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The impact of running on gastrointestinal symptoms in patients with irritable bowel syndrome

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Abstract

Introduction: Physical activity has been suggested to alleviate gastrointestinal (GI) symptoms in patients with irritable bowel syndrome (IBS); however, evidence is scarce. Running has become increasingly popular and may be beneficial for patients with IBS. To obtain more insight in the potential application of running as therapy, we aimed to explore the impact of running and its intensity on GI symptoms in patients with IBS.

Methods: Data from a large observational study in runners were used for this nested case–control study, which included 153 runners with IBS and 153 controls. All participants had completed a questionnaire on personal characteristics, running characteristics and GI symptoms. Regarding GI symptoms, the severity of nine symptoms was asked, both at rest and during and/or shortly (up to 3 h) after running. Each symptom could be scored on a scale from 0 (not bothersome) to 100 (very bothersome), resulting in a maximum total score of 900 points.

Key Results: The prevalence and total severity score of GI symptoms were higher in runners with IBS than in controls, both at rest and during running. Among runners with IBS, the median (25th–75th percentile) total severity score during/after running was significantly lower than at rest (118 [50–200] vs. 150 [90–217]), while in controls no significant difference between running and rest was observed. Analyses stratified for running intensity revealed that the beneficial effect in runners with IBS was present when their most intensive training session was moderately intensive or intensive but not very intensive.

Conclusions & Inferences: Running, particularly on moderate intensity, could have a beneficial effect on GI symptoms in patients with IBS.

KEYWORDS
gastrointestinal symptoms, irritable bowel syndrome, running

1 | INTRODUCTION

Irritable bowel syndrome (IBS) is a bowel disorder of gut–brain interaction[1] (previously known as a functional bowel disorder) in which recurrent abdominal pain or discomfort is associated with a change in bowel habits, and with features of disordered defecation such as constipation and/or diarrhea.[2,3] This disorder can substantially affect quality of life and social functioning.[4] The worldwide pooled prevalence of IBS based on Rome IV criteria is estimated at 3.8%, based on a meta-analysis of six studies which were done in 34

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countries and comprised 82,476 subjects.[5] Prevalence rates range from 0.2% to 21.3% between countries.[5]

Treatment of IBS addresses the gastrointestinal (GI) symptoms and may include both pharmacologic management and nonpharmacologic management such as dietary and psychotherapeutic interventions.[6–9] It has also been suggested that physical activity may alleviate GI symptoms in patients with IBS, however because of uncertainty in the evidence no firm conclusions can be drawn.[9–11] Moreover, contrasting to a potential beneficial effect of physical activity in patients with IBS, it is known that exercise can induce GI symptoms in (healthy) athletes.[12] These GI symptoms can be similar to those of IBS and generally worsen with increasing exercise intensity and duration.[12]

Taken together, the effect of physical activity on GI symptoms in patients with IBS needs further elucidation. Running has become increasingly popular in the last years[13] and could perhaps be advised to patients with IBS as part of management therapy. To our knowledge, only one study investigated the effect of running, and only at low-to-moderate intensity, on GI symptoms in patients with IBS.[14] Results from that study showed that running at low-to-moderate intensity decreased symptom severity in patients with IBS. To obtain more insight in the potential application of running as therapy, we aimed to explore the impact of running and its intensity on GI symptoms in patients with IBS who run regularly.

Key points

- In runners with irritable bowel syndrome (IBS), the total severity of gastrointestinal (GI) symptoms was lower during and/or shortly after running compared to at rest.
- In runners with IBS, the severity of the GI symptoms bloating, flatulence, and constipation was lower, while the severity of urge to defecate and fecal incontinence was higher, during and/or shortly after running compared to at rest.
- The beneficial effect of running was in particular present at moderate intensity exercise.
- Running exercise could be a smart approach to alleviate GI symptoms in patients with IBS, although future studies are needed to establish a clear advice.

2 | METHODS

The current study is an observational study with a nested case–control design. For this study, data from the previously conducted Eat2Run study were used.[15,16] The Eat2Run study aimed to assess the prevalence of running related tendinopathy and abdominal complaints/GI symptoms in a large cohort of runners and to assess its association with potential risk factors, with a particular focus on nutritional factors in the habitual diet.

The Eat2Run study has been extensively described elsewhere.[15,16] In brief, it is an observational study with a cross-sectional design. Participants were runners who completed two online questionnaires: a general questionnaire and a Food Frequency Questionnaire (FFQ). The general questionnaire contained questions about general participants characteristics, running habits, current and past injuries, the occurrence and perceived impact of GI symptoms, including questions about IBS diagnosis, and general health issues. The FFQ was not considered in the current study.

The Medical Ethical Review Commission from Wageningen University & Research assessed the study protocol of the Eat2Run study and concluded that it did not fall within the scope of the Dutch Medical Research Involving Human Subjects Act (WMO), and formal medical ethical approval was not required. The study was, however, conducted following the ethical principles contained in the current revision of the Declaration of Helsinki.

2.1 | Study population

A total of 1993 Dutch and Belgian runners were included in the Eat2Run study. These runners fulfilled the inclusion criteria, that is, they (1) were at least 18 years old; (2) ran at least once a week in the past year, no matter the time or distance, or would usually run at least once a week if they had not been injured; (3) completed both the general questionnaire and the FFQ; and (4) reported plausible habitual dietary intake in the FFQ.

The population for the current nested case–control study was selected from the total population of the Eat2Run study. Runners in that study who indicated that they were diagnosed with IBS by a general practitioner or gastroenterologist were selected as cases for the current study (further referred to as runners with IBS). An equal number of controls were randomly selected from the Eat2Run study population and matched with the cases using the Fuzzy command in SPSS software. Matching was done on gender, age, and running intensity of the most intensive training session each week. These intensities were defined as moderately intensive (running at a pace where one can easily carry on a conversation), intensive (running at a pace where one can just say a short sentence but where a conversation is no longer possible), and very intensive (running at a pace where one gets out of breath).

2.2 | Assessment of GI symptoms

Information on the occurrence of GI symptoms was obtained from a specifically designed section on GI symptoms in the general questionnaire. The GI symptoms questions were selected from multiple validated questionnaires that were previously used, mainly in patients with IBS.[17–19] Runners were asked whether they generally suffered from GI symptoms. In addition, the occurrence of specific

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symptoms was asked, for nine specific symptoms independently. These symptoms were divided into upper GI symptoms (nausea/vomiting and reflux) and lower GI symptoms (abdominal pain/side stitch, bloating, flatulence, urge to defecate, fecal incontinence, diarrhea, and constipation). Runners were instructed to indicate a complaint only if they experienced this as bothersome.

Additionally, runners were asked to rate the severity of the nine specific symptoms, both at rest (the resting condition) and during and/or shortly (i.e., up to 3 h) after running (the active condition). Each symptom could be scored on a scale from 0 (not bothersome) to 100 points (very bothersome), resulting in a maximum total score of 900 points. If runners indicated that a symptom occurred but they did not fill in a score, this missing value was set to 0. Occurrence of GI symptoms at rest and during and/or shortly after running was considered when the severity scores in the respective conditions were above 0.

Finally, runners were asked whether they run while mild GI symptoms are present and if so, whether walking and/or running results in an increase or a decrease of their GI symptoms compared to a resting condition. On a scale from −50 (large decrease of GI symptoms) to 50 (large increase of GI symptoms), runners could indicate the effect of walking and of moderately intensive and intensive running on their GI symptoms. Moderately intensive running was defined as running at a pace where one can easily carry on a conversation; intensive running was defined as running at a pace where conversation is no longer possible.

2.3 | Statistical analyses

Continuous data were first checked for normality using a Kolmogorov–Smirnov test and visual inspection of Q-Q normality plots. After that, descriptive analyses were performed. Personal characteristics, running characteristics, prevalence, and severity of GI symptoms were examined in runners with and without IBS. Because continuous data were not normally distributed, these data are presented as median (25th-75th percentile); categorical variables are presented as *n* (%).

Differences in the prevalence of GI symptoms between runners with IBS and controls were assessed using a Pearson chi-square test and differences in the prevalence of GI symptoms between rest and during and/or shortly after running using a McNemar's test. Differences in the severity of GI symptoms between runners with IBS and controls were assessed using a Mann–Whitney *U* test and differences in the severity of GI symptoms at rest and during and/or shortly after running using a Wilcoxon signed-rank test. The analyses on severity of GI symptoms were performed for the total study population as well as stratified for the intensity of the most intensive training session (moderately intensive, intensive, and very intensive).

The results of all statistical tests were considered significant when the level of significance was lower than 5%, that is, $p < 0.05$. Statistical analyses were performed with SPSS software (Version 25, IBM).

3 | RESULTS

3.1 | Study population

Study population characteristics are presented in Table 1. A total of 153 runners from the Eat2Run study population (8%) indicated that they were diagnosed with IBS by a general practitioner or gastroenterologist and were selected as cases for the current study. Another 153 runners were randomly selected as controls, matched on gender, age, and running intensity. In addition to these characteristics, no significant differences were observed between runners with IBS and controls for any of the other characteristics. The majority of runners with IBS ($n = 131$ [86%]) were women. An equal number of women were selected in the control group. The median (25th–75th percentile) age of runners with IBS was 43 (34–52) years and of controls 42 (34–51) years. Both in runners with IBS and controls, 29% of runners experienced their most intensive training session as moderately intensive, 50% as intensive, and 21% as very intensive. Most of the runners (82% of runners with IBS, 86% of controls) did consider their running level as intermediate, and about half of the runners (44% of runners with IBS, 48% of controls) ran for at least 10 years. The median distance covered per week was 25 (15–40) km for runners with IBS and 30 (18–40) km for controls.

3.2 | Prevalence and severity of GI symptoms

General prevalence rates of any GI symptoms and of the nine specific symptoms independently are presented in Table 2. The prevalence of any GI symptoms was higher in runners with IBS (94%) than in controls (54%) ($p < 0.001$), and also, all the specific symptoms were more often reported by runners with IBS than by controls ($p < 0.001$).

Prevalence rates of symptoms for the resting and active condition separately (i.e., a severity score above 0 in the respective conditions) are presented in Table 3. Among runners with IBS, at rest the prevalence of any GI symptoms was 90%, upper GI symptoms and lower GI symptoms occurred in, respectively, 30% and 88% of the runners. The most common symptoms among runners with IBS in the resting condition were bloating (68%) and flatulence (74%). During and/or shortly after running, the prevalence of any GI symptoms was 88%, of upper GI 24% and of lower GI 87%. The most common symptoms in the active condition were bloating (51%), flatulence (58%), and urge to defecate (54%).

Among controls, at rest the prevalence of any GI symptoms was 46%, upper GI symptoms and lower GI symptoms occurred in, respectively, 11% and 46% of the runners. The most common symptoms among controls in the resting condition were bloating (28%) and flatulence (27%). During and/or shortly after running, the prevalence of any GI symptoms was 46%, of upper GI 9% and of lower GI 45%. The most common symptoms in the active condition were bloating (24%), flatulence (25%), and urge to defecate (24%).

Severity scores for GI symptoms are presented in Table 4. Among runners with IBS, the median (25th-75th percentile) total score for

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TABLE 1 Study population characteristics.

	Runners with IBS ($n=153$)	Controls ($n=153$)	p-Value[a]
Gender			
Men	22 (14)	22 (14)	1.000
Women	131 (86)	131 (86)	
Age, years	43 (34–52)	42 (34–51)	0.981
Height, m	1.71 (1.68–1.76)	1.72 (1.65–1.78)	0.925
Weight, kg	65 (59–72)	65 (60–73)	0.284
BMI, kg/m^2	21.7 (20.4–23.6)	22.4 (20.8–24.1)	0.234
Running level			
Beginner	5 (3)	4 (3)	0.476
Intermediate, not competitive	126 (82)	132 (86)	
Competitive (in age group)	20 (13)	17 (11)	
(Semi)professional	2 (1)	0 (0)	
Running years			
<1 year	5 (3)	5 (3)	0.225
1–2 years	9 (6)	14 (9)	
3–5 years	32 (21)	36 (24)	
6–9 years	40 (26)	24 (16)	
≥ 10 years	67 (44)	74 (48)	
Running, km/week	25 (15–40)	30 (18–40)	0.212
Longest distance per week (km)	13 (10–18)	15 (10–20)	0.238
Intensity most intensive training session			
Moderately intensive	45 (29)	45 (29)	1.000
Intensive	76 (50)	76 (50)	
Very intensive	32 (21)	32 (21)	
Warming up (yes)	95 (62)	79 (52)	0.065
Other sports besides running in past year (yes)	103 (67)	100 (65)	0.717

Note: Data are presented as median (25th–75th percentile) for continuous variables, and as *n* (%) for categorical variables.

[a]*p*-Values were obtained with a Mann–Whitney *U* test for continuous variables and a Pearson chi-square test for categorical variables.

the severity of GI symptoms was significantly lower during and/or shortly after running (118 [50–200]) than at rest (150 [90–217]) ($p=0.005$). Among controls, the total scores tended to be higher during and/or shortly after running (80 [17–138]) than at rest (54 [11–129]), although this difference was not significant ($p=0.383$).

Regarding the specific symptoms, among runners with IBS, severity scores were significantly lower during and/or shortly after running than at rest for bloating (20 [0–38] vs. 50 [28–69], $p<0.001$), flatulence (27 [3–48] vs. 43 [20–63], $p<0.001$), and constipation (8 [0–31] vs. 50 [30–62], $p<0.001$), and higher for urge to defecate (49 [22–78] vs. 30 [1–50], $p<0.001$), and fecal incontinence (19 [10–52] vs. 0 [0–10], $p=0.009$). Among controls, scores were significantly lower during and/or shortly after running than at rest for bloating (12 [0–34] vs. 30 [10–74], $p=0.002$) and constipation (5 [0–39] vs. 49 [23–69], $p=0.004$), and higher for nausea/vomiting (33 [4–65] vs. 3 [0–24], $p=0.028$), abdominal pain/side stitch (30 [2–68] vs. 0 [0–30], $p=0.011$), flatulence (35 [10–50] vs. 34 [15–60], $p=0.026$), and urge to defecate (40 [12–63] vs. 14 [0–36], $p=0.004$).

Note that differences in median scores are group based and not representative for each individual. For 88 out of 143 runners with IBS who reported occurrence of GI symptoms, the total severity score was lower during and/or shortly after running than at rest, corresponding to the significant difference in median scores between the two conditions. However, for 53 runners with IBS the total severity score was higher in the active condition, and for 2 runners with IBS the total score was not different between the two conditions. Among 82 controls who reported occurrence of GI symptoms, the total severity score during and/or shortly after running was lower than at rest for 36 runners, higher for 40 runners, and not different for 6 runners. An overview of the number of runners that experienced an increase, decrease, or no difference in severity of the specific symptoms between the two conditions is presented in Table S1.

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TABLE 2 General prevalence of GI symptoms.

	Runners with IBS ($n=153$)	Controls ($n=153$)	p-Value[a]
Any GI symptoms	143 (94)	82 (54)	**<0.001**
Any upper GI symptoms	50 (33)	19 (12)	**<0.001**
Nausea/vomiting	28 (18)	10 (7)	**<0.001**
Reflux	36 (24)	16 (11)	**<0.001**
Any lower GI symptoms	142 (93)	80 (52)	**<0.001**
Abdominal pain/side stitch	78 (51)	32 (21)	**<0.001**
Bloating	108 (71)	51 (33)	**<0.001**
Flatulence	116 (76)	46 (30)	**<0.001**
Urge to defecate	96 (63)	40 (26)	**<0.001**
Fecal incontinence	24 (16)	10 (7)	**<0.001**
Diarrhea	76 (50)	21 (14)	**<0.001**
Constipation	62 (41)	22 (14)	**<0.001**

Note: Data are presented as *n* (%).

[a]*p*-Values were obtained with a Pearson chi-square test; statistical significance ($p<0.05$) is indicated in bold.

3.3 | Effect of intensity

Results from analyses on the severity of GI symptoms stratified for the intensity of the most intensive training session (moderately intensive, intensive, and very intensive) are presented in Table 5. Among runners with IBS, the total severity score during and/or shortly after running was significantly lower than at rest for those who rated the intensity of their most intensive training session as moderately intensive (75 [30–173] vs. 129 [63–200], $p=0.007$) or intensive (115 [40–191] vs. 150 [86–214], $p=0.045$). For those rating, the intensity of their most intensive training session as very intensive no significant difference in total severity score between rest and during and/or shortly after running was observed. Among controls, no significant differences between the two conditions were observed in any of the three intensity strata.

Among the 143 runners with IBS who reported occurrence of GI symptoms, 127 (90%) indicated to run while mild GI symptoms are present. Among the 82 controls who reported occurrence of GI symptoms, 59 (85%) indicated to run while mild GI symptoms are present. Reported differences in experienced GI symptoms between rest and exercise for walking, running moderately intensive, and running intensive by runners with IBS and controls are presented in Table 6. Among runners with IBS, walking resulted in a decrease of GI symptoms; the median (25th-75th percentile) difference score was −10 (−31 to 0) on a scale from −50 (large decrease of GI symptoms) to 50 (large increase of GI symptoms). On the contrary, the median difference score among controls for walking versus rest was −1 (−20 to 0), indicating that in controls overall hardly any difference in GI symptoms was experienced. For both runners with IBS and controls, the median difference scores for running moderately intensive and rest were around 0, indicating hardly any difference, while the median difference scores for intensive running and rest were 20, indicating an increase in experienced GI symptoms.

4 | DISCUSSION

The aim of this study was to explore the impact of running and its intensity on GI symptoms in patients with IBS who run regularly. As expected, GI symptoms were highly prevalent in runners with IBS, twice as frequent as in controls, and severity scores were higher in runners with IBS, both at rest and during and/or shortly after running. Interestingly, for runners with IBS, the total severity score during and/or shortly after running was significantly lower than at rest, while for controls, the total severity score in the active condition was not significantly different from the score in the resting condition. The lower total severity score during and/or shortly after running in runners with IBS was mainly reported by those patients rating their most intensive training session as moderately intensive or intensive, not very intensive. In addition, walking decreased GI symptoms compared to rest in runners with IBS but not in controls, while in both runners with IBS and controls running at moderate intensity had no effect and intensive running increased GI symptoms compared to rest. Our results suggest that low-to-moderate intensity exercise could be beneficial for patients with IBS.

The prevalence of IBS in the Eat2Run source population was 8%. Although this prevalence falls within ranges of 0.2%–21.3% that were observed in a meta-analysis of six studies which were done in 34 countries and comprised 82,476 subjects,[5] we can imagine that the prevalence rate in a population of runners might be lower than the prevalence in the general population because patients with IBS are likely to run less often due to the symptoms. The majority (86%) of runners with IBS in the current study were women, which has also been observed in the worldwide studies in the meta-analysis.[5]

Prevalence rates of any GI symptoms and of the nine specific symptoms independently were higher in runners with IBS than in controls, both at rest and during and/or shortly after running, although the difference in the prevalence of reflux and fecal incontinence at rest was not significant. Also, the total scores for the severity of GI symptoms were higher in runners with IBS than in controls, both in the resting and in the active condition. For runners with IBS, the total severity score during and/or shortly after running was significantly lower than at rest, while for controls, the total severity score in the active condition was not significantly different from the score in the resting condition. Regarding the specific symptoms, runners with IBS reported a lower severity score during and/or shortly after running compared to at rest for the three symptoms that they perceived as most severe at rest, that is, bloating, flatulence, and constipation. However, the scores for urge to defecate and fecal incontinence were higher during and/or shortly after running compared to at rest. This should not be overlooked because these symptoms could lead to considerable distress and embarrassment.[20] However, runners with IBS reported more often a lower severity score during and/or shortly after running compared to at rest than controls (3 vs. 2 symptoms for runners with IBS

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TABLE 3 Prevalence of GI symptoms at rest and during and/or shortly after running.

	Runners with IBS ($n = 153$)			Controls ($n = 153$)				
	At rest	During/after running	p-Value rest vs. running[a]	At rest	During/after running	p-Value rest vs. running[a]	p-Value IBS pts vs. controls at rest[a]	p-Value IBS pts vs. controls running[a]
Any GI symptoms	137 (90)	134 (88)	0.607	70 (46)	70 (46)	1.000	**<0.001**	**<0.001**
Any upper GI symptoms	46 (30)	37 (24)	0.022	16 (11)	13 (9)	0.453	**<0.001**	**<0.001**
Nausea/vomiting	27 (18)	22 (14)	0.125	5 (3)	8 (5)	0.250	**<0.001**	**0.007**
Reflux	31 (20)	26 (17)	0.227	15 (10)	10 (7)	0.125	0.100	**0.005**
Any lower GI symptoms	135 (88)	133 (87)	0.791	70 (46)	69 (45)	1.000	**<0.001**	**<0.001**
Abdominal pain/side stitch	57 (37)	67 (44)	0.089	15 (10)	25 (16)	**0.031**	**<0.001**	**<0.001**
Bloating	104 (68)	78 (51)	**<0.001**	43 (28)	36 (24)	0.167	**<0.001**	**<0.001**
Flatulence	113 (74)	88 (58)	**<0.001**	41 (27)	38 (25)	0.508	**<0.001**	**<0.001**
Urge to defecate	72 (47)	82 (54)	0.123	26 (17)	37 (24)	**0.013**	**<0.001**	**<0.001**
Fecal incontinence	9 (6)	22 (14)	**<0.001**	6 (4)	7 (5)	1.000	0.427	**0.003**
Diarrhea	63 (41)	60 (39)	0.690	16 (11)	18 (12)	0.727	**<0.001**	**<0.001**
Constipation	60 (39)	38 (25)	**<0.001**	20 (13)	11 (7)	**0.004**	**<0.001**	**<0.001**

Note: Data are presented as *n* (%). Prevalence of GI symptoms at rest and during and/or shortly after running was considered when the severity scores in the respective conditions were above 0.

[a]*p*-Values for differences between rest and running were obtained with a McNemar's test; *p*-values for differences between runners with IBS and controls were obtained with a Pearson chi-square test; statistical significance ($p < 0.05$) is indicated in bold.

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TABLE 4 Severity score of GI symptoms.

	Runners with IBS				Controls					
	n	At rest	During/after running	*p*-Value rest vs. running[a]	*n*	At rest	During/after running	*p*-Value rest vs. running[a]	*p*-Value IBS pts vs. controls at rest[a]	*p*-Value IBS pts vs. controls running[a]
Nausea/vomiting	28	27 (15–60)	29 (3–42)	0.322	10	3 (0–24)	33 (4–65)	**0.028**	**0.008**	0.482
Reflux	36	21 (9–38)	21 (0–48)	0.970	16	20 (9–30)	12 (0–44)	0.887	0.404	0.601
Abdominal pain/side stitch	78	27 (0–50)	31 (10–56)	0.116	32	0 (0–30)	30 (2–68)	**0.011**	**0.013**	0.947
Bloating	108	50 (28–69)	20 (0–38)	**<0.001**	51	30 (10–47)	12 (0–34)	**0.002**	**0.003**	0.608
Flatulence	116	43 (20–63)	27 (3–48)	**<0.001**	46	34 (15–60)	35 (10–50)	**0.026**	0.116	0.360
Urge to defecate	96	30 (1–50)	49 (22–78)	**<0.001**	40	14 (0–36)	40 (12–63)	**0.004**	0.082	0.256
Fecal incontinence	24	0 (0–10)	19 (10–52)	**0.009**	10	1 (0–20)	38 (0–65)	0.086	0.515	0.985
Diarrhea	76	29 (7–60)	30 (2–71)	0.651	21	13 (3–21)	30 (6–60)	0.159	**0.042**	0.965
Constipation	62	50 (30–62)	8 (0–31)	**<0.001**	22	49 (23–69)	5 (0–39)	**0.004**	0.855	0.853
Total score	143	150 (90–217)	118 (50–200)	**0.005**	82	54 (11–129)	80 (17–138)	0.383	**<0.001**	**0.001**

Note: Data are presented as median (25th–75th percentile).

[a]*p*-Values for differences between rest and running were obtained with a Wilcoxon signed-rank test; *p*-values for differences between runners with IBS and controls were obtained with a Mann–Whitney *U* test; statistical significance ($p < 0.05$) is indicated in bold.

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TABLE 5 Total severity score of GI symptoms per category of most intensive training session.

Intensity category	Runners with IBS				Controls					
	n	At rest	During/after running	*p*-Value rest vs. running[a]	*n*	At rest	During/after running	*p*-Value rest vs. running[a]	*p*-Value IBS pts vs. controls at rest[a]	*p*-Value IBS pts vs. controls running[a]
Moderately intensive	42	129 (63–200)	75 (30–173)	**0.007**	23	78 (32–161)	81 (0–180)	0.627	**0.050**	0.582
Intensive	71	150 (86–214)	115 (40–191)	**0.045**	41	49 (10–116)	70 (14–120)	0.246	**<0.001**	**0.015**
Very intensive	30	176 (98–272)	174 (94–229)	0.951	18	42 (0–184)	85 (27–138)	0.446	**0.003**	**0.004**

Note: Data are presented as median (25th–75th percentile).

[a]*p*-Values for differences between rest and running were obtained with a Wilcoxon signed-rank test; *p*-values for differences between runners with IBS and controls were obtained with a Mann–Whitney *U* test; statistical significance ($p < 0.05$) is indicated in bold.

and controls respectively) and less often a higher severity score (2 vs. 4 symptoms for runners with IBS and controls, respectively). This observation together with the lower total severity score during and/or shortly after running compared to at rest in runners with IBS suggests that running could have an overall beneficial effect on GI symptoms in patients with IBS.

It is common knowledge that exercise can induce GI symptoms in (healthy) athletes. The etiology of exercise induced GI symptoms is multifactorial.[12] The main physiological factors contributing to GI symptoms during exercise are gastrointestinal ischemia due to splanchnic hypoperfusion[21–23] and reduced overall gastrointestinal functional capacity due to increased sympathetic activation,[23] with increased gastrointestinal permeability and inflammation as a likely consequence.[23] These factors are more likely to play a role when exercising at high intensity and with long duration, explaining the higher severity scores of GI symptoms under these circumstances. In contrast, less is known about the effect of moderate exercise on GI symptoms. We observed that walking and running, particularly on moderate intensity, can have a beneficial effect on GI symptoms, which is in agreement with other studies that investigated the effect of physical activity and/or moderate exercise therapy on GI symptoms in patients with IBS.[10,11] Explanations for this observation may be related to beneficial effects of (moderate) exercise on inflammation, the gut, the brain, and the microbiome. These effects may be direct effects, but it has also been suggested that these effects interact via the microbiome–gut–brain axis.[24] Though IBS is not classified as an inflammatory disease, associations between pro- and anti-inflammatory cytokines with IBS symptoms have been observed.[25,26] In addition, results from studies suggest that changes in pro-antioxidant ratio toward peroxidation may have a role in the pathogenesis of IBS and inflammatory bowel disorders.[27,28] Although strenuous exercise may lead to inflammation, moderate exercise may reduce systemic low-grade inflammation. Indeed, studies have shown reduced markers of inflammation and oxidative stress, and increased anti-inflammatory and antioxidant markers after physical activity.[14,29–31] Another explanation for the beneficial effect of exercise on GI symptoms may be through an effect on the gut. It has been shown that moderate exercise can accelerate gas transit and colonic transit and improve abdominal distension.[32–35] Furthermore, the decrease in GI symptoms may be related to an effect of exercise on the brain. IBS can be related to psychological factors such as psychological stress.[8] Exercise is known to stimulate neurotransmitter release, especially monoamines, which have a beneficial effect on brain function.[36] Exercise may also distract attention and in such a way reduce perceived stress. Finally, the beneficial effect of exercise on GI symptoms may be related to changes in gut microbiota composition. There is convincing evidence that gut microbiota composition is perturbed in patients with IBS.[37] Exercise has been shown to increase health-beneficial bacteria populations and to promote microbial diversity which is associated with a healthier state.[38] In addition to direct effects of exercise on inflammation, the gut and the brain, these effects may also interact via the microbiome–gut–brain axis.[24]

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TABLE 6 Difference in experienced GI symptoms between rest and exercise at the intensities walking, running moderately intensive, running intensive.

	Runners with IBS		Controls	
	n[a]	Difference score	*n*[a]	Difference score
Walking	112	−10 (−31 to 0)	47	−1 (−20 to 0)
Running moderately intensive	120	1 (−15 to 16)	54	2 (−9 to 12)
Running intensive	108	20 (0 to 35)	45	20 (8 to 39)

Note: Data are presented as *n* (%) or as median (25th–75th percentile). Difference scores on a scale from −50 (strong decrease of GI symptoms when exercising) to 50 (strong increase of GI symptoms when exercising).

[a]These numbers represent the runners that answered the question on experienced difference in GI symptoms.

The beneficial effect of walking and/or moderate intensity running on perceived severity of GI symptoms was more often observed in runners with IBS than in controls. It could be that this type of exercise is particularly beneficial in patients with IBS. However, this observation could also be related to the fact that runners with IBS perceived GI symptoms as more severe than controls, meaning that runners with IBS have more room for alleviation of symptoms. This may also explain the significantly higher severity score at rest for runners with IBS compared to controls for four specific symptoms (beside the higher total severity score), while during and/or shortly after running no significant differences in severity were observed for any of the specific symptoms (only for the total severity score). Based upon our observations, future intervention studies are warranted to establish whether moderate intensity running could be an effective approach to alleviate symptoms in patients with IBS, and what an optimal intensity and duration could be.

4.1 | Strengths and limitations

To our knowledge, this is the first study exploring the impact of running at different intensities on GI symptoms in patients with IBS who run regularly.

We identified runners as cases when they answered "yes" on the question whether they were being diagnosed with IBS by a general practitioner or gastroenterologist, rather than using diagnostic criteria like the Rome IV criteria. We acknowledge that Rome IV criteria are the gold standard in the assessment of IBS. However, in daily clinical practice Rome IV criteria are not always sufficient.[39] Moreover, studies have shown that primary care physicians rarely apply formal diagnostic criteria for IBS,[40] but that they are able to diagnose IBS with confidence.[41] We believe that the IBS diagnosis made by the clinician is also of important value and is only made when other organic diseases or causes of GI symptoms are excluded. It is of note that not all people with IBS-like GI symptoms seek for medical care. A study on the prevalence of IBS among the general Belgian population reported that only 21% of subjects with GI symptoms in that study consulted a physician in the previous year and 42% of these subjects did so longer than 1 year ago.[42] If we had used the Rome III or Rome IV criteria for the selection of runners with IBS, we would probably have included more cases. Correspondingly, it could be that runners in the control group have IBS without being diagnosed by a general practitioner or gastroenterologist because they did not consulted a physician. This may have resulted in less pronounced differences between the IBS group and the control group.

The self-reporting method of data collection is also prone to other types of bias. For example, runners were asked for the occurrence and severity of GI symptoms in general, and not before and during or after individual runs. This could have introduced some recall bias.

However, despite these limitations this primary study in patients with IBS who run regularly clearly demonstrates that running could have an overall beneficial effect on GI symptoms in these patients.

5 | CONCLUSION

Results from this observational study indicate that the total severity of GI symptoms was lower during and/or shortly after running compared to at rest in runners with IBS, with the beneficial effect being in particular present at moderate intensity exercise. This suggests that running exercise could be a smart approach to alleviate symptoms in patients with IBS, although future studies are needed to establish a clear advice.

AUTHOR CONTRIBUTIONS

All authors were involved in the design of the study. AMB analyzed the data and prepared tables and figures; all authors interpreted the results. AMB drafted the manuscript; MM and BJMW critically reviewed it. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

No competing interests declared.

DATA AVAILABILITY STATEMENT

Data are available on reasonable request.

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