in IBD patients it ranged between 0.3% and 9.2%. Thus, IBD patients showed a higher prevalence of poor oral-health-related QoL (6.5% for IBD patients vs. 1.9% for the controls) and a higher mean OHIP-5 score (2.9 vs. 1.7, respectively). For details see Table 2.

The comparison of UC patients with CD patients indicated more oral health problems among those with CD. Specifically, CD patients had significantly fewer teeth and more often problems

TABLE 3 Self-reported dental characteristics and oral-health-related quality of life aspects of patients with ulcerative colitis (including unclassified inflammatory bowel disease; $n = 566$) and patients with Crohn's disease ($n = 527$).

Parameter		Ulcerative colitis	Crohn's disease	p-Value ^a	
Tooth number (n [%])	Edentulous	0 (0.0)	6 (1.2)	.003^b	
	1–9 teeth	7 (1.2)	7 (1.3)		
	10–19 teeth	64 (11.3)	87 (16.5)		
	≥20 teeth	495 (87.5)	427 (81.0)		
PESS ≥ 5 ^c	Yes (n [%])	171 (30.2)	173 (32.9)	.341	
Problems with oral lesions as EIM	Yes (n [%])	141 (24.9)	177 (33.6)	.002	
Because of the state of your teeth or mouth, how often have you experienced any of the following problems during the past 12 months? ^d	Difficulty in biting foods (n [%])	Very often	16 (2.8)	22 (4.2)	.006
		Fairly often	26 (4.6)	47 (8.9)	
		Sometimes	103 (18.2)	109 (20.7)	
		No	413 (73.0)	337 (63.9)	
	Difficulty chewing foods (n [%])	Very often	14 (2.5)	18 (3.4)	.001
		Fairly often	18 (3.2)	41 (7.8)	
		Sometimes	111 (19.6)	124 (23.5)	
		No	417 (73.7)	334 (63.4)	
	Difficulty with speech/trouble pronouncing words (n [%])	Very often	6 (1.0)	10 (1.9)	.159
		Fairly often	10 (1.8)	13 (2.5)	
		Sometimes	71 (12.5)	69 (13.1)	
		No	465 (82.2)	410 (77.8)	
	Dry mouth (n [%])	Very often	50 (8.8)	54 (10.2)	.566 ^b
		Fairly often	61 (10.8)	66 (12.5)	
		Sometimes	193 (34.1)	188 (35.7)	
		No	255 (45.1)	214 (40.6)	
Felt embarrassed due to appearance of teeth (n [%])	Very often	14 (2.5)	33 (6.3)	<.001^b	
	Fairly often	20 (3.5)	32 (6.1)		
	Sometimes	77 (13.6)	97 (18.4)		
	No	450 (79.5)	359 (68.1)		
Felt tense because of problems with teeth or mouth (n [%])	Very often	15 (2.7)	27 (5.1)	<.001	
	Fairly often	30 (5.3)	41 (7.8)		
	Sometimes	116 (20.5)	141 (26.8)		
	No	397 (70.1)	300 (56.9)		
Have avoided smiling because of teeth (n [%])	Very often	10 (1.8)	22 (4.2)	<.001	
	Fairly often	13 (2.3)	31 (5.9)		
	Sometimes	62 (10.9)	79 (15.0)		
	No	474 (83.8)	387 (73.4)		
Had sleep that is often interrupted (n [%])	Very often	46 (8.1)	31 (5.9)	.141	
	Fairly often	49 (8.7)	63 (12.0)		
	Sometimes	120 (21.2)	127 (24.1)		
	No	335 (59.2)	289 (54.8)		
	Do not know	16 (2.8)	17 (3.2)		

TABLE 3 (Continued)

Parameter		Ulcerative colitis	Crohn's disease	p-Value ^a	
Have taken days off work (n [%])	Very often	1 (0.2)	5 (0.9)	.207 ^b	
	Fairly often	4 (0.7)	6 (1.1)		
	Sometimes	52 (9.2)	62 (11.8)		
	No	469 (82.8)	414 (78.6)		
	Do not know	40 (7.1)	40 (7.6)		
Difficulty doing usual activities (n [%])	Very often	11 (1.9)	9 (1.7)	.180	
	Fairly often	13 (2.3)	17 (3.2)		
	Sometimes	69 (12.2)	88 (16.7)		
	No	458 (80.9)	396 (75.2)		
	Do not know	15 (2.7)	17 (3.2)		
Felt less tolerant of spouse or people who are close to you (n [%])	Very often	5 (0.9)	10 (1.9)	.081 ^b	
	Fairly often	24 (4.2)	22 (4.1)		
	Sometimes	124 (21.9)	139 (26.4)		
	No	389 (68.8)	324 (61.5)		
	Do not know	24 (4.2)	32 (6.1)		
Have reduced participation in social activities (n [%])	Very often	15 (2.7)	17 (3.2)	.084	
	Fairly often	22 (3.9)	21 (4.0)		
	Sometimes	84 (14.8)	110 (20.9)		
	No	430 (75.9)	362 (68.7)		
	Do not know	15 (2.7)	17 (3.2)		
Within the last 7 days...	...have you had difficulty chewing any food because of problems with your teeth, mouth, dentures or jaws?	Very often	6 (1.1)	16 (3.0)	.001 ^b
		Fairly often	20 (3.5)	38 (7.2)	
		Occasionally	100 (17.7)	115 (21.8)	
		Hardly ever	125 (22.1)	100 (19.0)	
		Never	313 (55.3)	252 (47.8)	
	Do not know	2 (0.3)	6 (1.2)		
	...have you had painful aching in your mouth?	Very often	11 (1.9)	15 (2.8)	<.001 ^b
		Fairly often	20 (3.5)	52 (9.9)	
		Occasionally	167 (29.5)	175 (33.2)	
		Hardly ever	195 (34.5)	156 (29.6)	
		Never	167 (29.5)	125 (23.7)	
	Do not know	6 (1.1)	4 (0.8)		
	...have you felt uncomfortable about the appearance of your teeth or dentures?	Very often	7 (1.2)	17 (3.2)	<.001 ^b
		Fairly often	11 (1.9)	30 (5.7)	
		Occasionally	58 (10.3)	65 (12.3)	
Hardly ever		64 (11.3)	75 (14.2)		
Never		422 (74.6)	337 (64.0)		
Do not know	4 (0.7)	3 (0.6)			
...have you felt that there has been less flavour in your food because of problems with your teeth, mouth, dentures or jaws?	Very often	0 (0.0)	4 (0.8)	<.001 ^b	
	Fairly often	6 (1.1)	10 (1.9)		
	Occasionally	28 (4.9)	37 (7.0)		
	Hardly ever	36 (6.4)	60 (11.4)		
	Never	470 (83.0)	368 (69.8)		
Do not know	26 (4.6)	48 (9.1)			

(Continues)

TABLE 3 (Continued)

Parameter		Ulcerative colitis	Crohn's disease	p-Value ^a
...have you had difficulty doing your usual jobs because of problems with your teeth, mouth, dentures or jaws?	Very often	0 (0.0)	0 (0.0)	.183 ^b
	Fairly often	0 (0.0)	3 (0.6)	
	Occasionally	14 (2.5)	20 (3.8)	
	Hardly ever	28 (4.9)	32 (6.1)	
	Never	512 (90.5)	457 (86.7)	
	Do not know	12 (2.1)	15 (2.8)	
Oral-health-related QoL (OHIP) (n [%])	Poor	22 (3.9)	47 (8.9)	.001
OHIP sum ^e	Mean (SD)	2.4 (2.7)	3.3 (3.3)	<.001^f
	Median (Q1; Q3)	2 (0; 4)	2 (1; 5)	

Note: Bold values indicate statistical significance.

Abbreviations: EIM, extra-intestinal manifestations; OHIP, oral health impact profile; PESS, periodontal screening score; Q1/Q3, first/third quartile; QoL, quality of life; SD, standard deviation.

^aNo adjustment for confounders was performed.

^bFisher's exact test was applied.

^cBased on 566 patients with ulcerative colitis (including unclassified inflammatory bowel disease) and 526 patients with Crohn's disease.

^dQuestions are derived from the World Health Organization (WHO) Oral Health Questionnaire.

^eBased on 524 patients with ulcerative colitis (including unclassified inflammatory bowel disease) and 459 patients with Crohn's disease.

^fp-Value relates to the median values, and Mann-Whitney *U* test was applied.

with oral lesions compared with UC patients. Further, CD patients reported for all questions of the WHO Oral Health Questionnaire a higher prevalence of problems in various daily-life activities due to the state of their teeth or mouth in the last 12 months compared with UC patients. This reached statistical significance in 5 out of 12 questions, in which the prevalence of reporting problems occurring 'fairly often' or 'very often' was 1.6–2.5 times higher for CD patients compared with UC patients. Similarly, in four out of five questions of the OHIP-5 questionnaire, a significant difference was detected. The prevalence of reporting problems occurring 'fairly often' or 'very often' was 2.2–2.9 times higher for CD patients compared with UC patients, that is, while the prevalence of 'fairly often' or 'very often' ranged between 0% and 5.4% for UC patients, for CD patients it ranged between 0.6% and 12.7%. This resulted in a higher prevalence of poor oral-health-related QoL for CD patients compared with UC patients (8.9% for CD patients vs. 3.9% for UC patients) and also in a higher mean OHIP-5 score (3.3 vs. 2.4, respectively). For details see Table 3.

3.4 | Self-reported IBD-related characteristics and IBD-specific health-related QoL aspects

CD patients presented with a significantly longer time since diagnosis and higher disease severity compared with UC patients; however, they presented less often with active disease (i.e., 44% vs. 55%). The sIBDQ for assessment of health-related QoL indicated for three out of four dimensions (i.e., bowel symptoms, social functioning and systemic symptoms) a significantly higher impact on health-related QoL for CD patients compared with UC patients. This resulted in a significantly lower overall sum for CD patients, indicating a lower health-related QoL, and being more often judged as having a

poor health-related QoL compared with UC patients (i.e., 48.6% vs. 39.8%, respectively). For details see Table A1.

3.5 | Prevalence of poor oral-health-related QoL

The results of the adjusted univariable analyses are presented in Table B1. In the adjusted multivariable analysis, all predictors showed a significant effect on the prevalence of poor oral-health-related QoL. Specifically, diagnosis of UC (odds ratio [OR]: 2.08; 95% confidence interval [CI]: 1.15–3.75), CD (OR: 3.33; 95% CI: 2.01–5.52), having fewer than 20 teeth (OR: 7.49; 95% CI: 4.75–11.80) and PESS ≥ 5 (i.e., severe periodontitis) (OR: 10.06; 95% CI: 5.63–17.98) significantly increased the odds for having a poor oral-health-related QoL. Among the confounders, a stressful daily life experience increased the prevalence of poor oral-health-related QoL. For details see Table 4.

3.6 | Overall sum of the sIBDQ

The results of the adjusted univariable analyses are presented in Table B2. In the adjusted multivariable analysis, three of the four predictors showed a significant effect on IBD-specific health-related QoL. Specifically, patients with CD (Coef. -1.45 ; 95% CI: -2.68 to -0.22), having fewer than 20 teeth (Coef. -2.13 ; 95% CI: -3.68 to -0.57) and presence of oral lesions (Coef. -3.08 ; 95% CI: -4.27 to -1.90) significantly impaired IBD-specific health-related QoL. Among the confounders, IBD activity and severity, presence of a depression and a stressful daily life experience lowered IBD-specific health-related QoL, while a longer time since diagnosis increased IBD-specific health-related QoL. For details see Table 5.

TABLE 4 Results of the adjusted multivariable binary logistic regression analysis for the dichotomous outcome parameter 'prevalence of poor oral-health-related QoL'; an odds ratio above 1 indicates higher odds for a poor oral-health-related QoL.

Parameter		OR	95% CI		p-Value
			Lower	Upper	
Patient group	Control	Ref.			
	Ulcerative colitis	2.076	1.150	3.749	.015
	Crohn's disease	3.332	2.012	5.518	<.001
Tooth number	≥20 teeth	Ref.			
	<20 teeth	7.485	4.749	11.797	<.001
PESS	<5	Ref.			
	≥5	10.059	5.629	17.977	<.001
Osteoporosis	Absent	Ref.			
	Present	1.469	0.647	3.332	.358
Rheumatoid arthritis	Absent	Ref.			
	Present	2.378	0.989	5.721	.053
Ankylosing spondylitis	Absent	Ref.			
	Present	0.949	0.192	4.680	.948
Psoriasis	Absent	Ref.			
	Present	0.898	0.372	2.170	.811
Depression	Absent	Ref.			
	Present	0.919	0.466	1.811	.806
Cardiovascular disease	Absent	Ref.			
	Present	1.448	0.777	2.699	.243
COPD	Absent	Ref.			
	Present	2.811	0.918	8.609	.070
Daily-life experience	Not stressful at all	Ref.			
	A little stressful	3.355	1.660	6.784	.001
	Average stressful	4.524	2.129	9.611	<.001
	Very stressful	14.738	6.252	34.740	<.001
Age	Years	0.943	0.923	0.964	<.001
Gender	Male	Ref.			
	Female	1.645	0.934	2.896	.085
Living area	City	Ref.			
	Suburban area	1.205	0.679	2.141	.524
	Countryside	2.014	1.236	3.280	.005
Education	No school/Primary school	Ref.			
	High school	0.230	0.084	0.631	.004
	Higher education up to 3 years	0.519	0.302	0.894	.018
	Higher education up to 6 years and/or PhD	0.695	0.379	1.275	.240
Income	<5,000 DKK	Ref.			
	5,000 to <10,000 DKK	0.634	0.358	1.123	.118
	10,000 to <20,000 DKK	0.574	0.323	1.020	.058
	≥20,000 DKK	0.416	0.194	0.890	.024
Smoking	Never	Ref.			
	Former	0.941	0.547	1.621	.827
	Current	1.573	0.904	2.738	.109

Note: The model has been adjusted for age, gender, living area, education, income and smoking status; in addition, all predictors and confounders presenting a p-value <.2 in the adjusted univariable analysis (Table B1) have been included in this adjusted multivariable analysis. Bold values indicate significance.

Abbreviations: BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease; DKK, Danish krone; OR, odds ratio; PESS, periodontal screening score.

TABLE 5 Results of the adjusted multivariable quantile regression analysis for the continuous outcome parameter 'sIBDQ overall sum'; a negative coefficient indicates an impaired health-related quality of life.

Parameter	Coef.	95% CI		p-Value	
		Lower	Upper		
Patient group	Ulcerative colitis	Ref.			
	Crohn's disease	-1.450	-2.682	-0.218	.021
Tooth number	≥20 teeth	Ref.			
	<20 teeth	-2.127	-3.684	-0.570	.007
PESS	<5	Ref.			
	≥5	-1.075	-2.441	0.291	.123
Oral lesions as EIM	Absent	Ref.			
	Present	-3.084	-4.270	-1.898	<.001
Years since diagnosis of IBD	Years	0.111	0.060	0.162	<.001
IBD activity	Remission/inactive disease	Ref.			
	Active disease	-8.466	-9.592	-7.341	<.001
IBD severity	No history of surgery or biological therapy	Ref.			
	Either history of surgery and/or biological therapy	-1.669	-2.889	-0.450	.007
Osteoporosis	Absent	Ref.			
	Present	-0.255	-2.449	1.940	.820
Rheumatoid arthritis	Absent	Ref.			
	Present	-0.626	-3.253	2.002	.640
Ankylosing spondylitis	Absent	Ref.			
	Present	-0.690	-3.953	2.572	.678
Psoriasis	Absent	Ref.			
	Present	-0.592	-2.856	1.673	.608
Depression	Absent	Ref.			
	Present	-2.038	-4.064	-0.013	.049
Cardiovascular disease	Absent	Ref.			
	Present	-1.216	-2.866	0.433	.148
Asthma	Absent	Ref.			
	Present	1.036	-0.885	2.956	.290
Daily life experience	Not stressful at all	Ref.			
	A little stressful	-3.116	-4.525	-1.707	<.001
	Average stressful	-4.819	-6.410	-3.229	<.001
	Very stressful	-4.785	-7.164	-2.405	<.001
BMI	Score	-0.043	-0.143	0.057	.396
Age	Years	0.052	-0.001	0.105	.055
Gender	Male	Ref.			
	Female	-1.322	-2.566	-0.078	.037
Living area	City	Ref.			
	Suburban area	0.814	-0.365	1.994	.176
	Countryside	0.274	-1.151	1.699	.706
Education	No school/Primary school	Ref.			
	High school	0.702	-1.546	2.951	.540
	Higher education up to 3 years	1.150	-0.496	2.796	.171
	Higher education up to 6 years and/or PhD	1.275	-0.527	3.078	.165
Income	<5,000 DKK	Ref.			
	5,000 to <10,000 DKK	3.372	1.536	5.209	<.001
	10,000 to <20,000 DKK	4.710	2.897	6.523	<.001
	≥20,000 DKK	5.434	3.420	7.448	<.001

TABLE 5 (Continued)

Parameter	Coef.	95% CI		p-Value	
		Lower	Upper		
Smoking	Never	Ref.			
	Former	−0.644	−1.831	0.542	.287
	Current	−1.029	−2.635	0.577	.209

Note: The model has been adjusted for age, gender, living area, education, income and smoking status; in addition, all predictors and confounders presenting a *p*-value <.2 in the adjusted univariable analysis (Table B2) have been included in this adjusted multivariable analysis. Bold values indicate significance.

Abbreviations: BMI, body mass index; CI, confidence interval; Coef., coefficient; COPD, chronic obstructive pulmonary disease; DKK, Danish krone; EIM, extra-intestinal manifestations; IBD, inflammatory bowel disease; PESS, periodontal screening score.

4 | DISCUSSION

A patient's QoL can be affected in a positive or negative manner by various factors and conditions; for example, both oral health problems and IBD have been shown to impact negatively on a person's QoL (Cao et al., 2019; Christiansen et al., 2019; Gerritsen et al., 2010; Graziani & Tsakos, 2020; Min Ho et al., 2019; Shanbhag et al., 2012). The results of the present study indicate, for the first time, that oral health problems are associated with an impairment of IBD-specific health-related QoL, and vice versa, IBD is associated with an impaired oral-health-related QoL.

The finding that IBD patients have a lower oral-health-related QoL comes as no surprise, since, as previously reported, the IBD patients included in this study had a higher frequency of oral health problems (i.e., severe periodontitis, fewer teeth) compared with the controls (Bertl et al., 2022). Specifically, 2 and 3 times higher prevalence of a poor oral-health-related QoL in UC and CD patients, respectively, was observed here compared with IBD-free controls. However, this association remained evident even after correcting for oral health problems, such as the number of teeth and presence of severe periodontitis, and other relevant confounders such as age, gender, daily life experience and so on. Hence, IBD itself seems to be associated with an impaired patients' oral-health-related QoL, something not reported earlier. Furthermore, the finding that IBD patients with oral health problems (i.e., fewer teeth, presence of oral lesions) have a significantly lower IBD-specific health-related QoL has also not been reported before. This association was evident even after adjusting for previously reported relevant confounders, such as years since IBD diagnosis, IBD activity and severity, other comorbidities, daily-life experience, age, gender and so on. In this context, it has previously been shown that other comorbidities might additionally impair the health-related QoL of IBD patients. Such a cumulative effect has been reported for the co-existence of other immune-mediated diseases (Conway et al., 2017), more specifically for arthritis, heart disease, hypertension, depression/anxiety and EIM such as rheumatic symptoms (Bernklev et al., 2004; Pizzi et al., 2006), although it may not apply for all conditions (Ananthakrishnan et al., 2010).

The results of the present study, regarding the various confounders for IBD-specific health-related QoL, are overall in good agreement with those of previous publications. Specifically, diagnosis of CD, depression,

in particular IBD activity and severity, and a (very) stressful daily-life experience were significantly associated here with an impairment of IBD-specific health-related QoL; in contrast, a longer time since IBD diagnosis was associated with an improvement. Indeed, IBD activity and severity—although defined in different ways—have been quite consistently reported to be strong, if not the strongest, predictors of patients' health-related QoL (Ananthakrishnan et al., 2010; Bernklev et al., 2004; Cao et al., 2019; Christiansen et al., 2019; Min Ho et al., 2019; Pizzi et al., 2006) often followed by time-since-IBD-diagnosis (Ananthakrishnan et al., 2010) and socioeconomic parameters (Cao et al., 2019; Christiansen et al., 2019; Min Ho et al., 2019); the evidence, however, regarding health-related QoL in CD patients is inconclusive (Ananthakrishnan et al., 2010; Bernklev et al., 2004; Casellas et al., 1999; Christiansen et al., 2019; Min Ho et al., 2019; Pizzi et al., 2006). Similarly, the results here regarding the various confounders for oral-health-related QoL are in good agreement with what is already described in the literature. Here, the strongest impairment of oral-health-related QoL was seen for fewer teeth, the presence of severe periodontitis and a stressful daily-life experience, which comes without surprise (for an overview, see Gerritsen et al., 2010; Graziani & Tsakos, 2020; Shanbhag et al., 2012). Socioeconomic parameters, such as a higher education and a higher income, have been used for adjustment of the model here. Both have been extensively documented to be associated with an improved oral-health-related QoL (Knorst et al., 2021). Furthermore, diabetes was not associated with (worse) oral-health-related QoL in the present study despite the well-known negative impact of diabetes on oral health (Graziani et al., 2018; Polak et al., 2020; Polak & Shapira, 2018; Rohani, 2019), this finding, however, is in line with the results of a recent systematic review (Mohseni Homagarani et al., 2023), indicating that diabetes does not seem to be associated with oral-health-related QoL. In this context, the prevalence of diabetes in the present study population was about 3%, which corresponds very well with the currently known prevalence of diabetes in the general population in Denmark. Specifically, in the current study, the median age of the participants was about 50 years. The prevalence of type 2 diabetes at 50 years of age was about 4% in 2017 in Denmark (Carstensen et al., 2020).

The significant association between oral lesions and an impaired IBD-specific health-related QoL needs to be emphasized, considering how infrequently this aspect appears to be addressed by physicians in

general, or even by gastroenterologists. For example, in a prospective study published already more than 15 years ago, gastroenterologists judged the mouth as 'abnormal' in only 45% of the cases, who had been previously diagnosed with oral EIM by dental health professionals (Harty et al., 2005). Within the current cohort of IBD patients, almost one-third reported having problems with oral lesions. However, at the same time, only 12.5% were informed by their physician about the possibility of oral lesions in connection with IBD, only about 10% indicated receiving treatment for them and less than 20% and 15%, respectively, believed that their physician is interested in or knows how to treat oral lesions (Bertl et al., 2023). This reduced interest or understanding by physicians on issues related to the oral cavity may reflect the relatively limited education on this part of the body included in curricula of medicine in general and the lack of integrated care covering all aspects of the patient's health. Thus, having multidisciplinary teams including dental professionals and/or dermatologists with special interest on oral mucosa—depending on each country's health-care system and distribution of responsibilities—appears advantageous (Sbeit et al., 2020). The inclusion of dental professionals could have the additional advantage to potentially reduce the development of other oral health problems, such as caries and periodontitis, and thereby prevent/reduce their occurrence and/or mitigate their progression and thereby also reduce tooth loss (Bertl et al., 2023; Sbeit et al., 2020).

The results of the present study are based solely on a questionnaire and has by its nature some limitations, one being that no medical or dental examination was included. However, the IBD patients here were recruited via the Danish Colitis-Crohn Association (www.ccf.dk), an association for patients and their relatives. Considering that the questionnaire included almost 100 questions, it is reasonable to assume that only a negligible number of the 1108 participants of the IBD group would actually be not suffering from IBD. Furthermore, potential controls were selected *a priori* without a UC or CD diagnosis, based on information in the National Patient Registry of the Danish public healthcare system. In addition, a question asking for potential IBD diagnosis was included in the very beginning of the questionnaire, and on a positive answer to this question, the online platform did not allow the person to proceed with the survey. Regarding the diagnosis of periodontitis, this was based on a validated tool (Carra et al., 2018), while self-reported number of teeth has been shown to be rather accurate (Buhlin et al., 2002; Matsui et al., 2016; Similä et al., 2018; Ueno et al., 2018). Here, although the controls were matched to cases at the time point they were contacted, still significant differences regarding some of the matching parameters (i.e., gender, education, and living area) were observed. Specifically, the control group included more women, while more cases were living in a city; fewer cases had a higher education up to 6 years and/or PhD. To account for any possible impact of the observed differences in matching on the results, all regression models were adjusted for the matching parameters. Further, although rather many relevant parameters, potentially causing a bias (e.g., smoking status, experience of daily life), were included in the analyses, other common causes (e.g., other

unhealthy habits, overall happiness) might have been missed. In addition, it is important to keep in mind that the current data are based on a cross-sectional examination, and longitudinal studies are needed to further examine the observed associations and possibly determine temporality/directionality of these associations. Finally, regarding the data presented here, it should be considered that QoL is a very dynamic parameter, which may not be fully captured in a single cross-sectional assessment. However, the use of a tool specifically designed for oral-health-related QoL (i.e., OHIP-5) and an IBD-specific tool for the assessment of health-related QoL (i.e., sIBDQ) as opposed to a more generic tool for QoL presented the advantage that any association due to co-occurrence of oral health problems and IBD could be assessed.

The finding that periodontal disease and tooth loss are related to a reduced oral-health-related QoL is, of course, not particularly novel. However, the present large-scale, questionnaire-based, case-control study shows, for the first time, that IBD, *per se*, is associated with an impairment of oral-health-related QoL, and vice versa, that oral health problems are associated with an impaired IBD-specific health-related QoL. This appears specifically of interest for IBD patients, as health-related QoL aspects have been judged as meaningful attributes influencing patients' decision making for the choice of IBD treatment (Louis et al., 2020). It appears therefore necessary to take the co-occurrence of other health problems, specifically from the oral cavity, into account when managing IBD, and inclusion of dental professionals in the multidisciplinary treatment team of IBD patients is strongly advocated.

AUTHOR CONTRIBUTIONS

Conceptualization: Kristina Bertl, Georgios Tsakos, and Andreas Stavropoulos. *Organization, execution and data collection:* Kristina Bertl, Johan Burisch, and Andreas Stavropoulos. *Data analysis, interpretation:* Kristina Bertl, Nikolaos Pandis, Georgios Tsakos, Anna Bogren, and Andreas Stavropoulos. *Manuscript drafting and revision:* Kristina Bertl, Georgios Tsakos, Nikolaos Pandis, Anna Bogren, Johan Burisch, and Andreas Stavropoulos.

ACKNOWLEDGEMENTS

The present study was financially supported by the Eklund Foundation. The authors acknowledge the Danish Colitis-Crohn Association for distributing the questionnaire.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Kristina Bertl  <https://orcid.org/0000-0002-8279-7943>

Georgios Tsakos  <https://orcid.org/0000-0002-5086-235X>

Nikolaos Pandis  <https://orcid.org/0000-0003-0258-468X>

Johan Burisch  <https://orcid.org/0000-0002-3312-5139>

Andreas Stavropoulos  <https://orcid.org/0000-0001-8161-3754>

REFERENCES

- Agossa, K., Dendooven, A., Dubuquoy, L., Gower-Rousseau, C., Delcourt-Debruyne, E., & Capron, M. (2017). Periodontal manifestations of inflammatory bowel disease: Emerging epidemiologic and biologic evidence. *Journal of Periodontal Research*, 52, 313–324.
- Agossa, K., Roman, L., Gosset, M., Yzet, C., & Fumery, M. (2021). Periodontal and dental health in inflammatory bowel diseases: A systematic review. *Expert Review of Gastroenterology & Hepatology*, 1–15.
- Alcalá, M. J., Casellas, F., Fontanet, G., Prieto, L., & Malagelada, J. R. (2004). Shortened questionnaire on quality of life for inflammatory bowel disease. *Inflammatory Bowel Diseases*, 10, 383–391.
- Alrubaiy, L., Rikaby, I., Dodds, P., Hutchings, H. A., & Williams, J. G. (2015). Systematic review of health-related quality of life measures for inflammatory bowel disease. *Journal of Crohn's & Colitis*, 9, 284–292.
- Ananthakrishnan, A. N., Beaulieu, D. B., Ulitsky, A., Zadornova, Y., Skaros, S., Johnson, K., Naik, A., Perera, L., Issa, M., Binion, D. G., & Saeian, K. (2010). Does primary sclerosing cholangitis impact quality of life in patients with inflammatory bowel disease. *Inflammatory Bowel Diseases*, 16, 494–500.
- Bernklev, T., Jahnsen, J., Aadland, E., Sauar, J., Schulz, T., Lygren, I., Henriksen, M., Stray, N., Kjellevold, Ø., Vatn, M., Moum, B., & the IBSEN Study Group. (2004). Health-related quality of life in patients with inflammatory bowel disease five years after the initial diagnosis. *Scandinavian Journal of Gastroenterology*, 39, 365–373.
- Bertl, K., Burisch, J., Pandis, N., Bruckmann, C., Klinge, B., & Stavropoulos, A. (2022). Periodontitis prevalence in patients with ulcerative colitis and Crohn's disease – PPCC: A case-control study. *Journal of Clinical Periodontology*, 49, 1262–1274.
- Bertl, K., Burisch, J., Pandis, N., Klinge, B., & Stavropoulos, A. (2023). Patients with inflammatory bowel disease have more oral health problems and higher costs of professional dental care than healthy controls: The periodontitis prevalence in ulcerative colitis & Crohn's disease (PPCC) case-control study. *Journal of Periodontology*.
- Buhlin, K., Gustafsson, A., Andersson, K., Håkansson, J., & Klinge, B. (2002). Validity and limitations of self-reported periodontal health. *Community Dent Oral Epidemiol*, 30, 431–437.
- Cao, Q., Huang, Y. H., Jiang, M., & Dai, C. (2019). The prevalence and risk factors of psychological disorders, malnutrition and quality of life in IBD patients. *Scandinavian Journal of Gastroenterology*, 54, 1458–1466.
- Carra, M. C., Gueguen, A., Thomas, F., Pannier, B., Caligiuri, G., Steg, P. G., Zins, M., & Bouchard, P. (2018). Self-report assessment of severe periodontitis: Periodontal screening score development. *Journal of Clinical Periodontology*, 45, 818–831.
- Carstensen, B., Rønn, P. F., & Jørgensen, M. E. (2020). Prevalence, incidence and mortality of type 1 and type 2 diabetes in Denmark 1996–2016. *BMJ Open Diabetes Res Care*, 8, e001071.
- Casellas, F., López-Vivancos, J., Vergara, M., & Malagelada, J. (1999). Impact of inflammatory bowel disease on health-related quality of life. *Digestive Diseases*, 17, 208–218.
- Chen, X. L., Zhong, L. H., Wen, Y., Liu, T. W., Li, X. Y., Hou, Z. K., Hu, Y., Mo, C. W., & Liu, F. B. (2017). Inflammatory bowel disease-specific health-related quality of life instruments: A systematic review of measurement properties. *Health and Quality of Life Outcomes*, 15, 177.
- Christiansen, L. K., Lo, B., Bendtsen, F., Vind, I., Vester-Andersen, M. K., & Burisch, J. (2019). Health-related quality of life in inflammatory bowel disease in a Danish population-based inception cohort. *United European Gastroenterology Journal*, 7, 942–954.
- Conway, G., Velonias, G., Andrews, E., Garber, J. J., Yajnik, V., & Ananthakrishnan, A. N. (2017). The impact of co-existing immune-mediated diseases on phenotype and outcomes in inflammatory bowel diseases. *Alimentary Pharmacology & Therapeutics*, 45, 814–823.
- Domokos, Z., Uhrin, E., Szabó, B., Czumbel, M. L., Dembrovsky, F., Kerémi, B., Varga, G., Hegyi, P., Hermann, P., & Németh, O. (2022). Patients with inflammatory bowel disease have a higher chance of developing periodontitis: A systematic review and meta-analysis. *Frontiers in Medicine*, 9, 1020126.
- Gerritsen, A. E., Allen, P. F., Witter, D. J., Bronkhorst, E. M., & Creugers, N. H. (2010). Tooth loss and oral health-related quality of life: A systematic review and meta-analysis. *Health and Quality of Life Outcomes*, 8, 126.
- Graziani, F., Gennai, S., Solini, A., & Petrini, M. (2018). A systematic review and meta-analysis of epidemiologic observational evidence on the effect of periodontitis on diabetes. An update of the EFP-AAP review. *Journal of Clinical Periodontology*, 45, 167–187.
- Graziani, F., & Tsakos, G. (2020). Patient-based outcomes and quality of life. *Periodontology 2000*, 83, 277–294.
- Guyatt, G., Mitchell, A., Irvine, E. J., Singer, J., Williams, N., Goodacre, R., & Tompkins, C. (1989). A new measure of health status for clinical trials in inflammatory bowel disease. *Gastroenterology*, 96, 804–810.
- Harty, S., Fleming, P., Rowland, M., Crushell, E., McDermott, M., Drumm, B., & Bourke, B. (2005). A prospective study of the oral manifestations of Crohn's disease. *Clinical Gastroenterology and Hepatology*, 3, 886–891.
- Harvey, R. F., & Bradshaw, J. M. (1980). A simple index of Crohn's-disease activity. *Lancet*, 1, 514.
- Irvine, E. J. (1993). Quality of life—measurement in inflammatory bowel disease. *Scandinavian Journal of Gastroenterology*, 199, 36–39.
- Irvine, E. J., Feagan, B. G., & Wong, C. J. (1996). Does self-administration of a quality of life index for inflammatory bowel disease change the results. *Journal of Clinical Epidemiology*, 49, 1177–1185.
- Irvine, E. J., Zhou, Q., & Thompson, A. K. (1996). The Short Inflammatory Bowel Disease Questionnaire: A quality of life instrument for community physicians managing inflammatory bowel disease. CCRPT Investigators. Canadian Crohn's Relapse Prevention Trial. *The American Journal of Gastroenterology*, 91, 1571–1578.
- John, M. T., Miglioretti, D. L., LeResche, L., Koepsell, T. D., Hujoel, P., & Micheels, W. (2006). German short forms of the Oral Health Impact Profile. *Community Dentistry and Oral Epidemiology*, 34, 277–288.
- Jowett, S. L., Seal, C. J., Barton, J. R., & Welfare, M. R. (2001). The short inflammatory bowel disease questionnaire is reliable and responsive to clinically important change in ulcerative colitis. *The American Journal of Gastroenterology*, 96, 2921–2928.
- Knorst, J. K., Sfreddo, C. S., Meira, G. D. F., Zanatta, F. B., Vettore, M. V., & Ardenghi, T. M. (2021). Socioeconomic status and oral health-related quality of life: A systematic review and meta-analysis. *Community Dentistry and Oral Epidemiology*, 49, 95–102.
- Lorenzo-Pouso, A. I., Castelo-Baz, P., Rodriguez-Zorrilla, S., Pérez-Sayáns, M., & Vega, P. (2021). Association between periodontal disease and inflammatory bowel disease: A systematic review and meta-analysis. *Acta Odontologica Scandinavica*, 79, 344–353.
- Louis, E., Ramos-Goñi, J. M., Cuervo, J., Kopylov, U., Barreiro-de Acosta, M., McCartney, S., Rosenfeld, G., Bettenworth, D., Hart, A., Novak, K., Donnet, X., Easton, D., Saldaña, R., Protze, K., Tzur, E., Alperovich, G., & Casellas, F. (2020). A qualitative research for defining meaningful attributes for the treatment of inflammatory bowel disease from the patient perspective. *Patient*, 13, 317–325.
- Madsen, G. R., Bertl, K., Pandis, N., Stavropoulos, A., & Burisch, J. (2023). The impact of periodontitis on inflammatory bowel disease activity. *Inflammatory Bowel Diseases*, 29, 396–404.
- Matsui, D., Yamamoto, T., Nishigaki, M. et al. (2016). Validity of self-reported number of teeth and oral health variables. *BMC Oral Health*, 17, 17.
- Min Ho, P. Y., Hu, W., Lee, Y. Y., Gao, C., Tan, Y. Z., Cheen, H. H., Wee, H. L., Lim, T. G., & Ong, W. C. (2019). Health-related quality of

- life of patients with inflammatory bowel disease in Singapore. *Intestinal Research*, 17, 107–118.
- Mohseni Homagarani, Y., Adlparvar, K., Teimuri, S., Tarrahi, M. J., & Nilchian, F. (2023). The effect of diabetes mellitus on oral health-related quality of life: A systematic review and meta-analysis study. *Frontiers in Public Health*, 11, 1112008.
- Nijakowski, K., Gruszczyński, D., & Surdacka, A. (2021). Oral health status in patients with inflammatory bowel diseases: A systematic review. *International Journal of Environmental Research and Public Health*, 18, 11521.
- Papageorgiou, S. N., Hagner, M., Nogueira, A. V., Franke, A., Jäger, A., & Deschner, J. (2017). Inflammatory bowel disease and oral health: Systematic review and a meta-analysis. *Journal of Clinical Periodontology*, 44, 382–393.
- Pizzi, L. T., Weston, C. M., Goldfarb, N. I., Moretti, D., Cobb, N., Howell, J. B., Infantolino, A., DiMarino, A. J., & Cohen, S. (2006). Impact of chronic conditions on quality of life in patients with inflammatory bowel disease. *Inflammatory Bowel Diseases*, 12, 47–52.
- Polak, D., Sanui, T., Nishimura, F., & Shapira, L. (2020). Diabetes as a risk factor for periodontal disease-plausible mechanisms. *Periodontology* 2000, 83, 46–58.
- Polak, D., & Shapira, L. (2018). An update on the evidence for pathogenic mechanisms that may link periodontitis and diabetes. *Journal of Clinical Periodontology*, 45, 150–166.
- Rohani, B. (2019). Oral manifestations in patients with diabetes mellitus. *World Journal of Diabetes*, 10, 485–489.
- Sbeit, W., Kadah, A., Mahamid, M., Karayanni, H., Mari, A., Tali, S., Srouji, S., & Khoury, T. (2020). Oral manifestations of inflammatory bowel disease: The neglected piece of the puzzle. *European Journal of Gastroenterology & Hepatology*, 32, 1422–1431.
- Shanbhag, S., Dahiya, M., & Croucher, R. (2012). The impact of periodontal therapy on oral health-related quality of life in adults: A systematic review. *Journal of Clinical Periodontology*, 39, 725–735.
- She, Y. Y., Kong, X. B., Ge, Y. P., Liu, Z. Y., Chen, J. Y., Jiang, J. W., Jiang, H. B., & Fang, S. L. (2020). Periodontitis and inflammatory bowel disease: A meta-analysis. *BMC Oral Health*, 20, 67.
- Similä, T., Nieminen, P., & Virtanen, J. I. (2018) Validity of self-reported number of teeth in middle-aged Finnish adults: the Northern Finland Birth Cohort Study 1966. *BMC Oral Health*, 18, 210.
- Slade, G. D., & Spencer, A. J. (1994a). Development and evaluation of the Oral Health Impact Profile. *Community Dental Health*, 11, 3–11.
- Slade, G. D., & Spencer, A. J. (1994b). Social impact of oral conditions among older adults. *Australian Dental Journal*, 39, 358–364.
- Tsakos, G., Bernabé, E., D'Aiuto, F., Pikhart, H., Tonetti, M., Sheiham, A., & Donos, N. (2010). Assessing the minimally important difference in the oral impact on daily performances index in patients treated for periodontitis. *Journal of Clinical Periodontology*, 37, 903–909.
- Tsakos, G., Marcenes, W., & Sheiham, A. (2001). Evaluation of a modified version of the index of Oral Impacts on Daily Performances (OIDP) in elderly populations in two European countries. *Gerodontology*, 18, 121–130.
- Ueno, M., Shimazu, T., Sawada, N., Tsugane, S., & Kawaguchi, Y. (2018) Validity of self-reported tooth counts and masticatory status study of a Japanese adult population. *J Oral Rehabil*, 45, 393–398.
- Walmsley, R. S., Ayres, R. C., Pounder, R. E., & Allan, R. N. (1998). A simple clinical colitis activity index. *Gut*, 43, 29–32.
- Wide, U., & Hakeberg, M. (2018). Oral health-related quality of life, measured using the five-item version of the Oral Health Impact Profile, in relation to socio-economic status: A population survey in Sweden. *European Journal of Oral Sciences*, 126, 41–45.
- World Health Organization. (2013). *Oral health surveys*. World Health Organization.
- Zhang, Y., Qiao, D., Chen, R., Zhu, F., Gong, J., & Yan, F. (2021). The association between periodontitis and inflammatory bowel disease: A systematic review and meta-analysis. *BioMed Research International*, 2021, 6692420.

How to cite this article: Bertl, K., Tsakos, G., Pandis, N., Bogren, A., Burisch, J., & Stavropoulos, A. (2023). Health-related quality of life aspects of the 'Periodontitis prevalence in ulcerative colitis and Crohn's disease' (PPCC) cohort. *Journal of Clinical Periodontology*, 1–20. <https://doi.org/10.1111/jcpe.13863>

APPENDIX A

TABLE A1 Self-reported IBD-related characteristics of all IBD cases ($n = 1093$) and separately for patients with ulcerative colitis (including unclassified inflammatory bowel disease; $n = 566$) and patients with Crohn's disease ($n = 527$).

Parameter		All IBD cases	Ulcerative colitis	Crohn's disease	p-Value ^a
Years since diagnosis of IBD	Mean (SD)	15.8 (11.6)	15.0 (11.5)	16.8 (11.6)	.003^b
	Median (Q1; Q3)	13 (6; 23)	12 (6; 22)	15 (7; 24)	
HBI (n [%])	Remission/inactive disease			297 (56.4)	
	Active disease			230 (43.6)	
SCCAI (n [%])	Remission/inactive disease		255 (45.1)		
	Active disease		311 (54.9)		
IBD severity	No history of surgery or biological therapy	556 (50.9)	420 (74.2)	136 (25.8)	<.001
	Either history of surgery and/or biological therapy	537 (49.1)	146 (25.8)	391 (74.2)	
sIBDQ sum	Bowel				
	Mean (SD)	14.9 (4.0)	15.2 (3.8)	14.6 (4.2)	.039^b
	Median (Q1; Q3)	15 (12; 18)	16 (13; 18)	15 (12; 18)	
	Emotional				
	Mean (SD)	14.8 (2.2)	14.9 (2.1)	14.7 (2.4)	.331 ^b
	Median (Q1; Q3)	15 (14; 16)	15 (14; 16)	15 (13; 16)	
	Social				
	Mean (SD)	11.0 (3.2)	11.5 (3.0)	10.6 (3.3)	<.001^b
	Median (Q1; Q3)	12 (9; 14)	13 (10; 14)	11 (8; 14)	
	Systemic				
	Mean (SD)	8.6 (3.1)	8.8 (3.0)	8.4 (3.1)	.011^b
	Median (Q1; Q3)	9 (6; 11)	9 (7; 11)	9 (6; 11)	
	Overall				
	Mean (SD)	49.4 (9.8)	50.4 (9.2)	48.3 (10.3)	<.001^b
	Median (Q1; Q3)	51 (43; 57)	52 (45; 58)	50 (42; 56)	

Note: Bold values indicate statistical significance.

Abbreviations: HBI, Harvey & Bradshaw's Activity Index; IBD, inflammatory bowel disease; Q1/Q3, first/third quartile; SCCAI, Simple Clinical Colitis Activity Index; SD, standard deviation; sIBDQ, Short Inflammatory Bowel Disease Questionnaire.

^aNo adjustment for confounders was performed.

^bp-Value relates to the median values, and Mann-Whitney *U* test was applied.

APPENDIX B

TABLE B1 Results of the adjusted univariable binary logistic regression analyses for the dichotomous outcome parameter 'prevalence of poor oral-health-related QoL'; an odds ratio above 1 indicates higher odds for a poor oral-health-related QoL.

Parameter		OR	95% CI		p-Value
			Lower	Upper	
Patient group	Control	Ref.			
	Ulcerative colitis	2.689	1.594	4.537	<.001
	Crohn's disease	5.279	3.446	8.088	<.001
Tooth number	≥20 teeth	Ref.			
	<20 teeth	12.016	7.994	18.061	<.001
PESS	<5	Ref.			
	≥5	19.716	11.551	33.654	<.001
Diabetes	Absent	Ref.			
	Present	0.580	0.178	1.889	.366
Osteoporosis	Absent	Ref.			
	Present	4.594	2.463	8.570	<.001
Rheumatoid arthritis	Absent	Ref.			
	Present	3.907	2.015	7.574	<.001

(Continues)

TABLE B1 (Continued)

Parameter		OR	95% CI		p-Value
			Lower	Upper	
Ankylosing spondylitis	Absent	Ref.			
	Present	2.892	0.958	8.730	.060
Psoriasis	Absent	Ref.			
	Present	2.016	1.011	4.019	.046
Depression	Absent	Ref.			
	Present	1.651	0.965	2.823	.067
High cholesterol	Absent	Ref.			
	Present	1.021	0.481	2.167	.957
Cardiovascular disease	Absent	Ref.			
	Present	1.765	1.054	2.958	.031
Asthma	Absent	Ref.			
	Present	1.399	0.780	2.507	.260
COPD	Absent	Ref.			
	Present	4.878	1.967	12.097	.001
Family status ^a	No current relationship	Ref.			
	Relationship	0.964	0.632	1.472	.866
Daily life experience	Not stressful at all	Ref.			
	A little stressful	3.635	1.904	6.940	<.001
	Average stressful	5.040	2.534	10.023	<.001
	Very stressful	15.458	7.346	32.525	<.001
BMI	Score	1.019	0.990	1.049	.203
Age	Years	0.998	0.984	1.012	.747
Gender	Male	Ref.			
	Female	1.591	0.967	2.619	.068
Living area	City	Ref.			
	Suburban area	0.866	0.532	1.410	.562
	Countryside	1.066	0.715	1.591	.753
Education	No school/Primary school	Ref.			
	High school	0.277	0.118	0.649	.003
	Higher education up to 3 years	0.462	0.294	0.725	.001
	Higher education up to 6 years and/or PhD	0.539	0.325	0.893	.016
Income	<5,000 DKK	Ref.			
	5,000 to <10,000 DKK	0.385	0.240	0.617	<.001
	10,000 to <20,000 DKK	0.367	0.229	0.589	<.001
	≥20,000 DKK	0.188	0.097	0.366	<.001
Smoking	Never	Ref.			
	Former	1.817	1.144	2.884	.011
	Current	5.668	3.661	8.776	<.001

Note: All models have been adjusted for age, gender, living area, education, income and smoking status. Bold values indicate significance.

Abbreviations: BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease; DKK, Danish krone; OHIP, oral health impact profile; OR, odds ratio; PESS, periodontal screening score.

^aSingle, divorced and widow/widower were collapsed as 'no current relationship' and relationship not living and living together were collapsed as 'relationship'.

TABLE B2 Results of the adjusted univariable quantile regression analyses for the continuous outcome parameter 'sIBDQ overall sum'; a negative coefficient indicates an impaired health-related quality of life.

Parameter		OR	95% CI		p-Value
			Lower	Upper	
Patient group	Ulcerative colitis	Ref.			
	Crohn's disease	-1.332	-2.830	0.166	.081
Tooth number	≥20 teeth	Ref.			
	<20 teeth	-3.224	-5.298	-1.151	.002
PESS	<5	Ref.			
	≥5	-2.988	-4.785	-1.190	.001
Oral lesions as EIM	Absent	Ref.			
	Present	-5.564	-7.030	-4.097	<.001
Years since diagnosis of IBD	Years	0.099	0.032	0.166	.004
IBD activity	Remission/inactive disease	Ref.			
	Active disease	-10.042	-11.373	-8.710	<.001
IBD severity	No history of surgery or biological therapy	Ref.			
	Either history of surgery and/or biological therapy	-2.586	-4.133	-1.039	.001
Diabetes	Absent	Ref.			
	Present	1.630	-2.113	5.374	.393
Osteoporosis	Absent	Ref.			
	Present	-3.174	-6.022	-0.327	.029
Rheumatoid arthritis	Absent	Ref.			
	Present	-3.667	-7.138	-0.195	.038
Ankylosing spondylitis	Absent	Ref.			
	Present	-4.593	-8.948	-0.237	.039
Psoriasis	Absent	Ref.			
	Present	-5.568	-8.527	-2.609	<.001
Depression	Absent	Ref.			
	Present	-5.693	-8.402	-2.984	<.001
High cholesterol	Absent	Ref.			
	Present	-1.125	-3.936	1.686	.432
Cardiovascular disease	Absent	Ref.			
	Present	-4.147	-6.332	-1.962	<.001
Asthma	Absent	Ref.			
	Present	-1.750	-4.274	0.774	.174
COPD	Absent	Ref.			
	Present	-1.875	-7.830	4.080	.537
Family status ^a	No current relationship	Ref.			
	Relationship	0.674	-1.068	2.417	.448
Daily life experience	Not stressful at all	Ref.			
	A little stressful	-3.859	-5.963	-1.755	<.001
	Average stressful	-5.184	-7.552	-2.816	<.001
	Very stressful	-9.994	-13.497	-6.491	<.001
BMI	Score	-0.230	-0.366	-0.094	.001
Age	Years	0.117	0.065	0.169	<.001
Gender	Male	Ref.			
	Female	-3.130	-4.782	-1.478	<.001

(Continues)

TABLE B2 (Continued)

Parameter		OR	95% CI		p-Value
			Lower	Upper	
Living area	City	Ref.			
	Suburban area	0	-1.594	1.594	1.00
	Countryside	0.078	-1.852	2.008	.937
Education	No school/primary school	Ref.			
	High school	2.325	-0.706	5.355	.133
	Higher education up to 3 years	1.286	-0.933	3.505	.256
	Higher education up to 6 years and/or PhD	0.688	-1.727	3.104	.576
Income	<5,000 DKK	Ref.			
	5,000 to <10,000 DKK	4.546	2.082	7.009	<.001
	10,000 to <20,000 DKK	7.351	4.926	9.775	<.001
	≥ 20,000 DKK	9.221	6.555	11.886	<.001
Smoking	Never	Ref.			
	Former	-1.779	-3.369	-0.190	0.028
	Current	-3.221	-5.284	-1.158	.002

Note: All models have been adjusted for age, gender, living area, education, income and smoking status. Bold values indicate significance.

Abbreviations: BMI, body mass index; CI, confidence interval; Coef., coefficient; COPD, chronic obstructive pulmonary disease; DKK, Danish krone; EIM, extra-intestinal manifestations; IBD, inflammatory bowel disease; OR, odds ratio; PESS, periodontal screening score.

^aSingle, divorced, and widow/widower were collapsed as 'no current relationship' and relationship not living and living together were collapsed as 'relationship'.