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1   **A Comparative Study of the Nature and Magnitude of Problems Sleeping in**

2   **Inflammatory Bowel Disease (IBD) Compared to Healthy Controls**

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12

13   **Abstract**

14   Inflammatory Bowel Disease (IBD) is commonly associated with poor global sleep

15   quality, and has been posited as a modifiable determinant of IBD related outcomes, with

16   recent calls to screen for, and subsequently treat problems sleeping as part of routine IBD

17   care. However, there is little evidence on the specific *types* of problems sleeping (e.g., sleep

18   apnea, insomnia etc.) that might characterize the poor sleep quality experienced by those with

19   IBD. The present research aimed to investigate the severity of seven specific types of

20   problems sleeping in those with IBD vs. a healthy control group. This cross-sectional

21   comparison study recruited $N = 409$ with IBD, and $N = 377$ healthy controls (total sample N

22   $= 786$). The Sleep-50 questionnaire was used to assess the presence of seven types of

23   problems sleeping. Multivariate Analysis of Covariance (MANCOVA) was used to compare

24   the severity of sleep disturbances between the IBD and control groups. Those in the IBD

25   group reported significantly more severe experiences of five of the seven domains of the

26   Sleep-50, including increased; sleep apnea, insomnia, narcolepsy, restless legs, and

27   nightmares. In conclusion, those with a diagnosis of IBD reported significantly more severe

28   symptoms across a range of specific problems sleeping when compared to controls. More

29   research is needed to; i) improve the identification and treatment of problems sleeping in

30   routine care; ii) understand the mechanism(s) of action that links problems sleeping to IBD

31   related outcomes; and iii) develop adapted interventions to improve sleep in those with IBD.

32   Word count: 246

33   *Keywords*: Sleep; Inflammatory Bowel Disease; IBD; Crohn's Disease; Ulcerative

34   Colitis.

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36   **A Comparative Study of the Nature and Magnitude of Problems Sleeping in**

37   **Inflammatory Bowel Disease (IBD) Compared to Healthy Controls**

38   In recent years, there has been a proliferation of research aiming to better understand

39   the role of sleep in a range of physical (Gallicchio & Kalesan, 2009; O'brien et al., 2010;

40   Pavlova, Ference, Hancock, & Noel, 2017; Wong et al., 2013), and mental health difficulties

41   (Baglioni et al., 2011; Scott, Rowse, & Webb, 2017; Taylor, Lichstein, Durrence, Reidel, &

42   Bush, 2005). The association between problems sleeping and health is particularly apparent

43   in those with Inflammatory Bowel Disease (IBD) - a chronic and incurable disease involving

44   inflammation of the gastrointestinal tract – where poor sleep quality is commonly reported

45   (Kinnucan, Rubin, & Ali, 2013; Swanson, Burgess, & Keshavarzian, 2011; Wilson et al.,

46   2015). Indeed, problems sleeping in those with IBD have been posited as a modifiable risk

47   factor for a number of IBD related outcomes including diagnosis incidence (Ananthakrishnan

48   et al., 2014), disease symptom flares (Ananthakrishnan, Long, Martin, Sandler, &

49   Kappelman, 2013; Uemura et al., 2016), poorer health related quality of life (Keefer,

50   Stepanski, Ranjbaran, Benson, & Keshavarzian, 2006; Ranjbaran, Keefer, Stepanski, Farhadi,

51   & Keshavarzian, 2007; Uemura et al., 2016), and fatigue (Graff et al., 2013). However,

52   despite a growing body of literature further elucidating our understanding of the experience

53   of sleep in those with IBD, there remains a number of opportunities that would facilitate calls

54   to screen for, and subsequently treat problems sleeping in those with IBD (Almedimigh et al.,

55   2018; Kinnucan et al., 2013).

56   **Opportunities for Advancement**

57   To date, the majority of research into the role of sleep disturbances in those with IBD

58   has tended to rely on more global measures of sleep quality (e.g., the Pittsburgh Sleep Quality

59   Index (PSQI); Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), rather than measures able

60   to detect *specific* types of problems sleeping. For example, the PSQI can tell us somebody

61   has poor, or good self-reported sleep quality; however, it cannot tell us this is due to the

62   experience of specific types of problems sleeping (e.g., due to insomnia, sleep apneoa,

63   nightmares etc.). Although there is evidence suggesting that those with IBD may experience

64   specific types of problems sleeping more commonly, including symptoms of sleep apnea

65   (Keefer et al., 2006), restless legs (Becker et al., 2018; Keefer et al., 2006), and nightmares

66   (Ranjbaran et al., 2007); the conclusions that can be drawn are limited - in that findings are

67   often reliant on single-item measures of specific problems sleeping, and/or small sample sizes

68   leading to underpowered studies. Consequently, is important that research also uses multi-

69   item measures of specific sleep disturbances along with larger samples to drawn more robust

70   conclusions. Secondly, few studies have compared the problems sleeping seen in IBD to

71   healthy controls (i.e., those without gastrointestinal diagnoses). Consequently, it is unclear

72   whether both the type and magnitude of problems sleeping differ between those with, and

73   without a diagnosis of IBD.

74   **The present research**

75   The lack of research investigating specific types of sleep disturbance in IBD relative

76   to healthy controls serves to inhibit two important avenues; i) the development and adaption

77   of interventions to target specific sleep disturbances experienced by those with IBD as a route

78   to improving IBD related outcomes; and ii) as has been recently suggested, the incorporation

79   of sleep disturbance screening into the routine clinical management of IBD (Almedimigh et

80   al., 2018; Kinnucan et al., 2013). The present research aims to address this by measuring the

81   severity of multiple types of specific problems sleeping in those with diagnosis of IBD

82   relative to healthy controls. We hope that doing so will provide a more comprehensive profile

83   of the types of problems sleeping that are experienced by people with IBD, with each type

84   generally having specific screening and treatment options.

Materials and Methods

Participants

The IBD group were recruited from three sources; (i) through an advertisement placed on a national IBD charity website in the UK (Crohn's & Colitis UK); (ii) from IBD specific online support groups; and (iii) from volunteer lists maintained by the research team. The healthy control group was recruited from two sources; (i) from volunteer lists maintained by the research team; and (ii) via a social media advertising campaign. Enrolment to the study began in May 2017, and concluded in November 2017. Prior to taking part in the present research, all participants were asked a number of screening and eligibility questions. To be eligible for the IBD group, participants were required to; (i) have a diagnosis of IBD; and (ii) be at least 16 years of age or older. To be eligible for inclusion in the control group, participants were required to; (i) have no diagnosis of any gastrointestinal disorder (e.g., IBD, Irritable Bowel Syndrome, coeliac disease etc.); and (ii) be at least 16 years of age or older. Participants not meeting these criteria, those who did not provide full informed consent, and those who did not start the online survey were excluded.

Procedure

Participants were invited to take part in an online study aiming to investigate the severity of problems sleeping in those with, and without, a diagnosis of IBD. All outcome measures were delivered anonymously online using Qualtrics, a web based survey hosting platform (Qualtrics, 2018). Participants first read an information sheet detailing aspects of the research before confirming eligibility via a series of screening items in line with the studies inclusion and exclusion criteria. If eligible, participants provided electronic consent to participate. The Research Ethics Committee based in the School of Health and Related Research (ScHARR), University of Sheffield, granted ethical approval.

109   **Outcome Measures**

110   **Demographics**

111   All participants were asked to provide information relating to their age, gender, and

112   whether they were currently receiving psychological therapy and/or medication for a mental

113   health or sleep related problem. Participants in the IBD group were asked a number of items

114   relating to their IBD, including their IBD diagnosis type (Ulcerative Colitis or Crohn's

115   Disease), number of years living with an IBD diagnosis, whether they had ever undergone

116   IBD related surgery, current and/or previous use of a stoma, and whether they were currently

117   taking medication for their IBD.

118   **The Sleep-50 Questionnaire**

119   The Sleep-50 is a 50 item self-report instrument designed to measure symptoms of

120   seven specific types of sleep disturbances (sleep apnea, insomnia, narcolepsy, restless legs,

121   circadian rhythm disruption, sleepwalking, & nightmares), as well as factors influencing

122   sleep (e.g., low mood, sleep environment not optimal, medication use), and the impact of

123   sleep complaints of daily functioning (e.g., feeling tired on awakening, difficulty

124   concentrating, worrying about sleep). Using a 4-point scale, participants are asked to rate the

125   extent to which they endorse each item over the last 4-weeks, ranging from 'not at all'

126   through to 'very much'. The Sleep-50 has been validated for use in both general population

127   samples, and those with clinically defined sleep disorders, demonstrating a clear factor

128   structure, high internal consistency, and good test-retest reliability (Spoormaker, Verbeek, van

129   den Bout, & Klip, 2005).

130   **The Short Inflammatory Bowel Disease Questionnaire (SIBDQ)**

131   The bowel symptoms subscale of the SIBDQ (Jowett, Seal, Barton, & Welfare, 2001)

132   was used as a proxy measure of disease symptom activity in the IBD group. The bowel

133   symptom subscale of the SIBDQ asks participants to rate the extent to which they endorse

134   three items pertaining to the frequency of IBD symptoms on a 5-point scale, with lower

135   scores indicating more frequent symptom activity. For example, participants are asked, "*How*

136   *often in the last two weeks have you been troubled by pain in the abdomen?*". The bowel

137   symptoms subscale correlates strongly with several validated measures of disease activity

138   (Jowett et al., 2001), including the Simple Clinical Colitis Activity Index (SCCAI; Walmsley,

139   Ayres, Pounder, & Allan, 1998), and the Seo index (Seo et al., 1992), suggesting its valid use

140   as a proxy measure of disease activity.

141   **Approach to Analysis**

142   A one-way multivariate analysis of covariance (MANCOVA) was conducted to

143   investigate the severity of seven specific types of sleep disturbances measured by the Sleep-

144   50, as well as factors influencing sleep, and the impact of sleep complaints on daily

145   functioning in the IBD group relative to controls. Where the MANCOVA demonstrated

146   significant differences between the IBD and control groups in terms of the type of problem

147   sleeping, a sensitivity analysis in the form of hierarchical linear regression (including only the

148   IBD group) was conducted to investigate whether any IBD related characteristics were

149   significantly associated with the sleep disturbance. G-Power 3.1 (Faul, Erdfelder, Lang, &

150   Buchner, 2007) was used to determine the sample size. For the MANCOVA, based on a

151   small-to-medium sized effect at 90% power, and a strict significance threshold of $p < .001$,

152   the desired total sample size is $N = 560$. Given that the heirarchical linear regression includes

153   only the IBD group, a less conservative alpha level was set; based on a small-to-medium

154   sized effect at 90% power, and a significance threshold of $p < .05$, the desired total sample

155   size is $N = 263$.

156   **Results**

157   **Participants**

158   Of the $N = 498$ participants in the IBD group who started the study procedures, N =

159   409 (82%) were included in the study, with $N = 89$ (18%) excluded. Of those excluded in the

160   IBD group, $N = 9$ (10%) were under the age of 16, $N = 7$ (8%) had no diagnosis of IBD, $N =$

161   22 (25%) did not provide consent to take part, and $N = 51$ (57%) did not start the online

162   surveys. With regards to the control group, $N = 472$ began the study procedures with $N = 377$

163   (88%) included in the study. Of the $N = 50$ (12%) who were excluded, $N = 3$ (6%) were under

164   the age of 16, $N = 4$ (8%) had a diagnosis of IBD, $N = 20$ (40%) had diagnosis of Irritable

165   Bowel Syndrome (IBS), $N = 10$ (20%) did not provide consent to take part, and $N = 13$ (26%)

166   did not start the online surveys. Figure 1 describes of the flow of participants through the

167   study, while Table 1 presents the demographic and clinical characteristics of both groups.
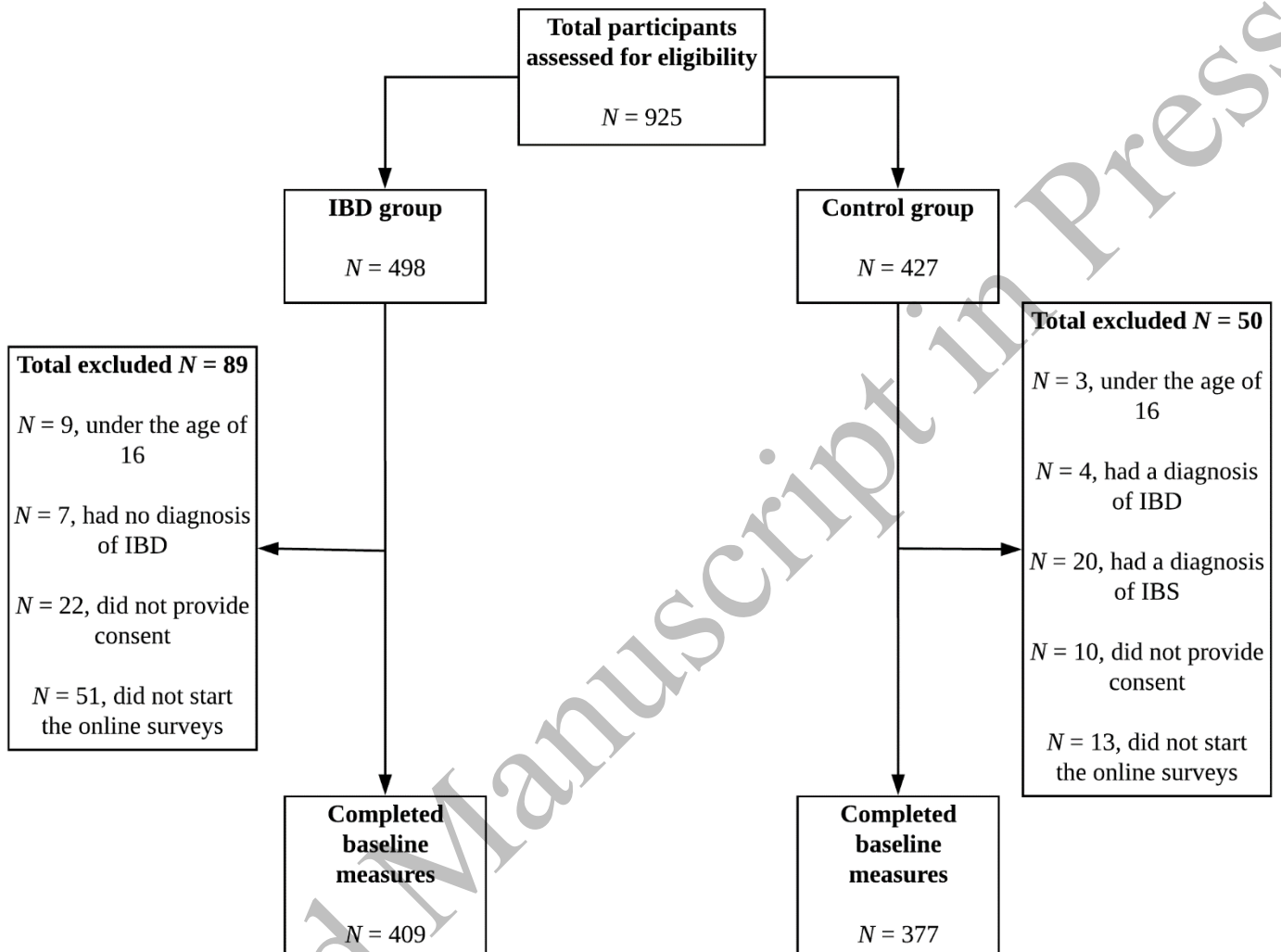
168

169   **Figure 1**

170

171   *A CONSORT Flow Diagram Showing the Flow of Participants Through the Study*

172

173 **Table 1**

174 *Baseline Sample Characteristics of the IBD and Control Group*

Variable	IBD group (N = 409)	Control group (N = 377)
Age, M (SD)	33.86 (11.57)	39.60 (14.51)
Gender, N (%)		
Male	74 (18%)	100 (27%)
Female	335 (82%)	277 (73%)
Sleep medication use, N (%)		
Yes	96 (23%)	17 (5%)
No	313 (77%)	360 (95%)
Sleep therapy, N (%)		
Yes	21 (5%)	3 (1%)
No	388 (95%)	374 (99%)
IBD type, N (%)		
Ulcerative Colitis (UC)	155 (38%)	-
Crohn's Diseases (CD)	254 (62%)	-
Years with IBD diagnosis, M (SD)	9.12 (8.52)	-
Surgery for IBD, N (%)		
Yes	172 (42%)	-
No	237 (58%)	-
Current stoma, N (%)		
Yes	58 (14%)	-
No	351 (86%)	-
Previous stoma, N (%)		
Yes	64 (16%)	-
No	345 (84%)	-
Immunosuppressant use, N (%)		
Yes	259 (63%)	-
No	150 (37%)	-

175

176   **Does specific sleep disturbance severity differ between groups?**

177   MANCOVA (controlling for age and gender) was used to examine whether the

178   severity of specific sleep disturbances differed between those in the IBD group vs. the control

179   group (see Table 2 for an overview of these analyses). There was a statistically significant

180   multivariate difference between groups ($F(9, 774) = 50.44$, $p < 0.001$, Eta^2 = 0.08), in that

181   participants in the IBD group reported significantly more profound sleep disturbance than the

182   control group. This effect was reflected in significantly more severe sleep disturbance across

183   seven of the eight subscales measured by the Sleep-50, including symptom severity of; **sleep**

184   **apnea** ($F(1, 782) = 12.94$, $p < 0.001$, Eta^2 = 0.02), **insomnia** ($F(1, 782) = 31.89$, $p < 0.001$,

185   Eta^2 = 0.04), **narcolepsy** ($F(1, 782) = 16.01$, $p < 0.001$, Eta^2 = 0.02), **restless legs** ($F(1, 782)$

186   = 17.98, $p < 0.001$, Eta^2 = 0.02), **nightmares** ($F(1, 782) = 13.87$, $p < 0.001$, Eta^2 = 0.02),

187   **factors influencing sleep** ($F(1, 782) = 35.81$, $p < 0.001$, Eta^2 = 0.04), and the **impact of**

188   **sleep disturbance on daily life** ($F(1, 782) = 63.69$, $p < 0.001$, Eta^2 = 0.08). There were no

189   significance differences between groups on the severity of **circadian rhythm disruptions**

190   ($F(1, 782) = 7.34$, $p = 0.01$, Eta^2 = 0.01), or **sleepwalking** ($F(1, 782) = 4.48$, $p = 0.04$, Eta^2 =

191   0.01).

192 **Table 2**

193 *Descriptive Statistics and Between Group Comparisons of Sleep Disorder(s) in the IBD group vs. Controls*

Sleep outcome	IBD group ($N = 409$)		Control group ($N = 377$)				
	M	SD	M	SD	F	p	Eta^2
Sleep-50 total	95.47	20.48	84.88	21.38	50.44	**< 0.001**	0.08
Sleep apnoea	14.03	3.49	13.19	3.99	12.94	**< 0.001**	0.02
Insomnia	20.33	3.49	17.99	5.57	31.89	**< 0.001**	0.04
Narcolepsy	7.74	2.34	7.06	2.29	16.01	**< 0.001**	0.02
Restless legs	6.59	2.47	5.87	2.41	17.98	**< 0.001**	0.02
Circadian rhythm disruption	5.23	2.01	4.79	1.80	7.34	0.01	0.01
Sleepwalking	3.36	0.99	3.23	0.78	4.48	0.04	0.01
Nightmares	8.29	5.51	6.73	5.65	13.87	**< 0.001**	0.02
Factors influencing sleep	11.09	2.71	9.94	2.50	35.81	**< 0.001**	0.04
Impact on daily function	18.89	4.87	16.08	5.18	63.69	**< 0.001**	0.08

194 *Note:* M = mean, SD = standard deviation, *p* values in bold type represent statistically significant effects at *p* < 0.001 .

195   **Clinical correlates of sleep disturbance in the IBD group**

196   Where there was a significant difference between the IBD and control group in the

197   preceding analysis, a sensitivity analysis was conducted using only the IBD group to investigate

198   potential clinical correlates of sleep disturbances. Table 3 presents the detailed results of this

199   analysis; however, in short, none of the characteristics of the IBD group were associated with the

200   experience of sleep apnoea ($F(8, 375) = 0.61$, $p = 0.77$), narcolepsy ($F(8, 375) = 0.46$, $p = 0.88$),

201   or nightmares ($F(8, 375) = 0.71$, $p = 0.68$). However, a higher IBD symptom activity as

202   measured by the bowel symptom subscale of the SIBDQ was negatively associated with

203   increased insomnia severity ($\beta = -0.14$, $p = 0.01$), restless legs symptom severity ($\beta = -0.14$, $p = $

204   0.03), increased factors influencing sleep, ($\beta = -0.15$, $p = 0.01$), and increased impact of sleep

205   disturbances on daily function ($\beta = -0.13$, $p = 0.01$). Furthermore, IBD diagnosis type was

206   associated with the impact of sleep complaints on daily function ($\beta = 0.14$, $p = 0.01$), with those

207   diagnosed with Ulcerative Colitis reporting more daily impact.

208

209 **Table 3**

210 *Clinical Correlates of Specific Sleep Disturbances in the Inflammatory Bowel Disease (IBD)*

211 *Group*

Sleep problem	*β*	*t*	*p*
Sleep apnea			
Age	-0.02	-0.31	0.75
Gender	-0.02	-0.40	0.69
IBD type	0.02	0.30	0.76
Years with IBD	-0.01	-0.09	0.93
IBD surgery	0.06	0.91	0.36
Current stoma	0.04	0.74	0.46
IBD medication	0.01	0.27	0.79
IBD symptom activity	-0.02	-0.44	0.66
Insomnia			
Age	-0.10	-1.62	0.11
Gender	-0.05	-0.91	0.36
IBD type	0.02	0.37	0.71
Years with IBD	0.05	0.79	0.43
IBD surgery	-0.07	-1.02	0.31
Current stoma	0.06	1.01	0.31
IBD medication	0.04	0.78	0.44
IBD symptom activity	-0.12	-2.21	**0.03**
Narcolepsy			
Age	-0.03	-0.55	0.59
Gender	0.02	0.43	0.66
IBD type	0.06	0.98	0.33
Years with IBD	-0.04	-0.65	0.52
IBD surgery	-0.05	-0.81	0.42
Current stoma	-0.03	-0.46	0.65
IBD medication	-0.05	-0.98	0.33

IBD symptom activity	-0.04	-0.65	0.51
Restless legs			
Age	0.04	0.75	0.45
Gender	0.02	0.31	0.75
IBD type	-0.01	-0.19	0.85
Years with IBD	-0.02	-0.24	0.81
IBD surgery	-0.01	-0.20	0.84
Current stoma	0.07	1.13	0.26
IBD medication	0.01	0.10	0.92
IBD symptom activity	-0.12	-2.22	**0.03**
Nightmares			
Age	0.01	0.19	0.85
Gender	0.04	0.76	0.45
IBD type	0.01	0.12	0.91
Years with IBD	-0.10	-1.53	0.13
IBD surgery	-0.11	-1.76	0.08
Current stoma	0.10	1.67	0.10
IBD medication	-0.02	-0.32	0.75
IBD symptom activity	0.06	1.16	0.25
Factors influencing sleep			
Age	-0.05	-0.81	0.42
Gender	-0.04	-0.80	0.42
IBD type	0.07	1.22	0.22
Years with IBD	0.07	1.11	0.27
IBD surgery	-0.06	-0.92	0.36
Current stoma	0.04	0.71	0.48
IBD medication	0.06	1.13	0.26
IBD symptom activity	-0.15	-2.70	**0.01**
Impact on daily function			
Age	0.02	0.35	0.73
Gender	-0.03	-0.60	0.55

IBD type	0.14	2.56	**0.01**
Years with IBD	0.01	0.17	0.86
IBD surgery	-0.06	-0.99	0.32
Current stoma	-0.07	-1.13	0.26
IBD medication	0.01	0.26	0.79
IBD symptom activity	-0.13	-2.48	**0.01**

212 *Note: p* values in bold type represent statistically significant effects at *p* < 0.05

213   **Discussion**

214   The present research aimed to investigate the nature and magnitude of specific types of

215   problems sleeping in those with IBD relative to a healthy control group (i.e., no gastrointestinal

216   diagnoses). Our findings suggest that relative to controls, those with IBD reported significantly

217   more severe symptoms of five of the seven sleep disturbances measured by the Sleep-50,

218   including; sleep apnea, insomnia, narcolepsy, restless legs, and nightmares. Furthermore, those

219   with IBD reported experiencing significantly more factors that are known to influence sleep

220   (e.g., low mood, sleep environment not optimal, medication use), and a greater impact of sleep

221   disturbances on daily life (e.g., feeling tired on awakening, difficulty concentrating, worrying

222   about sleep). Interestingly, only the experience of insomnia, and the impact of sleep disturbances

223   on daily life was associated with some clinical features of IBD. Greater insomnia severity was

224   associated with more frequent IBD symptoms, whereas a diagnosis of Ulcerative Colitis was

225   significantly associated with a greater impact of sleep disturbances on daily life.

226   The key finding reported in the present research is that those with IBD reported more

227   severe experiences of a variety of specific problems sleeping, including; sleep apnea, insomnia,

228   narcolepsy, restless legs, and nightmares, as well as more disruptions to factors known to

229   influence sleep, and a greater impact of sleep disturbances on daily life. Although the majority of

230   extant research reports the association between global sleep quality and IBD, the few studies that

231   have examined specific types of problems sleeping are supported by the present research. For

232   example, the findings reported here support previous research suggesting that those with IBD

233   experience sleep disordered breathing (i.e., a core symptom of sleep apnoea, Keefer et al., 2006),

234   restless legs (Becker et al., 2018; Keefer et al., 2006), and nightmares (Ranjbaran et al., 2007).

235   As well as strengthening existing findings using a larger sample size, and a multi-item measure

236   *specific* problems sleeping, the findings reported here also extend previous work by reporting an

237   increased severity of insomnia, and narcolepsy symptoms in the IBD group relative to controls.

238   Although more research is warranted, these findings suggest that the routine care of those with

239   IBD might consider incorporating assessments to screen for the presence a variety of specific

240   types of problems sleeping.

241   **Future directions**

242   It seems clear that problems sleeping are associated with IBD, and may even represent a

243   core experience of IBD itself (Keefer et al., 2006). However, *how* problems sleeping are related

244   to IBD, and the direction that best explains this association is currently unclear. Consequently,

245   future research might seek to elucidate the mechanisms of action that can explain how problems

246   sleeping can exert an effect on IBD related outcomes, using designs able to inform the direction

247   of effect. Research that is well placed to disentangle the impact of mediators and the direction of

248   association between sleep and IBD outcomes are those that employ longitudinal designs (i.e.,

249   designs that measure variables over time, so that the temporal relationship between variables can

250   be investigated), research that is currently lacking (for notable exceptions, see Ananthakrishnan

251   et al., 2014; Ananthakrishnan et al., 2013; Graff et al., 2013; Uemura et al., 2016). Problems

252   sleeping have been posited as a possible modifiable environmental risk factor that can adversely

253   affect IBD outcomes. However, despite recent calls to screen for, and subsequently treat

254   problems sleeping in those with IBD (Almedimigh et al., 2018; Kinnucan et al., 2013), there are

255   relatively few guidelines to facilitate clinical decision making in this area (National Institute for

256   Health and Care Excellence, 2015; Kinnucan et al., 2013). Therefore, future research might

257   profitably seek to understand the barriers and facilitators to effective sleep management in

258   routine IBD care, from both the patients', and healthcare professional's perspectives as a route to

259 developing effective guidelines to facilitate the detection and subsequent treatment of specific

260 sleep disturbances in those with IBD.

261 **Limitations of the present research**

262 Firstly, the present study recruited participants based on a self-reported IBD diagnosis.

263 Although recent research has demonstrated that self-reported diagnosis in online research has a

264 high concordance rate with physician diagnoses (Kelstrup, Juillerat, & Korzenik, 2014; Randell

265 et al., 2014), this should be taken into account when considering the present findings. Secondly, a

266 large proportion of the participants from which the present findings are based are female. This is

267 perhaps not surprising given that there is evidence to suggest that there is a greater prevalence of

268 IBD in women when compared to men (Bernstein, Blanchard, Rawsthorne, & Wajda, 1999;

269 Brant & Nguyen, 2008). Indeed, findings based on majority female participants are a common

270 occurrence in the sleep-IBD literature (Ananthakrishnan et al., 2014; Ananthakrishnan et al.,

271 2013; Graff et al., 2013), and in epidemiological research more broadly (Dunn, Jordan, Lacey,

272 Shapley, & Jinks, 2004; Galea & Tracy, 2007; Smith, 2008). The large sample size in the present

273 research does mitigate some of the effects of sample representativeness, and the analyses

274 controlled the effects of gender (gender was not associated with outcomes). That being said, the

275 gender distributions in the present research need to be taken into account when interpreting the

276 findings.

277 **Conclusions**

278 The present research found that, relative to controls, those with a diagnosis of IBD

279 reported significantly more severe experiences of sleep apnea, insomnia, narcolepsy, restless

280 legs, and nightmares, as well as more factors that influence sleep, and a greater impact of sleep

281 complaints on daily life. We recommend that future research should explore three possible

282   avenues; i) investigation of the barriers/facilitators to the effective management of problems

283   sleeping in the routine care of those with IBD; ii) research aiming to elucidate the directional

284   association between sleep and IBD related outcomes, as well as any mechanisms of action; and

285   iii) the effectiveness and efficacy of interventions designed to improve sleep as a route to

286   improving IBD related outcomes. We hope that the present research will highlight the nature and

287   magnitude of problems sleeping in those with IBD, and facilitate more research in this area.

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