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THESES OF THE DOCTORAL DISSERTATION

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The psychosocial aspects of irritable bowel syndrome

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1.   General Introduction

Irritable bowel syndrome (IBS) is a chronic functional gastrointestinal disorder. It is characterized by abdominal pain, bloating, and altered bowel habits. In the absence of physiological abnormalities, altered intestinal function may play a role in the background of the symptoms (Chey et al., 2015). The condition is significantly associated with reduced mental health, health-related quality of life, work productivity (Buono et al., 2017), and an increased prevalence of mental disorders, typically depression and anxiety (Gajdos & Rigó, 2018).

The etiology of IBS is complex with both physiological and psychological mechanisms involved in the development and exacerbation of symptoms. The biopsychosocial model of functional gastrointestinal disorders addresses the physiological factors potentially involved in pathogenesis, such as altered gut motility, increased intestinal permeability, or altered bacterial flora. The model also includes the central nervous system and psychological mechanisms that may influence these functions through a regulatory disturbance of the brain-gut axis, and thus have an effect on the development and the course of the disease (Van Oudenhove et al., 2016). The central nervous system factors include alterations in the processing of visceral stimuli, which are thought to be due to autonomic nervous system dysfunction (Park, 2008). In patients, the process is partly mediated by negative emotional states and anxiety (Elsenbruch et al., 2010). In terms of psychological mechanisms, gastrointestinal symptom-specific anxiety is a specific anxiety pattern in IBS patients. It is characterized by increased fear, bodily hypervigilance, and avoidance behavior. These factors can lead to increased pain sensitivity, altered gut motility, and thus exacerbation of symptoms (Kinsinger, 2017). This particular pattern of anxiety has a more significant role in the maintenance of symptoms, than neuroticism or trait anxiety, however, these factors can increase the risk of developing gastrointestinal symptom-specific anxiety (Labus et al., 2004).

IBS patients are also characterized by specific behavioral coping strategies, such as rigid daily routines or the avoidance of certain high-risk social activities. These strategies may initially be adaptive, but long-term control and avoidance behaviors can lead to isolation, a significant reduction in quality of life (Reme, Darnley, Kennedy, & Chalder, 2010) and may contribute to the exacerbation of symptoms (Kinsinger, 2017) and functional impairment (Kennedy et al., 2005). The eating behavior of the patients is also can be regarded as a coping strategy, which can be described by severe dietary restrictions (Guadagnoli et al., 2019; Reed-Knight et al., 2016). Several authors emphasize the potential negative psychological effects of elimination diets in irritable bowel syndrome (Chey, 2019). Empirical studies demonstrated the comorbidity of functional gastrointestinal disorders and eating disorders (Mari et al., 2018; Satherley et al., 2015). The investigation of symptoms of orthorexia nervosa or emotional eating may have great relevance in the field of IBS-related eating patterns. Orthorexia nervosa and IBS patients have several characteristics in common, such as avoidance of certain foods or dietary choices based on personal experience and individual judgment. Furthermore, the motivation behind the specific diet is also similar in the two conditions, being more about maintaining control and avoiding symptoms or disease rather than reducing weight (Håman et al., 2015; Koven & Abry, 2015).

Interoception is a key concept in the fields of medicine, neuroscience, and psychology, but still lacks a unified definition. According to Sherrington (1948), interoception can be

defined as the perception of visceral signals. Other theorists using a broader framework, define interoception as the perception of stimuli related to homeostatic regulation, physiological needs, and the state of the body in general (Craig, 2016). Garfinkel et al (2015) propose a model for the distinction of three interoceptive dimensions. According to this theory, interoceptive accuracy can be measured by experimental paradigms, while interoceptive sensibility, which is regarded as a subjective interoceptive dimension, involving top-down processes, is assessed by self-report questionnaires. Further, interoceptive awareness represents a metacognitive dimension. Several approaches propose the potential role of altered interoceptive dimensions in the background of functional somatic syndromes (Ricciardi et al., 2016; Valenzuela-Moguillansky et al., 2017). In some empirical studies, patients with functional symptoms showed reduced interoceptive accuracy compared to healthy controls (Duschek et al., 2017; Pollatos et al., 2011; Weiss et al., 2014), while other results demonstrated a negative association between interoceptive sensibility and the severity of functional symptoms (Valenzuela-Moguillansky et al., 2017). Diminished interoceptive accuracy can lead to reduced emotion regulation capabilities by limiting access to bodily cues during emotion processing (Duschek et al., 2017; Füstös et al., 2013). In functional somatic syndromes, this process has great relevance, because in this case bodily signals are usually related to increased anxiety. This experience can lead to the avoidance of somatic sensations thus reducing emotion regulation capacities and decreasing bodily trust. Regarding interoceptive sensibility, studies related to functional symptoms usually focus on negative emotions, attitudes, and aversion toward bodily processes (Valenzuela-Moguillansky et al., 2017).

Taking into account the dynamic interactions of physiological and psychological factors in the etiology of IBS, psychological interventions may have a significant role in the complex therapy of the condition. Several psychological methods and therapeutic approaches, such as cognitive behavioral therapy, relaxation techniques, mindfulness-based stress reduction, hypnotherapy, or psychodynamic psychotherapy have a significant positive effect on the mental health and daily functioning of the patients (Laird et al., 2017) and can lead to significant reductions in gastrointestinal symptoms (Laird et al., 2016).

2. Aims

Functional somatic symptoms and related syndromes in addition to their negative impact on the mental and physical well-being of patients, place a significant burden on the healthcare system, adversely affecting doctor-patient relationships and often posing an intractable problem from the perspective of the care providers (Haller et al., 2015).

My dissertation aims to contribute to the understanding and management of this complex problem by studying the biopsychosocial aspects of irritable bowel syndrome as one of the most common functional somatic syndromes. The dissertation focuses on two aspects of irritable bowel syndrome, interoception and disease-specific coping. The clinical study aims to investigate these factors in an explanatory model. To this end, the clinical study was preceded by two preliminary studies in which interoception and coping were analyzed separately in healthy populations. The latter samples were considered relevant because of the high prevalence of functional gastrointestinal complaints in the general population.

The **first study** focused on the relationship between different interoceptive dimensions and functional gastrointestinal symptoms. In addition to the questionnaires most commonly used to measure interoception, an experimental paradigm was used, and a widely used scale was adapted for the study.

The **second study** investigated specific coping behaviors associated with functional gastrointestinal symptoms through eating behavior. We aimed to explore the associations between physical symptoms and symptoms of orthorexia nervosa and emotional eating. Our explanatory model included health anxiety as a mediating factor, which may partly explain the association between functional symptoms and problematic eating behavior.

The **third study** was conducted in a clinical population. We aimed to test a complex theoretical model that integrates the behavioral coping of patients and the role of interoception in symptom frequency. In the case of interoception, the preliminary study provided an opportunity to include a wider range of measures, so we targeted two scales in our clinical research that we found to be effective for analyzing interoception associated with functional gastrointestinal symptoms.

The studies that form part of this dissertation are summarised in Figure 1.

Figure 1: Summary of the three studies
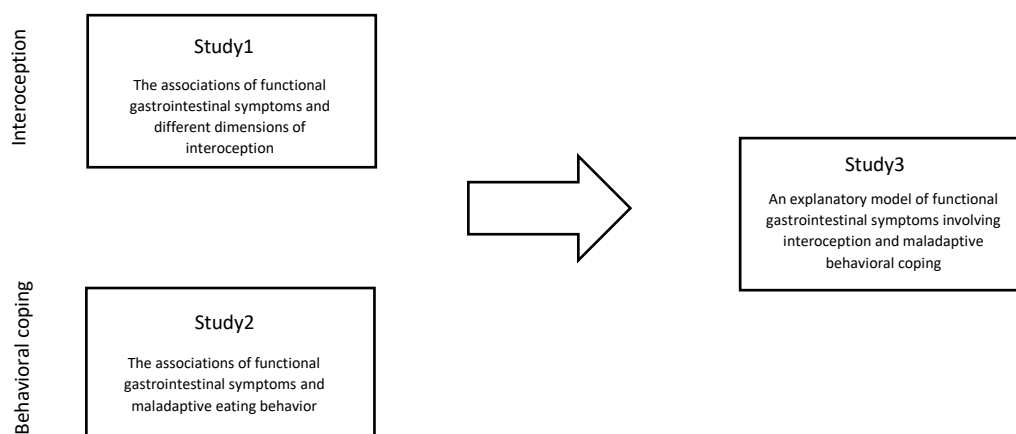
Empirical studies

3.   Study1[1]

Our first study aimed to explore the association of different interoceptive dimensions with functional gastrointestinal symptoms in a healthy population. Our first sub-study was a questionnaire study, while in our second sub-study, an experimental paradigm designed to measure interoceptive accuracy was also performed on a subsample of participants in the first study.

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[1] Gajdos, P., Chrisztó, Z., & Rigó, A. (2020). The association of different interoceptive dimensions with functional gastrointestinal symptoms: *Journal of Health Psychology*. https://doi.org/10.1177/1359105320929426

Based on previous results for other functional symptoms, we hypothesized that the frequency of functional gastrointestinal symptoms would be inversely related to interoceptive sensibility and interoceptive accuracy and that high-symptom reporters would have lower interoceptive sensibility and interoceptive accuracy than low-symptom reporters.

3.1. Sub-study1

3.1.1. Methods

3.1.1.1. Sample and procedure

A convenience sampling method was used, participants were recruited through university courses and social media platforms, and data collection took place from July 2018 to July 2019. The sample for our first sub-study consisted of 256 participants. A diagnosis of preexisting psychiatric disorder was defined as an exclusion criterion, resulting in the exclusion of 23 participants. The final sample included 233 individuals, 167 women (71.7%) and 66 men (28.3%) with a mean age of 28.68 years (sd: 11.15; range: 18-69). The study was approved by the Research Ethical Committee of ELTE, Eötvös Loránd University, Faculty of Education and Psychology (ethical permission number: 2018/251).

3.1.1.2. Measures

The **World Gastroenterology Organisation Irritable Bowel Syndrome Questionnaire (WGO-IBS)** was used to measure IBS-related functional gastrointestinal symptoms. The questionnaire contains ten items with scores ranging from 9 to 42. Higher scores indicate the presence of more functional gastrointestinal symptoms. The presence of diagnosed gastrointestinal disorders of organic origin and the presence of abdominal pain and discomfort related only and exclusively to menstruation were also monitored. These cases were excluded from statistical analyses with functional gastrointestinal symptoms.

The measurement of interoceptive sensibility

Body Awareness Very Short Form (BA-VSF) (Cabrera et al., 2017) was developed as a shorter version of the Body Perception Questionnaire (Porges, 1993). The 12-item questionnaire assesses subjective awareness of bodily signals related to the activity of the autonomic nervous system. The items of the questionnaire are answered on a five-point Likert scale (1- Never, 5- Always), with a score between 12 and 60 and a higher score indicating higher interoceptive sensibility (Cabrera et al., 2017).

The 17-item **Body Awareness Questionnaire** (BAQ) (Köteles, 2014; Shields et al., 1989) assesses trait-like individual tendencies to pay attention to bodily processes, independent of the perception of physiological cues related to emotional states or perceived or real somatic symptoms. Items are scored on a seven-point Likert scale (1-Absolutely not true, 7-Absolutely true), ranging from 17 to 119. Higher scores indicate higher interoceptive sensibility (Köteles, 2014).

The **Multidimensional Assessment of Interoceptive Awareness (MAIA)** (Mehling et al., 2012) (Ferentzi et al., 2021) represents a complex approach to interoceptive sensibility, integrating bodily sensation awareness with emotional and attentional processes. The 32 items of the MAIA are scored on a six-point Likert scale (0-Never, 5- Always). The items can be sorted into eight subscales (Noticing, Not distracting, Not worrying, Attention regulation, Emotional awareness, Self-regulation, Body listening, and Trusting), each subscale ranging from 0 to 5. Higher scores indicate higher interoceptive sensibility (Ferentzi et al., 2021).

3.1.1.3. Statistical analysis

Data were analyzed with the SPSS 26.0 statistical software package (IBM SPSS Inc., Chicago, IL). The Shapiro-Wilk test was used to check the condition of normal distribution. Since the condition of normal distribution was not met, to determine the correlations between variables, Spearman's rank correlation analysis was used. Mann-Whitney test was used for the comparison of low symptom reporters and high symptom reporters along interoceptive sensibility.

3.1.2. Key results

The summary scores of the three interoceptive sensibility scales showed a significant correlation with each other. Summary scores of the Body Awareness Questionnaire and Body Awreness-Very Short Form significantly correlated with Noticing, Attention regulation, Emotional awareness, Self-regulation, Body Listening, and Trusting MAIA subscales. The WGO-IBS total score showed a weak positive correlation with the summary score of Body Awreness-Very Short Form ($r=0.232$; $p=0.001$) and a negative correlation with Not-worrying ($r=-0.169$; $p=0.021$) and Trusting MAIA subscales ($r=-0.203$; $p=0.005$) (Table 1). A median split of participants was performed to distinguish between high and low symptom reporters; thus, high symptom reporters were those with a symptom score of 21 or above, while low symptom reporters had a symptom score of 20 or below. High symptom reporters showed higher Body Awareness-Very Short Form total score (HS = 47; LS = 44; Mann–Whitney U = 5037; $p = 0.048$) and lower scores on the Trusting subscale of MAIA (HS = 3.5; LS = 4; Mann–Whitney U = 3294.5; $p = 0.005$).

Table1: Spearman correlations between the measured variables in Sub-study1

	BAQ		BA-VSF		WGO-IBS	
	r	p	r	p	r	P
BAQ					0.051	0.494
BA-VSF	0.395	<0.001**			0.232	0.001**
MAIA	0.523	<0.001**	0.434	<0.001**	-0.037	0.613
I. Noticing	0.454	<0.001**	0.383	<0.001**	0.088	0.235
II. Not distracting	-0.023	0.725	0.079	0.23	-0.08	0.277
III. Not worrying	-0.065	0.326	-0.122	0.064	-0.169	0.021+
IV. Attention regulation	0.435	<0.001**	0.370	<0.001**	-0.059	0.427
V. Emotional awareness	0.469	<0.001**	0.379	<0.001**	0.037	0.62
VI. Self-regulation	0.376	<0.001**	0.324	<0.001**	-0.002	0.974
VII. Body listening	0.32	<0.001**	0.344	<0.001**	0.079	0.284
VIII. Trusting	0.358	<0.001**	0.178	0.007*	-0.203	0.005*

BAQ: Body Awareness Questionnaire, BA-VSF: Body Awareness-Very Short Form, MAIA: Multidimensional Assessment of Interoceptive Awareness, WGO-IBS: World Gastroenterology Organisation–Irritable Bowel Syndrome Questionnaire, r: Spearman's correlation coefficient, p: Significance.
$**p \leq 0.001$, $*p < 0.01$, $+p < 0.05$.

3.2. Sub-study2

3.2.1. Methods

3.2.1.1. Sample and procedure

The procedure for our second sub-study is the same as for the first sub-study described above. A subset of subjects in the first sub-study agreed to participate in physiological measurements and an experimental paradigm. These participants were included in the second sub-study. Our study sample was a sub-sample of 72 participants from the first sub-study, with a mean age of 21.92 years (sd: 2.68; range: 18-33). A diagnosis of psychiatric disorder was defined as an exclusion criterion. The final sample included 46 women (63.9%) and 26 men (36.1%).

3.2.1.2. Measures

For the questionnaire part of the study, the questionnaire package presented in the first study was used.

Experimental paradigm

For the measurement of interoceptive accuracy (IA), a mental tracking task, the heartbeat counting task by Schandry (1981), was performed. During the task, participants were sitting in a chair, with a polar belt placed on the chest, recording their heart rate. After a relaxation period of 3 minutes, they were instructed to silently count their heartbeats by concentrating on their bodily signals, without taking their pulse. The trial consisted of four counting intervals of 25, 35, 45, and 55 seconds separated by resting periods of 30 seconds. The beginning and the end

of the counting phases were signaled by a tone. The order of the time intervals was randomised in each trial and participants were not informed about the duration of the intervals. Then a heartbeat perception score was calculated for each counting interval according to the following formula: 1– ([recorded heartbeats counted heartbeats)) / recorded heartbeats. Interoceptive accuracy was calculated as the mean of the four heartbeat perception scores.

3.2.1.3. Statistical analysis

The Shapiro-Wilk test was used to check the condition of normal distribution. Since the condition of normal distribution was not met, to determine the correlations between variables, Spearman's rank correlation analysis was used. Mann-Whitney test was used for the comparison of low symptom reporters and high symptom reporters along interoceptive sensibility.

3.2.2. Key results

The summary scores of BAQ and BA-VSF and the subscales of MAIA did not correlate with the interoceptive accuracy score. WGO-IBS total score did not correlate with the interoceptive accuracy score (0.117; p>0.05) (Table 2). A median split of participants was performed to distinguish high and low symptom reporters; thus, high symptom reporters were those with a symptom score of 22 or above, while low symptom reporters had a symptom score of 21 or below. There was not a significant difference between high-symptom reporters and low-symptom reporters regarding interoceptive accuracy (MT=0.66; AT=0.59; Mann-Whitney U=773; p=0.152).

Table 2: Spearman correlations between the measured variables in Sub-study 2.

	MTT	
	r	**p**
WGO-IBS	0.117	0.385
BAQ	-0.118	0.323
BA-VSF	0.018	0.883
MAIA	0.096	0.421
MTT		
I. Noticing	0.041	0.731
II. Not distracting	-0.031	0.794
III. Not worrying	0.066	0.584
IV. Attention regulation	0.115	0.334
V. Emotional awareness	0.094	0.433
VI. Self-regulation	0.038	0.751
VII. Body Listening	0.144	0.228
VIII. Trusting	0.072	0.545

BAQ: Body Awareness Questionnaire, BA-VSF: Body Awareness-Very Short Form, MAIA: Multidimensional Assessment of Interoceptive Awareness, WGO-IBS: World Gastroenterology Organisation–Irritable Bowel Syndrome Questionnaire, r: Spearman's correlation coefficient, p: Significance.
**p <= 0.001, *p < 0.01, +p < 0.05.

3.3.   Discussion

The relevance of our study is based on the very limited empirical evidence on the relationship between functional gastrointestinal symptoms and interoception. According to our results, high gastrointestinal symptom reporters are characterized by bodily hypervigilance and increased attentional focus on bodily processes rather than a more accurate perception of somatic cues. Besides, they show decreased trust in bodily signals. These results are in line with the findings of Mallorquí-Bagué et al. (2014) investigating state anxiety. According to their conclusions, increased sensitivity to physiological arousal and uncertainty about the interpretation of the associated somatic cues may be highly relevant to the background of anxiety symptoms. Furthermore, our results support the importance of interactions between different interoceptive dimensions, which may provide a new approach to the relationship between interoception and symptom perception. Our results regarding the week-moderate associations between interoceptive sensibility scales are related to previous findings suggesting that interoceptive sensibility is not a single construct (Desmedt et al., 2022; Vig et al., 2022). Our results also support previous studies, that emphasize the independence of interoceptive accuracy and interoceptive sensibility dimensions (Calì et al., 2015; Garfinkel et al., 2015; Leiter, 2015).

Among the limitations of our study, it is important to mention the cross-sectional design, which does not allow us to conclude whether atypical interoception may contribute to the prevalence of functional gastrointestinal symptoms. The convenience sampling used resulted in an imbalance in sex ratios and limited the generalizability of our results. Furthermore, we investigated the presence of functional gastrointestinal symptoms in a healthy population, making it essential to explore similar associations in clinical populations. Considering the concerns raised about the multimodality of interoceptive accuracy (Ferentzi, Bogdány, et al., 2018), the heartbeat perception method used in this study may not be the most appropriate method to study interoception associated with gastrointestinal sensations.

4.   Study2[2]

Our second study aimed to investigate the association between IBS-related functional gastrointestinal symptoms and symptoms of orthorexia nervosa and emotional eating in a healthy population. Based on the results for other types of eating disorders, we hypothesized that the frequency of functional gastrointestinal symptoms would be positively associated with the frequency of orthorexia nervosa symptoms and the frequency of emotional eating symptoms. In addition, along with the correlates, we aimed to identify explanatory variables of orthorexia nervosa and emotional eating. We hypothesized that the frequency of functional gastrointestinal symptoms would explain both the tendency for orthorexia nervosa and the higher levels of emotional eating. We further hypothesized that functional gastrointestinal symptoms increase the likelihood of orthorexia nervosa through health anxiety, which in turn is associated with higher emotional eating. Although the issue of gender distribution in

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[2] Gajdos, P., Román, N., Tóth-Király, I., & Rigó, A. (2021). Functional gastrointestinal symptoms and increased risk for orthorexia nervosa. Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity. https://doi.org/10.1007/s40519-021-01242-0

orthorexia nervosa is not yet clear (Strahler, 2019), both body mass index and gender may influence the development of eating behavior (Konttinen et al., 2019), so these factors were included as control variables in the model.

4.1. Methods

4.1.1. Sample and procedure

Our study is part of a consortium research supporting the joint research work of colleagues and Ph.D. students at the Department of Personality and Health Psychology of Eötvös Loránd University. The research investigated the adaptive and maladaptive correlates of attitudes toward nutrition and healthy lifestyles in a population of Hungarian young adults. The focus of the study was on eating behaviors that can be regarded as protective or risk factors for eating disorders. Using convenience sampling, we recruited individuals aged 18 years and over into our study, primarily through their university courses, supplemented by online outreach. Our study sample consisted of 644 participants, 524 (81.4%) females and 120 (18.6%) males with a mean age of 22.32 years (sd = 3.95, range 18-54). The study was approved by the Research Ethical Committee of ELTE, Eötvös Loránd University, Faculty of Education and Psychology (ethical permission number: 2018/313).

4.1.2. Measures

To measure IBS-related functional gastrointestinal symptoms, the **Rome IV Diagnostic Questionnaire for adults - Irritable Bowel Syndrome Module (R4DQ-IBS)** was used. The self-completion questionnaire is an official diagnostic tool based on the Rome IV criteria and contains a total of 86 items and six modules. The IBS module we used consists of five questions and an additional item to define different subtypes of IBS. The following criteria must be fulfilled for the diagnosis of IBS: 1) Recurrent abdominal pain 2) Pain is associated with two or more of the following criteria: related to defecation, associated with a change in the frequency of stool, associated with a change in form (appearance) of stool 3) Symptom onset at least 6 months before the diagnoses.

Symptoms of orthorexia nervosa were measured by the Hungarian version (**ORTO-11-Hu**) (Varga et al., 2014) of the **ORTO-15 questionnaire** (Donini et al., 2005). The scale assesses the attitudes toward preparing and eating food perceived as healthy. The Hungarian adaptation of the 15-item questionnaire was shortened to 11 items to improve internal consistency. The items of the questionnaire are answered on a four-point Likert scale (1- Always, 4- Never), with a score between 11 and 44. Higher scores indicate lower orthorexia, therefore, a reversed scoring was used to ease the interpretation of the results (Varga et al., 2014).

Symptoms of emotional eating were measured by the Hungarian version (Czeglédi & Urbán, 2010) of the **Three-Factor Eating Questionnaire Emotional Eating Subscale (TFEQ-EE)** (Stunkard & Messick, 1985). The six-item subscale measures the tendency to overeat associated with negative emotions and tension. The questionnaire was scored using transformed scores ranging from 0 to 100. A higher value indicates higher emotional eating (Czeglédi & Urbán, 2010).

Symptoms of health anxiety were measured by the Hungarian version (Köteles et al., 2011) of the **Short Health Anxiety Inventory (SHAI)** (Salkovskis et al., 2002). The questionnaire contains 18x4 statements, the items are related to concerns about health, a possible illness, and increased attention to bodily processes. For each item, respondents indicate their answers by choosing one statement that best describes their experiences. The scale can range from 18 to 72, with a higher value indicating increased health anxiety (Köteles et al., 2011).

4.1.3. Statistical analysis

Data were analyzed with SPSS 26 (IBM SPSS Inc., Chicago, IL) and Mplus6 (Muthén & Muthén, 2007). The Shapiro-Wilk test was used to check the condition of normal distribution. Since the condition of normal distribution was not met, to determine the correlations between variables, Spearman's rank correlation analysis was used. Path analysis, using the robust maximum-likelihood (MLR) estimation method to account for the non-normality of the data, was performed to test the proposed mediation model. Model fit evaluation was based on the Standardized Root Mean Residual (SRMR;$\leq$0.05 excellent,$\leq$0.10 adequate), Root Mean Square Error of Approximation (RMSEA;$\leq$0.06 excellent,$\leq$0.08 adequate) with its 90% confidence interval, Tucker-Lewis Index (TLI;$\geq$0.95 excellent,$\geq$0.90 adequate) and Comparative Fit Index (CFI;$\geq$0.95 excellent,$\geq$0.90 adequate). The fit of the model was perfect according to the goodness-of-fit indices given that the model was fully saturated with zero degrees of freedom.

4.2. Key results

IBS-related functional gastrointestinal symptoms showed weak, positive correlations with symptoms of orthorexia nervosa (r= 0.248; p<0.001) and emotional eating (r= 0.156; p<0.001). Functional gastrointestinal symptoms, health anxiety, BMI, and gender explained 21.6% of the variance of orthorexia symptoms, while functional gastrointestinal symptoms, orthorexia symptoms, BMI, and gender explained 23.4% of the variance of symptoms of emotional eating (Figure 2). The relationship between functional gastrointestinal symptoms and symptoms of orthorexia was partially mediated by health anxiety, and the relationship between functional gastrointestinal symptoms and symptoms of emotional eating was partially mediated by orthorexic symptoms (Table 3).

Figure 2: The model of functional gastrointestinal symptoms, health anxiety, orthorexia nervosa, emotional eating, body mass index, and gender with standardized path coefficients and explained variance of the variables
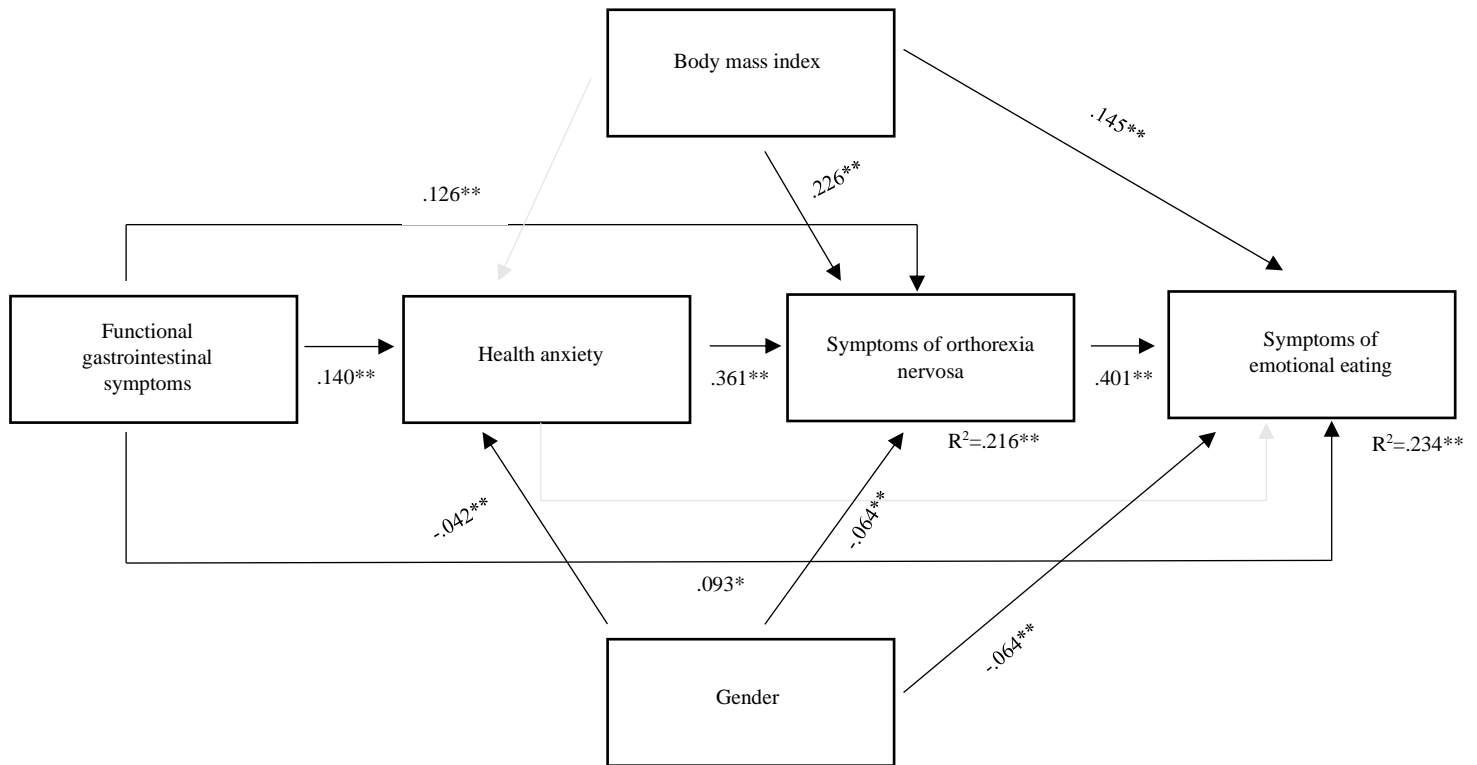
Notes: The light grey lines represent the non-significant path
**:p<=0.001 ;*:p<=0.01

Table 3: The mediation model of functional gastrointestinal symptoms, symptoms of orthorexia, and symptoms of emotional eating with total, direct, and indirect effects

	Total effect		Direct effect		Mediator	Indirect effect	
	β	95% CI	β	95% CI		β	95% CI
IBS-related symptoms -> Emotional eating	0.164**	[0.110; 0.218]	0.093**	[0.041; 0.146]	Orthorexia	0.05**	[0.031; 0.07]
					Health anxiety Orthorexia	0.02**	[0.011; 0.029]
IBS-related symptoms -> Orthorexia	0.176**	[0.123; 0.229]	0.126**	[0.074; 0.177]	Health anxiety	0.051**	[0.027; 0.074]

Notes: **: p<0.001, β standardized regression weights, 95% CI bootstrapped confidence intervals

4.3. Discussion

Our results are in line with previous studies demonstrating associations between irritable bowel syndrome and eating disorders (Melchior et al., 2020; Perkins et al., 2005; Spillebout et al., 2019) or maladaptive eating behavior (Reed et al., 2016; Soltani et al., 2019) and between somatoform disorders and symptoms of orthorexia nervosa (Barthels et al., 2019). In our study, the relationship of functional gastrointestinal symptoms with symptoms of orthorexia was partially mediated by health anxiety. This is well understood in the context of research on the relationship between health anxiety and food preoccupations. In these approaches, following a strict diet may be a coping strategy to deal with health anxiety resulting from uncertain physical symptoms (Hadjistavropoulos & Lawrence, 2007; Koven & Abry, 2015). These dynamics can

be paralleled with the eating behavior of patients with functional gastrointestinal disorders, where the aim of elimination diets is predominantly to reduce the emotional distress caused by the disease (Arigo et al., 2012), while the objective effectiveness of the diet is less relevant (Guadagnoli et al., 2019). Further, the relationship between functional gastrointestinal symptoms and symptoms of emotional eating was partially mediated by orthorexic symptoms. Accordingly, patients with functional gastrointestinal symptoms may show an increased attentional focus toward eating, leading to rigid diets and strict control of meals. This may increase the risk of developing orthorexic symptoms (Chey, 2019), while feelings of guilt regarding eating and the fear of loss of control can increase anxiety (Satherley et al., 2015), and result in episodes of emotional eating. Our findings support guidelines that emphasize the possible risks of elimination diets in irritable bowel syndrome (Chey, 2019).

Among the limitations of our study, it is important to mention the cross-sectional design, which does not permit causal inferences. Taking into account the bidirectional associations between functional gastrointestinal symptoms and maladaptive eating behavior, future studies should implement a longitudinal design to test the directionality between the variables. The convenience sampling used resulted in an imbalance in sex ratios and limited the generalizability of our results. Besides, we investigated the presence of functional gastrointestinal symptoms in a healthy population, making it essential to explore similar associations in clinical populations. Finally, we would like to draw attention to the critics of the questionnaire used to measure orthorexia nervosa (Strahler, 2019). These views question, whether the scale can distinguish between healthy eating and pathological forms of eating. To address this problem, research on orthorexia nervosa is currently focusing on the development of measurement tools (Rogoza & Donini, 2021).

5.   Study3

Our third study aimed to explore the psychological factors explaining irritable bowel syndrome symptom frequency in a clinical population. First, we aimed at testing the Hungarian version of the Rome IV. Diagnostic Questionnaire-IBS Module in a population of IBS patients. Second, we focused on the severity of irritable bowel syndrome as a biopsychosocial construct. We hypothesized that the frequency of irritable bowel syndrome symptoms would be positively correlated with the levels of trait anxiety, gastrointestinal symptom-specific anxiety, maladaptive behavioral coping, and interoceptive sensibility measured by Body Awareness-Very Short Form. We assumed a negative relationship between symptom frequency and interoceptive sensibility measured with the Trusting and Self-regulation subscales of the Multidimensional Assessment of Interoceptive Awareness. In addition, along with the correlates, we aimed to identify some of the psychological explanatory variables of irritable bowel syndrome symptom frequency. We hypothesized that altered interoceptive sensibility, increased trait anxiety, and gastrointestinal symptom-specific anxiety explain the increased prevalence of irritable bowel syndrome symptoms and that the association is partially mediated by maladaptive behavioral coping.

5.1.   Methods

5.1.1.   Sample and procedure

Participants in our clinical trial were invited to take part in a study focusing on the difficulties of living with chronic gastrointestinal symptoms, well-being, and quality of life. Our original idea was to distribute the questionnaire primarily through the collaborating healthcare institutions by contacting patients with IBS in the institutions online and on paper. However, the start of the survey in early 2020 coincided with the onset of the COVID-19 pandemic and the declaration of an emergency, which made institutional data collection impossible. As a consequence, we moved our data collection to the online platform, where we shared the questionnaire in specific forums and online communities for IBS patients. The inclusion of the Rome IV diagnostic questionnaire allowed us to subsequently screen our respondents according to official diagnostic criteria.

We included participants in our study under two conditions. The sample included patients with a medical diagnosis of irritable bowel syndrome. Those who self-diagnosed and met the criteria for irritable bowel syndrome of the Rome IV diagnostic system or the modified Rome III diagnostic system were included in the sample. A major criticism of the IBS module of the Rome IV diagnostic system is that, by restricting the criteria, it may exclude patients who, although not meeting the diagnostic criteria, would benefit from the treatment methods used in IBS. A significant difference between Rome IV and Rome III is that symptoms must have been present for at least six months for the diagnosis to be made. For the above reasons, this latter condition was not included in the inclusion criteria for our clinical sample, and in fact, the criteria set out in the Rome III criteria were applied.

From the sample, 30 participants were removed who neither had a medical diagnosis of irritable bowel syndrome nor met the criteria of the Rome III Diagnostic System. In terms of preexisting psychiatric disorder, diagnosed borderline personality disorder (2 persons), bipolar disorder (3 persons), eating disorder (3 persons), and post-traumatic stress disorder (1 person) were considered as exclusion criteria. The final sample included 337 individuals, 301 women (89.3%) and 36 men (10.7%) with a mean age of 37 years (sd = 11.06, range= 18-70).

Ethical consent was obtained from the Scientific and Research Ethics Committee of the Medical Research Council (ETT TUKEB).

5.1.2.   Measures

To measure IBS-related functional gastrointestinal symptoms, **the Rome IV Diagnostic Questionnaire for adults - Irritable Bowel Syndrome Module (R4DQ-IBS)** was used. The self-completion questionnaire is an official diagnostic tool based on the Rome IV criteria and contains a total of 86 items and six modules. The IBS module we used consists of five questions and an additional item to define different subtypes of IBS. The following criteria must be fulfilled for the diagnosis of IBS: 1) Recurrent abdominal pain 2) Pain is associated with two or more of the following criteria: related to defecation, associated with a change in the frequency of stool, associated with a change in form (appearance) of stool 3) Symptom onset at least 6 months before the diagnoses. To generate the irritable bowel syndrome symptom

frequency variable, the first four items of the module were used. The responses to the questionnaire could take a value between 4 and 42, with higher values indicating a higher symptom frequency.

Gastrointestinal symptom-specific anxiety was measured by the **Visceral Sensitivity Index (VSI)** (Labus et al., 2004). The questionnaire assesses anxiety, fear, and hypervigilance related to physical signals from the gastrointestinal tract. The 15 items of the instrument are scored on a six-point Likert scale (1=Strongly disagree, 6=Strongly agree), with a total score ranging from 15 to 90. A higher score indicates higher gastrointestinal symptom-specific anxiety.

IBS-specific maladaptive behavioral coping was measured by the **IBS-Behavioral Response Questionnaire (IBS-BRQ)** (Reme et al., 2010). The questions in the 16-item questionnaire are related to rigid, controlling, and avoidance behaviors to cope with gastrointestinal symptoms. Respondents are asked to answer on an eight-point Likert scale (1=Never, 7=Always), with a total score ranging from 0 to 182. A higher score indicates the presence of more maladaptive behavioral coping strategies.

Trait anxiety was measured by the **Spielberger Trait Anxiety Inventory (STAI-T)** (Spielberger et al., 1983; Sipos & Sipos, 1983). The 20 items of the instrument are scored on a four-point Likert scale (1=Never, 4=Always), with a total score ranging from 20 to 80. A higher score indicates higher trait anxiety.

Interoceptive sensibility was measured by the **Body Awareness-Very Short Form (BA-VSF)** (Cabrera et al., 2017). The scale was developed as a shorter version of the Body Perception Questionnaire (Porges, 1993). The 12-item questionnaire assesses subjective awareness of bodily signals related to the activity of the autonomic nervous system. The items of the questionnaire are answered on a five-point Likert scale (1- Never, 5- Always), with a score between 12 and 60 and a higher score indicating higher interoceptive sensibility (Cabrera et al., 2017).

Interoceptive sensibility was measured by the Trusting and Self-regulation subscales of the **Multidimensional Assessment of Interoceptive Awareness (MAIA)** (Mehling et al., 2012) (Ferentzi et al., 2021). The questionnaire represents a complex approach to interoceptive sensibility, integrating bodily sensation awareness with emotional and attentional processes. The 32 items of the MAIA are scored on a six-point Likert scale (0-Never, 5- Always). The items can be sorted into eight subscales (Noticing, Not distracting, Not worrying, Attention regulation, Emotional awareness, Self-regulation, Body listening, and trusting), each subscale ranging from 0 to 5. Higher scores indicate higher interoceptive sensibility (Ferentzi et al., 2021).

Based on the results of our first study in a healthy population, we decided to use the MAIA Trusting and Self-Regulation subscales to further investigate the relationship between interoceptive sensibility and irritable bowel syndrome symptom frequency in a clinical sample. The former measures the sense of trust and security associated with one's own body, while the latter examines the individual's ability to exert control over psychological tension through an attentional focus on bodily processes. We wanted to reduce the burden on our respondents by shortening the questionnaire. By averaging the two subscales in the analysis, we created an interoceptive sensibility continuous variable (Interoception Sum), which can be captured along the lines of positive attitudes toward bodily processes and one's own body.

5.1.3. Statistical analysis

Data were analyzed with SPSS 26 (IBM SPSS Inc., Chicago, IL) and Mplus6 (Muthén & Muthén, 2007). The Shapiro-Wilk test was used to check the condition of normal distribution. Since the condition of normal distribution was not met, to determine the correlations between variables, Spearman's rank correlation analysis was used. Path analysis, using the robust maximum-likelihood (MLR) estimation method to account for the non-normality of the data, was performed to test the proposed mediation model. Model fit evaluation was based on the Standardized Root Mean Residual (SRMR;≤ 0.05 excellent,≤ 0.10 adequate), Root Mean Square Error of Approximation (RMSEA;≤ 0.06 excellent,≤ 0.08 adequate) with its 90% confidence interval, Tucker-Lewis Index (TLI;≥ 0.95 excellent,≥ 0.90 adequate) and Comparative Fit Index (CFI;≥ 0.95 excellent,≥ 0.90 adequate). The fit of the model was perfect according to the goodness-of-fit indices given that the model was fully saturated with zero degrees of freedom.

5.2. Key results

5.2.1. Key descriptives

Regarding IBS-related characteristics, 209 people (62%) have a medical diagnosis of irritable bowel syndrome, with a mean time since diagnosis of 7 years (sd: 6.04, range: 1-33), 217 people (64.4%) meet the Rome IV diagnostic criteria for IBS, while 264 people (78.3%) meet the modified Rome III criteria. In the sample, 66 people (20%) have a medical diagnosis of irritable bowel syndrome only, 24 people (7.3%) meet the Rome III criteria only, 23 people (7%) have both a medical diagnosis of the disease and meet the Rome III criteria, 104 people (31.5%) meet both the Rome III and Rome IV criteria and 113 people (34.2%) have both a medical diagnosis of the disease and meet both the Rome III and Rome IV criteria. 54% of those with a medical diagnosis of the disease meet the Rome IV criteria, while 65% meet the modified Rome III diagnostic criteria. In the present study, the above groups were considered together in our explanatory model to achieve an adequate sample size, but in the future, it may be important to consider subgroups that can be separated along diagnostic criteria separately.

5.2.2. Results related to the Hungarian adaptation of the Rome IV Diagnostic Questionnaire – IBS Modul

To explore the psychometric properties of the irritable bowel syndrome module of the Rome IV Diagnostic Questionnaire, we aimed to investigate the factor structure by performing exploratory and then confirmatory factor analysis with covariates. However, this analysis was challenging in several respects. The five items in the module use a non-uniform scale. Furthermore, previous studies have not performed a factor analysis for individual modules, but have conducted similar analyses by including Likert scale items for the entire questionnaire (Clevers et al., 2018). To determine the sensitivity and specificity of the IBS module, the medical history, clinical diagnosis, and physiological indicators of patients have been mostly used (Palsson et al., 2016), which was not possible in the present study. Nevertheless, to determine convergent validity, we created a continuous variable (irritable bowel syndrome symptom frequency) from the four Likert-scale items of the five-item module and analyzed its

correlation with the IBS-specific questionnaires used in this study. The irritable bowel syndrome symptom frequency variable showed a weak correlation with the total score of IBS-BRQ (r=0.26; p<0.001), and VSI (r=0.324; p<0.001). Regarding interoceptive sensibility, IBS symptom frequency weakly correlated with the Trusting and Self-regulation subscales of the MAIA (Interoception sum) (r=-0.122; p<0.01) and did not correlate with BA-VASF total score (r=0.043; 0.459).

5.2.3. The explanatory model of irritable bowel syndrome symptom frequency

Trait anxiety, gastrointestinal symptom-specific anxiety, maladaptive behavioral coping, and interoception sum explained 9.8% in the variance of irritable bowel syndrome symptom frequency, while trait anxiety and gastrointestinal symptom-specific anxiety explained 42.9% in the variance of maladaptive behavioral coping (Figure 3). The relationship between gastrointestinal symptom-specific anxiety and irritable bowel syndrome symptom frequency was partially mediated by maladaptive behavioral coping, and the relationship between trait anxiety and maladaptive behavioral coping was partially mediated by gastrointestinal symptom-specific anxiety (Table 4).

Figure 3: The mediation model of irritable bowel syndrome symptom frequency
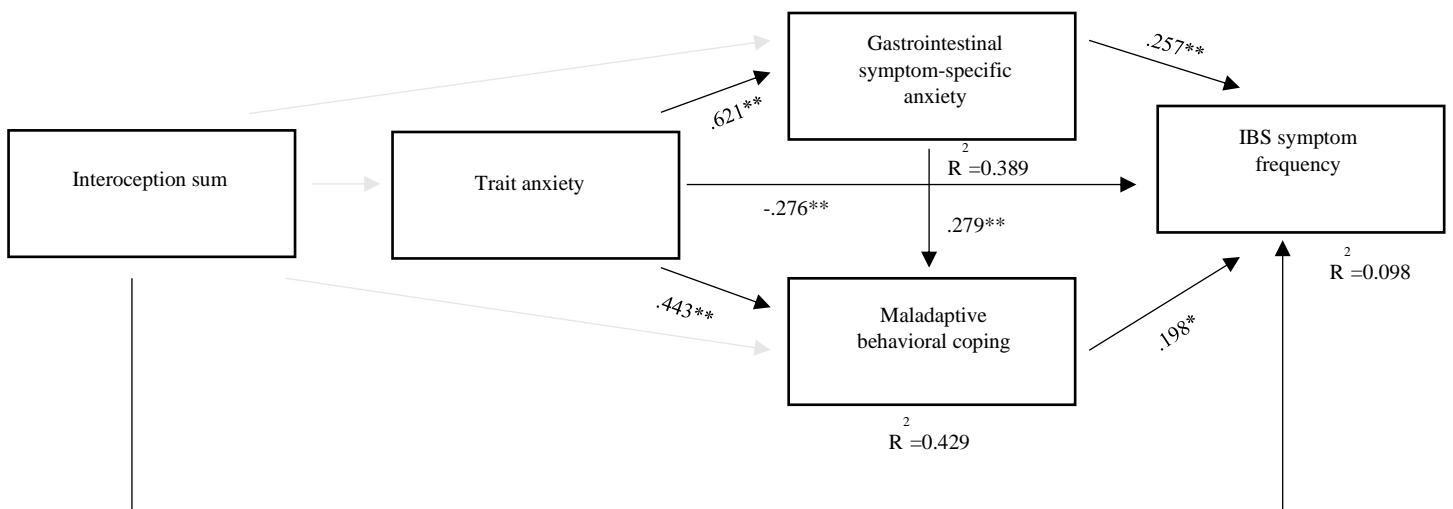
Notes: The light grey lines represent the non-significant path
**:p<=0.001 ;*:p<=0.01;+<=0.05

Table 4: The mediation model of irritable bowel syndrome symptom frequency

	Total effect		Direct effect		Mediator	Indirect effect	
	β	95% CI	β	95% CI		β	95% CI
Trait anxiety -> IBS symptom frequency	0.006	[-0.0089; 0.1]	-0.276**	[-0.411; -0.141]	Behavioral coping	0.088*	[0.033;0.143]
					Gastrointestinal symptom-specific anxiety	0.159**	[0.092;0.227]
					Gastrointestinal symptom-specific anxiety Behavioral coping	0.034+	[0.009;0.06]
Gastrointestinal symptom-specific anxiety -> IBS symptom frequency	0.312**	[0.212;0.412]	0.257**	[0.151;0.363]	Behavioral coping	0.055*	[0.018;0.093]
Trait anxiety -> Behavioral coping	0.616**	[0.552;0.68]	0.443**	[0.337;0.549]	Gastrointestinal symptom-specific anxiety	0.173**	[0.103;0.244]
Interoception sum -> IBS symptom frequency	-0.126+	[-0.22;-0.032]	-0.107+	[-0.196;-0.019]	Gastrointestinal symptom-specific anxiety	-0.012	[-0.035;0.011]
					Trait anxiety	0.006	[-0.25;0.37]
					Behavioral coping	-0.004	[-0.018-0.009]

Notes: **: $p<0.001$, *: $p<=0.01$; +: $p<=0.05$

β standardized regression weights, 95% CI bootstrapped confidence intervals

5.3. Discussion

Our results support the concept of the severity of irritable bowel syndrome as a biopsychosocial phenomenon (Drossman et al., 2011). These findings are in line with previous models suggesting that control and avoidance behavior can be regarded as coping strategies to deal with symptom-related distress (Adams & Turk, 2015). Our findings raise attention to the relevance of complex treatment protocols in the therapy of IBS. The psychological factors involved in this study may have a key importance in psychological interventions focusing on IBS patients (Henrich et al., 2015; Reme et al., 2011; Wolitzky-Taylor et al., 2012).

In our study, we also attempted to test the validity of the Rome IV Diagnostic Questionnaire-Irritable Bowel Syndrome Module, but this could not be done due to the characteristics of the scale and the lack of physiological measures. Nevertheless, the use of the questionnaire proved to be useful in understanding the Hungarian diagnostic process. In our sample, 54% of those with a medical diagnosis of the disease meet the Rome IV criteria. These are in line with international experiences demonstrating that the great majority of medical

doctors do not or not exclusively rely on the Rome criteria system when diagnosing irritable bowel syndrome (Casiday et al., 2009).

As a limitation of our study, it should be noted that the cross-sectional design does not allow us to conclude the psychological factors involved in the development of irritable bowel syndrome symptoms. Furthermore, although we were able to use the official diagnostic questionnaire of irritable bowel syndrome as inclusion criteria, our participants were recruited through Internet platforms rather than through healthcare institutions. This not only made access to medical data and medical history impossible but could be considered a biasing factor in several respects. Although irritable bowel syndrome has a much higher prevalence among women (Sperber et al., 2020), the sex ratio was nevertheless highly imbalanced in the sample. Furthermore, the sample included individuals who had a medical diagnosis of irritable bowel syndrome or met the criteria for irritable bowel syndrome of the Rome IV diagnostic system or the modified Rome III diagnostic system, but these groups were considered together for the analyses. In the future, it would be important to examine separately the groups that can be distinguished according to diagnostic criteria.

6.   Conclusion

This dissertation focused on the biopsychosocial aspects of irritable bowel syndrome by studying some of the key psychological factors. On the other hand, we considered it important to draw attention to the importance of the complex therapy of the disease in clinical practice. By testing Hungarian versions of some disease-specific measures, we wanted to contribute to the Hungarian research in this field.

Our results highlight some practical considerations that may be relevant when planning psychological interventions focused on irritable bowel syndrome patients. We consider it important to emphasize the relevance of gastrointestinal symptom-specific anxiety and illness-specific maladaptive coping behaviors. This particular pattern of anxiety has a more significant role in the maintenance of symptoms, than neuroticism or trait anxiety (Labus et al., 2004), and some authors argue that psychological interventions for IBS should be primarily aimed at modifying maladaptive coping strategies rather than reducing depression or general distress (Reme et al., 2011). Eating behavior can be also regarded as a coping strategy which is a critical issue in irritable bowel syndrome. In light of our results, we would like to emphasize that a critical part of psychological support is the assessment of eating habits, education about different maladaptive eating patterns, and screening and continuous monitoring of people following a diet. Several approaches propose the potential role of altered interoceptive dimensions in the background of functional somatic syndromes (Duschek et al., 2017; Ricciardi et al., 2016), and the possibility of interventions to normalize interoception (Merwin et al., 2010). Mehling (2016) suggests the role of the dynamic interactions between interoceptive dimensions, while Murphy (Murphy et al., 2019) emphasizes the relevance of different interoceptive profiles in the background of symptoms. This dissertation proposes the possibility of a specific interoceptive pattern in IBS patients, the assessment of which may be of great importance in the planning of psychological interventions.

According to our findings, we developed a six-week online intervention program for IBS patients, which is based on an e-learning method. The program mainly focuses on the

modification of maladaptive behavioral coping strategies and the development of adaptive behaviors. For this purpose, we have involved diary techniques and relaxation practices. Eating behavior is also a key topic during the program. Through education, self-monitoring, and stress management techniques, we wanted to contribute to an increase in perceived control and self-efficacy and a reduction in symptom-related anxiety.

The intervention is based on the novel, so-called stepped care approach, whereby a lower intensity, online intervention may represent the first stage of intervention for patients, followed by individual therapy for those who continue to present with severe symptoms. This would be very useful given the limited availability and capacity of professionals (Everitt et al., 2019). We propose to implement the program as part of an integrative treatment protocol in collaboration with health institutions. The online program would be part of the care, complemented by one or two consultation sessions with a psychologist. This protocol could also be a first step towards a biopsychosocial approach to complex care for a single health institution. This would support the clinical implementation of multidisciplinary therapy of the disease in our country, which could contribute to improving the mental and physical well-being of patients and reducing the burden on healthcare providers.

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