

# Irritable bowel syndrome and Physical activity

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Till Rebecka och Matilda

*Det är aldrig för sent att ge upp.*

Ronny Eriksson 1953-



## ABSTRACT

Irritable bowel syndrome (IBS) is a common functional gastrointestinal disorder. It is characterized by abdominal pain or discomfort associated with altered bowel habits. The symptoms of IBS limit the patients in daily life and affect their quality of life considerably.

The general aim of this PhD project was to elucidate the relationship between IBS symptoms and moderately increased physical activity in the short and long term. The other aims were to explore patients' experiences of the effects of physical activity in symptoms and of physical activity in general. A multimethod design was applied, combining physical measurements, questionnaires and qualitative patient interviews.

**Study I:** In a randomized controlled trial, the physical activity group improved their IBS symptoms at 12 weeks in comparison to the control group. A larger proportion in the control group experienced symptom deterioration. **Study II:** At long-term follow-up after 5.2 (range 3.8-6.2) years, IBS symptoms and psychological parameters improved compared with baseline. **Study III:** A qualitative content analysis on effects of physical activity revealed three themes in each area. *Gastrointestinal symptoms* covered normalizing bowel movements; experiencing changes in abdominal pain; and handling gas and bloating. *Extra-intestinal symptoms* covered flexibility, strength, and pain modulation; modulating stress level and mood; and stabilizing energy. *Quality of life* covered overcoming weaknesses; stimuli and distraction; and self-strengthening. **Study IV:** Two themes emerged in a hermeneutic analysis: *requirements of physical activity* and *capability for physical activity*. The first comprised the patients' motives for being physically active. The second theme described the possibility and resources to be physically active in everyday life.

**Conclusion:** Increased physical activity improves gastrointestinal symptoms in IBS. Physical activity is associated with improved IBS symptoms and psychological parameters in the long term. Increased physical activity is a treatment option in IBS. In order to understand the hindering and motivating factors, it is important to take into account the patient's experiences of the effects of physical activity, as well as the requirements and capabilities for physical activity.

**Keywords:** Irritable bowel syndrome; Gastrointestinal diseases; Functional disorder; Physical activity; Exercise; Physiotherapy

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# SAMMANFATTNING PÅ SVENSKA

Irritable bowel syndrome (IBS) är en vanlig funktionell mag-tarmsjukdom som kännetecknas av smärta och/eller obehag i magen i kombination med störda avföringsvanor. Symtomen vid IBS är besvärande för patienterna och begränsar deras vardagliga aktiviteter och påverkar livskvaliteten påtagligt negativt. Både farmakologiska och andra behandlingar riktar sig främst mot att minska symtomen. Tillgången till effektiva icke-farmakologiska behandlingarna är begränsad och varierar över landet och internationellt. Kunskapen om fysisk aktivitet vid IBS var begränsad och därför var syftet med den här avhandlingen att undersöka interaktionen mellan IBS och fysisk aktivitet. Det specifika syftet med avhandlingen var att undersöka hur IBS symptom påverkas av ökad fysisk aktivitet på lång och kort sikt. Andra syften var att testa fysisk aktivitet som en möjlig behandling vid IBS och att undersöka patienternas upplevelser av effekterna av fysisk aktivitet och av fysisk aktivitet i allmänhet. I avhandlingen har en multimetoddesign använts. Kvantitativa tester och frågeformulär har i avhandlingen kombinerats med kvalitativa djupintervjuer med patienterna.

**Studie I:** I en randomiserad studie förbättrades patienterna som ökade sin fysiska aktivitet efter 12 veckor med avseende på IBS-symtom jämfört med en kontrollgrupp. En större andel av patienterna i kontrollgruppen försämrades i sina IBS-symtom under studien. **Studie II:** Vid en långtidsuppföljning var patienternas IBS-symtom bättre jämfört med vid studiestart. Det fanns även förbättringar inom ångest- och depressionssymtom samt trötthet och livskvalitet. Patienterna rapporterade att de var fysiskt aktiva fler timmar per vecka vid uppföljningen än vid studiens start. Vanliga fysiska aktiviteter var promenader, motionsgymnastik och cykling. **Studie III:** En kvalitativ innehållsanalys av djupintervjuerna gav tre teman i relation till fysisk aktivitet. För varje tema framkom tre underteman. Inom temat *gastrointestinala symtom*; Att normalisera avföringsvanor, Att uppleva förändringar i smärta och Att hantera gas och uppblåsthet. *Extra intestinala symtom*; Rörlighet, styrka och smärthantering, Stresshantering och Stabilisera energi. *Livskvalitet*; Övervinna svagheter, Stimulans och distraktion och Stärkande av jaget. **Studie IV:** I en mer tolkande kvalitativ analys framkom två huvudteman. Det första temat är att patienterna har krav på vilka egenskaper fysisk aktivitet ska ha och det andra är att patienterna själva har olika förmågor att utföra fysisk aktivitet. Det första temat innehåller patienternas motivation att vara fysiskt aktiva medan det andra temat innehåller deras möjligheter och resurser för fysisk aktivitet i vardagen.

**Slutsatser:** Måttligt ökad fysisk aktivitet förbättrar magtarmsymtomen vid IBS. Fysiskt aktiva patienter har en lägre risk att drabbas av försämring jämfört med inaktiva patienter. Ökad fysisk aktivitet är associerad med förbättrade magtarmsymtom och symtom som trötthet, ångest och depression och med förbättrad livskvalitet på lång sikt. Ökad fysisk aktivitet är ett behandlingsalternativ vid IBS. Patientens upplevelse av effekterna vid fysisk aktivitet är viktiga såsom patientens krav och möjlighet till fysisk aktivitet för att förstå vad som motiverar eller hindrar patienten gällande fysisk aktivitet. Kunskap om patienternas upplevelser och resurser är nyckeln till ökad fysisk aktivitet.



# LIST OF PAPERS

This thesis is based on the following studies, which will be referred to in the text by their Roman numerals.

- I. Johannesson, E., Simrén, M., Strid, H., Bajor, A., Sadik, R. Physical activity Improves Symptoms in Irritable Bowel Syndrome: A Randomized Controlled Trial. *American Journal of Gastroenterology and Hepatology* 2011; 106: 915-22.
- II. Johannesson, E., Ringström, G., Abrahamsson, H., Sadik, R. Intervention to increase physical activity in irritable bowel syndrome shows long-term positive effects. *World Journal of Gastroenterology*; 2015; 14; 21(2):600-8.
- III. Johannesson, E., Jakobsson Ung, E., Sadik, R.\*, Ringström, G.\* Experiences of the effects of physical activity in persons with irritable bowel syndrome (IBS): a qualitative content analysis. *Submitted*.
- IV. Johannesson, E., Jakobsson Ung, E., Ringström, G.\*, Sadik, R.\* The experiences of physical activity in Irritable Bowel Syndrome: A qualitative study. *Submitted*.

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# ABBREVIATIONS

FIS	Fatigue impact scale
GI	Gastrointestinal
HAD	Hospital anxiety and depression scale
HRQOL	Health-related quality of life
IBS	Irritable bowel syndrome
IBS-SSS	Irritable bowel syndrome severity scoring system
IBS-QOL	Irritable bowel syndrome quality of life questionnaire
OATT	Oroanal transit time
QOL	Quality of life
SF-36	Short Form 36

# INTRODUCTION

Irritable bowel syndrome (IBS) is a functional bowel disorder characterized by abdominal pain or discomfort associated with altered bowel habits [1, 2]. The pathophysiology of IBS is complex and multi-factorial. IBS is the most common gastrointestinal (GI) disorder with a worldwide prevalence of 11 % [3] and many consultations to gastroenterologists are because of IBS [4]. IBS includes considerable suffering for the patients and reduced quality of life (QOL) [5]. There is not one simple over-all treatment for IBS, and the treatments available are aimed at symptom improvement [6].

Physical activity is known to have a positive effect on health [7]. Physical activity affects the body in different ways, and is often used in prevention and treatment of various disorders and conditions [8]. There are different effects on the GI system [9]. When the work with this thesis began, the knowledge of IBS and physical activity was very limited. For most patients with IBS, the availability of physical activity is higher than that of other non-pharmacological treatments.

This thesis is an attempt to acquire novel knowledge on IBS and physical activity by testing increased physical activity as an intervention in IBS and exploring the patients' experiences of physical activity. We believed that increased physical activity would advance patients with IBS towards better health. We aimed to study the effects of physical activity on the GI symptoms and extra-intestinal symptoms in IBS.

The results from this thesis can be useful to health care professionals irrespective of their profession or which health care setting they are practising in. Furthermore, the knowledge is useful to the patients themselves.

The following sections present IBS with the diagnostic criteria, the prevalence, the pathogenesis, and provides a view over previous qualitative research in IBS and a short overview over non-pharmacological treatments in IBS. Physical activity is defined and general recommendations as well as an overview of physical activity and the GI tract and views on health in general, are presented.

## IRRITABLE BOWEL SYNDROME

IBS is a functional GI disorder. It is characterized by abdominal pain or discomfort related to altered bowel habits, and often includes abdominal bloating [1, 2]. The symptoms in IBS are bothersome to the patients, limit them in their daily life [10], and affect their QOL [11]. Medical treatment is directed toward the symptoms [6], and access to non-pharmacological treatments is limited.

## DIAGNOSTIC CRITERIA AND PATHOGENESIS

IBS is diagnosed using symptom-based diagnostic criteria determined by the Rome Foundation, an organization aimed at improving the lives of people with functional GI disorders. The patients in this thesis were diagnosed according to the Rome II [12] criteria for IBS (Box 1), which were the applicable criteria when this work began in 2005. There have been two more recent updates of the criteria; Rome III [1] and Rome IV [2].

### **BOX 1. Rome II Criteria [12]**

At least 12 weeks, which need not be consecutive, in the preceding 12 months of abdominal discomfort or pain that has two of three features:

1. Relieved with defecation; and/or
2. Onset associated with a change in frequency of stool; and/or
3. Onset associated with a change in form (appearance) of stool

IBS is a heterogeneous condition, and patients experience a diverse range of symptoms. It can be subtyped into three groups: IBS with diarrhoea (IBS-D), IBS with constipation (IBS-C) and IBS with alternating bowel habits (IBS-A). Patients often report other symptoms which can support the diagnosis, such as abnormal stool frequency and/or consistency, abnormal stool passage (i.e. straining, urgency, or feeling of incomplete evacuation), and bloating [12].

The prevalence of IBS varies widely depending on the criteria used to define IBS and the context in which the prevalence is studied [13-16]. However, a meta-analysis showed the worldwide prevalence to be 11 % [3]. IBS is more

common in women than in men [17]. The pathophysiology of IBS is incompletely understood but is probably multi-factorial. Factors that have been suggested to explain IBS include visceral hypersensitivity, altered GI motility, changes in intestinal permeability, and genetic factors [18]. Low-grade intestinal inflammation has also been suggested to play a role in the pathophysiology of IBS; however, these findings are not unambiguous [19]. Changes in the microbial composition have been seen in IBS, but due to the heterogeneous nature of IBS and the complexity of the gut microbiota, the results point in different directions [20]. The central nervous system, the enteric nervous system, and the communication between these systems are believed to be important in the generation of IBS symptoms. This communication is described as a bi-directional communication between the brain and the gut, and referred to as the brain-gut axis [18].

## **COMORBIDITY AND QUALITY OF LIFE**

Patients with IBS often suffer from extra-intestinal symptoms such as musculoskeletal problems, fatigue, anxiety, and depression, and the majority of IBS patients consider dietary factors to trigger their GI symptoms [21]. Comorbidity is also more common among patients with IBS than among healthy controls [22-24]. Fibromyalgia and chronic fatigue syndrome are common comorbidities. Stress is reported to worsen IBS symptoms, and chronic stress affects both GI function and central stress response [25]. QOL is impaired when living with IBS [11, 26], and patients with IBS report a lower QOL than some patients with organic GI disorders [27]. QOL has been found to be more impaired in women than in men, but this difference is believed to be due to cultural norms rather than to differences in the disorder [28].

## **LIVING WITH IBS**

IBS has been explored qualitatively, using descriptions of patients' experiences of GI symptoms, comorbidities, impaired QOL, and interference with everyday life. A review by Håkanson [29], investigating illness-related experiences of IBS from the perspective of everyday life, healthcare, and self-care management, found that patients were challenged and limited by the unpredictable nature of IBS together with the shameful and troublesome symptoms. The author also found a lack of information and support to enable self-care management for the patients [29]. IBS patients feel constrained and dependent [30], and living with IBS has been described as "living with an

unreliable body” [10]. However, patients, strive to overcome this through different strategies in daily life [26, 31], including planning or avoiding activities, keeping to fixed routines, and avoiding various foods. Social events can be stressful and hard to handle, but support from family and friends is important to the patients. The experience of living with IBS differs between women and men due to different societal roles and expectations [32]. During health care encounters, patients have felt trivialised and disbelieved [33]. Partnership between the patient and the caregiver is important [34].

## TREATMENT OPTIONS

The primary treatment options for patients with mild IBS symptoms are giving a confident diagnosis, and offering some pathophysiological explanation together with dietary and lifestyle advices [6]. Medical treatment is directed towards the GI symptoms. In patients with more severe symptoms, this may include pharmacological treatment. In addition, patients with refractory IBS can be offered psychotropic drugs and psychological treatments such as cognitive behavioural therapy or hypnotherapy [6]. Dietary advice for patients with IBS [35] includes healthy eating, e.g. regular meals and general advice on lactose and non-starch polysaccharides. Further advice to reduce different specific types of food may be included but become more complicated for the patient to follow [36]. Structured patient education has positive effects on symptoms and on QOL [37], and patients also experience positive effects when this education is given in groups [38]. Psychological therapies have been successfully evaluated in IBS [39]. One example is cognitive behavioural therapy [40], which is designed to educate patients about the physical, cognitive, and behavioural factors connected to IBS and teach them methods to enhance self-control over stress, anxiety, and IBS symptoms [41]. Gut-directed hypnotherapy is another example, where mental and physical relaxation are offered together with hypnotic suggestions during 12 sessions [42]. Different versions of these non-pharmacological therapies have been evaluated in attempts to make them available to a larger number of patients; for example, a shorter version of patient education [43], internet-based cognitive behavioural therapy [44], and hypnotherapy administered by a nurse or in groups [45]. All these non-pharmacological therapies can be combined in different ways and they all require the patients to be active to some extent. The patients have to actively take responsibility and engage in the treatment. Access to these therapies also depends on local expertise, and can be limited due to the costs.



## PHYSICAL ACTIVITY

Physical activity is known to have a positive effect on health and is often used in prevention and treatment of various disorders and conditions [8].

### PHYSICAL ACTIVITY – DEFINITION AND GENERAL RECOMMENDATIONS

A widely used definition of physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure [46]. Caspersen [46] also argued that physical exercise should be a subcategory of physical activity, defined as physical activity which is planned, structured, repetitive, and purposive in the sense that the objective is improvement or maintenance of one or more components of physical fitness. Physical fitness is defined as, a set of attributes relating to the ability to perform physical activity [46].

There is a dose-response relationship between physical activity and general benefits for health [7]. The relationship appears to be a continuum without a lower boundary, which means any level of physical activity is positive for a person with an inactive lifestyle. The general recommendation for physical activity has previously been 30 minutes of physical activity per day at a moderate intensity; that is, the intensity of a brisk walk. This dose should be supplemented by more intense physical activity to increase or maintain cardio-respiratory fitness and muscle strength [47, 48]. Recommendations for daily activity have been updated recently; instead of 30 minutes of physical activity each day, the recommendation is now 150 minutes of moderate activity to be performed every week [8, 49].

### PHYSICAL ACTIVITY IN DISEASE

The risk of all-cause mortality is reduced in physically active persons [7] and physical activity can be used for the prevention or treatment of different conditions and disorders. In 2003 the Swedish National Institute of Public Health published a set of guidelines called *Physical activity in the Prevention and treatment of Disease* (FYSS) [50]. The main objective of FYSS is to be a knowledge base and tool for health care professionals when recommending and prescribing physical activity. FYSS describes the current evidence and recommendations for physical activity in health, both generally and for specific conditions and disorders including asthma, depression, heart failure, and

chronic back pain. One chapter discusses gastrointestinal diseases, but IBS is not mentioned. However, positive effects of physical activity have been seen in conditions associated with IBS, such as fibromyalgia [51] and depression [52]. Other studies have qualitatively explored experiences of physical activity among patients with chronic fatigue syndrome [53], chronic pain [54], and depression [55].

## **PHYSICAL ACTIVITY AND THE GI TRACT**

Physical activity and exercise affect the GI tract in different ways. During acute exertion, the blood flow shifts to the skeletal muscles performing the physical activity and the blood flow to other areas, for example the splanchnic bloodflow, is restricted [9]. Strenuous exertion can produce GI symptoms such as abdominal pain and diarrhoea, and acute exertion affects gastric emptying, motility, digestion and absorption, and secretion of hormones [48]. Two studies of healthy persons tested in an experimental found that mild physical activity increased gas transit and improved abdominal distension but not the perception of bloating [56], and that gas transit was improved in an upright body posture compared to supine [57]. There is an inverse association between physical activity and colon cancer [7, 58, 59]. The recommendation to reduce the risk of specific cancer, such as colon cancer, is 30 minutes of moderate to vigorous exercise on most days of the week [7]. Among patients with chronic constipation, regular physical activity improves defecation pattern and colonic transit [60], and increased physical activity or physical exercise are suggested lifestyle modifications [61, 62]. However, there are known negative effects on the GI tract, and some studies show GI symptoms to be associated with physical activity. In endurance athletes, heavy exercise increases transit through the GI-tract [63] and the stool frequency and consistency is affected. Triathletes and long-distance runners report GI problems such as diarrhoea, nausea and dyspepsia in relation to activity [64, 65].

In a questionnaire study, women with IBS were found to be less physically active than healthy women but physically active women with IBS reported less fatigue and fewer feelings of incomplete evacuation [66]. However, it was unclear whether IBS prevented these women from being physically active or if physical inactivity worsened their symptoms. Patients with long-term experience of living with IBS find strategies to manage symptoms in daily life, including regular exercise [31]. IBS affects activities in general, and limits everyday life [10].

## PHYSIOTHERAPY IN IBS

Physiotherapy consist of services provided by physiotherapists to individuals to develop, maintain, and restore maximum movement and functional ability throughout the lifespan [67]. If movement and function are threatened by injury or disorders, the physiotherapist can provide functional movement. This is central to what it means to be healthy [67]. Patients with IBS can therefore meet a physiotherapist when seeking health care for musculoskeletal pain or other co-morbidities [55, 68] however, the patients will not meet a physiotherapist because of their IBS or GI symptoms. Physiotherapeutic involvement in IBS treatments has been studied in patient education [37] or in body awareness therapy [69].

## ASPECTS OF HEALTH

The World Health Organization (WHO) defined health in 1946 as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” [70]. This definition includes multidimensional aspects of health such as biological, psychological, and social experiences. However, there has been a debate over this definition due to the expression “complete physical, mental and social wellbeing”, which may seem practically impossible to achieve. In the late 1970s, Antonovsky’s [71] research findings led him to look for what creates health, rather than the limitations of health, and for the causes of disease. Antonovsky named this “salutogenesis”, which is the opposite of pathogenesis. The salutogenic theory focuses on the causes of health and what makes someone maintain health. Antonovsky described health as a continuum between “total health and total unhealth”, which is more relative than the WHO definition, and every person is somewhere on the continuum all the time. Through this he excluded the dichotomy between health and disease [72]. Another part of the salutogenic framework is the ability to deal with uncertainty in life, and Antonovsky found that the experiences of coherence is important for health. In practice, a salutogenic orientation which takes a person’s diagnosis into account involves asking how that person can be helped to move toward greater health; towards “health end” of the health continuum.

The springboard for this thesis was the current evidence of positive effects of physical activity on health in general. There is no over-all treatment for IBS, and the treatments available are aimed at symptom improvement. For most patients with IBS, the availability of physical activity is higher than that of

other non-pharmacological treatments. We believed that increased physical activity would push patients with IBS towards greater health on the health continuum, and thus wanted to study any effects on the GI symptoms and/or extra-intestinal symptoms in IBS. When this work began, knowledge of IBS and physical activity was very limited.

## AIM

The general purpose of this PhD project was to elucidate the relationship between IBS symptoms and physical activity in the short and the long term. The other purpose was to assess increased physical activity as a possible treatment for IBS and to explore patients' experiences of the effects of physical activity and experiences from physical activity in general.

Specific aims were:

- I. To test the hypothesis that increased physical activity decreases the severity of IBS symptoms and assess the impact of an intervention to increase physical activity on QOL, psychological symptoms, fatigue, and oroanal transit time in patients with IBS.
- II. To assess the long-term effects of the previous intervention to increase physical activity in patients with IBS.
- III. To explore IBS patients' experiences of the effects of physical activity.
- IV. To explore IBS patients' general experiences of physical activity.

# METHODS

## METHODOLOGY

This thesis strives to provide a novel understanding of the relation between IBS and physical activity. Diverse methodologies were used to explore this field of research and broaden the understanding. A mix of quantitative and qualitative methods gave the possibility to address the research questions in suitable ways and enhance clinical implementation of the findings. The different approaches also allowed for progress of the understanding, validation of the results, and the development of further research questions. The qualitative studies can help us to interpret and use the quantitative findings in clinical practice.

An overview of the study designs, data, and analytical methods is presented in Table 1. The general inclusion criteria were a diagnosis of IBS and the ability to increase level of physical activity; the specific inclusion/exclusion criteria for each study are presented in Table 2. Studies I and II were based on quantitative measures and patient-reported outcome measures (PROMs) gathered via questionnaires. Studies III and IV were based on deep interviews with patients, aiming to explore the patients' experiences of physical activity. Through the progress of this thesis, it was important to define the context in which the research questions were developed and to consider the pre-understanding of the researchers.

*Table 1. Overview of the study designs, data and analyses*

Study	Patients	Design	Data	Data analysis
I	102 patients: consecutive sampling	Quantitative: randomized controlled trial	Questionnaires and physical measurements	Paired and unpaired <i>t</i> -tests, Wilcoxon's signed rank test, Mann-Whitney <i>U</i> -test, McNemar's exact test
II	39 patients: recruited from study I	Quantitative: long-term follow-up	Questionnaires and physical measurements	Paired <i>t</i> -test, Wilcoxon's signed rank test.
III	16 patients: purposeful sample	Qualitative	Individual deep interviews	Deductive and inductive content analysis,
IV	16 patients: purposeful sample	Qualitative	Individual deep interviews	Hermeneutic method

Table 2. Overview of patient characteristics

Study	Inclusion criteria	Exclusion criteria	Age in years, range (median)	Number of patients included (female)	Number of patients completing the study (female)	Other characteristics
<b>I</b>	IBS diagnosed by gastroenterologist according to Rome II, ability to increase level of physical activity	Pregnancy, organic GI diseases, respiratory or cardiac disease	18-77 (38.5)	102 (81)	75 (55)	22 IBS-D, 20 IBS-C, 33 IBS-A 34 patients had physically demanding work
<b>II</b>	Baseline data from Study I, participating in the intervention in Study I	Pregnancy, organic GI diseases, other organic disease hindering physical activity	28-61 (45)	39 (32)	39 (32)	17 patients had physically demanding work
<b>III and IV</b>	Participating in the intervention in Study I	Organic GI diseases	31-78 (52)	16 (10)	15 (10)	Family: 12 married/cohabiting, 9 living with children at home. Education: 2 elementary school, 7 high school, 6 university education.

The German philosopher Hans-George Gadamer (1900-2002) aimed to uncover the nature of human understanding, and through this he developed the field of hermeneutics. According to Gadamer [73], all understanding takes place through interpretation and the understanding develops through a circular movement between 1) the horizon of the interpreter and the horizon of what is to be understood and 2) the parts of what is to be interpreted and the meaning of the whole. This circular movement is an iterative process with the aim of understanding through interpretation, and is often referred to as the hermeneutic circle. The interpretation produces a “fusion of horizons” between the interpreter’s horizon and the horizon of what is studied. In the present work, the patients’ experiences of physical activity were understood through the movement between the patients’ experiences and the researchers’ pre-understanding, and through the movement between the whole and the parts of the data material.

## DATA COLLECTION AND PARTICIPANTS

All the patients included in this thesis were diagnosed with IBS by gastroenterologists according to the Rome II criteria [12]. The patients were referred from gastroenterology units at community hospitals and the university hospital in Västra Götaland County, Sweden. The referring gastroenterologists had been informed of the study and were asked to refer the patients they considered suitable, regardless of symptom burden or subtype of IBS. An overview of the participant characteristics is given in Table 2.

The majority of visits in all the studies were conducted at the gastroenterology outpatient clinic. A few visits in the long-term follow-up and interviews were conducted at a primary care rehabilitation unit convenient to the patients. The patient chose the location of the interview in Studies III and IV; one interview was conducted at the patient’s place of work and the others at the abovementioned units.



## QUANTITATIVE APPROACHES (STUDIES I AND II)

### QUESTIONNAIRES

*The IBS Severity Scoring System (IBS-SSS)* [74] consists of visual analogue scales, and is divided into two subscales: an overall IBS score and an extra-colonic score. The IBS score contains questions regarding pain severity, pain frequency, abdominal bloating, bowel habit dissatisfaction, and life interference. The extra-colonic score contains questions regarding vomiting, gas, belching, satiety, headache, fatigue, musculoskeletal pain, heartburn, dysuria, and urgency. Scores on each subscale range from 0 to 500, with higher scores meaning more severe symptoms. A change of 50 in the IBS-score is considered to reflect a clinical improvement or deterioration [74].

*The IBS Quality of Life questionnaire (IBS-QOL)* is a disease-specific instrument measuring health-related quality of life (HRQOL). It consists of 30 items that measure nine QOL dimensions: emotional functioning, mental health, sleep, energy, physical functioning, diet, social role, physical role, and sexual relations. For each subscale the scores are transformed to a range from 0 to 100, with 100 representing the best possible disease-specific QOL [75].

*Short Form 36 (SF-36)* measures general HRQOL and includes 36 items divided into eight subscales: physical functioning, physical role, bodily pain, general health perceptions, vitality, social functioning, emotional role, and mental health. The raw scores for each subscale are transformed into a scale from 0 to 100, with 100 representing the best possible HRQOL [76, 77].

*The Hospital Anxiety and Depression scale (HAD)* is a reliable instrument that was developed for medical outpatients [78]. It includes two subscales, anxiety and depression, each consisting of seven items answered on a 4-point Likert scale (0-3). Scores on each subscale range from 0 to 21, with a high score indicating more severe symptoms. Cut-off scores can be used to identify cases of clinically significant mood disorders for both subscales. A score up to 7 indicates no mood disorder, scores of 8-10 show a borderline mood disorder, and a score above 10 indicates a case of mood disorder. The HAD scale has been found valid for assessing severity of anxiety and depression in different non-psychiatric patient groups as well as in the general population [79]. HAD was used in Studies I and II.

*The Fatigue Impact Scale* (FIS) was initially developed for patients with chronic fatigue syndrome [80], but has been used in studies in previous studies among IBS patients [27]. The scale consists of 40 questions divided into three subscales: physical functioning (10 items), cognitive functioning (10 items), and psychosocial functioning (20 items). Each item consists of a statement, regarding which the patients are asked to rate extent to which fatigue has caused problems for them, during the previous month on a scale of 0 (“no problem”) to 4 (“extreme problem”) [80].

## **BOWEL MOVEMENTS AND OROANAL TRANSIT TIME**

The patients used the Bristol stool form scale [81] to record the consistency of all their bowel movements during the week before the visits in Studies I and II. This scale ranges from hard and lumpy stools (types 1 and 2) to loose and watery stools (type 6 and 7).

Oroanal transit time (OATT) was assessed by an established method with radiopaque markers [82] in Study I. The patients ingested 10 radiopaque markers daily for the six days before the visit (on day seven). During the visit, the radiopaque markers were counted by fluoroscopy. The OATT was calculated by dividing the number of retained markers by the number of markers ingested per day.

## **OXYGEN UPTAKE, PHYSICAL ACTIVITY, AND WEIGHT**

Cardio-respiratory fitness was measured via maximal oxygen uptake, estimated from the heart rate response to submaximal work on an ergometer cycle according to the Åstrand-Rhyming nomogram [83, 84]. This way of estimating the maximal oxygen uptake is both convenient for the patients and valid for use in the clinic and in research [85]. The maximal oxygen uptake is presented as the volume of oxygen which can be transported in the body at a given time (l/minute, Study I) or as the volume of oxygen transported in the body at a given time per body weight (ml/minute/kg, Study II). A training diary was used to register physical activity during the week before the visits. The patients recorded the type, duration and intensity of the activity. The intensity was rated on the Borg rating of perceived exertion scale [86], which ranges from 6 (no exertion at all) to 20 (maximal exertion). The training diaries were

used to motivate the patients in Study I, and the data from the training diaries were analysed in Study II. Weight was measured to the nearest 0.1 kg.

## **BASELINE AND FOLLOW-UP VISITS, AND INTERVENTION TO INCREASE PHYSICAL ACTIVITY (STUDIES I AND II)**

Patients in Study I were randomized to the control group or the physical activity group. To allocate an equal number of patients to both groups, randomization was carried out in blocks of four patients. Two out of four were randomized to the physical activity group. Both groups came for a baseline visit during which all the measurements and questionnaires were completed. The control group was given instructions to maintain their lifestyle for 12 weeks, whereas the intervention group were instructed to increase their level of physical activity for 12 weeks. The control group had regular supportive telephone contact with a physiotherapist once a month. The physical activity group had regular telephone contact once or twice a month with a physiotherapist who gave individual advice to increase the level of physical activity. The patients were encouraged by being asked to complete a training diary and to perform an extra cycle test after 6 weeks. After 12 weeks, all the tests and questionnaires were repeated.

The advice followed the general recommendations for physical activity in the first edition of FYSS [50], and was aimed at moderately increasing the level of physical activity. To increase the cardiorespiratory fitness the recommendation is to be physically active three to five days per week, for 20-60 minutes of physical activity on a moderate-to-vigorous level (40-85 % of maximal oxygen uptake). Moderate-to-vigorous entails becoming breathless and sweaty and corresponds to a perceived exertion of 12-16 on Borg's Scale [86]. The patients were given individual advice depending on their previous experiences of physical activity and their current level of physical activity. The activities suggested could be any physical activity fulfilling the abovementioned criteria depending on individual factors such as time, opportunities, or costs.

In study II the patients came for one visit during which all the measurements and questionnaires from Study I were repeated except from the oroanal transit time measurement.

## STATISTICAL METHODS (STUDIES I AND II)

The primary end point in Study I was the difference between the control group and the physical activity group in the change of IBS-SSS score between base line and 12 weeks. The secondary end points were differences between the groups regarding changes in the questionnaires assessing QOL, anxiety, depression, fatigue, as well as changes in weight, oxygen uptake, OATT and Bristol Stool Form Scale.

Within-group comparisons were performed for exploratory reasons. Normally-distributed data were analysed with paired and unpaired *t*-tests. The *t*-test was used only for oxygen uptake. The results from the questionnaires were considered as ordinal data, and hence analysed using Wilcoxon's signed rank test and the Mann-Whitney *U*-test. McNemar's exact test was used to assess the differences between the physical activity group and the control group regarding the proportion of patients with decreased or increased IBS symptoms.

The primary endpoint in Study II was change in IBS-SSS from baseline to follow-up. The secondary endpoints were changes in questionnaires assessing QOL, anxiety, depression, fatigue, and bowel movements, as well as changes in oxygen uptake, weight, and duration of physical activity reported in the training diary. As an exploratory endpoint, changes in the abovementioned parameters in the period between the end of the intervention and the follow-up visit were assessed. A paired *t*-test was only used for oxygen uptake and body weight. The results from the questionnaires were considered as ordinal data, and analysed using Wilcoxon's signed rank test.

The results are presented as medians and 10th and 90th percentile. Significance was accepted at the 5% level ( $<0.05$ ). Statistical analyses were performed using versions 14.0 (Study I) and SPSS version 20 (Study II) of the SPSS software package (SPSS, IBM; Corporation, NY).

## QUALITATIVE APPROACHES (STUDIES III AND IV)

To gain a deeper understanding of the phenomenon of IBS and physical activity, the patients' experiences of physical activity and its effects were explored with qualitative methods. Two different qualitative approaches were chosen based on the nature of the research questions of the respective studies and the character of the data. As described previously, according to Gadamer, interpretation is necessary for all understanding [73].

### HERMENEUTIC APPROACH

A hermeneutic approach was considered suitable for the data collection in Studies III and IV and the analysis in Study IV, and so we applied the work of Gadamer [73]. Gadamer did not offer a methodology or a method, but rather an insight into how to develop an understanding of the data to be studied. We therefore used the Gadamerian-based research method and guide for researchers in caring sciences developed by Fleming et al. [87]. This guide structures Gadamer's philosophical work into five steps:

- 1) Deciding on a research question
- 2) Identifying pre-understandings
- 3) Gaining understanding through dialogue with participants
- 4) Gaining understanding through dialogue with text
- 5) Establishing trustworthiness

The first three steps of Fleming's guide were used in designing Studies III and IV, and steps four and five were used in the analysis in Study IV. The authors discussed their pre-understandings between themselves in order to enhance the interviews and the understanding of the participants' experiences. The team of researchers consisted a physiotherapist, two registered nurses, and a gastroenterologist. Our different experiences from research and from clinical practice allowed for reflexivity. The third step in the guide was used during the interviews, where the researcher performing the interviews was aware of the pre-understanding and of the context in which the interviews were made.

## **INTERVIEWS**

The interviews were unstructured, and were started by asking “Can you tell me what physical activity means to you?” This starting question was followed by the questions “Can you tell me if there is anything strengthening or motivating in being physically active?” and “Can you tell me if there are things hindering or stopping you from being physically active?” The interviewer encouraged the participants to exemplify and elaborate, and used follow-up questions and sometimes repeated what the participant had said, in order to probe the phenomenon. During the interview, the interviewer summarized the patient’s view to ensure the understanding was correct and to enable a deeper understanding.

The participants chose the location for the interview. All interviews were recorded, and after each interview had taken place the interviewer took notes on the interviewing situation. After the first two interviews had been conducted, the interviewer and one of the co-authors listened through the recording of the interviews to enhance the interviewing technique. The interviews lasted between 30 to 80 minutes and were transcribed verbatim.

## **CONTENT ANALYSIS (STUDY III)**

The authors first read the transcriptions thoroughly in order to grasp a sense of the whole. The results from this first reading were combined with the results from Study I in order to structure the deductive content analysis [88]. Three questions were formed: 1) What does the effect of physical activity on GI symptoms mean to the patients, and how do the patients control their symptoms by using physical activity? 2) What does physical activity mean to the patients in relation to extra-intestinal symptoms? and 3) What does physical activity mean to the patients in relation to QOL?

Each transcript was then systematically read with the three questions in mind. Exact statements were derived from the transcripts, each containing aspects related to each other by content and context. These exact statements constituted the meaning units. The meaning units were condensed by shortening the text, and these units were then labelled with codes to capture the meaning. This condensing and coding procedure maintained the meaning of the text while allowing the data to be seen in a new way [89]. The meaning units extracted through questions 1) and 2) allowed for the analysis to be manifest, but the answers to question 3) needed to include interpretations of latent content in the analysis due to the more abstract character of the question.

## **HERMENEUTIC ANALYSIS (STUDY IV)**

The data were analysed by continuing to follow steps four and five of the guide mentioned above [87]. The researchers read the transcriptions individually and repeatedly in order to develop an understanding of each patient's experience and a general understanding of the whole. The texts were then read systematically to identify meanings and themes. The researchers met and discussed the themes which emerged. During the discussions, the authors' pre-understandings were challenged due to their different backgrounds. The accuracy of the identified themes was related to the meaning of the whole text by reading the transcriptions several times and thereby verifying the themes in the hermeneutic circle. The expanded understanding of the whole text widened the meaning of the parts [87].

## ETHICS

The research conducted in this thesis was approved by the Regional Ethical Review Board in Gothenburg and the radiation safety committee of the University of Gothenburg. Each patient was given written and verbal information about the studies and had the opportunity to ask questions about this information. In accordance with the 2003 Declaration of Helsinki, the patients were also informed they could withdraw at any time without influencing their future care. Following this, the patients gave their consent to participate.

In the first application to the ethical review board, the intervention in study I was planned to last for one year of increased physical activity, with the control group being offered the intervention after one year. The ethical board denied this with reference to the long wait for the control group to take part in the intervention, and so this was not possible to study differences in long-term effects between an intervention group and a control group.

Some risks for the patients were identified when designing the studies. One example is the choice to estimate maximal oxygen from a submaximal ergometer cycle test. Measuring maximal oxygen uptake with a direct test is extremely demanding for the person being tested, and there are serious ethical and practical concerns with such testing in patients. Another issue was the exposure to radiation in the OATT measurement. We decided not to perform this measurement in Study II, after analysing the results from Study I and weighing the expected scientific gain against the slight exposure to radiation.

In Studies II-IV the patients were able to influence the location of the visit to some extent, in order to be as convenient as possible to them. Moreover, given the possibility of the patients being bothered by unpleasant thoughts or memories when completing questionnaires and/or during the interviews, health care professionals were available to support the patients after completing the questionnaires, and the unstructured interviews allowed the patients to choose which subjects to leave out and which to explore further.



## RESULTS

The main results for each study are presented separately below, followed by a synthesis of the results (Studies I-IV), and a synthesis of the intervention in Study I and the results from Study IV. The syntheses are presented together with quotations from the interviews in Studies III and IV.

### STUDY I

The physical activity group improved significantly in both IBS score (Figure 1,  $P=0.001$ ) and extra-colonic score (184 [98 and 315] vs. 161 [56 and 267]) between baseline and 12 weeks ( $P=0.013$ ). There was no significant change in the control group in IBS score (Figure 1) or in extra-colonic score (185 [78 and 296] vs. 175 [78 and 337],  $P=NS$ ). There was a significant difference in the improvement in overall IBS score between the physical activity group and the control group (-51 [-130 and 49] vs. -5 [-101 and 118],  $P=0.003$ ), but no significant difference regarding the extra-colonic score (-36 [-99 and 52] vs. (-19 [-70 and 113],  $P=NS$ ).

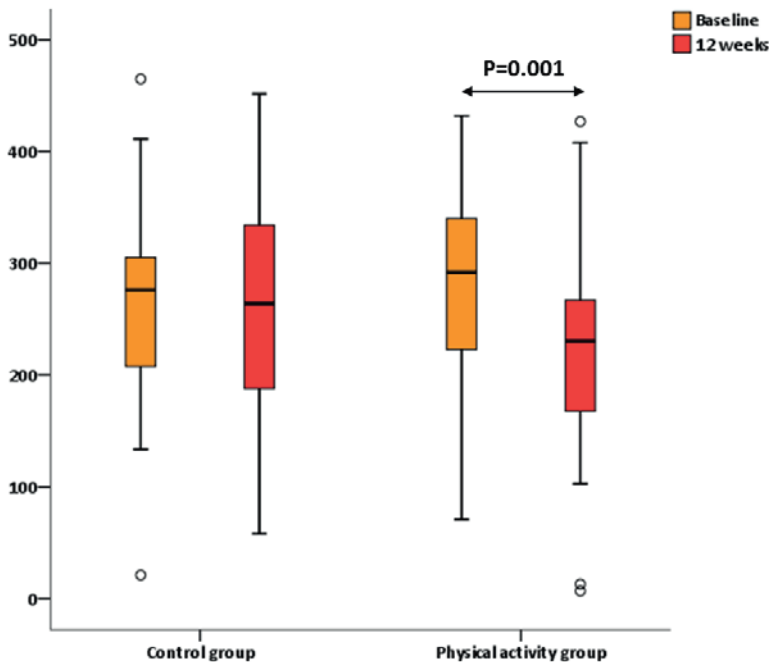


Figure 1. IBS Severity Scoring System, IBS score, in the control group and the physical activity group, at baseline and after 12 weeks.

There was a significantly larger proportion of patients with clinically significant increased IBS symptoms (>50 score change) in the control group (23 %) compared with the physical activity group (8 %) ( $P<0.01$ ). The proportion of patients with a clinically significant decrease in IBS symptoms was 43 % in the physical activity group and 26 % in the control group ( $P=0.07$ ). There was a significant difference between the groups in the improvement in disease-specific QOL in two dimensions, namely physical functioning and physical role. In physical functioning, the change was 16 (-2 and 35) in the physical activity group and 0 (-27 and 30) in the control group, ( $P=0.015$ ), while for physical role the change was 6 (-14 and 50) in the physical activity group and 0 (-39 and 31) in the control group ( $P=0.032$ ). Oxygen uptake increased significantly within the physical activity group, from 2.36 (1.51 and 3.23) to 2.47 (1.80 and 3.28) litres per minute ( $P=0.02$ ), while there were no significant change in the control group (2.24 [1.41 and 3.20] to 2.20 [1.65 and 3.22] litres per minute). The three most commonly reported activities were walking, cycling, and swimming. There were no significant changes in health related QOL, anxiety and depression, fatigue, body weight, OATT, reported bowel movements, or stool consistency.

## STUDY II

The median follow-up time was 5.2 years, with a range of 3.8-6.2 years. IBS score improved significantly, as illustrated in Figure 2; 54% of the patients had a clinically significant improvement. Extra-colonic score showed no significant changes.

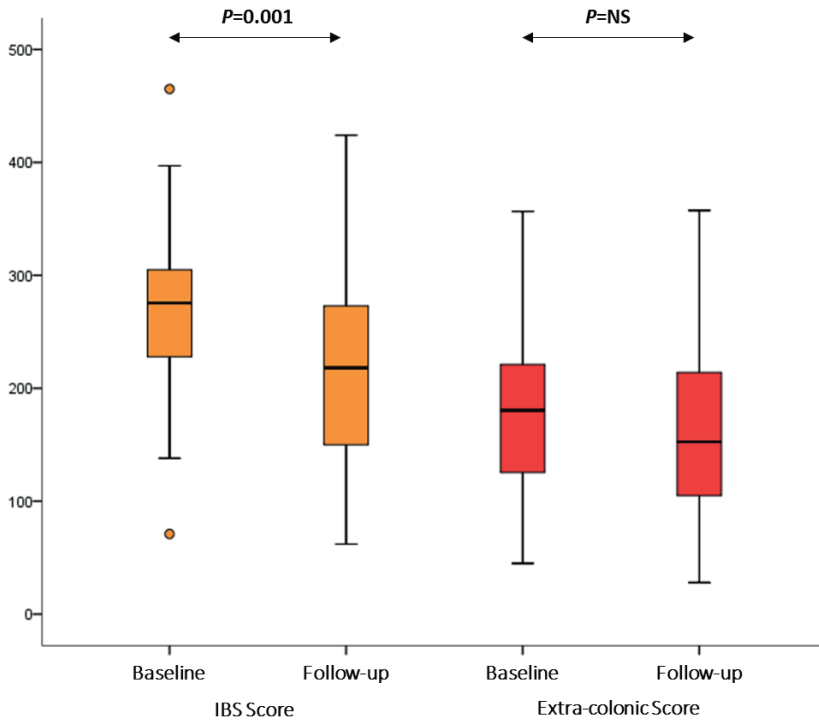


Figure 2. IBS Severity Scoring System, IBS score and Extra-colonic score, at baseline and at follow-up.

Stool consistency had become firmer on the Bristol Stool Form Scale (4.5 [2.3-5.8] vs. 3.8 [1.5-4.8],  $P=0.004$ ), there was no significant change in stool frequency. The levels of anxiety and depression in HADS were low at baseline, and were reduced further at follow-up (depression: 4 [1-10] vs. 2[0-6]; anxiety: 7 [3-13] vs. 4.5 [1-11]). There were significant improvements in five of the nine dimensions in IBS-QOL (Table 3). Improved quality of life was also demonstrated on three of the eight SF-36 subscales: general health perceptions, emotional role, and mental health (Table 4).

*Table 3. IBS Quality of Life at baseline and at follow-up*

<b>Dimension</b>	<b>Baseline</b> N=39	<b>Follow-up</b> N=38	<b>P value</b>
<b>Emotional functioning</b>	56(31-88)	69(44-100)	0.001
<b>Mental health</b>	80(50-100)	90(45-100)	NS
<b>Sleep</b>	67(33-100)	83(42-100)	0.008
<b>Energy</b>	50(38-88)	75(50-100)	0.005
<b>Physical functioning</b>	67(33-100)	92(49-100)	0.002
<b>Diet</b>	60(47-87)	73(40-93)	NS
<b>Social role</b>	69(43-94)	81(50-100)	0.009
<b>Physical Role</b>	69(31-100)	81(38-100)	NS
<b>Sexual relations</b>	60(18-80)	60(20-80)	NS

*Table 4. Short Form 36 at baseline and at follow-up*

<b>Subscale</b>	<b>Baseline</b> N=39	<b>Follow-up</b> N=39	<b>P value</b>
<b>Physical functioning</b>	90(65-100)	95(64-100)	NS
<b>Physical role</b>	50(0-100)	100(0-100)	NS
<b>Bodily pain</b>	51(31-84)	51(22-100)	NS
<b>General health perceptions</b>	54(25-83)	67(32-97)	0.006
<b>Vitality</b>	45(20-80)	55(25-85)	NS
<b>Social functioning</b>	75(38-100)	75(49-100)	NS
<b>Emotional role</b>	67(0-100)	100(0-100)	0.027
<b>Mental health</b>	72(32-92)	74(52-96)	0.016

Fatigue was significantly reduced according to two of the three subscales on the FIS. Physical subscale scores were 12 (2.8-29.4) at baseline versus 7 (0-28) at follow-up ( $P=0.006$ ) and cognitive subscale scores were 15 (2.8-34.4) at baseline versus 10 (0-29.6) at follow-up ( $P=0.016$ ). There was no change on the psychosocial subscale. There was no significant difference in oxygen uptake between baseline (31.8 [19.7-45.8] ml/min per kg) and follow-up (34.6 [19.0-54.6] ml/min per kg). Patients reported 3.2 (0.0-10.0) h of physical activity during the week before the baseline visit and 5.2 (0.0-15.0) h during the week before the follow-up visit, ( $P=0.019$ ). Intensity on the Borg scale ranged from 9 (very light exertion) to 18 (very hard). The three most commonly reported activities were walking, aerobics, and cycling. Body weight had increased significantly, from 66.6 (53.7-97.9) kg at baseline to 73.3 (52.6-95.7) kg at follow-up ( $P=0.037$ ).

Figure 3 includes the data from the end of the intervention and further illustrates the patients' progress of symptoms. There was no significant change between the end of intervention and the follow-up.

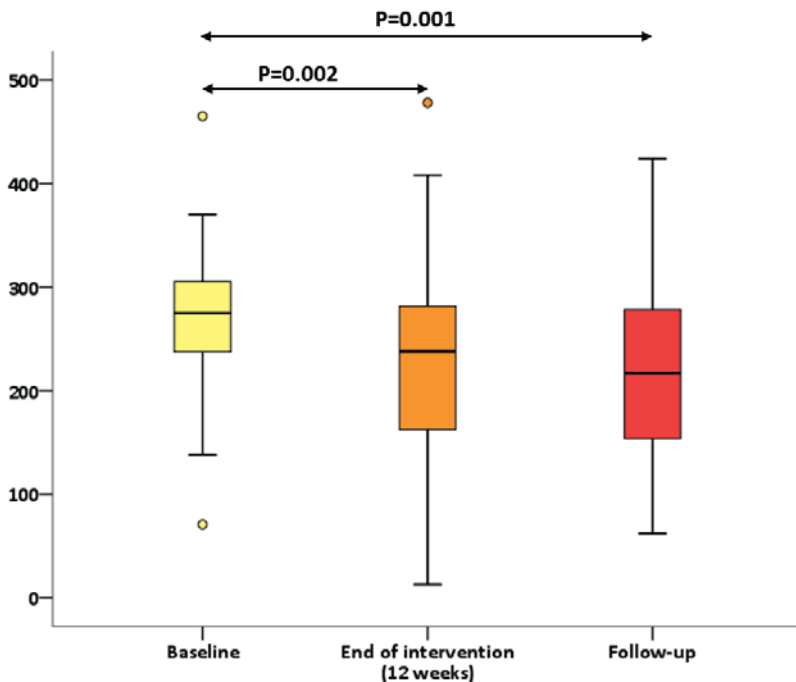


Figure 3. IBS Severity Scoring System, IBS score, at baseline Study I ( $N=39$ ), at the end of intervention ( $N=33$ ), and at follow-up ( $N=39$ ). The median follow-up time was 5.2 (range 3.8-6.2) years.

## STUDY III

Study III revealed a total of nine subthemes, three corresponding to each question in the deductive analysis, (Figure 4).

<b>Patients' experiences of effects of physical activity in relation to IBS</b>		
<b>Gastrointestinal symptoms</b>	<b>Extra-intestinal symptoms</b>	<b>Quality of life</b>
Normalizing bowel movements	Flexibility, strength, and pain modulation	Overcoming weaknesses
Experiencing changes in abdominal pain	Modulating stress level and mood	Stimuli and distraction
Handling gas and bloating	Stabilizing energy	Self-strengthening

*Figure 4. Patients' experiences of effects of physical activity in relation to IBS, themes and sub-themes.*

In relation to GI symptoms, the patients discussed how physical activity affected these symptoms and how they used physical activity to normalize and control their symptoms. They shared their experiences of general effects on GI symptoms; as one woman said, “... *getting moving certainly makes your tummy feel better.*” The effects on GI symptoms fell into three subthemes: 1) normalizing bowel movements, 2) experiencing changes in abdominal pain, and 3) handling gas and bloating. Within these three subthemes, the patients described how they “took control” of their bowel habits and made their bowels “work”. When experiencing increased GI problems, they sometimes used physical activity in an attempt to improve their symptoms.

Extra-intestinal symptoms were also affected by physical activity. The patients described how they experienced a general bodily wellbeing as well as improved mood and energy in relation to physical activity. This wellbeing was connected both to physical experiences, and to more psychological

impressions. Three subthemes emerged: 1) flexibility, strength, and pain modulation, 2) modulating stress level and mood, and 3) stabilizing energy. Within the subthemes, the patients discussed the connection between the more concrete bodily feeling of wellbeing and the more abstract feeling of psychological wellbeing, and how they used their knowledge of this in relation to physical activity.

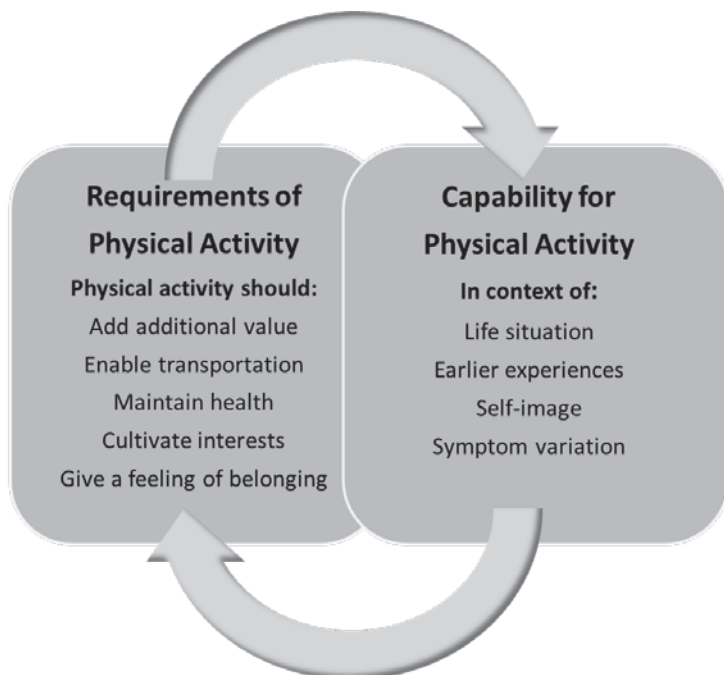
In terms of QOL, the patients discussed their perspectives on physical activity as giving them achievements, being pleasurable, and feeling a strengthening of the self. Three subthemes emerged from these discussions: 1) overcoming weaknesses, 2) stimuli and distraction, and 3) self-strengthening. The patients shared their experiences of managing and handling symptoms in relation to physical activity, and reported an improved wellbeing connected to QOL. This connection consisted of the patients' perspectives on physical activity as giving them achievements, being pleasurable, and strengthening the self.

## STUDY IV

Two themes emerged from the data, each affecting the other reciprocally: requirements of physical activity and capability for physical activity (Figure 5). The first of these consisted of five subthemes covering how the physical activity should be in order to feel good to the patients and give them enjoyment. The second consisted of four subthemes describing the possibility and resources to be physically active in everyday life.

The qualities of physical activity required by the patients comprised their motives and reasons to be physically active. The patients expressed that physical activity should add additional value, enable transportation, maintain health, cultivate interests, and give a feeling of belonging. If the patients did not enjoy the activity, they altered it by adding or removing something and they also defined activities in daily life which they considered physically active.

Irrespective of which requirements for physical activity the patients described, they handled the physical activity consciously and made active choices to adjust their physical activity in terms of type, intensity and amount. The capability for physical activity was found to occur within four subthemes: life situation, earlier experiences, self-image, and symptom variation. These subthemes affected the patients' capability, while at the same time their capability mutually affected the four subthemes.



*Figure 5. The relation between requirements of and capability for physical activity, in patients with IBS: themes and sub-themes.*

## SYNTHESIS

One of the patients' requirements was that physical activity should maintain health (Study IV). The patients seemed to follow different social norms of how physical activity should be performed in order to maintain health. The patients also felt that an experience of wellbeing from being physically active was important. There was an ambiguity towards following one's own experience or following advice from others. One patient (Study IV) discussed walking despite the low intensity:

*"I guess I feel better when I'm outside and getting some fresh air when I get moving. It's really pretty gentle exercise but I think it makes me feel good anyway. Walking makes my gut feel better, too – it really does."*



The patients used their earlier experiences of physical activity to choose the level or type of physical activity, and they modulated the dose of physical activity they needed to handle their symptoms. One man (Study IV) stated:

*“Yes, if I stick to this level of physical activity. Then life becomes pretty easy. If I don’t do it, it’ll get me at both ends – I’ll become more tired and unable to cope. No, you have to get moving. [...] Yes, then you have to keep going to the toilet and stuff all the time.”*

Physical activity was found to improve the GI symptoms in IBS (Study I) and is associated with improved GI symptoms in the long term (Study II). The patients described positive experiences of physical activity on GI symptoms and actively used physical activity to reduce their symptoms (Studies III and IV). Simultaneously, the patients described how the symptom variation affected their level of physical activity; sometimes they had to refrain from physical activities (Studies III and IV). One man (Study IV) said:

*“... I’ve learnt that if I exercise, and especially when I do it regularly, I feel so much better. And my belly kind of sorts itself out. Everything slows down and you get firmer stools and all kinds of good effects.”*

Some patients had found that the passage of gas was affected by physical activity, and that inactivity led to increased feelings of bloating, sometimes combined with pain (Study III). Some avoided certain activities in preference for walking, which could facilitate flatulence (Study IV). The patients experienced problems with gas, but physical activity facilitated flatulence and passage of gas, which relieved the bloating and some of the pain. One patient (Study III) described this as following:

*“Gas...um...you feel bloated, or your stomach grumbles, but it hurts...um...It’s mainly that. But once I get moving, it goes away.”*

A positive effect from increased physical activity was seen in the IBS score, including abdominal bloating and abdominal pain (Studies I and II). The patients explained this by the physiological features mentioned above, and by the changes experienced in stool frequency and stool consistency. The patients described a conscious approach to abdominal pain; they knew which kind of pain could be relieved by physical activity, and when to avoid physical activity in order to avoid increasing the pain (Studies III and IV).

The patients stated that physical activity could lead to a change in stool frequency, which could be experienced as either positive or negative,

depending on the starting point and the direction of the change (Study IV). However, the quantitative studies showed no effects on OATT or stool frequency (Studies I and II). A small change was detected in stool consistency (Study II). Physical activity did have an effect on the experienced quality of the passage of stool, as described by one woman (Study III):

*“Yes, it means I have better, more frequent bowel movements, and then I feel better.”*

While the patients described how they used physical activity to normalize their bowel movements (Study III), the bowel movements also influenced the choice of activities. For example, patients with diarrhoea avoided running and jumping and these patients often reflexively checked their access to toilets (Study IV). Severe GI problems often led to lower intensity of physical activity. One woman (Study IV) shared her experience:

*“...I’m always worried about how my bowels will react, since I’ve had such a tough time with loose stools and diarrhoea – ‘cause that’s something you can’t control and it’s really challenging, eh. It’s like an adult’s worst nightmare, I think, – the sensation that you’re about to poop your pants [laughter]...”*

The patients described how they avoided participation in group activities because they were unsure how they would feel when the activity started, and they worried they would have to interrupt the activity and disturb the others if they had to go to the toilet. The fear of passing gas during the activity was also a hindering factor. One woman (Study IV) said:

*“But I can’t go exercise if I’m going to have to suddenly rush to the toilet – it doesn’t work. I have to finish pooping first [laughter].”*

The patients discussed fatigue, tiredness, energy, and sleep in relation to physical activity (Study III). Study I did not reveal any changes in fatigue, but in the long-term follow-up (Study II) we observed significant improvements in the physical and cognitive subscales of FIS. These findings are in line with the patients’ experiences. Fatigue and lack of energy can hinder the onset of physical activity, but the knowledge of the positive effect of long-term regular physical activity motivated the patients (Study IV). Physical activity improved the patients’ quality of sleep, and found that it helped them relax, clear their thoughts, and handle negative feelings of anger and aggression. One man described the effects of physical activity as follows:

*“Yes, it’s good. It just winds everything down.”*

This included being physically active on the way home from work, which allowed the patients to leave their work-related thoughts behind them. Interrelations between two themes from studies III (physical activity should enable transportation) and IV (modulating stress level and mood) were evident. One patient (Study III) reflected on this:

*“And it’s the same when you bike or walk home from work. When you get home you’re sort of done you’ve left work, come home, and sort of cleared yourself out. So it feels good to move your body, to get away and just be yourself.”*

The patients sometimes had to adjust their dose of physical activity because of pain from muscles and joints (Study IV). They said physical activity increased their strength and flexibility (Study III), and decreased their musculoskeletal pain (Study III). Dimensions of IBS-QOL and SF-36 which was improved in Study II also included this. The physical role dimension of IBS-QOL, which assess limitations in work or other activities, was significantly improved with increased physical activity (Study I). One of the subthemes in Study IV (physical activity should add additional value) included physical work such as, for example gardening, house cleaning, and doing professional work. The patients described these activities as making them feel productive, and increased physical activity as lessening their limitations. The dimension of QOL interacts with the patients’ capability to be physically active and the relation between the physical role scores and the requirement that physical activity should add additional value can be described as the circular movement in Figure 4. One patient (Study IV) described planning his physical exercise with respect to physical activities over the year:

*“... if I sit still a lot then I have to exercise more, but during more active periods, like in the summer, I know I don’t have to exercise as much instead I just work on my house and my garden, I can sense when I need to work out.”*

The subtheme of stimuli and distraction in Study III was closely connected to the requirement that physical activity should cultivate interests (Study IV). These subthemes both comprised different ways to handle the symptom variation (Study IV) as well as motivations for the patients to be physically active, beyond symptom improvement (Studies I and II). Physical activity included impressions which added to a positive experience and contributed to reduce the patients’ consciousness of their symptoms (Studies III and IV). Some of the patients used physical activity to distract themselves from their symptoms. One man (Study IV) said:

*“... I imagine when you push your muscles hard your bowels don't have time to act up...”*

The requirement that physical activity should give a feeling of belonging took place in a social context and was closely connected to the patients' capability to be physically active, as seen in the subtheme covering life situation (Study IV). The patients described how they made an activity pleasurable through the social setting, but at the same time they reported that their life situation sometimes limited their possibility for physical activity. Some patients had found that prioritizing physical activity during periods of negative events had strengthened them while some of them also experienced an inability to be physically active when times were hard. One woman (Study IV) said:

*“It's been pretty challenging, physically and mentally, eh. But actually, the exercise has also been a way to relax. When I've been away doing that. [...] Yes, it certainly has been that, it's been a way to cope with everyday life. I – It's been free, – what's it called, – a free space.”*

The patients' self-image was connected to which physical activity they performed and changed over time depending on fluctuation in symptoms and life situation (Study IV). When the patients described their physical activity, they described themselves and how they related to physical activity. Patients who were inactive described taking up an active lifestyle to improve their self-image, which was also seen in two subthemes of Study III: self-strengthening and overcoming weaknesses. The patients showed to themselves and others the importance of their own wellbeing, and described physical activity as an investment. It was important for this physical activity to be performed on their own terms, as one woman (Study III) described:

*“It's, like, it's my time to do as I please – I just want to do it my way [laughs].”*

The intervention in Study I was designed from the general health-enhancing recommendations of physical activity and one of the patients' requirements of physical activity was that it should maintain health (Study IV). In this theme the patients shared different benefits from physical activity, such as experience of wellbeing, and decreased symptoms. The patients described how they handled the physical activity consciously in relation to their symptoms, their self-image, and their situation in life. They made active choices to adjust their physical activity in terms of type, intensity and amount. The intervention (Study I) the patients took part of included individual advice depending on their previous experiences of physical activity and their current level of physical activity. This was also capabilities described by the patients in the

subthemes earlier experiences and self-image (Study IV). The patients had tested the dose of physical activity they needed to achieve positive effects without exacerbating their symptoms and they believed this level of physical activity was specific to each individual. The patients' self-image was connected to which type of physical activity they performed. Some patients had tried many different activities with varying experiences. These patients described that it took them some time to find suitable activities to engage in. One woman in Study IV:

*“... I would never in my whole life have believed that I would be longing for exercise. I've never found anything that suited me. But well, I never thought I would long for it, physically or mentally, but I actually do.”*

In the two subthemes: physical activity should cultivate interests and give a feeling of belonging (Study IV) the patients described their individual preferences of the physical activities. The activities the patients chose to engage in during the intervention in Study I could be any physical activity fulfilling the general recommendations for physical activity.

The advices for physical activity were given depending on individual factors such as time, opportunities, or costs (Study I). This was also included in the patients' individual capability for physical activity in the context of their life situation (Study IV), which sometimes limited the space for physical activity. The limitation could be due to concerns, such as experiencing problems in relationships, or in being a parent. The patients also described in the subtheme symptom variation (Study IV), how a “bad day” affected their level of physical activity. Disruptive GI symptoms, fatigue, or pain generally made them adjust their physical activities or refrain from activities.

## DISCUSSION

### DISCUSSION OF METHODS

The patients had been referred by gastroenterologists for participation in Study I at the specialized outpatient clinic. This must be taken into account before any attempt is made to generalize the results, since patients referred to specialized care can be assumed to experience more severe symptoms and higher comorbidity. The choice to recruit patients from the first study to Studies III and IV ensured that all participants had experiences of physical activity, which not only produced rich and nuanced descriptions in the interviews but is also relevant to transferability. The patients' wide age span as well as different educational and employment backgrounds allowed for variation in the data. Socioeconomic status is connected to health, and therefore important [90]. The different backgrounds of the researchers designed and conducted the studies added to the trustworthiness of the qualitative studies. Although we are all educated health care professionals, we have different professions and come from diverse areas of health care. This allowed reflexivity and enhanced the awareness of pre-understandings within the group [91].

Physical activity had positive effects on the patients' GI symptoms. In the qualitative studies, the patients described symptom improvement and effects on the symptoms which were not found in Studies I and II; this may be due to the design and length of the quantitative studies. The results regarding oxygen uptake were probably also affected by this. The between-group comparisons of oxygen uptake showed no significant differences, probably due to the abovementioned factors and variation in the intensity of the activities performed. A submaximal test is a predicted value, but has been found to be valid for use in both the clinical and research setting [85]. To catch a changes in level of physical activity which perhaps were not detected on the ergometer cycle test it would have been sufficient to have added a validated questionnaire to measure the level of physical activity. Such questionnaires also have problems however, the combination of a questionnaire and the ergometer cycle test would have been preferred [92].

Studies to test interventions of physical activity or exercise can be designed in different ways. In order to stay close to both real life and the clinical practice, we chose to have a self-management design and use the recommendations from FYSS [50]. FYSS is available online, and is known in primary care, which is where most patients with IBS seek health care. Our design was close to the

setting in which the results will be used. The patients could perform the physical activity at a place which was convenient for them, instead of at a clinic or as a group-led activity at specific times. Despite the disadvantages of not being in control of the patients' level of physical activity this design was found to be important and favourable to the patients. The number of drop-outs in Study I was to some extent explained by the patients to be due to lack of time to visit the clinic, the inconvenience of visiting the clinic, or lack of time to be physically active. The patients in our study could be in control of their own activities (Study I) and they expressed that physical activities should be easy to perform in order to overcome hindering factors (Study IV).

Walking was a commonly reported activity in our studies. For many people, an activity which is adjustable to the individual's capability for physical activity. A pilot study which compared yoga to walking found that both interventions had positive effects on IBS symptoms, but at the follow-up only the walking group had continued to perform the relevant activity [93]. This supports our results describing the patients' requirements of physical activity, and may also be a reason why walking was the most frequently reported physical activity in Studies I and II. The patients in study IV reported that although walking did not always provide the desired intensity and health effects, it still fulfilled some of their requirements for physical activity and led to symptom improvement.

The design of Study I was a randomized controlled study. Due to the difficulty of blinding the intervention of increased physical activity, the patients knew their randomized allocation. The control group could have been offered something else than telephone calls during the control period. A design where the patients came to a clinic to be physically active at set times and a control group came for a sham activity at the same amount of times would have partly solved this. There are however, problems for IBS patients with such an intervention where the patients would have come to a clinic to engage in physical activity.

The results from Study II show an association between taking part in an intervention to increase physical activity and improved IBS symptoms, and improved QOL in the long term. The data shows this association but the study does not prove causality between increased physical activity and improved symptoms. Due to the lack of a control group a causality cannot be proven. A control group would have made the results stronger by allowing a comparison of changes in IBS symptoms on the long term. This was not possible due to the decision from the ethical review board.

We know from Study II that IBS patients involved in an intervention to increase physical activity will probably continue to be physically active in the long term. The level of improvement in IBS symptoms will probably also be maintained. Finally, the data shows a long-term improvement in QOL and fatigue in this group of IBS patients without providing a certain cause of that. This information is very important for the patients and will encourage them to increase their physical activity.

The qualitative studies give a nuanced picture of the patients' experiences of physical activity and of the effects of physical activity. Quantitative methods and qualitative methods complement one another, and so the inclusion of two qualitative methods in the thesis widens the perspective of the patients' views even further. From the quantitative studies, we know that physical activity improves symptoms in IBS, while the qualitative studies reveals how to use this knowledge in the clinic and bring new ideas that allow us to learn more about the mechanisms behind the improvement.

## DISCUSSION OF RESULTS

The results from these studies indicate that physical activity improves symptoms in IBS, and that physical activity should be seen as a complement to other treatment options which can be used in combination with advice on physical activity.

The patients described how they experienced changes in their bowel movements connected to physical activity, but the quantitative studies could not detect any changes in OATT or in stool frequency. Patients with diarrhoea-predominant IBS may be bothered if increased stool frequency is experienced. Despite this, for some it meant that they could choose to be physically active when they wanted to induce a bowel movement, and then they knew they would not feel the need to pass stool for a while. In a qualitative study by Farnedal [5] the patients described different techniques to induce bowel movements, where of exercise was one. Törnblom et al. [94] found that abnormal colonic transit time was of importance for the altered bowel habits seen in IBS, but the transit time seemed to be of minor importance for the other symptoms, such as abdominal pain, bloating, and flatulence. The patients in the present thesis expressed that physical activity improved these symptoms, despite the lack of effects on transit time and frequency of bowel movements. Some patients reported that being physically active gave them a feeling of more complete evacuation when passing stool, which is in line with the findings of Lustyk et al. [66]. The effects on problems with gas, abdominal bloating and



pain are related to the increase in passage of intestinal gas when being physically active [56].

Patients diagnosed with IBS do experience a symptom fluctuation over the years [95, 96]. A Danish group found that a majority of the patients who fulfilled the Rome III criteria at baseline still fulfilled the criteria or had unspecific symptoms after one and three years [97]. The majority of the patients in this thesis can therefore be assumed to be stable in their diagnosis even though their symptoms most likely changed over the years.

The mechanisms behind the improved GI symptoms seen in this thesis is unclear, partly due to the unknown pathophysiology of IBS. Exercise has an effect on chronic inflammation [98]. However, in order to have positive effects, the intensity of physical activity needs to be moderate to vigorous, but the amount must not be excessive [99]. Despite the unambiguous findings of low-grade inflammation in IBS [19], the impact of physical activity on inflammation may play a role in the mechanisms behind the improvements. The gut microbiota plays an unclear role in IBS [20], but still might be a part of the explanation for our results, since exercise is believed to affect the microbiota [100]. It is unknown if the microbiota can be “trained” by exercise alone, or if a combination of physical activity and dietary change is required. So far most studies have studied elite athletes, and there is a need for further research on healthy controls with a more general level of physical activity followed by studies of the microbiota in patients with IBS. Costa et al. [101] found strenuous exercise had a major reversible impact on the GI tract and its function in healthy populations. The health implications of prolonged strenuous exercise in patients with chronic gastrointestinal disorders therefore require further investigation.

Fatigue was discussed in relation to physical activity by the patients in the qualitative studies, and the long-term follow-up showed that fatigue was improved in the physical and cognitive subscales of FIS. Frändemark et al. [102] found in a mixed methods study that fatigue is a distressing symptom in many patients with IBS and suggested that fatigue should be included in the management of these patients. When discussing physical activity with patients, it is important to bear in mind and inform the patients that the effects on fatigue requires a longer time to appear, and also that fatigue may hinder the start of a physical activity. These patients might therefore need extra support when they start to become physically active.

The patients discussed how they handled their musculoskeletal pain in relation to physical activity. Similar motivating factors and barriers for physical

activity have been found in other patients groups with pain, for example in patients with rheumatoid arthritis [103]. They also had knowledge of the positive effects of physical activity on their disease and on health in general, but there were still barriers to being active. The evidence for positive effects on health in general is convincing, and these effects are known and accepted. Still, compliance with an active life-style can be hard, even in patient groups where the evidence is convincing. Our findings in Study IV revealing the patients' requirements of and capability for physical activity are important not only for patients with IBS but for anyone promoting physical activity or aiming to increase physical activity. It is important to find out the motives for a person to be physically active and what capabilities can be made use of to successfully promote physical activity or other lifestyle changes.

This thesis tells us that physical activity has positive effects on symptoms in IBS, and so physical activity can be a part of the advice and intervention provided to patients with IBS. The patients' experiences and knowledge of their symptoms also point toward how this can be done in the clinic. Our findings, Antonovsky's theory of salutogenesis [71], and the fact that a person-centred approach is relevant in the care of patients with IBS [34, 104] suggest a person-centred approach [105] would be suitable for advice on physical activity in IBS. This type of approach is based on the partnership between the patient and the caregiver, and the partnership should be initiated by the patients' narratives. This allows the patient to share their views on physical activity, and allows the caregiver to take the patient's experiences and preferences into account. We found the patients' requirements of and capability for physical activity to be important, and a person-centred approach provides space for this. Health care professionals should combine the patient's narrative with their professional knowledge of the effects of physical activity in IBS, and then share the decision making before documenting the patient's narrative and what is agreed upon: which type of physical activity should be performed, at what intensity, how often, and for how long.

The patients described a general feeling of wellbeing, both physical and psychological, in relation to physical activity. This feeling is most likely hard to detect in questionnaires, since the patients in qualitative studies struggled to find an appropriate term for this feeling of general wellbeing. They described it as "wellbeing" or "feeling good". It is possible that patients find this aspect hard to describe on a questionnaire containing pre-designed questions with pre-defined answers. Movement is essential in physiotherapy [67], and physical activity is bodily movement. Wikström-Grotell et al. [106] discussed movement in physiotherapy in terms of feelings of health and well-being, QOL, and joy; this is similar to the discussion by the patients in Studies III and

IV. These experiences are important to the individual patient in finding motivation to be physically active, and should be accounted for when supporting patients with IBS to be physically active. Knowledge of movement and physical activity from the physiotherapeutic field can be used to advantage by professionals working in the fields of gastroenterology and in functional GI disorders, either by taking part in research or through consulting physiotherapists. Patients who need more specific advice due to severe IBS symptoms, fatigue, co-morbidities, or other issues would gain from a physiotherapeutic contact [55].

## CONCLUSION

Increased physical activity improves GI symptoms and some aspects of QOL in IBS. Physically active patients with IBS have a lower risk of experiencing symptom deterioration than physically inactive patients. There are probably also positive long-term effects on GI symptoms and different aspects of QOL, fatigue, and depression and anxiety. Increased physical activity is therefore a suitable treatment option in IBS, and advice on physical activity should be given to patients with IBS.

When advice on physical activity is given to patients, the patient's experiences of the effects of physical activity must be taken into account. A person-centred approach incorporating the patient's own experiences and resources is the key to successfully promoting physical activity. The patient's requirements and capabilities for physical activity are important in understanding their experience of hindering and motivating factors. This understanding can help health care professionals to guide their patients towards increased physical activity.

Physiotherapists' specific knowledge of physical activity can be a useful resource both to patients with IBS and to other health care professionals meeting patients with IBS in the clinic. This physiotherapeutic knowledge can help patients to adjust their physical activity and increase their motivation for physical activity.

## FUTURE PERSPECTIVES

This thesis is merely a start to exploring IBS in relation to physical activity, and further research is needed. IBS is a heterogeneous disorder with a wide variation of symptoms, and it would be of value to perform larger studies in which the effects of physical activity can be studied in different sub-groups. It would also be of interest to examine the effects of physical activity in IBS patients divided into subgroups according to co-morbidities. It is likely that a physical activity intervention should be designed differently due to symptom profile, co-morbidities, and, current level of physical activity and physical capacity.

There is a dose-response relationship between health effects and physical activity, and so it would be worthwhile to investigate which intensity, duration, frequency, and type of physical activity are preferable in IBS. Since high doses of physical activity can induce GI symptoms, the cut-off for patients with IBS should be studied. Research collaboration between gastroenterologists and physiotherapists may improve the design and conduct of such studies.

The abovementioned suggestions will not explain the mechanisms behind the positive effect of increased physical activity on symptom improvement in IBS. Therefore, mixed methods or qualitative methods are likely to be a valuable approach in future studies. It is also important to explore the experiences of physical activity in persons with IBS in a primary care setting as well as for non-consulters with IBS. Finally, it would be of interest to also investigate the effects of physical activity in other functional GI disorders.

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