EFFECT OF REMEDIAL YOGA MODULE IN THE MANAGEMENT OF IRRITABLE BOWEL SYNDROME

Thesis submitted by

VIJAYALAKSHMI KAVURI

Towards partial fulfillment of

DOCTOR OF PHILOSOPHY (YOGA)

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Submitted to

Swami Vivekananda Yoga Anusandhana Samsthana
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Certificate

The Doctoral Committee confirms that this is an authentic approved copy of the thesis titled **"Effect of Remedial Yoga Module in the Management of IBS: A Randomized Controlled Trial"**.

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DECLARATION

I hereby declare that this study was conducted by me at White Memorial Medical Center, Los Angeles, California, under the guidance of Dr. Nagarathna Raghuram, Dean, Division of Yoga and Life Sciences (S-VYASA), Dr. Senthamil R. Selvan, Research Director, VYASA-LA, Los Angeles, California and Dr. Ramachandra Bhat, Vice Chancellor, Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University, Bengaluru, India.

I also declare that the subject matter of my thesis entitled "**EFFECT OF REMEDIAL YOGA MODULE IN THE MANAGEMENT OF IRRITABLE BOWEL SYNDROME: A RANDOMIZED CONTROLLED STUDY**" has not formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles previously.

Date: January, 2016 **VIJAYA KAVURI**

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STANDARD INTERNATIONAL TRANSLITERATION CODE USED TO TRANSLITERATE SANSKRIT WORDS

a	=	अ	ṅa	=	ङ	pa	=	प
ā	=	आ	ca	=	च	pha	=	फ
i	=	इ	cha	=	छ	ba	=	ब
ī	=	ई	ja	=	ज	bha	=	भ
u	=	उ	jha	=	झ	ma	=	म
ū	=	ऊ	ñ	=	ञ	ya	=	य
ṛ	=	ऋ	ṭa	=	ट	ra	=	र
ṝ	=	ॠ	ṭha	=	ठ	la	=	ल
e	=	ए	ḍa	=	ड	va	=	व
ai	=	ऐ	ḍha	=	ढ	śa	=	श
o	=	ओ	ṇa	=	ण	ṣa	=	ष
au	=	औ	ta	=	त	sa	=	स
ṁ	=	अं	tha	=	थ	ha	=	ह
ḥ	=	अः	da	=	द	kṣa	=	क्ष
ka	=	क	dha	=	ध	tra	=	त्र
kha	=	ख	na	=	न	jña	=	ज्ञ
ga	=	ग						
gha	=	घ						

ABSTRACT

INTRODUCTION

Irritable Bowel Syndrome (IBS) is a group of symptoms manifesting as a functional gastrointestinal (GI) disorder in which patients experience abdominal pain, discomfort, and bloating that is often relieved with defecation. IBS is often associated with a host of secondary comorbidities such as anxiety, depression, headaches, and fatigue and Yoga is well proven in the management of these conditions. To treat IBS and its complexities, a holistic approach is the need of the hour. The scope of the study is to provide insight into the complexities of IBS as a mind-body-breath disorder and to evaluate the efficacy of a Remedial Yoga Module (RYM) in treating / managing the primary and secondary symptoms of IBS.

LITERATURE REVIEW

The traditional literature review provides a theoretical framework for the holistic understanding of human well-being with the concepts of *Pañca Kośās*, *Triguṇās, Tridoṣās*, and *Ādhi Vyādhi* (mind originated diseases) and how it relates to IBS. The modern scientific literature review gives an overview of IBS and its treatment with conventional modality and its shortcomings.

AIM AND OBJECTIVES

The aim of the study was to investigate the efficacy of the Remedial Yoga module, in a Randomized Controlled Trial (RCT), that was formulated based on the traditional concepts of holistic health on the primary and secondary symptoms of IBS patients.

METHODS

Subjects: Ninety seven patients, both male (n=13; median age 46 years; median weight 157 pounds) and female (n=84; median age, 45 years; median weight 157 pounds) qualified as IBS patients (Rome iii criteria) were randomized into three groups: Yoga group (n = 36); Combination group (n = 36) and Wait-list Control group (n = 31). For the long term impact of RYM study, a total of 28 patients (Follow-up group), have volunteered.

Design: The study design was Randomized Control trial with three groups (Yoga; Combination; and Wait-list Control group) and three measurements, Week 0, end of Week 6 and end of Week 12. For the follow-up group, another measurement was done at the end of Week 24.

Assessment tools: The primary outcome assessments were IBS- Symptom Severity Scale (IBS-SSS) and IBS Quality of Life (IBS-QOL) questionnaires. To assess the secondary symptoms, Hospital Anxiety and Depression Scale (HADS), Autonomic Symptom Score questionnaires, IBS-Global Assessment of Improvement (IBS-GAI) and Medicine and Supplement Use were used. To assess the autonomic changes, two sympathetic reactivity tests and two parasympathetic reactivity tests were conducted. Physical body changes such as BMI and flexibility (hip-trunk, and shoulder) were also measured.

Data was extracted manually from all questionnaires, and the HRV data was extracted using kubios software. All the data were analyzed with SPSS 20.0.

RESULTS

A total of 78 patients completed the study with an adherence (to yoga sessions) rate of 90%. There were significant improvements in IBS-SS scores and IBS–QOL in Yoga

(n=25; p<0.001) and Combination groups (n=26; p<0.001) compared to Control group (n=27). Also, Hospital Anxiety and Depression Score, Autonomic Symptom Score, IBS Global Assessment of Improvement, physical flexibility, and autonomic functions were significantly improved in the Yoga intervention groups. Correlatively, the amount of Medicine and Supplement use were significantly reduced in Yoga and Combination groups. Seven patients in the Wait-List Control group completed 12 weeks of RYM intervention. The results of WL-Yoga group were similar to those of Yoga and Combination groups in most of the assessments. Results of the Follow-up group revealed that after 12 more weeks of RYM maintenance intervention, all the improvements were sustained and further improvements in few outcome assessments were observed.

CONCLUSION

Our observation suggests that RYM is very effective in relieving symptoms of IBS, easy to be administered, and cost effective with high adherence rate. In the long term study, all the improvements that were observed at the end of 12 weeks were sustained / enhanced at the end of 24 weeks. Thus, RYM could be a viable stand-alone treatment or an integrative option with conventional modality for IBS patients.

Keywords: IBS, IBS-SSS, IBS-QOL, Anxiety, Depression, Remedial Yoga Module

CONTENTS

CHAPTER-1

INTRODUCTION

1. INTRODUCTION

1.1 DEFINITION AND CLINICAL FEATURES

Irritable Bowel Syndrome (IBS) is a chronic functional disorder characterized by abdominal pain or discomfort associated with disordered defecation, either constipation (IBS-C), diarrhea (IBS-D), or mixed / alternating symptoms of constipation or diarrhea (IBS-M) (Longstreth et al., 2006). However, the definition of IBS has been evolving over the years in order to integrate new information that has been developing about this complex disorder. According to Rome III diagnostic criteria, the onset of symptoms should be at least six months before the patient is diagnosed, abdominal pain or discomfort should be present at least three days per month for 3 months and should be associated with two or more of the following: improvement with defecation, onset associated with a change in stool frequency and onset associated with a change in stool form. The American College of Gastroenterology (ACG) guidelines emphasizes on a clinically oriented approach and defines IBS as lower abdominal pain or discomfort with disordered defecation (Brandt et al., 2009).

The diagnostic evaluation of patients with IBS can be challenging. It is generally agreed that the initial diagnosis of IBS can be fulfilled by symptom-based diagnostic criteria such as Rome III; it is important to exclude organic causes of symptoms compatible with IBS. However, to avoid unnecessary and costly testing, the diagnosis of IBS should not be made simply by excluding organic disorders. Emphasis is placed on identifying a symptom complex compatible with IBS and using prudent, although not exhaustive, testing to make a positive diagnosis.

Evidence exists for a diagnostic and treatment approach based on the predominant symptom, its severity, and associated psycho-social features, although more studies are needed to understand the mechanism underlying these symptoms and to develop effective treatments.

1.2 BURDEN

1.2.1 Global Prevalence

The worldwide prevalence of IBS is 5-20%. The prevalence rates vary in each country; in U.K. it ranges from 2.5 to 22.5%, in Spain 4.4-13.6%, and is less than 10% in Italy, Denmark and Sweden (Brandt et al., 2009; Khan & Chang, 2010). In Asian countries such as China, Korea, Singapore, Malaysia, the occurrence varies from 6 to 11.5% (Chang, Lu, & Chen, 2010). In India, the prevalence is between 2.5 – 6.5% (Gwee, Lu, & Ghoshal, 2009). In Asia, the ratio of female and male sufferers is almost equal but in India males suffer more than females. The low rate of incidence in females in India is attributed to the health seeking behavior of males more than females (Chua, 2011).

1.2.2 Prevalence in the USA

The prevalence of IBS in North America ranges from 3 to 20% with most estimates in the range of 10-15% and South America reports at 21% (Canavan, West, & Card, 2014). In the United States, the prevalence is 10-15% and females suffer more than males, a 2:1 ratio (Brandt et al., 2009). IBS is strongly related to poor quality of life and a diminished functional status of an individual which in turn poses a burden on the healthcare system.

1.2.3 Economic Burden of IBS

The burden of illness of IBS is significant because IBS patients experience decreased health related quality of life compared with healthy controls, GERD patients and organic GI disorders (Graham et al., 2010; Simrén et al., 2002). The high prevalence of diagnosis also poses a significant socio economic burden through decreased work productivity, increased direct and indirect healthcare costs (Hungin, Chang, Locke, Dennis, & Barghout, 2005). Patients with IBS consume a disproportionate amount of resources, about 50% more health care resources than matched controls without IBS (Longstreth et al., 2003). In a systematic review of studies conducted on the burden of illness in USA, total direct costs per patient ranged from $348 to $8,750 and indirect costs from $355 to $3,344 per year in 2002 and the latest figures remained almost the same (NIDDK Scientists, 2014; Hulisz, 2004). The average number of days off work due to IBS ranges between 8 to 21.6 days a year (Maxion-Bergemann, Thielecke, Abel, & Bergemann, 2006). A 20% decrease in work productivity was observed in patients suffering from IBS when compared to fellow employees without IBS (Dean et al., 2005). Overall, between 3.6 million physician visits for IBS, and direct and indirect costs, IBS care consumes over $20 billion annually (Brandt et al., 2009). Besides, IBS patients also undergo more surgical procedures including cholecystectomy, appendectomy, hysterectomy, back surgery compared to individuals without IBS (Longstreth & Yao, 2004).

1.3 PATHOPHYSIOLOGY OF IBS

To date the pathophysiology of IBS is not completely understood, no physiologic mechanism unique to IBS has been identified. Evidence supports that it is biopsychosocial disorder resulting from an interaction among a number of factors:

visceral hyperalgesia, genetic and environmental factors, infection, inflammation, gut motility, and psychological factors. Dietary factors, GI dysmotility, dysfunction, and the role of gut flora are evolving mechanisms (Drossman, Camilleri, Mayer, & Whitehead, 2002). Genetic factors, chronic stress and enteric infections are few of the predispositions to develop IBS. Dysregulations in the brain gut axis, referred to as enteric nervous system (ENS), has been established as a cause of IBS. Furthermore, the disturbed brain-gut axis is thought to be responsible for alterations in autonomic response, immune function, gut motility and visceral perception that manifest as symptoms of IBS (Crowell, Harris, Jones, & Chang, 2005). Studies have shown that in patients with IBS, there is a diminished threshold and exaggerated severity of pain caused by balloon distention in the large and small bowel (Clemens, Samsom, van Berge Henegouwen, & Smout, 2003). Enhanced gut transit is seen in some patients with diarrhea-predominant IBS, and decreased gut transit is seen in some patients with constipation-predominant IBS. Increased motility compared with healthy subjects is seen in response to various stimuli, such as psychological stress, meals, and balloon inflation in the gut (Drossman et al., 2002).

IBS has long been dismissed as a psychosomatic condition due to lack of clear pathophysiology. Psychological stress and emotional events, such as physical or sexual abuse, can result in GI symptoms in healthy subjects, but patients with IBS are affected deeply. The common psychological symptoms associated with IBS are depression, somatization, anxiety, hostility, phobia, and paranoia. Up to 50% of patients with IBS meet criteria for a psychiatric diagnosis as compared with an average of 20% with

organic GI disorders and 15% of control subjects (Pellissier, Dantzer, Canini, Mathieu, & Bonaz, 2010; Drossman et al., 2002).

1.4 NEED FOR THE PRESENT STUDY

Since there is no clear diagnostic criteria, and lack of established pathophysiology, many different treatment strategies are used to treat IBS. Due to the associated co-morbidities such as anxiety, depression, headaches, fibromyalgia, these patients end up taking a host of medications to resolve each symptom (Woolery, Myers, Sternlieb, & Zeltzer, 2004; Wood, 1993). The conventional treatment modalities are not without side effects. However, these patients remain inadequately treated and dissatisfied with their QOL, and about 50% often seek alternative treatments like, probiotics, Chinese herbal therapy, Yoga, acupuncture and hypnosis (Shen & Nahas, 2009).

Recent reviews on complementary and alternative medicine (CAM) on IBS have all concurred with the fact that various CAM modalities could benefit IBS patients in improving their symptoms and QOL (Grundmann & Yoon, 2014; Yoon, Grundmann, Koepp, & Farrell, 2011; Shen & Nahas, 2009). However, as empirical evidence is lacking in many of these CAM modalities, no consensus could be reached about the efficacy of the said CAM therapies. It was suggested that a combination of pharmacological treatment with a CAM treatment would serve these patients well.

Yoga is an ancient Indian (3,500 B.C.) 'mind-body-breath' discipline, aimed to unite the mind, body, and spirit (Taimni, 1999). Personal transformation and good health is possible with the physical and mental discipline that is fostered by *Yoga*. *Yoga* emphasizes on making one feel 'more connected' with their body, and promotes a sense

of well-being (Woolery et al., 2004; Wood, 1993). Several studies have alluded to the benefits of *Yoga* in the management of various associated disorders that IBS patients also experience. *Yoga* has been shown to improve headaches, anxiety, depression, chronic fatigue, and fibromyalgia (Oka et al., 2014; Mist, Firestone, & Jones, 2013; Rocha et al., 2012; Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012; Wells, Bertisch, Buettner, Phillips, & McCarthy, 2011). In a report of IBS and current treatment options, Ducrotte had suggested that *Yoga* postures targeting the lower abdomen would help in relieving the symptoms of IBS by enhancing energy circulation in and around the intestines (Ducrotté, 2007).

There are four studies that addressed the effects of *Yoga* in IBS patients, of which, three assessed adolescents and only one study assessed the adult population. Kuttner, et al. randomized 25 adolescents (aged 11-18 years) in which *Yoga* group improved functional disability, anxiety, and emotion-focused avoidance when compared to controls (Kuttner et al., 2006). In another pilot study of 17 children with functional abdominal pain and IBS, the observed pain reduction following *Yoga* practices was maintained marginally at 3 month follow up (Brands, Purperhart, & Deckers-Kocken, 2011). In a recent study of 51 adolescents and young adults randomized to *Yoga* and usual care groups, adolescents reported improved physical functioning, and young adults reported improved IBS symptoms, global improvement, disability, psychological distress, sleep quality and fatigue, in the *Yoga* group (Evans et al., 2014).

The only *Yoga* study on adults (Taneja et al., 2004) showed that both *Yoga* and Control groups show significant improvements in bowel symptom scores, state anxiety scores, gastric motility, and physical flexibility, but *Yoga* group showed more favorable changes. *Yoga* group was given intervention materials (*Yoga* postures) and were asked to practice at home. There was no record of subjects practicing at home in this study.

Various studies that examined the effect of *Yoga* on IBS patients had different routines, varying duration of sessions; making it difficult for the patients to better appreciate the positive impact of *Yoga*. There is a need to create a *Yoga* module based on the understanding that a human being has to be treated in a holistic approach. A standardized one hour Yoga module that is easy to follow, and help in alleviating symptoms in all types of IBS (C, D, M) patients is the need of the hour. Hence, the present study reviewed the holistic approach provided by the ancient Indian scriptures; created and examined the efficacy of a Remedial *Yoga* Module on the primary and secondary symptoms of IBS through a randomized controlled design in adult IBS patients.

C H A P T E R - 2

LITERARY RESEARCH

2. LITERARY RESEARCH

Irritable Bowel Syndrome is a common functional disorder of the intestines, causing abdominal pain, bloating, and altered bowel habits. IBS has been established to be a brain-gut disorder, and stress has been found to be one of the major factors in exacerbating the symptoms. Even though the diagnosis of IBS is symptom-based, and the etiology is not well established, stress and dysfunction of the brain-gut axis are two factors that have been established. Most of the IBS patients suffer from co-morbidities such as anxiety, depression, headaches, fatigue, and fibromyalgia (Wood, 1993; Woolery, Myers, Sternlieb, & Zeltzer, 2004). Lifestyle change is a recommended treatment option for these patients. The ancient Indian *Vedic*, *Yogic*, and *Āyurvedic* scriptures, define health as balance in the *Guṇās*, *Kośās* , and *Doṣās*, and ill-health at *Annamaya Kośa* as imbalance in the *Guṇās* of ***Rajas*** and *Tamas*; leading to an imbalance of either of the *Tridoṣās* and hence ill-health. The aim of *Āyurveda* / *Yoga* therapy is to restore balance (health) through corrective techniques at each layer of our existence. *Yoga* is defined as a tool to gain mastery over the mind and thereby gaining health through managing chronic stress.

The ancient Indian scriptures have elaborated on the mind and its role in health and disease. The definition of mind and its role in disease from various texts and concepts such as *Pañca Kośās* (the five layers of human existence), *Triguṇās* (three *gunās* / attributes), *Ādhi Vyādhi* (mind originated diseases), will be discussed to help develop a *Yoga* model for IBS as a mind-body therapy i.e., correcting imbalances at several levels.

Since this imbalance is born (*prasava*) in the mind and is a reversible phenomenon, a Remedial *Yoga* Module will be proposed as a therapeutic intervention to manage / reverse (*pratiprasava*) the syndrome by restoring balance at all levels. In this section, the concept of health as described in the scriptures, the various causes that bring about an imbalance in the *Guṇās*, *Kośās*, and *Doṣās,* and the corrective measures to bring homeostasis to the body systems, particularly in IBS patients, will be discussed. A brief description of available *Āyurveda* (an ancient Indian medicine) treatment for *grahaṇi* (IBS) is also mentioned.

2.1 CONCEPT OF HEALTH

2.1.1 Definition of Health according to W H O

Health is the capability of individuals to adapt and self-manage when facing physical, mental, or social challenges. The World Health Organization (WHO) defined health as "a state of complete physical, mental, social and spiritual well-being and not merely the absence of disease or infirmity" (Awofeso, 2005). This definition clearly identifies that health is a continuous function of the state of well-being.

2.1.2 Concept of Health according to Ancient Scriptures

Ancient texts such as *Bhagavad gīta*, *Upaniṣads*, *Yoga Vāsiṣta,* and *Āyurvedic* literature enunciate that the balanced state of *guṇās* makes the person enjoy health and happiness. The importance of mind and its influence on the body is stressed upon as cause of disorder / disease. *Sattva* marks a clear humanistic and healthy approach of human beings. Few of the views of these texts are stated below:

रागद्वेषविमुक्तैस्तु विषयानिन्द्रियैश्चरन्।

आत्मवश्यैर्विधेयात्मा प्रसादमधिगच्छति ॥भ गी ॥२-६४ ॥

rāgadveṣavimuktaistu viṣayānindriyaiścaran।
ātmavaśyairvidheyātmā prasādamadhigacchati ।। Bha Gī ।।2-64।।

Meaning: A man of disciplined mind, who has his senses under control and who has neither attraction nor aversion for sense objects, attains tranquility, though he may be moving amidst objects of the senses.

कालबुद्धीनिन्द्रियार्थानां योगो मिथ्या न चाति च।

द्यायश्रयाणां व्याधीनां त्रिविधो हेतुसंग्रहः ॥च सं सू ॥१-५४ ॥

kālabuddhīnindriyārthānāṁ yogo mithyā na cāti ca।
dyāyaśrayāṇāṁ vyādhīnāṁ trividho hetusaṁgrahaḥ।।ca sam sū ।।1-54।।

शरीरं सत्वसंज्ञं च व्याधीनामाश्रयो मतः।

तथा सुखानां योगस्तु सुखानां करणम् समः ॥च सं सू ॥१-५५ ॥

śarīraṁ satvasañjñaṁ ca vyādhīnāmāśrayo mataḥ।
tathā sukhānāṁ yogastu sukhānāṁ karaṇam samaḥ।।ca sam sū ।।1-55।।

Meaning 1-54, 55: The soul is essentially devoid of all pathogenecity. He is the cause of consciousness through the *Sattva* mind and the specific qualities of basic elements, He is eternal. He is an observer of all activities. The body and mind (*Sattva*) constitute the substrate of disease and happiness (i.e. positive health). Balanced utilization of *Sattva*, *Rajas* and *Tamas* (of time, mental faculties and objects of sense organs) is the cause of health and happiness.

समदोषः समाग्निश्च समधातुमलक्रियः ।

प्रसन्नत्मेन्द्रियमनाः स्वस्थ इत्यभिधीयते ॥सु सूत्र स्था ॥१५-४१ ॥

samadoṣaḥ samāgniśca samadhātumalakriyaḥ।

prasannatmendriya manāḥ svastha ityabhidhīyate||Su sutra sthā||15-41||

Meaning: One is in perfect health when the *Tridoṣās* (*Vāta, Pitta, Kapha*) Digestive fire (digestion, assimilation and metabolism) all the body tissues & components (*Dhātus*) (the entire physical body) all the excretory functions (the physiological functions of urination and defecation) are in perfect order with a pleasantly disposed and contented mind, senses and spirit.

2.2 WAY TO A HEALTHY LIFE ACCORDING TO SCRIPTURES

According to the scriptures, health can be achieved by a balanced state of mind, using all faculties of the human existence in a timely and balanced manner. The scriptures also described various ways to achieve this balance. *Patañjalī Maharṣi* stated that with a pure and happy mental state, one can be free from misery. The way to have a harmonious life (*cittaprasādanam)* is stated in the verse below:

मैत्रीकरुणामुदितोपेक्षाणां सुखदुःखपुण्यापुण्यविषयाणां

भावनातश्चित्तप्रसादनम् ॥पा यो सु ॥२-३३ ॥

maitrīkaruṇāmuditopekṣāṇāṁ sukhaduḥkhapuṇyāpuṇyaviṣayāṇāṁ
bhāvanātaścittaprasādanam ||PYS||2-33||

Meaning: In relationships, the mind becomes purified, and retains its peace and undisturbed calmness by cultivating attitudes of friendliness towards those who are happy, compassion for those who are suffering, goodwill towards those who are virtuous, and indifference or neutrality towards those we perceive as wicked or evil.

We find similar ways of life values being practiced in the Vedic times, known as *Śiṣṭācāra*. *Matsya Purāna* (Basu, 1974) describes the eight characteristics of dharma that were followed: charity, truthfulness, asceticism, learning, sacrifice, worship, *dama* or self-restraint, and absence of greed. If a person was able to follow these principles, he/she would lead a happy, healthy, and stress-free life. According to *Āyurveda*, (*Caraka Samhita Sūtra 8-18*) to maintain health and happiness, *Sadvṛtta*, an ethical code of conduct must be followed.

बलीनामुपहर्ता ग्रतिथीनां पूजकः पितृभ्यः पिण्डदः काले हितमितमधुरार्थवादी
वश्यात्मा धर्मात्मा हेतावीर्ष्युः फले नेर्ष्युः निश्चिन्तः निर्भिकः ह्रीमान् धीमान्
महोत्साहः दक्षः क्षमवान् धार्मिकः ग्रास्तिकः विनयबुद्धि
विद्याभिजनवयोवृद्धसिद्धाचार्यणामुपासिता छत्री दण्डी मोली सोपानत्को
युगमात्रदृग्विचरेत् मङ्गलाचारशीलः
कुचेलास्थिकण्टकामेध्यकेशतुषोत्करभस्मकपालस्त्रानबलिभूमीनां परिहर्ता प्राक्
श्रमाद् व्यायामवर्जी स्यात् सर्वप्राणिषु बन्धुभूतः स्यात् क्रुध्दानामनुनेता
भीतानामश्वासयिता दीनानामभ्युपपत्ता सत्यसन्धः सामप्रधानः
परपुरुषवचनसहिष्णुः ग्रमर्षघ्नः प्रशमगुणदर्शी रागद्वेशहेतूनां हन्ता च ॥
च सं सू ॥८- १८ ॥

Balīnāmupahartā gratithīnāṁ pūjakaḥ pitṛbhyaḥ piṇḍadaḥ kāle
hitamitamadhurārthavādī vaśyātmā dharmātmā hetāvīrṣyuḥ phale nerṣyuḥ niścintaḥ
nirbhikaḥ hrīmān dhīmān mahootsāhaḥ dakṣaḥ kṣamavān dhārmikaḥ grāstikaḥ

vinayabuddhi vidyābhijanavayovṛddhasiddhācāryaṇāmupāsiatā chatrī daṇḍī moulī sopānatkoo yugamātradṛgvicaret maṅgalācāraśīlaḥ kucelāsthikaṇṭakāmedhyakeśatuṣotkarabhasmakapālastrānabalibhūmīnāṁ parihartā prāk śramād vyāyāmavarjī syāt sarvaprāṇiṣu bandhubhūtaḥ syāt krudhdānāmanunetā bhītānāmaśvāsayitā dīnānāmabhyupapattā satyasandhaḥ sāmapradhānaḥ parapuruṣavacanasahiṣṇuḥ gramarṣaghnaḥ praśamaguṇadarśī rāgadveśahetūnāṁ hantā ca||ca sam sū||8-18||

Meaning: A righteous way of acquiring material wealth and gratifying desires is to be practiced. Being truthful at all times, respecting all living beings, being kind and compassionate should be a way of life. One must never possess things that do not belong to them, or ill treat others. The weaknesses or secrets of others should not be made public. Bad company should be avoided and one should be surrounded by good company who think of societal welfare without disruptive tendencies.

All of the above scriptures, essentially, ascribe to the same principles to be followed which would keep the mind calm, and peaceful. This would lead to a *Sāttvic* mind and a healthy body.

2.3 HOLISTIC APPROACH OF HEALTH ACCORDING TO SCRIPTURES

The first domain of understanding the human system in a holistic view is from the view point of the *Pañca Kośās*, which was mentioned in detail in *Taittiriya Upaniṣad*. This is the earliest reference to the study of human personality from the Indian psycho-philosophical point of view. The second domain of understanding personality is from the *Sāṅkhya* philosophy, from the view point of the *Triguṇās* - the psychological attributes responsible for the exhibition and behavior traits and types of human personality - consisting of *Sattva, Rajas,* and *Tamas*. Each and every action, food consumption, and

behavior can be classified as being a representation of one of the *Triguṇās*. The third domain of understanding personality is also from *Sāṅkhya* philosophy. In the principles of *Pañca Mahā Bhūtās*, the personality is said to be a composition of the five 'elements' of Ether / Sky (Ā*kaśa*), Air (*Vāyu*), Fire (*Agni*), Water (Ā*pa*), and Earth (*Pṛthivī*) (Sinha, 2010). These five elements combine with each other to form the *Tridoṣās* - the physiological traits of human persona – *Vāta, Pitta,* and *Kapha* which give each and every one the unique characteristic of what and who each person is and the reasons for the behaviors (Shilpa & Venkatesha Murthy, 2011). These three concepts, *Pañca kośās*, *Triguṇās,* and *Tridoṣās* form the most important and comprehensive methodology of understanding Human Persona from the Indian Traditional view point and perspective (Kiran Kumar, 2010) and each of these three concepts are examined below.

2.3.1 Concept of *Pañca Kośās*

Taittiriya Upaniṣad (Swami Gambhirananda, 1986) described *Pañca Kośās* concept of five intertwined layers of human existence. The first four layers are interacting and interdependent layers on the background of the fifth layer of bliss in which there is perfect balance, harmony, and health. Accordingly, the goal of human life is to transcend to the 5th layer of bliss, beyond all disturbing mental processes, by performing each and every duty/action in blissful awareness without unwanted reactions to chronically demanding situations of life. This is the key to achieving total peace that leads to perfect health.

2.3.1.1 Annamaya Kośa (physical body)

Annamaya Kośa is the physical frame of the body and is the grossest of all five layers, representing the anatomy that is a conglomeration of subtle particles (such as electrons) that go on to form highly organized systems. This is nurtured by the nutrients in the food we eat. A healthy body is the key to maintain homeostasis of the different systems within.

2.3.1.2 Prāṇamaya Kośa (vital life force)

The *Prāṇamaya Kośa* ensures the harmonious functioning of these organs by the physiological processes. *Prāṇa* (vital life force) is the basic life energy inside and outside the body. A uniform flow of this life force to each and every cell of the physical body (*Annamaya Kośa)* keeps it healthy. If there is a disturbance in the flow of *Prāṇa* to any organ, it can lead to dysfunction of that organ at the physical body level. *Prāṇāyāma* is an important tool to maintain a balanced flow of *Prāṇa* to all organs.

2.3.1.3 Manomaya Kośa (mind)

Manomaya Kośa is the mental and emotional library of the human system. According to *Bhagavad Gīta* (Chinmayananda, 1992) [ch II, verses 60-62], the psychological stresses (emotions) begin as uncontrolled rewinding surge of thoughts in this layer. Meditation is the tool to manage the stresses from the mind level.

2.3.1.4 Vijnānamaya Kośa (intellect)

Vijnānamaya Kośa is the discriminating faculty (inner mind, conscience), which guides the *Manomaya Kośa* constantly to get mastery over the basic instincts perceived by the

sense organs. The secret for happiness, according to scriptures, is conquering the mind through knowledge.

2.3.1.5 Ānandamaya Kośa (bliss)

Ānandamaya Kośa is the most subtle layer in the array of the five layers of human existence. This layer is not bound by time or space and is devoid of emotions, a state of total silence, complete harmony and perfect health (Nagarathna & Nagendra, 2006). Happiness is within us, a state of inner silence. *Taittiriya Upaniṣad* describes the process in which a student realizes that all layers of our existence emerge from *Ānandamaya Kośa* (Swami Gambhirananda, 1986). It leads to the insight that happiness is within us and 'each one of us' in our causal state is '*Ānanda*' (bliss) embodied.

2.3.2 *Triguṇās*

Guṇa means a quality or an attribute of an individual. According to the ancient Indian scriptures (specifically *Sāṅkhya* philosophy), the *Prakṛti* consists of three constituents (*Guṇās*), *Sattva*, *Rajas,* and *Tamas* (Dasgupta, 1997). The three *Guṇās* have been equated to the psychological attributes of human beings. While all individuals have mixed amounts of the three *Guṇās*, the predominant *Guṇa* determines the nature of an individual. At the microcosmic level, the three *Guṇās* manifest themselves at different levels of consciousness and are in dynamic interaction. They are intertwined and affect each other, and rarely do we find individuals with pure *Sattva*, *Rajas,* or *Tamas*. Sometimes *Sattva* is predominant, sometimes *Rajas,* and at times *Tamas* is predominant.

Once a *Guṇa* becomes predominant, it continues to dominate for some time. Hence, it is possible, though challenging, to change our nature from *Tamas* to *Rajas* to *Satva*. In equilibrium, the three *Guṇās* preserve the mind (and indirectly the body), maintaining it in a healthy state. In the following sections, *Guṇās* as described in *Bhagavad Gīta* and *Patañjalī Yoga Sūtrās* are mentioned briefly.

2.3.2.1 Guṇās and their characteristics according to Bhagavad Gīta (Tapasyananda, 1984)

The three *Guṇās*, *Sattva*, *Rajas* and *Tamas* are explained in the following verses. We get a glimpse of the nature of each *Guṇa*, its influence on the attitudes, food habits and work habits.

सत्त्वं रजस्तम इति गुणाः प्रकृतिसम्भवाः ।

निबध्नन्ति महाबाहो देहे देहिनमव्ययम् ॥भ गी ॥१४-५ ॥

sattvaṁ rajastama iti guṇāḥ prakṛtisambhavāḥ ।
nibadhnanti mahābāho dehe dehinamavyayam ||Bha Gī ||14-5||

Meaning: The three *Guṇās* of *Sattva*, *Rajas* and *Tamas* born of *Prakṛti*, bind down the immortal soul to the body in its embodied state.

तत्र सत्त्वं निर्मलत्वात्प्रकाशकमनामयम् ।

सुखसङ्गेन बध्नाति ज्ञानसङ्गेन चानघ ॥भ गी ॥१४-६ ॥

tatra sattvaṁ nirmalatvātprakāśakamanāmayam ।
sukhasaṅgena badhnāti jñānasaṅgena cānagha ||Bha Gī||14-6||

Meaning: Among these, *Sattva* is luminous and harmonious due to its essential purity. It binds the soul, O sinless one; with the feeling 'I am happy, I am full of knowledge'.

नियतं सङ्गरहितमरागद्वेषतः कृतम् ।

अफलप्रेप्सुना कर्म यत्तत्सात्त्विकमुच्यते ॥भ गी ॥१८-२३ ॥

niyataṁ saṅgarahitamarāgadveṣataḥ kṛtam ।
aphalaprepsunā karma yattatsāttvikamucyate ।।Bha Gī।।18-23।।

Meaning: Work of the nature of duty done by one without hankering for fruits, and without attachment, or passion or hate – such work is spoken of as born of *Sattva*.

रजो रागात्मकं विद्धि तृष्णासङ्गसमुद्भवम् ।

तन्निबध्नाति कौन्तेय कर्मसङ्गेन देहिनम् ॥भ गी ॥१४-७ ॥

rajo rāgātmakaṁ viddhi tṛṣṇāsaṅgasamudbhavam ।
tannibadhnāti kaunteya karmasaṅgena dehinam ।।Bha Gī।।14-7।।

Meaning: Know *Rajas* to be passion based, and productive of longings for unattained objects and attachment for those in one's possession. It binds the (actionless) soul, O son of *Kunti*, by entangling it in action (through the feeling 'I am the doer').

Persons of *Rājasic* nature are action oriented and exhibit attachment for objects. Their nature of work is selfish and they try to fulfill their desires with their mind getting swayed by emotions, either positive or negative.

यत्तु कामेप्सुना कर्म साहंकारेण वा पुनः ।

क्रियते बहुलायासं तद्राजसमुदाहृतम् ॥भ गी ॥१८-२४ ॥

yattu kāmepsunā karma sāhaṅkāreṇa vā punaḥ ।
kriyate bahulāyāsaṁ tadrājasamudāhṛtam ।।Bha Gī।।18-24।।

Meaning: But work that is done by a person merely for the gratification of his desire, and with great strain and a feeling of self-importance is said to be born of *Rajas*.

तमस्त्वज्ञानजं विद्धि मोहनं सर्वदेहिनाम्।

प्रमादालस्यनिद्राभिस्तन्निबध्नाति भारत ॥भ गी ॥१४-८ ॥

tamastvajñānajaṁ viddhi mohanaṁ sarvadehinām ।
*pramādālasyanidrābhistannibadhnāti bhārata ।।Bha Gī।।*14-8।।

Meaning: As for the *Guṇa* known as *Tamas,* it is ignorance-born and is productive of delusion in all beings. It binds the soul, O scion of the *Bharata* clan! With the obsession of a disposition characterized by negligence, indolence and sleepiness.

अनुबन्धं क्षयं हिंसामनपेक्ष्य च पौरुषम्।

मोहादारभ्यते कर्म यत्तत्तामसमुच्यते ॥भ गी ॥१८-२५ ॥

anubandhaṁ kṣayaṁ hiṁsāmanapekṣya ca pauruṣam ।
mohādārabhyate karma yattattāmasamucyate ।।Bha Gī।।18-25।।

Meaning: And that work which is performed under delusion, without any regard to consequences, loss, injury to others, and to one's own capacity – is said to be born of *Tamas*.

सत्त्वं सुखे सञ्जयति रजः कर्मणि भारत।

ज्ञानमावृत्य तु तमः प्रमादे सञ्जयत्युत ॥भ गी ॥१४-९ ॥

sattvaṁ sukhe sañjayati rajaḥ karmaṇi bhārata ।
*jñānamāvṛtya tu tamaḥ pramāde sañjayatyuta ।।Bha Gī।।*14-9।।

Meaning: *Sattva* enslaves one to a mood of joy and happiness, and *Rajas* to one of activity, while *Tamas* which veils up knowledge, fills one with negligence and laziness.

2.3.2.2 Guṇās according to Patañjalī Yoga Sūtrās (Saraswati, 2002)

Patañjalī Maharṣi gives a similar definition of *Guṇās* and points out that the objects of perception are the result of the three *guṇās* expressed through Cognition, Activity, and Stability.

प्रकाशक्रियास्थितिशीलं भूतेन्द्रियात्मकं
भोगापवर्गार्थं दृश्यम् ॥पा यो सू ॥२-१८ ॥

prakāśakriyāsthitiśīlaṁ bhūtendriyātmakaṁ
bhogāpavargārthaṁ dṛśyam ||PYS 2-18||

Meaning: The '*Seen*' is of the nature of *guṇas*, Illumination (quality of brightness), activity and inertia; and consists of the elements and sense organs whose purpose is to provide both experience and liberation to the Self. '*Seen*' is a combination of different elements and organs controlled by three *guṇas*.

The entire manifested Universe is based on the three qualities of *Prakṛti*, and according to *Sāṅkhya* philosophy*, Prakṛti* itselfis a combination of three *guṇās* with perfect equilibrium (Muller, 1921). Thus, *guṇās* are at the root of the manifested world, and even the working of the mind and its nature depends upon their manifestation. *Sattva* is a state of equilibrium with least agitation in the mind. The element of freedom is highest in *Sattva* and least in *Tamas* (Ilavarasu, Mohan, & Hankey, 2013).

2.3.3 *Tridoṣās*

Āyurveda's concept of the *tridoṣa* is unique to medical science. This oldest system of medicine states the body is made up of tissues (*dhātu*s), waste products (*malās*), and *doṣās* (loosely translated to Energetic Forces). *Tridoṣās* assist with the creation of all of the various tissues of the body and in removing any unnecessary waste products from the body. These *tridoṣās* also influence all movements, transformations, sensory functions, and many of the other activities in the human body and mind. The *tridoṣās* are *Vāta*, *Pitta,* and *Kapha* (Sharma & Dash, 2005).

2.3.3.1 Vāta

Vāta is rough, cool, light, subtle, mobile, clear, and solid. The *Vāta doṣa* is the most important of the three *doṣās*. If *Vāta* becomes imbalanced for long time, it can also cause an imbalance in the other two *doṣās* (*Pitta* and *Kapha*). *Vāta* is the main driver or mover of the body, including the other two *doṣās*, all the tissues (*dhātus*), and all the waste products (*malās*).

2.3.3.2 Pitta

Pitta is greasy, hot, sharp, fluid, sour, runny, and pungent. The *Pitta doṣa* is associated with fire or heat. *Pitta* is essential in areas where there is transformation, such as gastro-intestinal tract, liver, skin, eyes, and brain.

2.3.3.3 Kapha

Kapha is heavy, cold, soft, greasy, sweet, fixed, and slippery. *Kapha* is the heaviest of the three *doṣās*. It provides the structures and the lubrication that the body needs. These qualities help to counterbalance *Vāta's* movement and *Pitta's* metabolism.

2.4 *TRIDOṢA* AND *TRIGUṆA* CORRELATION

Vāta – is associated with *Rajas guṇa*. *Vāta doṣa* is a combination of *Sattva* and *Rajas*; but is referred to as being predominantly *Rājasic*, as *Rajas* is stronger than *Sattva guṇa*.

Pitta – is associated with *Sattva* and *Rajas guṇās*. *Pitta doṣa* is said to be more *Sāttvic* in nature, even though *Rajas* and *Tamas* are present.

Kapha – is associated with *Tamas guṇa*. *Kapha doṣa* is said to be more *Tāmasic* in nature, though *Sattva* is present to some extent. *Rajas* is not present here.

According to *Āyurveda*, the *Sattva guṇa* is free of diseases. *Rajas* and *Tamas* along with the vitiation of *tridoṣās*, is prone to diseases. *Rajas* is dominated by excessive activity and prompted by imbalanced emotions, and *Tamas* is dominated by laziness, inactivity, delusions, and confusion. Interplay between the body and mind influencing each other requires a holistic approach of treating body and mind and correcting at each *kośa* to try to balance the *doṣās* and transcend from a lower *guṇa* to a higher *guṇa*. **Table 1** summarizes the correlation of *tridoṣās and triguṇās* and **Figure 1** represents their intertwined nature below:

Table 1: **Correlation of *Tridoṣās and Triguṇās***

Doṣa	*Guṇa*
Vāta doṣa	*Satva*↓ and *Rajas*↑
Pitta doṣa	*Satva*↑, *Rajas*↓ and *Tamas*↓
Kapha doṣa	*Tamas*↑, *Satva*↓

↑: predominant; ↓: less dominant

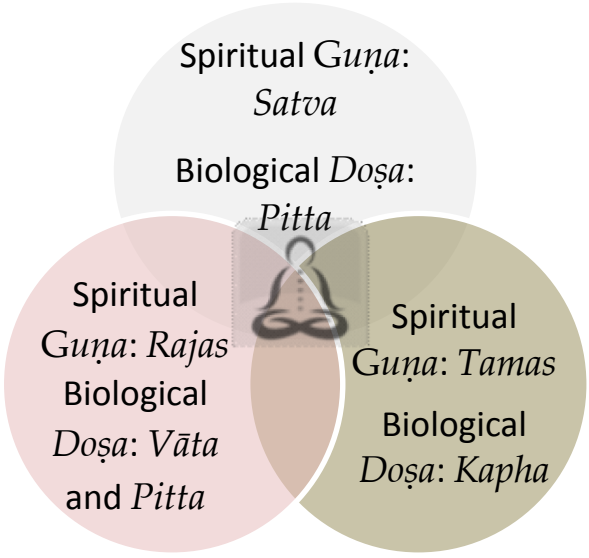


Figure 1: Intertwined nature of *Guṇās* and *Doṣās*

2.4.1 Correlation of *Pañca kośās, Triguṇās* and *Tridoṣās*

As described earlier, *Pañca Kośās* are intertwined layers of human existence. *Triguṇās* are the psychological aspects, and *Tridoṣās* are the physiological aspects. According to *Pañca Kośa* concept, complete health is possible in *Vijnānamaya* and *Ānandamaya Kośās*. According to *Triguṇa* concept, *Sattva* is free of disease, and therefore, *Sattva* is predominant in *Vijnānamaya* and *Ānandamaya Kośās*. According to the *Tridoṣa* concept, *Rajas* and *Tamas* are the vitiating factors that cause imbalance in the *doṣās*. As *Rajas* and *Tamas* are psychological factors, inference could be drawn that *Manomaya Kośa* is where this vitiation of *Rajas* and *Tamas* happen. In the Yogic literature, mind is where all the imbalances happen and percolate to the body. The correlation of all three aspects of human personality and the birth of mind originated diseases / disorders that can lead to physical imbalances are summarized as follows (**Table 2**) and are illustrated in **Figure 2**:

Table 2. Correlation of *Pañca kośās, Triguṇās* and *Tridoṣās*

Kośās	***Guṇās***	***Doṣās***
Ānandamaya kośa	*Satva*	*Pitta* (and balanced *doṣās*)
Vijnānamaya kośa	*Satva is predominant*	*Pitta (*balanced *doṣās)*
Manomaya kośa	*Satva*↓/ *Rajas*↑/ *Tamas*↑ (vitiation of rajas and tamas)	Imbalance of *doṣās* initiated
Prāṇamaya kośa	*Satva*↓/ *Rajas*↑/ *Tamas*↑	Percolation of Imbalanced *doṣās*
Annamaya kośa	*Satva*↓/ *Rajas*↑/ *Tamas*↑	Disturbed *Vāta* / *Pitta* / *Kapha*

↑: predominant; ↓: less dominant

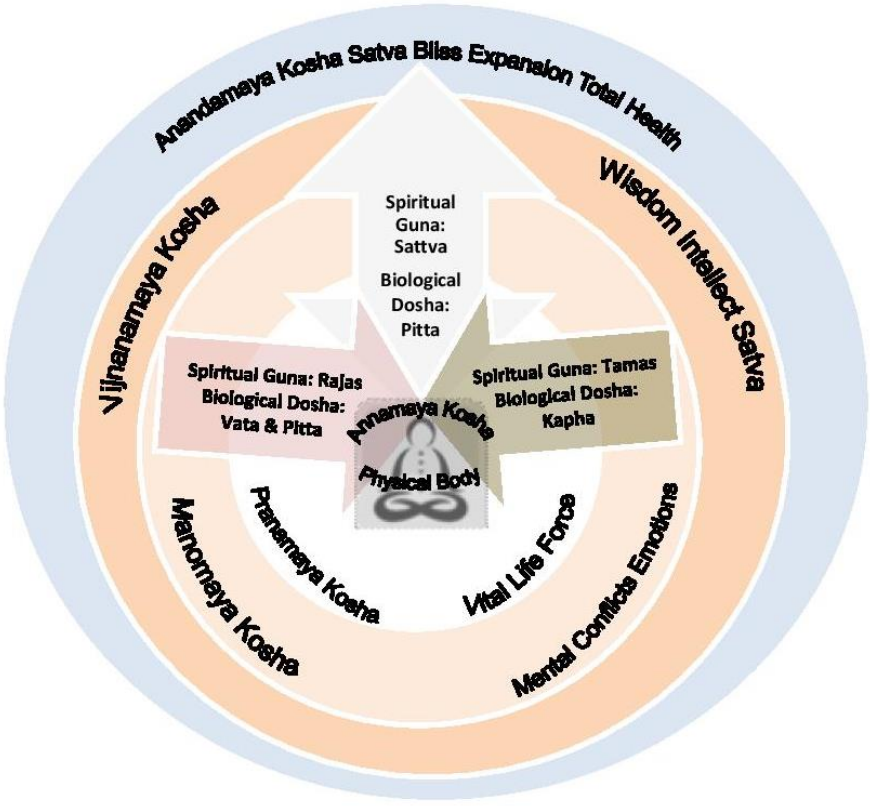


Figure 2: **Interrelated *Pañca kośās, Triguṇās* and *Tridoṣās***

2.5 CONCEPT OF STRESS, ITS CAUSES AND CONSEQUENCES

Stress is the reaction to a demanding situation in the human physiology. Stress can occur at two levels – physical and psychological; physical stress is where the entire physiology is affected, for example, accidents, burns, major surgeries, infections. Psychological stress occurs when under pressure or having difficulty coping with a situation or stimulus. It produces an emotional response, like fear, anxiety, tension, worry, jealousy, hatred, anger, excitement, and emotional conflicts (Baum, 1990).

Stress according to *Yoga* is the speed of thoughts (*vṛttis*), causing imbalance of the mind. The imbalance at the emotional level manifests as upsurges, which are caused by strong likes and dislikes. At the psychological level, the imbalance leads to conflicts and often manifests as an ego-centric behavior. Lack of holistic knowledge and a balanced outlook at the subtle levels are responsible for imbalances found at gross levels (Nagarathna & Nagendra, 2006).

2.5.1 Causes of stress according to *Yoga*

वृत्तयः पञ्चतय्यः क्लिष्टाऽक्लिष्टाः ॥पा यो सू ॥१-५॥

vṛttayaḥ pañcatayyaḥ kliṣṭā'kliṣṭāḥ||PYS 1-5||

Meaning: The mental modifications are of five kinds; some are painful and a few are not painful.

According to *Patañjalī Yoga Sūtras* (Taimni, 1999), when an event or object in the external world is recorded by the senses, a thought wave arises in the mind. The ego sense identifies itself with this wave. If the thought wave is pleasant, the ego sense feels

'I am happy' and if the wave is unpleasant, 'I am unhappy'. This false identification is the cause of all misery.

अविद्यास्मितारागद्वेषाभिनिवेशाः क्लेशाः ॥पा यो सू ॥२-३ ॥

avidyāsmitārāgadveṣābhiniveśāḥ kleśāḥ ||*PYS 2-3*||

Meaning: These obstacles are the causes of man's suffering: ignorance, egoism, attachments, aversion and desire to cling to life.

Patañjalī explains that ignorance creates all obstacles - to regard the non-eternal as eternal, impure as pure, painful as pleasant, and non-atman as atman. Egoism identifies consciousness with that which merely reflects consciousness; Attachment is that which dwells upon pleasure; the desire that arises towards pleasure through the memory enjoyed previously is *raga*; pleasure and *rāga* are inseparable. Aversion is that which dwells upon pain; through the memory of pain, aversion comes towards objects that give pain; the desire to cling to life is inherent in both ignorant and the learned and this is because the mind retains impressions of the death experience from many previous lives (Saraswati, 2002).

In this context*, Bhagavad Gīta* also explains the cause of emotional distress and mental disturbance as follows:

ध्यायतो विषयान्पुंसः सङ्गस्तेषूपजायते ।

सङ्गात्सञ्जायते कामः कामात्क्रोधोऽभिजायते ॥भ गी ॥२-६२ ॥

dhyāyato viṣayānpuṁsaḥ saṅgasteṣūpajāyate ।
saṅgātsañjāyate kāmaḥ kāmātkrodho'bhijāyate ||*Bha gī*|| *2-62*||

Meaning: In one who dwells longingly on sense objects, an inclination towards them is generated. This inclination develops into desire, and desire begets anger.

क्रोधाद्भवति सम्मोहः सम्मोहात्स्मृतिविभ्रमः ।

स्मृतिभ्रंशाद् बुद्धिनाशो बुद्धिनाशात्प्रणश्यति ॥भ गी ॥२-६३ ॥

krodhādbhavati sammohaḥ sammohātsmṛtivibhramaḥ ।
smṛtibhraṁśād buddhināśo buddhināśātpraṇaśyati ।।Bha gī।।2-63।।

Meaning: Anger generates delusion, and delusion results in loss of memory. Loss of memory brings about the destruction of discriminative intelligence, and loss of discriminative intelligence spells ruin to a man.

Brihadāranyaka Upaniṣad defines the nature of mind in a similar way as having desire, determination, doubt, faith, lack of faith, steadfastness, and lack of steadfastness, shame, intelligence and fear.

त्रीण्यात्मनेऽकुरुत इति मनो वचं प्राणं तान्यात्मनेऽ कुरुत अन्यत्रमना अभूवम् नादर्शम् अन्यत्रमना अभूवम् नाश्रौशम् इति मनसा ह्येव पश्यति मनसा श्रुणोति । कामः सण्कल्पो विचिकित्सा श्रद्धाऽश्रद्धा दृतिरदृतिर्ह्रीधीर्भीरित्येतत्सर्व मन एव तस्मादपि पृष्ठत उपस्पृष्टो मनसा विजानाति यः कश्च शब्दो वागेव सा । एषा ह्यन्तमायात्ता एषा हि न प्राणोऽपानो व्यान उदानः समानोऽन इत्येतत्सर्व प्राण एव एतन्मयो व अयमत्मा वङ्मयो मनोमयः प्राणमयः

॥बृ उ ॥१-५- ३ ॥

trīṇyātmane'kuruta iti mano vacaṁ prāṇaṁ tānyātmane' kuruta anyatramanā abhūvam nādarśam anyatramanā abhūvam nāśrauśam iti manasā hyeva paśyati manasā śruṇooti। kāmaḥ saṇkalpoo vicikitsā śraddhā'śraddhā dṛtiradṛtirhrīdhīrbhīrityetatsarva mana eva tasmādapi pṛṣṭhata upaspṛooṣṭo manasā vijānāti yaḥ kaśca śabdo vāgeva sā। eṣā hyantamāyāttā eṣā hi na prāṇoo'pānoo vyāna udānaḥ samānoo'na ityetatsarva prāṇa eva etanmayo va ayamatmā vaṁmayo manoomayaḥ prāṇamayaḥ||Bri U||1-5-3||

Meaning: Three he designed for himself"—that is to say, the mind, the organ of speech and the vital breath; these he designed for himself. They say: "My mind was elsewhere, I did not see it; my mind was elsewhere, I did not hear it." It is clear that a man sees with his mind and hears with his mind. Desire, determination, doubt, faith, lack of faith, steadfastness, lack of steadfastness, shame, intelligence and fear—all this is truly the mind. Even if one is touched from behind, one knows it through the mind; therefore the mind exists. Whatever sound there is, it is just the organ of speech; for it serves to determine a thing, but it cannot itself be revealed. The *prāṇa*, *apāna, udāna, vyāna,* and *samāna* - all these are but the vital breath (*prāṇa*). This body (*Ātma*) consists of these - the organ of speech, the mind and the vital breath.

2.5.2 Consequences of Stress

Emotional imbalances in the form of strong likes and dislikes bring about imbalances in *Prāṇa* (the vital energy) in the *Prāṇamaya Kośa,* causing stress symptoms and health hazards at *Annamaya Kośa* (Atreya & Samvid, 2005).

भृशं स्फुरन्तीष्विछासु मोख्र्ये चेतस्यनिर्जिते ।

दुरन्नाभ्यवहारेण दुर्देशाक्रमणेन च ॥यो वा ॥७१२ ॥

bhṛśaṁ sphurantīṣvichāsu mourkhye cetasyanirjite।
durannābhyavahāreṇa durdeśākramaṇena ca||Yo Vā||712||

दुष्कालव्यवहारेण दुश्क्रियास्फुरणेन च ।

दुर्जनासङ्गदोषेण दुर्भावोभ्दावनेन च ॥यो वा ॥७१३ ॥

duṣkālavyavahāreṇa duśkriyāsphuraṇena ca।
durjanāsaṅgadoṣeṇa durbhāvobhdāvanena ca|| Yo Vā||713||

क्षीणत्वाद्वा प्रपूर्नत्वान्नाडीनां रन्ध्रसन्ततौ ।

प्राणे विधुरतां याते काये तु विकलीकृते ॥यो वा ॥७१४ ॥

kṣīṇatvādvā prapūrnatvānnāḍīnāṁ randhrasantatau।
prāṇe vidhuratāṁ yāte kāye tu vikalīkrute||Yo Vā||714||

दौः स्थित्यकारणं दोषात् व्याधिर्देहे प्रवर्तते ॥यो वा ॥७१५ ॥

dauḥ sthityakāraṇaṁ doṣāt vyādhirdehe pravartate||Yo Vā||715||

Meaning 712-715: When desires are springing up excessively, when stupidity in the mind is not conquered, by taking bad food, by occupying bad places, by working at improper times, by the arising of evil actions, by the bad consequence of association with evil persons and by the generation of bad emotions, when the vital energy is reduced to an adverse state due to depletion or excessive fullness in the continuous channels of *nadis* (arteries, veins or nerves), and the body is (consequently) weakened, physical disease, the cause of indisposition, arises in the body due to (such) defects.

चित्ते विधुरिते देहः संक्षोभमनुयात्यलम् ।

संक्षोभात्साम्यमुत्सृज्य वहन्ति प्राणवयवः ॥यो वा ॥७१६ ॥

citte vidhurite dehaḥ saṅkṣobhamanuyātyalam।
saṅkṣobhātsāmyamutsṛjya vahanti prāṇavayavaḥ||Yo Vā||716||

Meaning: When the mind is afflicted, the body completely follows the disturbance. Due to the disturbance, the vital airs (or energies) flow, abandoning evenness.

द्विविधो व्याधिरस्तीह सामान्यः सार एव च ।

व्यवहारस्तु सामान्यः सारो जन्ममयः स्मृतः ॥यो वा ॥७२६ ॥

dvividho vyādhirastīha sāmānyaḥ sāra eva ca।
vyavahārastu sāmānyaḥ sāro janmamayaḥ smṛtaḥ||Yo Vā||726||

Meaning: Disease is of two kinds here – the ordinary, and the essential (or the ultimate one). The usual one is ordinary. The essential (or the ultimate) one is considered as consisting of birth (or life in the world).

Figure 3 summarizes the *Yogic* classification of diseases as understood from the text *Yoga Vāsiṣṭa*. Diseases *(Vyādhis*) are twofold – *Ādhi* and *Anādhi vyādhis*. *Ādhi vyādhis* are twofold, *Sāmānya* (ordinary/mind originated) and *Sāra* (essential). The ordinary diseases are normally produced during interactions with the world and can be termed as psychosomatic ailments. These can be treated with suitable techniques and congenial atmosphere such as life style changes. The latter, essential diseases (such as congenital birth defects), which cause the birth of the physical body can be destroyed only by self realization. *Anādhi vyādhi* is not mind originated and could include infections, contagious diseases; and can be handled with available medicines, prayers and good actions.

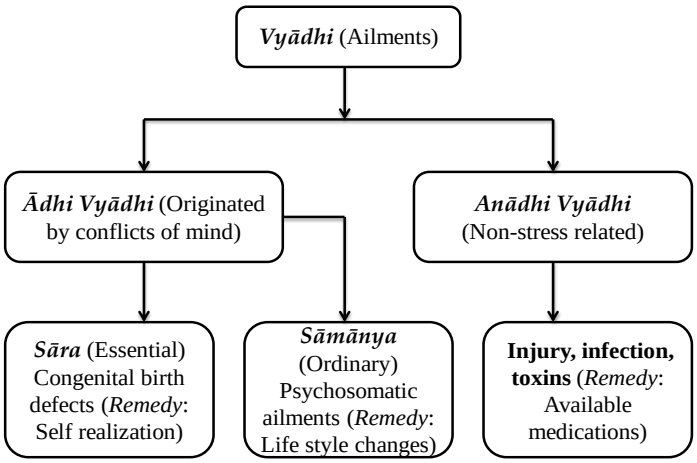


Figure 3: Yogic classification of diseases

Among the two types of *Ādhis*, the *Sāmānya* (ordinary) type corresponds to the modern psychosomatic ailments. When the mind is agitated during the interactions with the world at large, the physical body also follows in its wake. These agitations cause violent fluctuations in the flow of *prāṇa* in the *nāḍīs*. This process is explained in detail in the next few verses of *Yoga Vāsiṣṭa.*

प्राप्तेनाभिमतेनैव नश्यन्ति व्यावहारिकाः ।

आत्मज्ञानम् विन सारो नाधिर्नशयति राघव ॥यो वा ॥७२७ ॥

prāptenābhimatenaiva naśyanti vyāvahārikāḥ।
ātmajñānam vina sāro nādhirnaśayati rāghava||Yo Vā||727||

Meaning: The usual (ailments) perish just by obtaining what is wanted (or approved). Rama, without self-knowledge, the essential (or ultimate) mental afflictions do not perish.

आधिव्याधिविलासानां राम साराधिसंक्षयः ।

सर्वेषां मूलहा प्रावृण्नदीव तटवीरुधाम् ॥यो वा ॥७२८ ॥

ādhivyādhivilāsānāṁ rāma sārādhisaṅkṣayaḥ।
sarveṣāṁ mūlahā prāvṛṇnadīva taṭavīrudhām ||Yo Vā||728||

Meaning: Rama, the destruction of the essential (or ultimate) mental affliction is the one that removes the roots of all the plays of mental afflictions and physical ailments, as a river in the rainy season (removes the roots) of creepers on the banks.

असमं वहति प्राणे नाड्यो यान्ति विसंस्थितिम् ।

काश्चिन्नाड्यः प्रपूर्णत्वं यान्ति काश्चिच्च रिक्तताम् ॥यो वा ॥७१७ ॥

asamaṁ vahati prāṇe nāḍyo yānti visaṁsthitim।
kāścinnāḍyaḥ prapūrṇatvaṁ yānti kāścicca riktatām||Yo Vā||717||

Meaning: When the vital energy flows unevenly, the channels of such energy are reduced to an adverse state. Some such channels go to the state of excessive fullness and some others to the state of depletion.

कुजीर्णत्वमजीर्णत्वमतिजीर्णत्वमेव वा ।

दिषायैव प्रयात्यन्नं प्राणसञ्चारदुषकरम् ॥यो वा ॥७१८ ॥

kujīrṇatvamajīrṇatvamatijīrṇatvameva vā|
diṣāyaiva prayātyannaṁ prāṇasañcāraduṣakaram||Yo Vā|| 718||

Meaning: (Under such circumstances, there arises) bad digestion, indigestion or excessive digestion. Due to the methodical movement of the vital energy, the food only sets out for (causing) harm.

2.6 IBS AS A LIFESTYLE DISORDER

IBS can be considered as a modern day lifestyle disorder. The clinical features are abdominal pain, distension, and altered bowel habits, traceable to brain-gut dysfunction and life style habits such as wrong eating habits. The co-morbidities associated with IBS, such as anxiety, depression, fatigue, headaches, can be correlated to mental conflicts. Although the causes of IBS are not clear, wrong eating habits, lifestyle of stress, and the co-morbidities could be equated to the *Sāmānya* component of *Ādhija Vyādhi* (Fig 4). Two factors are enlisted on how the *Ādhija Vyādhi* manifests: a) genetic predisposition to a particular disease and b) an inherent weak / vulnerable organ in an individual (Nagarathna & Nagendra, 2002). The target organ in each individual might be different depending on the predisposition, but wrong lifestyle is the root cause for all imbalances (mental conflicts) at the *Manomaya Kośa*. The starting point of mind body disorders is the voluntary speed at the mind level that results in speed of mind, which is the definition

of stress according to Yoga. The speeded-up rewinding negative emotional response becomes habituated to concretize as a personality trait. This gradually percolates to *Prāṇamaya Kośa* and then to *Annamaya Kośa*.

The *Prāṇa* flows in wrong directions and wrong quantities. Due to these disturbances of the *Prāṇa*, the food does not get digested properly. There arises *Kujīrṇatvam* (wrong digestion), *Atijīrṇatvam* (over digestion), and *Ajīrṇatvam* (non-digestion). When this improperly digested food settles down in the body, it results in psychosomatic ailments. The present study focuses on Irritable Bowel Syndrome, which can be directly related to stress. Treatment with Yoga is given in detail in later part of the thesis. **Figure 4** schematically represents the mental conflicts percolating as disease at body level, in particular, IBS.

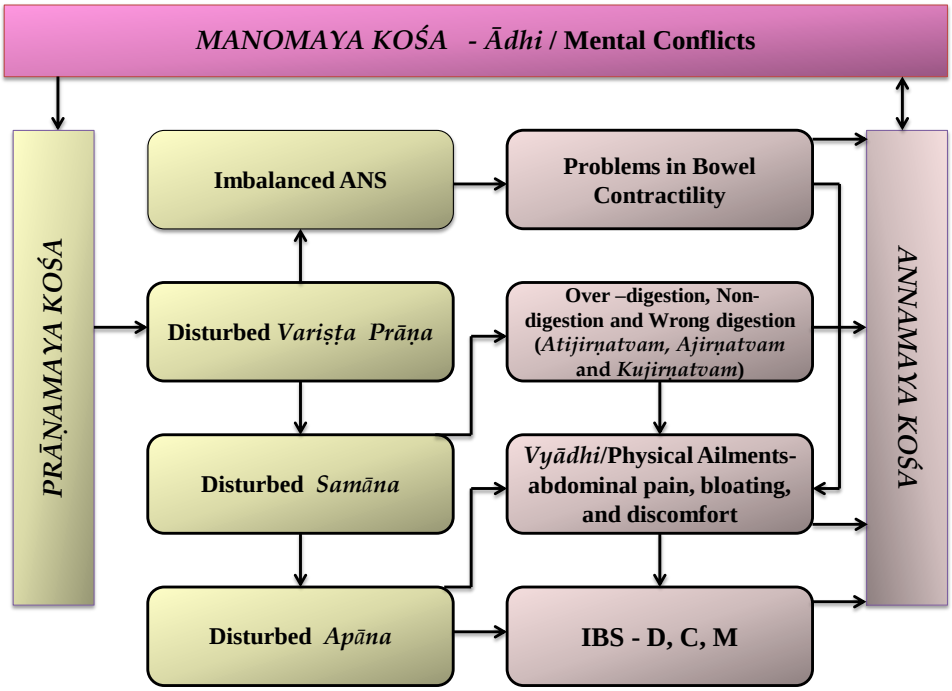


Figure 4: Schematic representation of *Ādhi* becoming *Vyādhi* in the context of IBS.

2.7 YOGIC MANAGEMENT OF MENTAL CONFLICTS (IMBALANCES)

As mentioned earlier, a state of *Sattva*, which is dominant in *Ānandamaya Kośa*, is complete health according to various scriptures. At *Vijnānamaya Kośa*, *Sattva* is dominating, so total health is possible in this *Kośa* too. *Sattva* is balanced and well controlled emotions, mind, and senses, leading to balanced *Prāṇamaya Kośa* and a homeostasis at the *Annamaya Kośa*, hence total health. We discuss the *Triguṇās, Tridoṣās* and *Pañca Kośa* from the mind level.

Rajas is associated with action, positive and negative emotions. The mind is always under sway of ambitions, desires, and worldly status. *Tamas* is associated with inaction, laziness, and mind under distress, depression, vacillation and overbearing insolation. There would be an imbalance because of the interactions of *Rajas* and *Tamas* with the vitiated *Doṣās, which* would percolate to the physical body. The disturbance at the *Manomaya Kośa* gives way to *Sāmānya Vyādhis* or stress-originated psychosomatic disorders. This is the *Prasava* or birth of the imbalances in the physical body. The imbalances at the *Manomaya Kośa* impact the *Prāṇamaya Kośa*, where wrong quantities and wrong directions of *Prāṇa* disturb this *Kośa*. This leads to an imbalanced *Annamaya Kośa*, where wrong digestion, non-digestion, or over digestion takes place. This wrong digestion in the case of IBS / *Grahaṇi* results in abdominal pain, constipation, diarrhea, and a host of other problems. The *Pratiprasava* or the reversal of the imbalances starts

with the treatment of these disorders at body level with *Yoga*, *Āyurveda* treatment at a holistic level of 'mind-body', and bringing homeostasis to the system. This would bring balance at *Prāṇamaya Kośa* and *Manomaya Kośa* where the balance of mind happens and leads to a *Sāttvic* state. **Figure 5** illustrates the process of *Prasava and Pratiprasava* of disease in a holistic model, in particular, IBS / *Grahaṇi*. We look into the specifics of *Āyurvedic* treatment of *Grahaṇi* (a limited part of it) and *Yoga* treatment in the next sections.

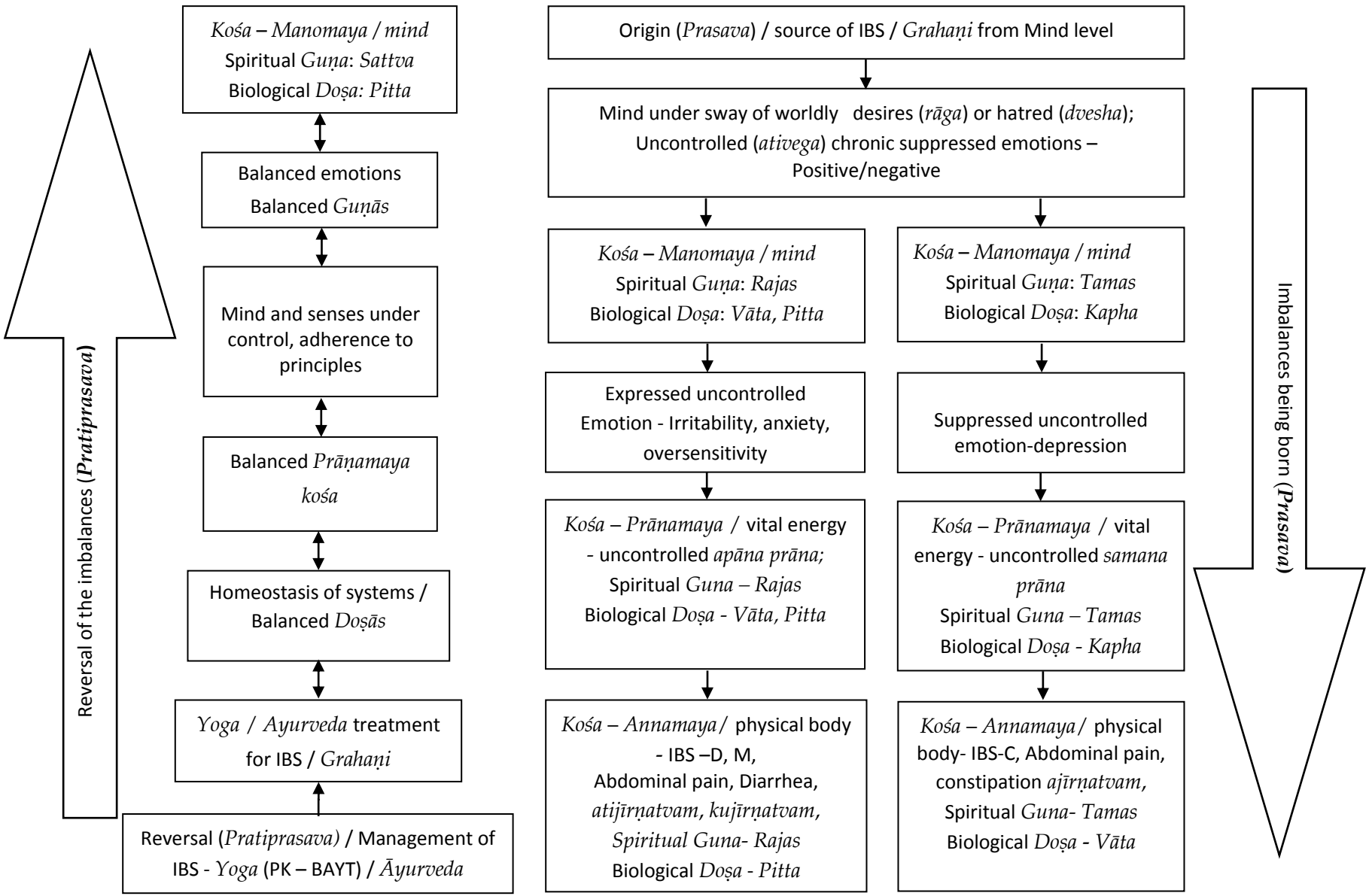


Figure 5: *A holistic Model of IBS / Grahaṇi, as mind-body disease /disorder based on vedic concepts (Guṇās, Doṣās, Kośās)*

2.8 AYURVEDA APPROACH OF MANAGING *GRAHAṆI* / IBS

Āyurveda agrees with the view of *Guṇās* (Sharma & Dash, 2005) of ancient Indian scriptures. It is in agreement that mind is in the domain of *Sattva* in its natural state. *Sattva* creates clarity, concentration, and devotion, whereas, *Rajas* and *Tamas* are factors of mental disharmony, causing agitation and delusion. Few concepts of *Āyurveda* and the holistic approach, 'mind body', in the treatment of the patient were mentioned earlier. A brief description of *Grahaṇi* and its treatment is enlisted.

2.8.1 *Grahaṇi*

In the ancient system of Indian medicine *Āyurveda*, (developed around 3500 BC), a disorder known as *Grahaṇi*, is similar to the modern day IBS (Kulkarni & Tiwari, 2014). Some of the symptoms of *Grahaṇi* are applicable to IBS. *Grahaṇi* is the seat of *agni* or the digestive fire. Normally, it holds up the food (until it is digested) and releases it after it is digested. If *Grahaṇi* is deranged due to an imbalance in the *Tridoṣās*, the *Jatharāgni* (digestive fire) becomes weak, releasing the ingested material even in undigested conditions. *Grahaṇi Roga* is mentioned in the *Caraka Samhita*, *Cikitsa Sthāna*, chapter 15.

2.8.2 Symptoms of *Grahaṇi*

Āyurveda characterizes the disease by the passage of stools alternating with constipation or diarrhea and with undigested food particles. This disease is also associated with thirst, distaste, blackouts, pedal edema, pain in the bone, fever (which is not found in IBS), and vomiting (Kulkarni & Tiwari, 2014). It is a motility disorder involving the entire gastrointestinal tract (GI), causing recurring upper and lower GI symptoms, including variable degrees of abdominal pain, constipation and diarrhea, and abdominal bloating.

2.8.3 Types of *Grahaṇi*

Āyurveda indicates that there are four different types of *Grahaṇi*. They are 1) *Vāta Grahaṇi* (Constipation- predominant), 2) *Pitta Grahaṇi* (Diarrhea-predominant), 3) *Kapha Grahaṇi* (Dysentery-predominant), and 4) *Tridoṣa Grahaṇi* (Complex IBS), all three *doṣās* are involved (*vāta*, *pitta*, and *kapha*). Other literature also describes two chronic types of IBS: accrual IBS (*samgraha Grahaṇi*) and an incurable type called tympanitis predominant IBS (*ghatiyanthra Grahaṇi*) (Dash & Kashyap, 1994). However, IBS is mainly classified as three types, IBS-Constipation; IBS-Diarrhea; and IBS-Mixed or alternating between constipation and diarrhea. We will limit the description to *Vāta Grahaṇi* and *Pitta Grahaṇi*, as both are similar to the three types of IBS.

2.8.4 Clinical features of *Grahaṇi*

2.8.4.1 Vāta Grahaṇi

This type of IBS presents the clinical features of dryness in skin, mouth, or throat; constipation or alternating constipation and diarrhea; thirst; bloating; flatulence; and a cold feeling. It is also associated with back or groin pain, weight loss, debility, anal fissures, insomnia, and anxiety.

2.8.4.2 Pitta Grahaṇi

This type of IBS clinically shows the presence of heartburn, thirst, feeling hot, irritable or angry, inflammation, sweating and fever, fluid, and foul smelling stools and belching.

2.8.5 *Āyurvedic* Treatment of *Grahaṇi*

Āyurvedic treatment of *Grahaṇi* focuses on specific treatment regimen to balance the imbalanced *doṣās*. The main cause of *Grahaṇi* is *mandāgni* (weak digestive fire), and any treatment of *Grahaṇi* focuses on increasing or revitalizing the digestive fire. The general line of treatment is: *Snehanam* (Oleation), *Swedanam* (sudation), *Suddhi* (purification), *Langhanam* (fasting), *Deepanam* (gastric stimulation), *Oushadha prayoga* (use of herbal powders). *Āyurvedic* treatment is based on the nature of the stool with (*sāma*, presence of, *āma*, a toxin) or without (*nirāma*, absence of *āma*) enterotoxin stool. *Āyurveda* utilizes not only diet, herbs, and *Yoga*, but also lifestyle advice, so that treatment of *Grahaṇi* can be more specific and successful.

2.8.5.1 Vāta Grahaṇi

The first line of treatment is administration of digestives like *chitrakādi vati* and *shankha vati* to eliminate enterotoxin. An administration of medicinal ghee preparations such as *Dashamuladi ghrita* and *Thryushanadi ghrita* is recommended for digestion. Herbs such as ginger, cloves, fennel, cumin, and cinnamon are used to stimulate digestive enzymes. *Haritaki* (*terminalia chebula*) helps in clearing excess *vāta* from the bowel, and *Triphala* is good for constipation. *Shatavari* (*Asparagus racemosus*), *Ashwagandha* (*Withania somnifera*), and sesame oil, all calm *vāta* and this is often given as an enema.

2.8.5.2 Pitta Grahaṇi

Emesis (*vāmana*) is the first line of treatment in diarrhea-predominant IBS, followed by the herbal treatments. Herbs that are used to balance pitta, include *Amalaki* (*Emblica officinalis*) for balancing *doṣas*, coriander water, and *Musta* (*Cyperus rotundus*) for improving intestinal absorption and stopping diarrhea.

2.8.6 Diet and lifestyle changes in *Grahaṇi*

A light *Sāttvic* food is the prescribed diet for *Grahaṇi*. Patients with abdominal distention and increased flatulence are suggested a dietary reduction or elimination of beans, cabbage, and other foods containing fermentable carbohydrates. Reduced intake of apple and grape juice, bananas, nuts, and raisins may also lessen the incidence of flatulence. Patients with evidence of lactose intolerance should reduce their intake of milk and dairy products. Generally, in the treatment of *Grahaṇi*, the use of Buttermilk (*takra*) is

emphasized. As a lifestyle change, the patients are advised to identify and remove intolerant foods from their diet. To improve gut motility, water intake along with soluble fiber like psyllium (*Isabgol*) is encouraged.

Yoga is a prescribed mind-body therapy in *Āyurveda* in the treatment of *Grahaṇi*. Postures such as *bhujangāsana*, *śalabhāsana*, *śavāsana*, and *prāṇāyāma* are prescribed (Bhaduri Tapas, Biswas, Panja, & Mahapatra Dass, 2013).

2.9 MANAGING IBS WITH *YOGA*

Yoga is to unite the individual self with the universal self. "*Yoga* is an expansion of the narrow constricted egoistic personality to a pervasive, eternal, and blissful state of reality moving away from individual level to perfection" (Nagarathna & Nagendra, 2006). Following are various views from scriptures on how *Yoga* is a tool in treating the mind and body.

आधिक्षयेणाधिभावाः क्षीयन्ते व्याधयोऽप्यलम् ॥यो वा ॥७२१ ॥

ādhikṣayeṇādhibhāvāḥ kṣīyante vyādhayo'pyalam||Yo Vā||721||

Meaning: By the removal of mental afflictions, physical diseases arising from mental afflictions are also completely destroyed.

According to *Patañjalī, Yoga* is a conscious process of gaining mastery over the mind. Similar opinion is found in *Bhagavad Gīta.*

योगश्चित्तवृत्तिनिरोधः ॥पा यो सु १-२ ॥

yogaścittavṛttinirodhaḥ || PYS 1.2||

Meaning: *Yoga* is the controller of thought-waves in the mind

योगस्थः कुरु कर्माणि सङ्गं त्यक्त्वा धनञ्जय ।

सिद्ध्यसिद्ध्योः समो भूत्वा समत्वं योग उच्यते ॥भ गी ॥२-४८ ॥

yogasthaḥ kuru karmāṇi saṅgaṁ tyaktvā dhanañjaya ।
siddhyasiddhyoḥ samo bhūtvā samatvaṁ yoga ucyate ||Bha gī||2-48||

Meaning: Engage yourself in action with the mind steadfast in *Yoga*. Abandon attachments, O Arjuna, and be unperturbed in success and failure. This unperturbed sameness in all conditions is *Yoga*.

2.9.1 Attaining Balanced State of Mind with Behavior and Food

Further ways of acquiring a balanced state of mind were discussed in the scriptures by ways of behavior and eating habits, specifically in *Bhagavad Gīta*:

मनः प्रसादः सौम्यत्वं मौनमात्मविनिग्रहः ।

भावसंशुद्धिरित्येतत्तपो मानसमुच्यते ॥भ गी ॥१७-१६ ॥

manaḥ prasādaḥ saumyatvaṁ maunamātmavinigrahaḥ ।
bhāvasaṁśuddhirityetattapo mānasamucyate ||Bha gī||17-16||

Meaning: Serenity of mind, gentleness, moderation in speech, self-control, and purity of heart – these are called the austerity of mind.

युक्ताहारविहारस्य युक्तचेष्टस्य कर्मसु ।

युक्तस्वप्नावबोधस्य योगो भवति दुःखहा ॥भ गी ॥६-१७ ॥

yuktāhāravihārasya yuktaceṣṭasya karmasu ।
yuktasvapnāvabodhasya yogo bhavati duḥkhahā ।।Bha gī।।6-17।।

Meaning: For one who is temperate in food and recreation, who is detached and self-restrained in work, who is regulated in sleep and vigil – *Yoga* brings about the cessation of the travail of *Samsāra.*

आयुःसत्त्वबलारोग्यसुखप्रीतिविवर्धनाः ।

रस्याः स्निग्धाः स्थिरा हृद्या आहाराः सात्त्विकप्रियाः ॥भ गी ॥१७-८ ॥

āyuḥsattvabalārogyasukhaprītivivardhanāḥ ।
rasyāḥ snigdhāḥ sthirā hṛdyā āhārāḥ sāttvikapriyāḥ ।।Bha gī।।17-8।।

Meaning: Persons who are *sāttvic* by nature like foods that promote longevity, vitality, energy, health, happiness and cheerfulness, as also those that are juicy, soft, nourishing and agreeable.

Purity of food has been given much importance, since the body and the mind is formed out of the eaten food and are influenced by it. *Bhagavad Gīta* enumerates the qualities of food which people dominated by the three constituents of Nature prefer. It may also be taken that the consumption of foods belonging to the types mentioned, could enhance the particular elements in a person – be it *Sattva*, *Rajas* or *Tamas*. *Patañjalī* explains the eight limbs of Yoga to achieve the necessary health, transcending from lower to higher levels, from *Annamaya* to *Ānandamaya Kośa*.

यमनियमासनप्राणायामप्रत्याहारधारणाध्यानसमाधयोऽष्टावङ्गानि ॥पा यो सू॥ १-२९॥

yamaniyamāsanaprāṇāyāmapratyāhāradhāraṇādhyānasamādhayo'ṣṭāvaṅgāni ||PYS 1.29||

Meaning: The limbs of the eight-fold path are as follows: respect for others (*yama*) and yourself (*niyama*); harmony with your body (*āsana*), your energy (*prāṇāyāma*), and your emotions (*pratyāhāra*), your thoughts (*dhāraṇa*), contemplation (*dhyāna*), ecstasy (*samādhi*).

Yoga as a therapeutic tool brings about a *pratiprasava*, reversal of the imbalances in the IBS patients, from illness to a happy, healthy, and harmonious state, as shown in **Figure 5**. *Aṣṭānga Yoga* brings harmony to the body at various levels. Based on the understanding from the ancient scriptures, we propose a model in which all layers of human existence are addressed and balanced to lead the IBS patients to homeostasis.

2.9.2 *Yoga* as Remedial Therapy for Management of IBS

Long standing persisting anxiety, anger, or depression (stresses) that lead to mind-body illnesses are the habituated pattern of responses characterized by this rewinding violent loop of thoughts. Hence the remedy is to slow down (*Praṣamana*) these looping thoughts that would have gathered enough power to disturb the grosser layers of *Prāṇamaya* and *Annamaya Kośās* (Atreya & Samvid, 1993). According to *Patañjalī*, mastery over the modifications of the mind is *Yoga* (Saraswati, 2002). *Pañca Kośa* -Balanced Approach of

Yoga Therapy (*PK*-BAYT) utilizes mind-body-breath healing techniques to balance and harmonize the disturbances of psychosomatic ailments at all the five levels of our existence (Kavuri, Raghuram, Malamud, & Selvan, 2015). Physical exercise is a key component to maintain health at *Annamaya Kośa*. Physical movements with breathing are emphasized at this *Kośa* - breathing practices to expand lung capacity, loosening practices to stretch and relax the muscles and loosen the joints. *Yoga* postures can provide the strength and endurance to the physical body and provide deep relaxation to the body and mind. Varying postures are used based on the specific ailment. *Kriyās* (cleansing techniques) are also used in enhancing the treatment to the physical layer. At *Prāṇamaya Kośa*, various breathing practices are used to expand the lung capacity and to balance the breath in order to impact the functioning of the cells by calming the nervous system. The first step is to master the *Āsana* or posture to control the body and sit comfortably for a length of time to practice *Prāṇāyāma* (Sivananda, 1997). This helps to achieve varying breathing exercises and get relief from the dysfunctional parts of our body.

At *Manomaya Kośa*, various levels of meditation that includes *Pratyāhāra* (withdrawal of mind from the objects of sense perception), *Dhāraṇa* (focusing on a single thought), *Dhyāna* (effortless flow of a single thought in the mind), and *Samādhi* (merger in the object of meditation) (Saraswati, 2002) are used to calm down the mind. Notional corrections, self-analysis to enhance better judgment, are some techniques that are helpful in balancing the *Vijnānamaya Kośa*. At *Ānandamaya Kośa*, action-in-relaxation is

practiced to experience bliss continually. **Table 3** enlists the general benefits of *Pañca Kośa* -Balanced Approach of *Yoga* Therapy (*PK*-BAYT).

Table 3. General benefits of PK-BAYT

Kośa	Techniques	Effects
Annamaya Kośa	Breathing practices	Expansion of lung capacity
	Loosening practices	Loosen the joints, removes lethargy from mind-body complex
	Āsanās	Physical revitalization, deep relaxation and calmness of the mind
	Relaxations (IRT, QRT, DRT)	Relaxes the body, various organs and mind
Prāṇamaya Kośa	*Kriyās*	Cleansing of the lungs, builds stamina
	Prāṇāyāma	Regulation and control of breath and remove random agitations in the flow of prana
Manomaya Kośa	Meditation	Culturing of emotions, mind by relaxed dwelling in a single thought
Vijnānamaya Kośa	Yogic counseling	Knowledge brings about acceptance, letting go of likes and dislikes and hence the agitations of mind are lessened
Ānandamaya Kośa	Work in blissful awareness	Learning to be detached from fruits of action and maintain equipoise at all times

In light of the knowledge of ancient scriptures, *Pañca Kośa* -Balanced Approach of Yoga Therapy, and various aspects of traditional Yoga (*Patañjalī* and *Yoga Vāsiṣṭa*) are used to create a Remedial *Yoga* Module for the management of IBS symptoms. A brief summary of *Yoga* remedy that would be most applicable for IBS patients with the goal of balancing each *Kośa* is given in **Table 4**.

Table 4: *Pañca Kośa* -Balanced Approach of Yoga Therapy (*PK*-BAYT) for IBS

Layers/ *kośās*	**Natural State**	**Altered State**	**Yogic Remedy**
Physical (*Annamaya*)	Relaxed	Muscular tensions, abdominal pain, bloating, constipation, diarrhea	Stimulate the body with various loosening practices, relax with postures, cleanse the internal organs with cleansing techniques
Life force (*Prāṇamaya*)	Slow Rhythmic Breath	Haphazard breathing, wrong direction, wrong quantities, imbalances	Slow down the breath with breath control, balance the flow of vital life force
Mind (*Manomaya*)	Calm State	Mental agitations, stress, anxiety, depression	Calm down the mind with meditation, devotion
Intellectual (*Vijnānamaya*)	Wisdom	Wrong perceptions, distorted cognition, lack of discrimination	Notional corrections and self-inquiry for better judgment, increased self confidence
Bliss (*Ānandamaya*)	Harmony	Disharmony, unhappiness	Action in relaxation, to experience the bliss continuously, selflessness, happiness within

The *Yoga* module was designed to cover the whole body with particular focus on the abdominal region for the IBS patients. Stretching and twisting of the abdomen with awareness that offers deep local rest to the abdominal viscera were emphasized; this

would help in alleviating distension and pain in the abdomen. *Uddiyāna bandha* (abdominal lock) and *Kriyās* (Saraswati, 1997), like *agnisāra* (rigorous movement of the abdominal muscles) and *Viparitakaraṇi kriya* (cleansing breath in half shoulder stand) are considered very helpful for IBS patients. *Prāṇāyāma* relevant to IBS, in harmonizing the autonomic nervous system, such as slow sectional breathing, alternate nostril breathing, and cooling *Prāṇāyāma,* have been included. A-U-M *meditation* and OM *meditation* are included to calm down the mind. The practices designed are - breathing practices, abdomen-stretching and twisting postures, and resting the body and systems with relaxation to give relief to the symptoms. This module emphasizes on "mind-body-breath" connection. As one becomes more involved with *meditation*, the mind becomes silent and with a sense of expanded awareness, rises to a higher state of consciousness. This silence seems to be the 'healer within' that can help these patients to reverse the long-standing imbalances of the mind. **Table 5** summarizes the RYM practices of one hour developed for IBS patients.

Table 5. Protocol of One Hour Remedial *Yoga* Module used for IBS

	Name of *Yoga* Practice	Number of rounds	Duration (minutes)
Starting Affirmation (A-U-M, sound three times, OM, three times)			**2 min**
Breathing Practices			**5 min**
1	Hands-stretch breathing	5 x 3	2 min
2	*Vyāghrāsana /* Tiger pose breathing	5	1 min
3	*Saśānkāsana/* Moon pose breathing	5	1 min
4	*Padottānāsana*/ Straight leg raise breathing (supine position, both legs)	5	1 min
***Śavāsana* / Instant Relaxation**			**2 min**
***Sithilikarana Vyāyāma*/ Loosening exercises**			**6 min**
1	Forward and backward bending	20	2 min
2	Side bending	10	1 min
3	Twisting	10	1 min
4	*Pavanamuktāsana Kriya*/ Wind relieving pose with leg rotation	5 + 5 x 2	2 min
***Śavāsana* / Quick Relaxation**			**3 min**
***Āsanas*/ Postures- Standing, Sitting, Prone, Supine**			**18 min**
1	*Ardhakati cakrāsana/* half-waist wheel pose	1 + 1	2 min
2	*Ardha cakrāsana*/ Half wheel pose	1	1 min
3	*Pādahastāsana*/ Hands to feet pose	1	1 min
4	*Trikoṇāsana*/ Triangle pose	1 + 1	2 min
5	*Parivritta trikoṇāsana*/ Revolved triangle pose	1 + 1	2 min
6	*Vrikśāsana*/ Tree pose	1 + 1	2 min
7	*Vakrāsana*/ Half spinal twist	1 + 1	2 min
8	*Paścimottānāsana/* Seated forward bend pose	1	1 min
9	*Bhujangāsana*/ Cobra pose	1	1 min
10	*Śalabhasana*/ Locust pose	1	1 min
11	*Sarvāngāsana*/ Shoulder stand	1	1 min
12	*Viparitakaraṇi* with wall support/ Legs up the wall	1	1 min
13	*Matsyāsana*/ Fish pose	1	1 min
***Śavāsana* / Deep Relaxation**			**6 min**
***Kriyās*/ Cleansing and *Prāṇāyāma* / Regulated Breathing**			**11 min**

1	*Uddiyāna Bandha* and *Agnisāra*/ Abdominal lock and rigorous movement of abdomen	3 (30 count)	3 min
2	*Kapālabhāti*/ Forceful exhalation	1 (60 count)	1 min
3	*Vibhāgiya Śvāsana*/ Sectional breathing	5	1 min
4	*Nādiśuddhi prāṇāyāma/* Alternate nostril breathing	9	3 min
5	*Sitali/* Cooling *prāṇāyāma*	5	1 min
6	*Sitkāri*/ Cooling *prāṇāyāma*	5	1 min
7	*Bhrāmari*/ M-chanting	5	1 min
***Dhyana*/ Meditation :**			**6 min**
1	*Nādānusandhāna* / *Yoga* of Sound (A-U-M)	9	3 min
2	OM meditation (OM)	9	3 min
Closing Affirmation - OM three times			**1 min**

5x3– Three positions of hand stretch; 5+5x2– 5 rounds each clock wise and anti clock wise each leg; 1+1– on both sides.

To conclude, we attempted to provide a distinct synthesis of the Eastern (India) scriptural concepts of IBS as of mental origin, and thus, *Yoga* approach of managing IBS. The *Yoga* module comprises of the essential components of traditional *Yoga* i.e. postures, breathing and meditation, which can be easily practiced by most patients with the least complications to enhance the therapeutic impact on IBS. Importantly, *Yoga* modality is cost effective in managing IBS and its related co-morbidities, like anxiety, depression, and fatigue. This module was administered on few patients for a period of two weeks to test for its practicality and feasibility. After the feedback from these patients, this module was implemented in the present randomized controlled trial.

CHAPTER-3

LITERATURE SURVEY OF SCIENTIFIC STUDIES

3. LITERATURE SURVEY OF SCIENTIFIC STUDIES

3.1 DEFINITION, CLASSIFICATION AND SYMPTOMS

Irritable bowel syndrome (IBS) is a common disorder that affects the large intestine (colon) and commonly causes cramping, abdominal pain, bloating, gas, diarrhea, and constipation. IBS is a chronic condition that needs to be managed long-term.

IBS can be classified as either diarrhea-predominant (IBS-D), constipation-predominant (IBS-C), or with alternating stool pattern (IBS-A) or pain-predominant (Holten, Wetherington, & Bankston, 2003). In some individuals, symptoms of IBS may begin after an episode of acute gastroenteritis. This post-infective syndrome has consequently been termed 'post-infectious IBS' (IBS-PI) (Thabane & Marshall, 2009).

The signs and symptoms of IBS can vary widely from person to person and often resemble those of other diseases such as ulcerative colitis or celiac disease. For most people, IBS is a chronic condition with varying severity of signs and symptoms. The primary symptoms of IBS are abdominal pain or discomfort in association with frequent diarrhea or constipation and a change in bowel habits (Schmulson & Chang, 1999). In addition, there may be urgency for bowel movements, a feeling of incomplete evacuation (tenesmus), bloating, or abdominal distension (Talley, 2006). In some cases, the symptoms are relieved by bowel movements. People with IBS, more commonly than others, have gastro esophageal-reflux, symptoms relating to the genitourinary system, chronic fatigue syndrome, fibromyalgia, headache, backache, and psychiatric symptoms, such as depression and anxiety (Talley, 2006; Whitehead,

Palsson, & Jones, 2002). About a third of men and women who have IBS also report sexual dysfunction typically in the form of decreased libido (Sperber & Dekel, 2010). Some studies indicate that up to 60% of people with IBS also have a psychological disorder, typically anxiety or depression (Dekel, Drossman, & Sperber, 2013; Singh et al., 2012).

3.2 EPIDEMIOLOGY OF IBS

Population-based studies estimate the prevalence of IBS around the globe at 10-20%. Of the people with IBS, approximately 10-20% seek medical care. An estimated 20-50% of gastroenterology referrals relate to this symptom complex (Brandt et al., 2009). The incidence is markedly different among countries (Quigley et al., 2012). American and European cultures demonstrate similar frequencies of IBS across racial and ethnic lines. In the United States, as many as 15% of adults (about 35 million people) report IBS symptoms, the frequency of IBS among Caucasian, African American and Hispanic populations is relatively consistent and according to another study more Hispanics are affected (Johns Hopkins, 2012; Ladabaum et al., 2012). Populations of Asia and Africa may have a lower prevalence of IBS. The role of different cultural influences and varying health care–seeking behaviors is unclear.

In Western countries, women are 2-3 times more likely to develop IBS than men, in contrast to the Indian subcontinent where males represent 70-80% of IBS patients. Women seek health care more often, but the IBS–specific influence of this occurrence remains unknown. Other factors, such as a greater incidence of abuse in women, may confound interpretation of this statistic (Gwee, Lu, & Ghoshal, 2009).

Approximately 50% of people with IBS report symptoms beginning before they were aged 35 years. The development of symptoms in people older than 40 years does not exclude IBS but should prompt a closer search for an underlying organic etiology (Lovell & Ford, 2012).

3.3 ETIOLOGY OF IBS

The causes of IBS remain poorly defined, but they are being fervently researched. Some suggested etiologies of IBS are abnormal transit profiles and enhanced perception of normal motility. Up to one third of patients with IBS may have altered colonic transit. Delayed colonic motility may be more common in IBS-C patients and similarly, accelerated colonic transit may be more common in IBS-D patients than in healthy controls (Camilleri, 2005). Abnormalities in the gastrointestinal nervous system also may play a role, in experiencing greater than normal discomfort in the abdomen. Poorly coordinated signals between the brain and the intestines (brain-gut dysfunction) can make the body overreact to the changes that normally occur in the digestive process. This overreaction can cause pain, diarrhea or constipation (Mayer & Tillisch, 2011).

Infection with Giardia lamblia has been shown to lead to an increased prevalence of IBS, as well as chronic fatigue syndrome. In a historic cohort study of patients with G. lamblia infection as detected by stool cysts, 3 years after exposure, the prevalence of IBS was 46.1% in the exposed group, compared to 14% in controls (Wensaas et al., 2011). The limbic system mediation of emotion and autonomic response enhances bowel motility and reduces gastric motility to a greater degree in affected patients than in controls. Limbic system abnormalities, as demonstrated by positron emission

tomography, have been described in patients with IBS and in those with major depression (Naliboff et al., 2001). Additional etiologic factors include increased intestinal permeability in IBS-D patients (Lacy, 2015). Alterations in the intestinal biome – small bowel bacterial overgrowth has the common symptoms of bloating and gaseous distension as exhibited by IBS patients. In a study of 202 patients with IBS, 78% of the patients had small bowel bacterial overgrowth (Pimentel, Chow, & Lin, 2000) and dietary intolerance. Studies of elimination and challenge diets have suggested that poorly absorbed short-chain carbohydrates, in the form of fructose and fructans, may create symptoms among IBS patients, as measured by a visual analogue scale (Shepherd, Parker, Muir, & Gibson, 2008). Many theories about the causes of IBS are evolving, but still remain ambiguous.

3.4 PATHOPHYSIOLOGY OF IBS

Traditional theories regarding pathophysiology of IBS may be visualized as a 3-part complex of altered GI motility, visceral hyperalgesia, and psychopathology. A unifying mechanism is still unsubstantiated.

3.4.1 Altered GI motility

Altered GI motility includes distinct aberrations in small and large bowel motility. The myoelectric activity of the colon is composed of background slow waves with superimposed spike potentials. Colonic dysmotility in IBS manifests as variations in slow-wave frequency and a blunted, late-peaking, postprandial response of spike potentials, which is more visible in IBS-D patients than in IBS-C patients (El-Salhy, 2012).

Small bowel dysmotility manifests in delayed meal transit in patients prone to constipation and in accelerated meal transit in patients prone to diarrhea. In addition, patients exhibit shorter intervals between migratory motor complexes (the predominant inter digestive small bowel motor patterns). Current theories integrate these widespread motility aberrations and hypothesize a generalized smooth muscle hyper-responsiveness. They describe increased urinary symptoms, including frequency, urgency, nocturia, and hyper-responsiveness to methacholine challenge (Drossman, Camilleri, Mayer, & Whitehead, 2002). Despite the fact that the actual mechanisms responsible for these disorders are partially unknown, there is a body of evidence that a brain-gut axis dysfunction, further impaired by psychological stress, may be the leading cause of IBS (Dekel et al., 2013; Mayer & Tillisch, 2011; Mantides, 2002).

3.4.2 Visceral Hyperalgesia

Visceral hyperalgesia is the second part of the traditional 3-part complex that characterizes IBS. Enhanced perception of normal motility and visceral pain characterizes IBS. Affected patients describe widened dermatomal distributions of referred pain. Sensitization of the intestinal afferent nociceptive pathways that synapse in the dorsal horn of the spinal cord provides a unifying mechanism (Quigley, 2009).

3.4.3 Psychopathology

Psychopathology is the third aspect, although associations between psychiatric disturbances and IBS pathogenesis are not clearly defined. Patients with psychological disturbances relate more frequent and debilitating illnesses than control

populations. Patients who seek medical care have a higher incidence of panic disorder, major depression, anxiety disorder, and hypochondriasis, than control populations. A study has suggested that patients with IBS may have suicidal ideation and/or suicide attempts strictly as a result of their bowel symptoms (Miller, Hopkins, & Whorwell, 2004). A higher prevalence of physical and sexual abuse has been demonstrated in patients with IBS (Chang, 2011). Whether psychopathology incites the development of IBS or vice versa remains unclear. Microscopic inflammation has been documented in some patients (Bercik, Verdu, & Collins, 2005).

Laparoscopic full-thickness jejunal biopsy samples revealed infiltration of lymphocytes into the myenteric plexus and intraepithelial lymphocytes in a subset of patients in one study (Törnblom, Lindberg, Nyberg, & Veress, 2002). Neuronal degeneration of the myenteric plexus was also present in some patients (Wood, Liu, Drossman, Ringel, & Whitehead, 2012).

3.5 COMMON TRIGGERS OF IBS

Some common triggers that exacerbate the symptoms of IBS include foods, stress, and hormones. The role of food allergy or intolerance in irritable bowel syndrome is not yet clearly understood, but many people have more severe symptoms when they eat certain foods like chocolate, spices, fruits, cabbage, broccoli, cauliflower, and milk, to name a few (Heizer, Southern, & McGovern, 2009). Most people with IBS find that their signs and symptoms are worse or more frequent during periods of increased stress. Stress has been associated with exacerbation of IBS symptoms. Even though stress does not cause IBS, chronic stress levels have been associated with the onset of IBS by altering the brain-gut axis interactions (Konturek, Brzozowski, &

Konturek, 2011). **Figure 6** illustrates the role of stress in the exacerbation of IBS (Kavuri, Raghuram, Malamud, & Selvan, 2015). Women are twice as likely to have IBS; researchers believe that hormonal changes play a role in this condition. Many women find that signs and symptoms are worse during or around their menstrual periods (Houghton, Lea, Jackson, & Whorwell, 2002).

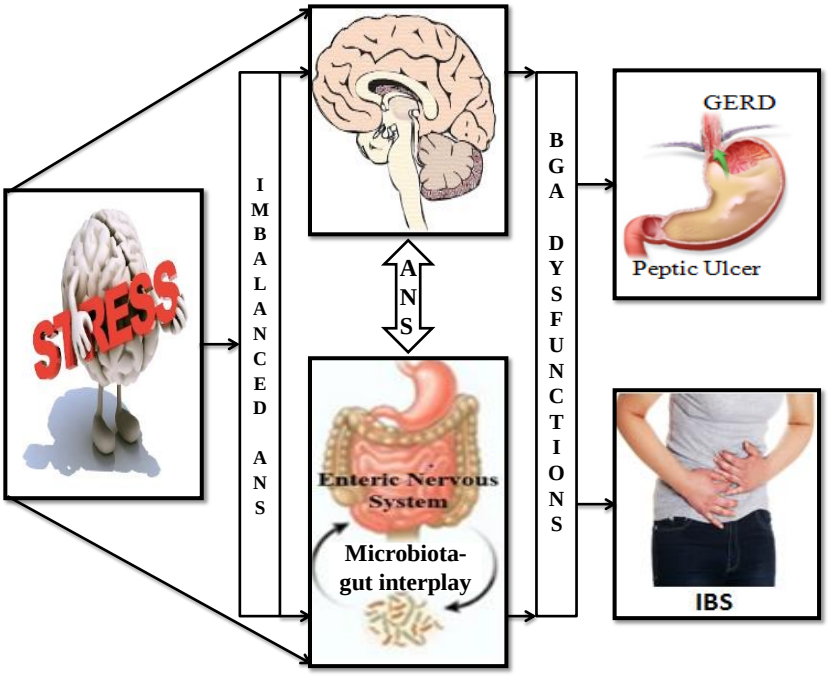


Figure 6. Role of stress in the exacerbation/development of IBS. Stress induced pathophysiological consequences of the disruption of brain-gut- axis. Exposure to stress affects autonomic nervous system, causing an imbalance that result in the disturbance of brain-gut axis (BGA). This leads to the development of different diseases of the gastrointestinal tract, including gastro-esophageal reflux disease (GERD), peptic ulcer disease, and irritable bowel syndrome (IBS)
(*Source of various images:* Stress- http://www.1stclassmed.com/;
Brain- http://lifehacker.com/ ;
Stomach/intestines- http://www.rechildrens.org/blog/gut-brain-axis/;
Gerd- http://www.highlandersurgicalassociates.com/;
Holding the stomach- http://www.paleoibs.com/).

3.6 DIAGNOSIS OF IBS

There is no specific laboratory or imaging test performed to diagnose IBS. Diagnosis involves excluding conditions that produce IBS-like symptoms, and then following a procedure to categorize the patient's symptoms. Ruling out parasitic infections, lactose intolerance, small intestinal bacterial overgrowth, and celiac disease is recommended for all patients before a diagnosis of IBS is made. In patients over 50 years old, they are recommended to undergo a screening colonoscopy (Yawn et al., 2001). IBS sufferers are at increased risk of undergoing inappropriate surgeries such as appendectomy, cholecystectomy, and hysterectomy due to their IBS symptoms being misdiagnosed as other medical conditions (Bixquert Jiménez, 2009).

Following is a step wise approach to diagnosing IBS (Brandt et al., 2009; Drossman et al., 2002):

Step 1: Assessment of Symptoms

- Abdominal pain as the dominant symptom, with altered bowel function.
- Psychological factors about physical and sexual abuse once the physician–patient relationship has been established.
- Dietary history and medications.
- Red flag symptoms such as weight loss, fever, persistent diarrhea, rectal bleeding, anemia, nocturnal symptoms of pain and abnormal bowel habit, new onset of symptoms in patients >50 yr old, and the family history of gastrointestinal (GI) malignancy, inflammatory bowel disease, and celiac disease.

Step 2: Physical Examination

- The physical examination findings could be normal in IBS. The patient may have nonspecific abdominal tenderness.
- Identifying red flag signs such as anemia, jaundice, organomegaly, and abdominal mass is important.

Step 3: Laboratory Tests

- Complete blood count, chemistry panel, and thyroid function studies help exclude organic diseases.
- When presented with diarrhea as a predominant symptom, stool analysis for ova, parasites, and fecal leukocytes could be performed.
- Antigliadin and antiendomysial IgA antibody serologies may be reasonably effective screening tests to exclude celiac disease.
- These tests are indicated for most patients for exclusion and inclusion of diagnosis.

Step 4: Invasive Tests

- Invasive tests include flexible sigmoidoscopy and colonoscopy.
- Invasive tests are indicated for select patients, in particular:
  - Age >50 years with chronic, stable symptoms
  - Age >50 years and recent onset
  - Persistent diarrhea, rectal bleeding
- Routine flexible sigmoidoscopy with biopsy has a low diagnostic yield and is not cost effective, particularly in young patients. It might help reassure an anxious patient or may be performed in an older patient with chronic, stable symptoms.
- Performing a colonoscopy or sigmoidoscopy in younger patients is determined by clinical features suggestive of structural disease (e.g., hematochezia, diarrhea, weight loss) and might not be indicated.
- In patients with persistent diarrhea, if inflammatory bowel disease or microscopic colitis is suspected, a mucosal biopsy is indicated.

Step 5: Initiate a symptom-oriented treatment program

- The treatment goal should be relief of symptoms and addressing the patient's concerns.

Step 6: Follow-up

- Assess clinical response in 3 to 6 weeks.

3.7 CO-MORBIDITIES

Several medical conditions, or comorbidities, appear with greater frequency in patients diagnosed with IBS. Headaches, fibromyalgia, and depression were commonly found in IBS patients (Cole, Rothman, Cabral, Zhang, & Farraye, 2006). IBS was found to be common in chronic fatigue syndrome and fibromyalgia patients, and 94% of IBS patients had psychiatric disorders (Whitehead et al., 2002). A three-year study found that patients diagnosed with IBS were 16.3 times more likely to be diagnosed with IBD during the study period (García Rodríguez, Ruigómez, Wallander, Johansson, & Olbe, 2000). Serum markers associated with inflammation have also been found in patients with IBS (Chang et al., 2012). IBS patients are 87% more likely to undergo abdominal and pelvic surgery and three times more likely to undergo gallbladder surgery and hysterectomy (Cole et al., 2005; Longstreth & Yao, 2004). One study reported a statistically significant link between migraine headaches, IBS, and endometriosis (Tietjen et al., 2007).

3.8 MANAGEMENT OF IBS

3.8.1 Pharmacological Treatments

Since the causes for IBS are not clear, treatment focuses on the relief of symptoms. First-line treatment has conventionally been aimed at treating the symptom that needs immediate relief due to the lack of effective treatment for the overall improvement of multiple symptoms in IBS patients. The pharmacological treatments include antispasmodics, anticholinergics, and antidepressants.

3.8.1.1 Antispasmodics / anticholinergics

Antispasmodics/anticholinergics may improve abdominal pain, but there is a lack of clinical trial data to support an effect on global IBS symptoms. Furthermore, there are insufficient trial data to draw conclusions on the relative efficacy of the different agents or classes of agent (Tack, Fried, Houghton, Spicak, & Fisher, 2006). Anticholinergic / antispasmodic agents inhibit the action of acetylcholine, and inhibit the transmission of parasympathetic nerve impulses, lessening the spasms of smooth muscle in the gastrointestinal tract. Most commonly used antispasmodics/ anticholinergics are Hyoscyamine, Dicyclomine, Scopolamine, Phenobarbital, Ergotamine, Belladonna, and Atropine, which help treat spasms or conditions with disturbances in gastrointestinal motility. Other recent drugs include Alverine, Cimetropium, Otilonium, Pinaverium. A review of recent studies of pharmacological interventions (Year 2000 onwards) is listed below in **Table 6**:

Table 6. Pharmacological interventions (anticholinergics / antispasmodics) for IBS

Authors, (year) & Journal	Sample size and Study design	Intervention	Conclusion
Wittmann, et al. (2010), Aliment Pharmacol Ther.	412 IBS patients, RCT double blind Placebo-Controlled study	Alverine citrate 60 mg with simethicone 300 mg 3 times daily for 4 weeks; Placebo for Control group	Alverine Citrate/Simeticone combination is significantly more effective than placebo ($p<0.001$) in relieving abdominal pain / discomfort in IBS patients
Pace, et al. (2010), Eur Rev Med Pharmaco	186 IBS patients (Rome II criteria), a multicenter, randomized placebo-controlled trial	Octatropine 40 mg +Diazepam 2.5 mg twice daily for 6 weeks; Placebo for Control group	Octatropine plus diazepam demonstrated significant improvements from baseline in abdominal pain, swelling, discomfort, symptom severity and bowel movements but not when compared with placebo.
Chassney, et al. (2007), Aliment Pharmacol Ther	307 IBS (Rome II criteria) randomizd double blind placebo-controlled study	Phloroglucinol 62.2 mg + trimethyl phloroglucinol 80 mg, twice a day, for 7 days; Placebo for Control group	One week treatment of phloroglucinol/trimethyl phloroglucinol treatment significantly reduces ($p<0.01$) pain intensity in IBS patients when compared with Controls.
Mueller-Lissner, et al. (2006), Aliment Pharmacol Ther	1637 patients 4 arm double blind study	Hyoscine 10 mg 3 times a day; Paracetamol 500 mg 3 times a day; a combination of both three times a day for 3 weeks; Placebo for Control group	Hyoscine, Paracetamol, and their fixed combination are effective in the treatment of recurrent crampy abdominal pain and well Tolerated if used three times daily continuously for 3 weeks.

Jafri, et al. (2006), J Pak Med Assoc	100 IBS (Rome II) criteria) patients	Phloroglucinol 50 mg thrice a day for 2 months	When compared to baseline, there were significant improvements in abdominal pain ($p<0.001$), frequency and urgency of stools per day ($p<0.001$), bloating ($p<0.01$) and the medication was well tolerated.
Vahedi, et al. (2005), Aliment Pharmacol Ther	44 IBS (Rome II criteria) a double blind randomized controlled study	Fluoxetine 20 mg once daily for 12 weeks; Placebo for Control group	Fluoxetine was significantly more effective ($p<0.001$) than placebo in decreasing abdominal discomfort, bloating, increased number of bowel movements and well tolerated short term treatment for pain and constipation in IBS-C patients.
Mitchell, et al. (2002), Aliment Pharmacol Ther.	107 IBS patients, RCT double blind, placebo-Controlled study	Alverine citrate 120 mg 3 times daily for 12 weeks	Alverine citrate is no better than placebo at relieving symptoms of IBS
Glende, et al. (2002), Eur J Gastroenterol Hepatol	378 IBS patients, double blind placebo controlled RCT	Otilonium bromide 40 mg, thrice a day, for 15 weeks; placebo for Control group	Otilonium bromide is very efficient in releing abdominal pain and discomfort ($p<0.01$) when compared to placebo.
Gilbody, et al. (2000), Int J Clin Practice	213 IBS patients; comparison of two different formulations of Mebeverine hcl	Mebeverine hydrochloride 200 mg twice a day or 135 mg thrice a day for 8 weeks	Mebeverine hcl 200 mg twice a day was shown to be therapeutically equivalent to 135 mg thrice a day in the treatment of abdominal pain

From the available data, antispasmodics / anticholinergics appear to be generally well tolerated, and helps in reducing the abdominal pain/bloating. However, several side effects were reported such as nausea, constipation, hyposalivation, and cardiovascular events (Grundmann & Yoon, 2010).

3.8.1.2 Anti-depressants

Anti-depressants are another class of pharmacological treatment used for IBS patients. Current treatment guidelines endorse the use of TCA's (tricyclic antidepressants) or SSRI's (selective serotonin reuptake inhibitors) for patients with IBS (Brandt et al., 2009). Commonly used TCA's for IBS are Amitriptyline, Desipramine, Imipramine, and Nortriptyline. Commonly used SSRI's are Fluoxetine, Citalopram, and Paroxetine, which help to improve overall well-being and reduce anxiety. Despite few side effects, SSRI's and TCA's are well tolerated in the treatment of pain in IBS (Ford, Talley, Schoenfeld, Quigley, & Moayyedi, 2009). Following is a review of few studies on TCA's and SSRI's since year 2000 in **Table 7**.

Table 7. Anti-depressant intervention for IBS

Author, (year), & Journal	Sample size and Study design	Intervention	Conclusion
Masand, et al. (2009), Psychosomatics	72 IBS patients, a double blind, randomized, placebo-controlled trial	Paroxetine CR(controlled release) 12.5mg-50mg, once a day; Placebo for Control group for 12 weeks	There was no difference between two groups on composite pain scores; but paroxetine group showed significant improvement in clinical global impression improvement, and severity ratings than placebo group.
Talley, et al. (2008), Dig Dis Sci	51 IBS (Rome II criteria) patients; a double blind, placebo-controlled, parallel group pilot trial	Imipramine 50 mg once a day; Citalopram 40 mg once a day; Placebo for Control group for 12 weeks	Neither Citalopram nor Imipramine significantly improved global IBS symptoms compared with placebo ($p=0.8$). Imipramine showed significant improvements in bowel symptom severity rating ($p<0.05$). Citalopram is no better than Placebo.
Vahedi, et al. (2008), Aliment Pharmacol Ther	54 IBS (Rome II criteria) patients; clinical trial	Amitriptyline 10 mg daily; Placebo for Control group for 2 months	Amitriptyline group showed greater reduction in incidence of loose stool ($p<0.05$) and feeling of incomplete defecation when compared to placebo.
Tack, et al. (2006), Gut	23 non-depressed IBS patients, a controlled crossover study	Citalopram 20 mg for 3 weeks and 40 mg for 3 weeks; Placebo for Control group for 6 weeks	The SSRI Citalopram significantly improved ($p<0.05$) abdominal pain, bloating, impact of symptoms on daily life, and overall well-being compared

			with placebo.
Kuiken, et al. (2003), Clin Gastroenterol Hepatol	40 IBS patients, a double blind, randomized, placebo-controlled study	Fluoxetine 20 mg; Placebo for Control group for 6 weeks	Fluoxetine does not change rectal sensitivity and abdominal pain reduction was non-significant.
Zhou, et al. (2002), Chin J Clin Rehab	70 IBS patients	Paroxetine Hcl 10 mg, once a day and Pinaverium bromide 50 mg thrice a day; Pinaverium bromide 50 mg thrice a day for 12 weeks	The combination of small dose Paroxetine Hcl and Pinaverium bromide can significantly improve gastrointestinal, partial psychogenic and psychosomatic symptoms of IBS when compared to Pinaverium bromide alone.

Though some of the anti-depressant pharmacological interventions might be useful in treating anxiety/depression, they were found to be not successful in treating the global symptoms of IBS. While the benefits of reduced frequency of nerve impulses and central pain modulation help in abdominal pain reduction, adverse effects of TCA's could include sedation, restlessness, constipation, palpitations, tachycardia, insomnia, and sexual dysfunction (Barboza, Talley, & Moshiree, 2014; Khan & Chang, 2010). Notable side effects of SSRI's include diarrhea, sedation, agitation, and suicidal tendencies (Barboza et al., 2014; Grover & Drossman, 2008; Healy & Whitaker, 2003).

3.8.1.3 Diarrhea and Constipation

Other treatments of IBS focus on diarrhea and constipation. Loperamide is the most commonly used drug for IBS-D patients. It is a synthetic opioid, which acts on intestinal muscles to prolong transit time and inhibit peristalsis. While Loperamide was found to be effective in decreasing stool frequency and improving consistency, there could be an

increase in abdominal pain. Alosetron is another anti-diarrheal drug that was tested but was discontinued in year 2000 due to the severe adverse effects of severe constipation, ischemic colitis, and deaths being reported. However, Alosetron was later approved in 2002 to treat women with severe IBS-D. Other side effects with anti-diarrheals such as diphenoxylate with atropine may include dry mouth, constipation, and urinary retention (Jailwala, Imperiale, & Kroenke, 2000).

Lubiprostone is commonly used in the treatment of IBS-C patients. It is a gastro-intestinal chloride-channel activator that enhances intestinal fluid secretion, which leads to increased motility and facilitation of stool passage. Adverse effects commonly reported were nausea and diarrhea (Chey et al., 2012). Linaclotide is another drug, a guanylate Cyclase-C agonist that increases intestinal fluid and electrolyte secretion, which was shown to improve symptoms of IBS-C patients with minimal side effect of diarrhea (Chey et al., 2012). Due to lack of evidence in pediatric population, Linaclotide is not prescribed to patients less than 18 years of age. Another option of treating IBS-C is using osmotic laxatives such as polyethylene glycol (PEG) and lactulose. PEG has been shown to be effective in relieving constipation by increasing water in the intestinal lumen and decreasing transit time, but did not show any improvement in abdominal pain or bloating (Chapman, Stanghellini, Geraint, & Halphen, 2013). Lactulose may cause bloating due to fermentation in the intestinal lumen and hence not recommended for IBS patients (Wall, Bryant, Bottenberg, Maki, & Miesner, 2014). Bulking agents such as psyllium, calcium polycarbophil, and ispaghula husk are some of the alternatives used to increase stool frequency and transit time, but a recent review showed that fiber supplements do not improve abdominal pain, IBS symptom scores, or global assessment (Ford et al., 2008).

3.8.1.4 Emerging drug therapies

Emerging drug therapies being investigated for IBS-C include Naronapride, Velusetrag (Shin et al., 2014), Elobixibat (Wong et al., 2011), and Chenodeoxycholate (Rao et al., 2010), and but the results were not conclusive. For IBS-D, the drugs, Eluxadoline (Dove et al., 2013), Mesalamine (Tuteja, Fang, Al-Suqi, Stoddard, & Hale, 2012), Dextofisopam (Leventer et al., 2008), and Asimadoline (Mangel et al., 2008) are being investigated but the results are not very encouraging. Rifaximin is an antibiotic proven to be safe in IBS-D patients if administered for 2 – 4 weeks, but the cost of this antibiotic (2 weeks supply of three times a day could cost $1,100) is extremely high. Adverse reactions for rifaximin include flatulence, abdominal pain, nausea, and headaches (Pimentel et al., 2011). Other antibiotics include neomycin and metronidazole have shown similar benefits, but more evidence is needed (Pimentel, 2009).

Newer drugs being investigated for IBS pain, are Glutamate (Niddam, Tsai, Lu, Ko, & Hsieh, 2011), Chlorphenamine (Hattori, Watanabe, Kano, Kanazawa, & Fukudo, 2010), Crofelemer (Mangel & Chaturvedi, 2008), and Pregabalin (Houghton et al., 2007), but the results are inconclusive. More rigorous trials are needed to conclude if any of the above medications can help the symptoms of IBS patients (Barboza et al., 2014).

Most of the pharmacological treatments, though effective in treating particular symptoms, are often limited by significant side effects. Patients remain dissatisfied with the conventional treatments, and about 50% often opt to other treatments such as herbals, dietary supplements, or other Complementary and Alternative Medicine (CAM) approaches to improve their IBS symptoms (Harris & Roberts, 2008; van Tilburg et al., 2008).

3.8.2 Lifestyle and Complementary Therapies for IBS

3.8.2.1 Prevalence of the use of CAM therapies

National Center for Complementary and Alternative Medicine (NCCAM) defines CAM as those health care practices not currently considered an integral part of conventional medicine. A therapy is called 'complementary' when it is used in addition to conventional treatments, and when a therapy is used in place of conventional treatment, it is known as 'alternative'. Most often, people are seeking ways to improve their health and well-being, but more importantly, to relieve symptoms and side effects of conventional treatment. According to NIH (National Institute of Health, USA), as of 2012, about 30% of adults and 12% of children use some type of CAM treatment. As of 2012, the most commonly used CAM therapies among adults were, natural products (besides vitamins and minerals) 18%, deep breathing 11%, Yoga 9.5% and Meditation 8% (NIH, 2012).

Among the wide variety of CAM approaches available for IBS, diet and lifestyle change (regular exercise), herbal products, hypnosis, relaxation techniques, acupuncture, and probiotics are the most sought after (Grundmann & Yoon, 2014). Harris et al. reported that most acceptable treatment options for IBS patients, besides pharmacological intervention (tablets 84%), was diet and lifestyle changes (82%), yoga (77%), and acupuncture (59%) (Harris & Roberts, 2008). In the following section, we focus on diet and exercise, herbal medicines and supplements, acupuncture, mind-body therapies such as hypnotherapy, and cognitive behavior therapy.

3.8.2.2 Diet and lifestyle modifications

Diet modifications, such as excluding lactose, eggs, coffee, yeast, citrus fruits, may benefit IBS patients (Lea & Whorwell, 2005). Fiber is an often recommended dietary change to reduce the global symptoms of IBS, but the clinical data is not clear. Regular exercise is an important lifestyle modification in IBS patients. The studies listed below emphasize that physical exercise reduces IBS symptoms and alleviates bloating. **Table 8** has a review of select studies on diet and exercise since year 2000.

Table 8. Diet and exercise interventions for IBS

Authors, (year), & Journal	**Sample size and Study design**	**Intervention**	**Conclusion**
Yang, et al. (2013), Clin Gastroenterol Hepatol	60 IBS patients and 60 healthy controls	10, 20 and 40 grams lactose in random order, 7-14 days apart; hydrogen breath tests conducted to detect malabsorption and intolerance after administration	Lactose intolerance resulted in more frequent self-reported symptoms in IBS-D patients ($p<0.001$) than controls and IBS-D patients consumed significantly less dairy products ($p<0.01$).
Rao, et al. (2011), Am J Physiol Gastrointest Liver Physiol	12 IBS-D patients and 12 healthy controls; 10 patients with inactive ulcerative colitis; 3 way crossover study	Oral lactulose and Mannitol with oral solution was administered to the three groups and results recorded at 2h, 8h and 24hours	IBS-D patients showed significant increase in small bowel and mucosal permeability for mannitol and lactulose sugars compared to healthy controls.
Saberi-Firoozi, et al. (2007), Indian J Med Sci	1978 subjects	Questionnaire	Potential for higher lactose intolerance incidence in patients with IBS compared to healthy subjects.

Gupta, et al. (2007), J Gastroenterol Hepatol	124 IBS (Rome II criteria) and 54 healthy subjects	All patients and healthy subjects underwent Lactose Hydrogen Breath Test (LHBT), Lactose Tolerance Test (LTT) and 69 IBS patients had Glucose Hydrogen Breath Test (GHBT)	Symptomatic lactose intolerance more frequent in IBS patients than in healthy subjects but the incidence of lactose intolerance is not different between groups.
Johannesson, et al. (2011), Am J Gastroenterol	102 IBS patients; randomized controlled trial	Physical activity group to increase physical activity; control group to maintain current lifestyle for 12 weeks	There was a significant difference in the improvement in the IBS-SSS score between the physical activity group and the control group ($p<0.01$).
Daley, et al. (2008), Int J Sports Med	56 IBS (Rome II criteria) patients randomized controlled study	Exercise group to exercise regularly and Control group to maintain usual care for 12 weeks	The exercise group reported significantly improved symptoms of constipation when compared to Control group. No differences between the two groups in quality of life at the end of 12 weeks.
Villoria, et al. (2006), Am J Gastroenterol	8 (7 IBS patients (Rome II criteria) and 1 functional bloating patient; crossover study	Gas mixture continuously infused for 120 min (12 mL/min) into the jejunum with simultaneous duodenal lipid perfusion 91 Kcal/min). Supine position intermittent pedaling, versus rest	Gas retention during rest was associated with significant abdominal symptoms in IBS patients ($p<0.01$); symptoms improved during exercise ($p<0.05$) compared to rest.

These restricted diets may be hard to follow and could result in bouts of increased IBS symptom severity. In addition, skipping meals has shown to worsen IBS symptoms (Kim & Ban, 2005). In a review, Ford et al., concluded that fiber, either soluble or insoluble, was not able to reduce pain perception in IBS patients, and insoluble fiber, such as nuts and whole grains, and may exacerbate the IBS symptoms (Ford et al., 2008). Physical exercise has been effective in reducing symptom severity and constipation, but not in improving quality of life, or anxiety.

3.8.2.3 Herbal medicines and Supplements

Another commonly used CAM intervention by IBS patients, often self-administered is the use of herbal supplements. Many of the commonly used supplements have evolved from popular and traditional applications as remedies for gastrointestinal disorders (Grundmann & Yoon, 2014). A few well-designed clinical studies could not make a definitive case about the effectiveness of such supplements. Peppermint extract has been investigated in a number of trials and was concluded to be effective in reducing abdominal pain and severity, but the effects did not last once peppermint extract was discontinued (Alam et al., 2013). Artichoke leaf extract was shown to reduce IBS symptoms, bloating, distension, abdominal pain, and cramps, but the results provide limited evidence when compared to placebo (Walker, Middleton, & Petrowicz, 2001). Turmeric, an Asian spice, was evaluated in IBS patients and has been reported to decrease IBS symptoms and increase quality of life (Bundy, Walker, Middleton, & Booth, 2004). Iberogast, a mixture of nine herbal plant extracts, was investigated in IBS patients and was found to be effective in reducing abdominal pain and IBS-SSS (Madisch, Holtmann, Plein, & Hotz, 2004). Padma Lax, a Tibetan herbal preparation,

was also found to be effective in reducing constipation, abdominal pain, and flatulence (Sallon et al., 2002). Traditional Chinese Medicine (TCM) was investigated in a randomized controlled study of 119 patients but was found not effective in improving IBS symptoms (Leung et al., 2006). Probiotics are dietary supplements (with live or attenuated bacteria) that may have beneficial effects to the IBS patients by altering the gastrointestinal flora (Ford & Talley, 2012). Most commonly used strains of bacteria in the probiotics are lactobacillae and bifidobacteria. Several studies have evaluated the effectiveness of probiotics in IBS patients. To summarize, peppermint oil preparations and Iberogast have the strongest evidence for IBS patients.

Some supplement trials have shown positive results on the reduction of IBS symptoms, but showed deterioration after stopping its use (peppermint oil). Few supplements like Padma lax needs more empirical evidence as only one pilot study has published data with a side effect of diarrhea. Probiotics have shown positive impact but the evidence remains weak due to the heterogeneity of the studies and the varying probiotics evaluated (Wilkins, Pepitone, Alex, & Schade, 2012). More robust trials are needed to validate the herbs/supplement use. **Table 9** summarizes few of these clinical trials since year 2000.

Table 9. Herbal Supplement interventions for IBS

Authors, (year), & Journal	Sample size and Study design	Intervention	Conclusion
Alam, et al. (2013), Mymensingh Med J	74 IBS patients; double blind, randomized, place-controlled study	Peppermint oil or placebo for 6 weeks	Significant reduction in abdominal pain in peppermint oil group when compared to placebo group ($p<0.001$), but pain score increased 2 weeks after completion of trial.
Merat, et al. (2010), Dig Dis Sci	90 IBS patients; randomized, double blind, place-controlled study	One peppermint oil capsule, thrice a day; Placebo for Control group for 8 weeks	Significant reduction in IBS symptoms, abdominal pain ($p<0.001$) when compared to placebo.
Walker, et al. (2001), Phytother	279 IBS patients; Post-marketing surveillance	Artichoke Leaf Extract for 6 weeks	Significant reduction in overall IBS symptoms ($p<0.05$) after 6 weeks.
Madisch, et al. (2004), Aliment Pharmacol Ther	203 IBS (Rome I criteria) patients; double blind, randomized, place-controlled, multicenter trial	Four groups: STW 5 (9 plant extracts); STW 5-II (six plant extracts); bitter candytuft mono extract; and placebo for 4 weeks	Significant reduction in abdominal pain scores for STW 5 and STW 5-II ($p<0.01$); and in IBS-SSS ($p<0.001$) when compared to placebo; there were no differences between placebo group and bitter candytuft group.
Sallon, et al. (2002), Digestion	61 IBS (Rome I criteria) patients; double blind randomized study	Padma Lax – 2 capsules a day; Placebo for Control group for 3 months	Significant improvements in global IBS symptom scores compared to placebo ($p<0.05$).

3.8.2.4 Mind-Body Therapies

Since there is evidence of dysfunction of brain-gut axis in the pathophysiology of IBS, mind-body CAM interventions may benefit these patients. According to NIH, mind-body therapies are interventions that primarily focus on the interactions among the brain, mind, body, and behavior with intent to use the mind to affect physical functioning and promote health (NIH, 2012). Yoga, Tai-chi, meditation, hypnotherapy, and acupuncture fall under this category. Clinical trials investigating yoga, acupuncture, relaxation, hypnotherapy, and cognitive behavior therapy (CBT) reported improvements in IBS symptoms and overall quality of life. Yoga and meditation for IBS will be discussed in the next section. **Table 10** details some of the clinical trials for acupuncture, hypnotherapy, and CBT since year 2000.

Table 10. Mind-Body therapy interventions for IBS

Authors, (year), & Journal	Sample size and Study design	Intervention	Conclusion
Lembo, et al. (2009), Am J Gastroenterol	230 IBS patients; randomized, single blind, wait-list controlled study	Acupuncture group 6 treatments in 3 weeks; sham acupuncture group 6 treatments in 3 weeks; and a wait-list control group	Acupuncture and sham acupuncture groups significantly improved IBS-GIS scores ($p<0.001$) when compared to wait-list control group; there were no differences between acupuncture and sham acupuncture groups.
Schneider, et al. (2006), Gut	43 IBS (Rome II criteria) patients; randomized single blind study	Acupuncture group and Sham acupuncture group 10 sessions in 5 weeks	Significant improvements ($p<0.05$) in quality of life for both groups when compared to baseline; no differences between groups.
Moser, et al. (2013), Am J Gastroenterol	90 IBS patients; randomized controlled trial	GHT (Gut directed hypnotherapy) group and SMT (Supportive talks with Medical Treatment) 10 weekly sessions in 12 weeks	Significant improvement in overall IBS symptoms in GHT and SMT ($p<0.05$); improvements remained up to 12 months after intervention in GHT group ($p<0.01$) compared to SMT.
Gerson, et al. (2013), Int J Clin Exp Hypn	75 IBS (Rome II criteria) patients, pre-post design	Group hypnotherapy, 7 biweekly sessions of 45 minutes each	Significant decreases in symptom severity ($p<0.01$) at 3, 6 and 12 months post intervention.
Lindfors, et al. (2012), Am J Gastroenterology	138 IBS patients; randomized controlled trial in two different clinical settings	Gut directed hypnotherapy in private psychology offices; supportive therapy; 12 sessions, weekly once, one hour Second setting: Gut directed hypnotherapy in county hospitals 12 sessions, once a	Significant reduction in IBS symptoms in hypnotherapy groups ($p<0.05$) compared to supportive therapy after 12 weeks and continued at 1 year. In the second setting, though not statistically significant ($p=0.17$) a similar trend was observed.

		week; wait-list controls for 12 weeks	
Craske, et al. (2011), Behav Res Ther	110 IBS patients; Randomized controlled trial	IE (Cognitive Behavioral therapy with interoceptive exposure to visceral sensations); SM (Stress Management); AC (Attention controls); 10 sessions in 12 weeks, of one hour each	IE showed significant improvements in reducing visceral sensitivity ($p<0.0001$) than SM or AC.
Mahvi-Shirazi, et al. (2008), Arch Med Sci	50 IBS (Rome II criteria); quasi experimental study	Case group (CBT combined with medical treatment) 8 weekly sessions; medical treatment group	Mental health of patients and IBS symptoms significantly improved ($p<0.001$) in the Case group when compared to medical treatment group.
Kennedy, et al. (2006), Health Technol Assess	149 IBS patients; randomized trial	CBT (6 sessions of 50 min each) with Mebeverine 270 mg, thrice daily, and Mebeverine 270 mg thrice daily for 6 weeks	Significant reduction in symptom severity scores in CBT with Mebeverine group compared to Mebeverine group at 6 weeks, 3, 6 and 12 month follow-up ($p<0.01$).

To summarize, psychological or behavioral therapies such as hypnotherapy, CBT, acupuncture can be effective in the management of IBS and can be a good combination along with pharmacotherapy. However, the main drawback for such treatments is the patient's motivation, time, interest, and affordability of such treatment plans (Khan & Chang, 2010).

3.9 *YOGA*

Yoga, a traditional "mind-body-breath" discipline, was derived in India about 3,500 BC. The Sanskrit word for *Yoga* is '*yuj*' meaning to unite the mind, body, and spirit (Taimni, 1999). *Yoga* encompasses mental and physical discipline to help in personal transformation that leads to perfect health as envisioned by WHO. *Yoga* practitioners are totally immersed in the practices with an awareness and command over every movement of the body and synchronizing it with the breath. This gives them a feeling of self-control and calmness leading to relaxation and health. The popularity of *Yoga* is evident with a prevalence of 8.7% Yoga practitioners in 2012 within the USA that is equivalent to 20 million adults, and women practitioners outweigh males by a ratio of almost 4:1 (Walton, 2013). There is a vast amount of literature available, listing the benefits of *Yoga*, among which few select studies including IBS and *Yoga* are alluded to below.

3.9.1 *Yoga* and Physical Well-being

Flexibility is an important component of health-related physical fitness and well-being (American College of Sports Medicine, 2006). Adequate range of motion, flexibility in lower back and shoulder region are extremely important for day to day performance. Several studies have shown that *Yoga* improves the flexibility of the body. In 1986, Ray et al. have shown that six month practice of *Yogic āsanās* increased trunk, hip, neck, and shoulder flexibility in middle-aged men, whereas physical exercises had no such effect (Ray, Hegde, & Selvamurthy, 1986). Two recent studies of chronic low-back pain patients also concluded that *Yoga* increased spinal flexibility and quality of life more than

physical exercise (Tilbrook et al., 2011; Tekur, Chametcha, Hongasandra, & Raghuram, 2010). *Yoga's* emphasis on developing body awareness and physical discipline supports the adoption of healthy dietary and exercise habits, thus potentially could influence the management of IBS symptoms. Several research studies have emphasized that *Yoga* makes one feel 'more connected' to their bodies (internal and external organs), promotes a positive body experience, and a sense of well-being (Woolery, Myers, Sternlieb, & Zeltzer, 2004; C. Wood, 1993). Ducrotté suggested that *Yoga* postures targeting the lower abdomen would help in relieving the symptoms of IBS by enhancing bio-energy circulation in and around the intestines (Ducrotté, 2007).

3.9.2 *Yogic* Breathing and Autonomic Balance

Yoga practices offer the possibility of reducing inappropriate activation of the autonomic nervous system (ANS). Clinical trials on IBS patients have shown abnormalities in autonomic function and psychological profiles. Some studies have shown that there is an increased sympathetic activity in IBS patients. Using spectral analysis of heart-rate variability in 54 subjects (18 IBS patients and 36 healthy controls), it was reported that IBS patients had significantly increased sympathetic activity compared to healthy controls, whereas there was no difference in parasympathetic activity between these two groups (Karling et al., 1998). In a study conducted by Waring et al., on 69 female subjects (39 with IBS and 30 healthy controls), sympathetic excess in IBS patients was observed during stimulation (handgrip exercise and orthostatic test) when compared to the healthy controls (Waring, Chui, Japp, Nicol, & Ford, 2004). In contrast, Punyabati, et

al., reported increased parasympathetic reactivity and elevated levels of anxiety in 65 IBS patients (Punyabati, Deepak, Sharma, & Dwivedi, 2000).

The relaxing and calming effects of *Śavāsana* (Total Relaxation) and *Prāṇāyāma* (Breath Control) have been widely studied and reported. The effects of these practices provide a short-term 'time out' from stress and create positive physiological changes in the whole body through modulating the nervous system (Uyterhoeven, 2006). *Sudarshan Kriya* is a simple rhythmic breathing technique with specific natural rhythms of the breath, harmonizing the body, mind, and emotions. This is shown to alleviate symptoms of anxiety, depression, and stress-related ailments (Janakiramaiah et al., 2006). Slow and deep breathing techniques could be used to minimize physiologic responses to stress by increasing the parasympathetic response (Jerath, Edry, Barnes, & Jerath, 2006). Breathing through right nostril was shown to increase oxygen consumption, an indicator of increased metabolism and sympathetic activity, whereas left-nostril breathing led to parasympathetic shift (Telles, Nagarathna, & Nagendra, 1994).

3.9.3 *Yoga* and Psychological Well-being

A large number of studies confirm that *Yoga* enhances general psychological well-being. A moving meditation called "Cyclic Meditation", based on stimulation and relaxation, showed reduced oxygen consumption compared to resting in supine position, reduced sympathetic activity, and increased parasympathetic dominance (Sarang & Telles, 2006; Nagendra & Nagarathna, 1997). A subsequent study showed reduced stress and increased quality of sleep after 23 minutes of Cyclic Meditation (Patra & Telles, 2009). Rosary

(Ave Maria) and certain *Yoga* mantras when recited at specific frequencies (six times a minute) improved physiological and psychological well-being and an increase in the synchronicity of cardiovascular rhythms were observed in 23 healthy volunteers (Bernardi et al., 2001). *Yoga* is also shown to reduce anxiety, symptoms of depression, and enhance quality of life. Two studies have reiterated that three and four months of *Yoga* practice had significantly improved the subjective well-being and quality of life (Damodaran et al., 2002; Malathi, Damodaran, Shah, Patil, & Maratha, 2000).

3.9.4 *Yoga* and Quality of Life

In an eight week intervention of mindfulness meditation study, meditators were shown to have higher activation in left-sided frontal lobe that is associated with positive feelings, such as joy, happiness, compassion, and lower levels of anxiety, when compared with the control group of non-meditators (Davidson et al., 2003). A recent study investigated the effects of Brain Wave Vibration (BWV), a meditation involving rhythmic movements of the head, neck and body practiced with related Yoga style exercises for eight weeks. 31 healthy adults were assessed in total for both groups. BWV group showed better mood, sleep, mindfulness, health, and well-being compared to controls that participated in *Yoga* -style exercise without the movements (Bowden, McLennan, & Gruzelier, 2014).

An earlier study assessed the role of stress in 50 medical students, in which the *Yoga* group practiced one hour *Yoga*, three times a week for a month and the control group did reading/writing for the same duration (Malathi & Damodaran, 1999). *Yoga* group showed improvements in various parameters, such as sense of well-being, feeling of

relaxation, improved concentration, self-confidence, improved efficiency, better interpersonal relationship, increased attentiveness, lowered irritability levels, and an optimistic outlook in life. Similar findings were reported in the *Yoga* practitioners by later studies. In a survey, 61 *Yoga* practitioners had a positive outlook on life and happiness within, when compared to 135 who were non-*Yoga* practitioners (Monk-Turner & Turner, 2010). Rocha and colleagues concluded that regular Yoga practice (6 months) can improve aspects of cognition and quality of life for healthy individuals (Rocha et al., 2012). Slow and deep breathing for six weeks improved cognition, general well-being, and increased parasympathetic activity when compared to controls (Chandla et al., 2013). In yet another survey, 1,045 *Yoga* practitioners reported to have improved energy, happiness, social relations, and sleep (Ross, Friedmann, Bevans, & Thomas, 2013).

Taken together, *Yoga* practices enhance physical flexibility, energy levels, and quality of life with improved psychological disorders. It also increases self-awareness and happiness within, while making one feel relaxed and rejuvenated. Therefore, *Yoga* practices are considered much more useful in IBS patients at various levels to better manage their symptoms.

3.9.5 Clinical trials of *Yoga* / Meditation for IBS

There are only a few trials with *Yoga* as an intervention for IBS patients. Three studies focused on *Yoga* postures for children/adolescents with IBS, and one study focused on adult male population with IBS-D. Two other studies focused on mindfulness meditation, which in fact is a part of *Yoga*. **Table 11** gives details of these studies.

Kearney et al. used Mindfulness Based Stress Reduction (MBSR) as an intervention for 93 IBS patients. The intervention was 2.5 hours once a week for 8 weeks and reported no significant changes in IBS-SSS, IBS-QOL, or Anxiety in IBS patients after 2 months of MBSR. However, at 6 months, significant improvements were found in IBS-QOL and anxiety, but not in IBS-SSS (Kearney, McDermott, Martinez, & Simpson, 2011). In another study of Mindfulness training, Gaylord et al. investigated 75 IBS patients for 8 weeks. The intervention was 2 hours once a week for both mindfulness and social support groups and a half day retreat. It was concluded that IBS-SSS showed significant improvements after two months of intervention, but no improvements were observed in IBS-QOL or anxiety. The improvements in IBS-SSS were sustained at the 3 month follow-up (Gaylord et al., 2011).

Yoga intervention for IBS adolescent patients that consisted of four weeks of daily home practices showed lower levels of functional disability, less use of emotion-focused avoidance, and lower anxiety than the control group. A 10 minute video was provided to the children to practice at home for four weeks. A 65% practice was reported. Most of the children also reported that they did not practice when in pain and also could not find time to practice (Kuttner et al., 2006). Even though the study reported improvement, a close supervision of *Yoga* sessions was deficient. In another pilot study of 17 children with functional abdominal pain and IBS, the observed pain reduction following *Yoga* practices was maintained marginally at 3 month follow-up (Brands, Purperhart, & Deckers-Kocken, 2011). The intervention was *Hatha Yoga* for 12 weeks, a 90 minute session

once a week (10 sessions in 12 weeks) instructed by a *Yoga* teacher. The details of the *Yoga* module or the adherence rates were not mentioned.

A recent study on 51 adolescent and young adult IBS patients using *Iyengar Yoga* for 6 weeks, 90 minute class twice a week, reported positive changes in IBS symptoms, sleep, fatigue, and psychological distress when compared to control group with usual care (Evans et al., 2014). *Iyengar Yoga* is characterized by great attention to detail and precise focus on body alignment, with the use of "props" such as cushions, benches, blocks, straps, and sand bags, which the IBS patients might not appreciate. Timing (how long to hold a position), technique (precision of the body alignment), and sequence of the asanas are very important for this style of *Yoga*, which could be a challenge for IBS patients.

A two month study of 21 male adult IBS-D patients (*Yoga* group = 9, Conventional group = 12), with *Yoga* intervention of a few postures and 'voluntary' regulated right-nostril breathing to be practiced at home, showed both the groups had positive changes over time in general autonomic functions, bowel symptoms, state anxiety scores, and gastric motility [Electrogastrography, (EGG)] amplitude. The *Yoga* group showed significant improvements in autonomic symptom score, bowel symptom score, state anxiety, and physical flexibility, whereas the control group had significant improvements in resting EGG amplitude (Taneja et al., 2004). The sample size lacked female patients in whom IBS is more prevalent. As the evidence is clear that IBS patients could have sympathetic / parasympathetic dominance, balancing the autonomic nervous system should be a focus rather than emphasizing on right nostril breathing, which could increase the sympathetic activity.

Table 11. *Yoga* / Meditation intervention for IBS

Authors, (year), & Journal	Sample size and Study design	Intervention	Conclusion
Kearney, et al. (2011), Aliment Pharmacol Ther	93 IBS (Rome III criteria) a prospective, pre-post study	All patients received 2.5 hours of mindfulness based stress reduction (MBSR) once a week for 8 weeks and 7 hours retreat	Non-significant changes in IBS-SSS IBS-QOL and Visceral sensitivity index (VSI) at the end of 8 week intervention; but at 6 month follow-up, there were significant changes in IBS-QOL and VSI ($p<0.05$).
Gaylord, et al. (2011), Am J Gastroenterol	75 female IBS patients, randomized controlled trial	Mindfulness group – Support group – both receive 2 hours of mindfulness training/ social support, once a week for 8 weeks	Mindfulness group (MG) had significant reduction in IBS-SSS ($p<0.01$) compared to Support group; this was maintained at 3 month follow-up ($p<0.01$). No changes were observed in IBS-QOL or anxiety in MG.
Evans, et al. (2014), J Pediatr Gastroenterol Nutr	51 adolescents/Young adults IBS patients; randomized, wait-list controlled study	Yoga group, Iyengar Yoga, 90 minute sessions twice a week, for 6 weeks; wait-list Control group usual care	Positive changes in IBS symptoms ($p<0.01$), sleep, fatigue, and psychological distress when compared to control group

Brands, et al. (2011), Complement Ther Med	20 children / adolescents with functional abdominal pain or IBS; pilot, pre-post study	10 sessions of Hatha Yoga, 90 minutes each in 12 weeks	Significant decreases in pain frequency and pain intensity ($p<0.05$) compared to baseline; decrease in pain frequency ($p<0.01$) was maintained at 3 month follow-up for children 8-11 years
Kuttner, et al. (2006), Pain Res Manag	25 adolescent IBS patients; randomized wait-list controlled study	Yoga group received 1 hour instruction about postures and was given a 10 minute video to be practiced at home for 4 weeks; wait-list controls had usual care for 4 weeks	Yoga group had significant improvements in functional disability ($p<0.07$), emotional avoidance and anxiety ($p<0.09$) when compared to the controls.
Taneja, et al. (2004), Appl Psychophysiol Biofeedback	21 adult male IBS-D (Rome II criteria) patients; randomized controlled study	Yoga group was given a list of 12 postures and regulated right nostril breathing to be practiced at home, twice a day for 2 months; Conventional group was given 2-6 mg loperamide per day for 2 months	Both groups had significant improvements in GI symptoms. Yoga group had a higher parasympathetic reactivity ($p<0.01$), more favorable changes in bowel symptom score, anxiety, and gastric activity when compared to conventional group.

All the *Yoga* intervention studies have reported beneficial outcomes for IBS patients. But all of the interventions had varied postures, *yoga* routines, time periods, instructed sessions and few at home practice interventions. This emphasizes an urgent need of a systematic clinical trial, testing the most practical *Yoga* module. Remedial *Yoga* Module (RYM) is a one hour module with precise routines and specific number of rounds for each practice and breathing pattern. It includes regulated controlled breathing and meditation. The *Yoga* way of managing IBS was implemented in our randomized clinical trial (Clinical Trial #: ISRCTN 42102754) with our design of concise ~an hour Remedial *Yoga* Module, and supervised by trained/certified instructors.

CHAPTER-4

AIM AND OBJECTIVES

4. AIM AND OBJECTIVES

4.1 AIM OF THE RESEARCH

To assess the efficacy of Remedial *Yoga* Module intervention in patients with Irritable Bowel Syndrome at 12 weeks and at 24 weeks.

4.2 OBJECTIVES

1. To explore the understanding of modern day mind-body disorders, Irritable Bowel Syndrome, according to ancient scriptures, including Yogic texts.
2. To investigate the effects of 12 weeks of Remedial Yoga Module (RYM) intervention on clinical symptoms and quality of life in IBS patients.
3. To study the effect of 12 weeks of RYM intervention on psychological well-being of IBS patients.
4. To assess the changes in autonomic nervous system of the IBS patients after 12 weeks of RYM intervention.
5. To examine the effect of 12 weeks RYM intervention on the BMI and physical flexibility in IBS patients.
6. To evaluate if the improvements at week 12 could be sustained at week 24 (with once a week RYM maintenance intervention for 12 more weeks) in all the above parameters.

4.3 RESEARCH QUESTIONS

4.3.1. What is the impact of RYM on IBS-Symptom Severity and IBS-Quality of Life in the intervention groups when compared to control group? And, what would be the impact of RYM on psychological well-being, physical flexibility and autonomic nervous system?

4.3.2. Are the improvements, if any, sustained at the end of 24 weeks with maintenance Yoga intervention?

4.4 RESEARCH HYPOTHESES

4.4.1. The study hypothesized that the impact of RYM on IBS symptoms will be significantly different between intervention and control groups. In comparison to Wait-list control group, RYM intervention would improve the symptom severity, quality of life, anxiety and depression, physical flexibility, autonomic functions in the Yoga and Combination groups.

4.4.2. The improvements in the intervention groups can be replicated.

4.4.3. All the improvements in the intervention groups will be sustained at the end of 24 weeks with maintenance Yoga intervention.

4.5 NULL HYPOTHESES

4.5.1. There are no significant differences in IBS symptoms between intervention and control groups.

4.5.2. The improvements are not replicated.

4.5.3. The improvements are not sustained at the end of six months with maintenance Yoga intervention.

4.6 STUDY RATIONALE

4.6.1 The study may provide a standardized one hour RYM for IBS patients as a holistic approach.

4.6.2 The study may provide an alternative treatment modality that is non-invasive, and easy to follow and adhere to.

4.6.3 The study may offer a long-term solution, a holistic alternative treatment along with the conventional treatment modalities, to the IBS patients.

CHAPTER-5

METHODOLOGY OF EXPERIMENTAL RESEARCH

5. METHODOLOGY OF EXPERIMENTAL RESEARCH

5.1 SUBJECTS

The study was carried out on adult IBS patients aged 18 and older in East Los Angeles, California, USA, and included patients from around (~10 mile radius) White Memorial Medical Center, Los Angeles, California, USA.

5.1.1 Sample size

To calculate the sample size, the between group effect size was calculated from the reported statistics (F value = 2.84; n1 = 9; n2 = 12) of an earlier study (Taneja et al., 2004). The calculated effect size, Cohen's *d*, was 0.74. From this a required sample was calculated to be 30 subjects in each group (total sample size, n = 90), with $\alpha = 0.05$ and power = 0.80. Assuming 10% attrition (9), it was planned that 99 subjects should be enrolled into the study. Ethics committee approval was obtained prior to the commencement of the trial.

5.1.2 Source of subjects

Male and female patients from around East Los Angeles and surrounding White Memorial Medical Center, Los Angeles, California within a radius of ~10 miles were screened and recruited for the study.

5.1.3 Selection Criteria

Male and female patients, ages 18 and above with a diagnosis of IBS using Rome III criteria were considered eligible. Rome III criteria are as follows (Rome III Criteria for IBS, 2006):

Recurrent abdominal pain or discomfort at least 3 days/month in the last 3 months associated with two or more of the following:

- Improvement with defecation
- Onset associated with a change in frequency of stool
- Onset associated with a change in form (appearance) of stool

Diagnostic Criterion fulfilled for the last 3 months with symptom onset at least 6 months prior to diagnosis. To note, in pathophysiology research and clinical trials, a pain/discomfort frequency of at least 2 days a week during screening evaluation is recommended for subject eligibility (Spiller et al., 2007).

5.1.3.1 Inclusion Criteria

(i) Patients that did not practice *Yoga* during the last 6 months.

(ii) Patients not enrolled in any other alternative medicine program(s).

(iii) Patients committed to three months of *Yoga*, three times a week.

5.1.3.2 Exclusion Criteria

(i) Patients with pregnancy.

(ii) Patients with physical or mental disability to do *Yoga*.

(iii) Patients with history of drug, alcohol, or chemical abuse within 6 months prior to screening.

(iv) Patients with any organic bowel disease.

(v) Patients with inability to comply with study and follow-up procedures.

5.2 ETHICAL AND INSTITUTIONAL REVIEW BOARD CLEARANCE

The study was approved by the Institutional Ethics Committee of Swami Vivekananda *Yoga* Anusandhana Samsthana (SVYASA, a *Yoga* University). The Ethics Committee and the Institutional Review Board of White Memorial Medical Center, Los Angeles, California, have given clearance and continuance for the study (**Appendix IX**).

5.2.1 Informed Consent Form

All patients, before signing an informed consent, were explained about the details of the study, such as, randomization into three groups, length of the study, assessments measured and expectations from the study participants. A detailed consent form which had all of the above details was given to the patients and a voluntary signed consent form was obtained from the patients willing to participate. A complete consent form is attached in **Appendix VI.**

5.3 SCREENING

A total of 120 patients were referred to the study from gastroenterology clinics, primary care physicians, and psychiatry offices in and around Los Angeles, California, USA. All patients, that contacted the research staff, were given the Rome III criteria questionnaire to check for the eligibility as an IBS patient. After receiving the signed informed consent form, patients were randomized (parallel) 1:1:1 into three groups; *Yoga* group, Combination group and Wait-list Control group. A detailed health history was then solicited by the research staff that included demographic variables, (date of birth, height, weight, sex, education, and income) and details of their IBS history (length of time since diagnosed with IBS, Medications / Supplements taken to relieve the symptoms and time lost from work because of IBS). Ninety seven eligible IBS patients (according to Rome

III criteria), both male (n=13; median age 46 years; median weight 157 pounds) and female (n=84; median age, 45 years; median weight 157 pounds), meeting the inclusion and exclusion criteria, were enrolled in the study between September 2012 and June 2014.

5.4 DESIGN OF THE STUDY

This was a randomized, Wait-list Controlled trial in which 97 patients were randomized into three study groups: *Yoga* group practiced one hour RYM session thrice a week for 12 weeks (limited medicine/supplement use to three days a week); Combination group practiced one hour *Yoga* session thrice a week for 12 weeks, and was on usual dosage of medicine and supplement use; and the Wait-list Control group maintained their life style with usual dosage of medicine and supplement use for 12 weeks and were promised the same *Yoga* intervention for 12 weeks after their waiting period had ended. All three groups were assessed three times; Week 0 (baseline), Week 6 (mid-intervention) and Week 12 (post-intervention). The Wait-list Control group subjects were assessed one more time after completing the 12 weeks of RYM intervention.

For the long term study, all the three groups subjects that completed 12 weeks of RYM intervention were combined into one group, 'Follow-up group', and were given a maintenance intervention of once a week, one hour *Yoga* session (RYM) for 12 more weeks and were assessed at the end of the maintenance intervention period, Week 24.

5.5 RANDOMIZATION

97 IBS patients were randomized (parallel) into three groups - 33 in *Yoga*, 33 in Combination, and 31 in Waitlist Control groups. In order to ensure allocation of an equal number of patients to all three groups, randomization was carried out in blocks of six patients, and the patients were asked to pull out numbers from an envelope. The random numbers were generated using online software ("Randomization," 2012). The randomization process was handled by research team member not involved in data collection and was concealed from the research team that was involved in data collection process.

5.6 BLINDING AND MASKING

Double blinding of the subjects was not possible due to the nature of the intervention. *Yoga* instructors, research staff collecting data were blind to the groups. The statisticians that analyzed the data, and the research staff that analyzed questionnaires (after the completion of the study) were blind to the source of the data.

5.7 ASSESSMENTS

All the assessments of the study were chosen to provide a comprehensive representation of the symptoms of IBS patients. Since RYM brings about changes at various levels, few assessments were chosen to capture those subtle changes. All these variables would provide insights into the intervention and would help detect the differences between intervention groups and Wait list Control group.

5.7.1 Demographic and Health Check List

This was developed for the present study to solicit demographic details such as personal and family history and clinical data (**Table 12**).

Table 12. Patient's Demographic and Health Check List

Patient Number: **Date:**	
PERSONAL INFORMATION	
Date of Birth	
Age	
Sex	M F
Education	High school and below College and beyond
Economic Status	Yearly income 1. < 30 k 2. 30-60k 3. 60-100k 4. >100k
Family Status	1. Single 2. Married 3. Divorced 4. Living together
Children	1. One 2. Two 3. Three or more
Stress Factors	1. Family 2. Job related 3. Other factors
ANTHROPOMETRIC MEASURES (Taken at every 6 weeks)	
Height (inches)	
Weight (pounds / lbs)	
BMI (kg/m^2)	
Hip-Trunk Flexibility	
Right Shoulder Flexibility	
Left Shoulder Flexibility	
CLINICAL SYMPTOMS	

Number of years suffering from IBS	
During the last 6 weeks:	(Information collected every 6 weeks)
Medications used for IBS symptoms	
Number of times health services used (doctor/hospital)	
Days lost from work due to complications from IBS	
IBS symptoms of the patients now:	1. Terrible; 2. Worse; 3. Slightly worse; 4. No change; 5. Slightly better; 6. Better; 7. Excellent.

5.7.2 Previous Medical History

This was adapted for the present study to solicit previous medical history and medication details if any (**Table 13**).

Table 13. Patient's Medical History

Code	System	Yes	No
1	Cardiovascular		
2	Respiratory		
3	Hepato-biliary		
4	Gastro-intestinal		
5	Genito-urinary		
6	Endocrine		
7	Hematological		
8	Musculo-skeletal		
9	Neoplasia		
10	Neurological		
11	Psychological		
12	Immunological		
13	Dermatological		
14	Allergies		
15	Eyes, ear. Nose. Throat		
00	Other		

5.7.3 Primary Outcome Assessments

5.7.3.1 Irritable Bowel Syndrome-Symptom Severity Scale (IBS-SSS)

IBS-SSS is a self-reported questionnaire regarding pain severity, frequency, abdominal distension/bloating, bowel habit satisfaction, and interference in life. The score for each question ranged from 0-100 with a visual analog scale. The total score was 500 points; a higher score represents severity of the symptoms. A reduction of 50 points was considered to be adequate for clinical improvement (Francis, Morris, & Whorwell, 1997).

5.7.3.2 Irritable Bowel Syndrome Quality of Life (IBS-QOL)

IBS-QOL is a self-reported tool designed to assess various aspects of quality of life in IBS patients. The questionnaire consisted of a 5 point rating of 34 items inquiring into the emotional well-being and interference with activity, body image, health worry, food avoidance, social reaction, sex, and relationships. The scores (reverse scoring) were transformed to 0 to 100 range, higher score indicating better quality of life. An increment of 14 points was considered to be clinically significant improvement (Patrick, Drossman, Frederick, DiCesare, & Puder, 1998).

5.7.4 Secondary Outcome Assessments

5.7.4.1 Hospital Anxiety and Depression Scale (HADS)

Hospital Anxiety and Depression Scale is a 14 item self-reported questionnaire, seven items for anxiety and seven items for depression. This questionnaire used a 4 point rating (0-3) and was divided into two subscales. Each subscale score ranged from 0 to 21 (a score of 0-7 represents normal levels; 7-14 borderline and 14-21 abnormal levels of

anxiety/depression), higher score meaning more severe symptoms of anxiety/depression (Zigmond & Snaith, 1983).

5.7.4.2 IBS-Global Assessment of Improvement Score (IBS-GAI)

Patients were asked to give a global assessment of their IBS symptoms at 0, 6, and 12 weeks using the question , "Compared with your IBS symptoms six weeks ago, are you now: terrible (1), worse (2), slightly worse (3), no change (4), slightly better (5), better (6) or excellent (7)". Minimum score was 1 and maximum score was 7, higher score meaning improvement of symptoms (Atkinson, Sheldon, Shaath, & Whorwell, 2004).

5.7.4.3 Autonomic Symptom Score

Autonomic Symptom Score is a 10 item self-reported scale, with a score of 1 for presence and 0 for absence (Taneja et al., 2004). Maximum score was 10 and minimum was 0. The score was at least 1 at the baseline for all patients, because all the enrolled patients had gastrointestinal disturbances, namely IBS.

5.7.4.4 Medicine and Supplement Use

Subjects were interviewed about use of IBS symptom relieving medications: prescription, non-prescription, herbal or dietary supplements and were recorded at Week 0. Changes in the drug consumption from baseline were evaluated at Week 6 and at Week 12. If the subject changed a drug regimen that was equivalent to baseline drug regimen with respect to medication class and / or dosing period, and expected to yield a similar response, the drug usage was considered unchanged. Changing the dosage or stopping one or more components of multiple drug regimens was also considered alteration in drug usage. Final outcomes were measured in frequency intervals of success (decrease in dosage or

cessation of medication) and failure (no change or increase in dosage) (Williams et al., 2005). At 0, 6 and 12 weeks, patients were asked the names and dosages of Medicines and Supplements (prescription/over the counter drugs/alternate therapies) being used on a daily basis to relieve IBS symptoms. Reduction in medicine and supplement use during the *Yoga* intervention was monitored (Williams et al., 2005).

5.7.5 Autonomic Function Testing

To assess sympathetic and parasympathetic reactivity before and after intervention in the present study, a battery of four cardiovascular reflex tests (two sympathetic tasks and two parasympathetic tasks) were conducted. Electrocardiogram (ECG) and respiration were acquired with a two channel Biopac MP 45 Data Acquisition System, (BIOPAC, CA, USA). An automatic blood pressure apparatus and hand grip dynamometer were used in sympathetic reactivity tests (Zygmunt & Stanczyk, 2010). **Plates 1 and 2** have the images of Biopac MP 45 and related equipment used in the data acquisition of this study.

Plate 1. Images of equipment used in data collection (Sympathetic reactivity and Parasympathetic reactivity tests). a. Data acquisition; b. Biopac MP 45 2 channel system; c. lateral view of MP 45; d. ECG lead cable; e. respiratory belt

5.7.5.1 Sympathetic Reactivity Tests

5.7.5.1.a Handgrip task

Changes in diastolic blood pressure while undergoing handgrip task, measures the sympathetic reactivity (Zygmunt & Stanczyk, 2010). An electronic hand grip dynamometer (Camry EH 101, Guangdong, China) and a noninvasive automatic blood pressure monitor (Omron HEM 7121, Kyoto, Japan) were used for this isometric test. The subjects were directed to grip the hand-grip dynamometer with their right hand and contract to the maximum extent possible for five seconds. The maximum reading (in lbs) was taken as the maximum volumetric contraction (MVC). The subject was then asked to contract the dynamometer continually at 30% of the MVC for 4 minutes. The changes in diastolic blood pressure were measured in the contra lateral arm at 1, 2, and 4 minutes.

Plate 2. Images of equipment used in sympathetic reactivity tasks. a. Camry Hand grip dynamometer; b. Omron Automatic blood pressure machine.

5.7.5.1.b Mental Arithmetic Task

A five minute mental arithmetic task was used to induce cognitive stress and elicit sympathetic reactivity (Zygmunt & Stanczyk, 2010). Subjects were given a three digit number and asked to perform serial subtraction using number 7 or 3. Subjects answered verbally and were encouraged by an investigator to subtract very quickly. In case of a wrong answer, a verbal error message was given before a new number was read. There was no time pressure exerted by the investigator. The heart-rate was monitored by continuous ECG and blood pressure was monitored by automatic blood pressure machine at 1, 2, and 5 minutes of the test.

5.7.5.2 Parasympathetic Reactivity Tests

5.7.5.2.a Heart-rate variability in deep breathing task

The deep breathing was conducted with the patient resting in supine position for 5 minutes, connected to the standard electrocardiogram (ECG) leads (Zygmunt & Stanczyk, 2010). Before beginning the test, patients were taught to breathe at a rate of 6 respiration cycles per one minute, 5 seconds for each inhalation and 5 seconds for each exhalation. The ECG was recorded at a speed of 25 mm/sec for 180 seconds while the patient breathed as instructed. Heart Rate Variability was extracted using the Kubios (version 2.2, Finland) software. **Plate 3** has the image of data acquisition during deep breathing in a noise and temperature controlled suite of White Memorial Medical Center.

Plate 3. Image of data collection, during deep breathing

5.7.5.2.b Supine to upright position (30-15 ratio)

Using the body's physiological response upon moving from a supine to an upright posture, parasympathetic measurements were obtained (Zygmunt & Stanczyk, 2010). The "30-15" ratio was used to provide a measure of vagus nerve function. The patients were asked to remain in supine position for 5 minutes (until their heart rate has stabilized), and then were instructed to move from the supine to an upright posture. From the continuous ECG recording, after the patient has stabilized in the upright posture, the R-R interval at 30^{th} beat and 15^{th} beat was obtained, and the "30-15" ratio was calculated.

5.7.6 Physical Measurements

5.7.6.1 Weight and Height

Weight was measured on a weighing scale, (Detecto FH 133/11/CH, Webb city, Missouri) to the nearest 0.1 lb, and height was measured with a Seca stadiometer (Seca 222, Chino, CA) to the nearest 0.1 inches (in). Body Mass Index (BMI) was calculated using a BMI calculator (Seca 491, Chino, CA). **Plate 4** has the images of data acquisition tools for physical measurements.

5.7.6.2 Hip and Trunk flexibility

Hip and trunk flexibility was measured with a sit and reach box (Baseline Corporation, Golden, Colorado) (Barlow, 2004). Patient was asked to sit on the floor, shoes off and legs stretched with soles of the feet against the sit and reach box, and back straight. The subject was then asked to place one hand over the other on the measuring stick (stretch indicator), and with knees straight, reach as far as possible by moving the measuring stick. Best of three tries was recorded to the nearest 0.1 cm.

a

b

c

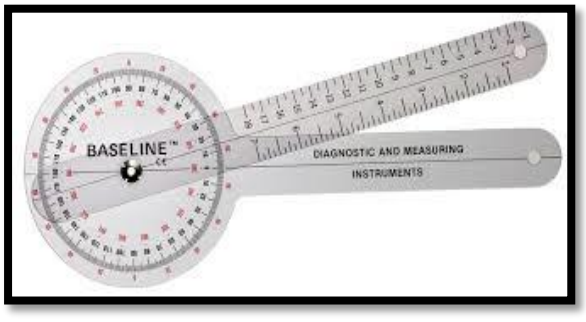


Plate 4. Images of equipment used in physical measurements. a. Weighing Scale; b. Sit and Reach box; c. Goniometer

5.7.6.3 Shoulder flexibility

Flexibility of both shoulders was measured with a standard goniometer (Baseline corp., Golden, Colorado) in centimeters (cm) (Rikli & Jones, 2012). The patient was asked to stand straight, raise their right hand over the shoulder and reach down their back as far as possible while the left hand reached up the middle of the back behind the waist, trying to bring fingers of both hands together. The distance between the extended middle fingers of both hands was measured and recorded as (-), and if the fingers overlapped it was recorded as (+) to the nearest cm, for the right shoulder. The same procedure was followed for the left shoulder.

5.7.6.4 Exercise journal

An exercise journal was provided to all the patients of the three groups to fill out their daily exercise routine, (*Yoga*, walking etc.) during the 12 week period. *Yoga* and Combination group patients were to record any additional exercise routine besides the three *Yoga* sessions a week. All patients were instructed to report performed activity and duration. This journal was to keep the patients motivated and was not checked.

5.7.7 Definition of a Responder

Responders were identified for the two primary endpoints.

(i) IBS-SSS: A responder was defined as patient whose overall symptom severity on the IBS-SSS improved ≥50 points from baseline to Week 6 and Week 12 (Passos et al., 2009).

(ii) IBS-QOL: a responder was defined as patient whose quality of life had a meaningful change of ≥14 points, from baseline to Week 6 and Week 12 (Lorenzo-Zúñiga, 2014).

5.8 INTERVENTION

The specific Remedial *Yoga* Module for IBS intervention was developed by an expert team that included *Yoga* therapy physician, Gastroenterologist and the experts in *Yoga* field. Care was taken that there were no differences in intervention procedure among all *Yoga* instructors that assisted with the intervention using RYM practices.

5.8.1 Remedial *Yoga* Module (RYM)

The concepts for the Remedial *Yoga* Module intervention were derived from traditional yogic scriptures (*Upaniṣads*, *Patañjalī Yoga Sūtrās* and *Yoga Vāsiṣta*) that highlight a holistic approach to health management not only at physical body level, but also at the mental, emotional and intellectual levels treating an individual as a mind-body complex. The practices in the RYM consisted of breathing practices, loosening practices, postures, relaxation techniques, *Prāṇāyāma* and meditation. *Kriyās* were not administered due to the difficulties and liability of administering on the patients in USA. *Yogic* counseling was for 2-3 minutes in each session.

RYM progressed from (a) Breathing practices that enhance the utilization of the lungs, normalize breathing rate and develop an awareness of breathing through the movements of different parts of the body; (b) Instant relaxation technique - enhances stimulation to the body from toes to head and relaxes the whole body; (c) Loosening practices to loosen various joints in the body, flex the spine. The loosening practices remove lethargy and tardiness in the body, and enhances discipline in the mind-body complex (Nagarathna & Nagendra, 2006); (d) Quick relaxation technique helps in releasing the tension in the

muscles and relaxing the whole body; (e) Postures / *āsanās* aimed at twisting and stretching the abdominal region that could alleviate the discomfort in the abdominal region and also help in attaining mental equanimity when maintaining the posture with breathing and thus transcending to higher layers of existence; (f) Deep relaxation technique which brings about deep rest to all the systems and organs with awareness; (g) *Prāṇāyāma* or regulated breathing to slow down the breath, remove random agitations and calm down the mind; and ended with h) Meditation to culture the emotions by dwelling on a single thought (OM) for long duration of time, thus providing deep rest to the organs.

A module specific to IBS was formulated keeping in mind the general benefits PK-BAYT had to offer (**Table 3** enlisted the general benefits of *Pañca Kośā* based *Yoga* therapy). A specific one hour *Yoga* module that was easily followed even by the people who never heard of *Yoga* was developed. This module was tested for practicality on few patients and was satisfactorily agreed upon that it was a feasible module. The results of this study can validate RYM as an intervention modality for IBS patients. **Table 14** details the benefits of RYM practices for IBS patients.

Table 14. Benefits of RYM practices for IBS

Practice	Technique	Affected areas
Breathing practices	Coordinate breathing with body movements	Lung capacity, rhythmic breathing
Loosening practices	Loosen all joints	Remove tardiness in body and get prepared for *āsanās*
Āsanās	Maintain in final posture with normal slow breathing transcending from physical body to higher layers of *Pañca Kośās*	Bring balance at *Prāṇamaya Kośa* and *Manomaya Kośa*, slowing down of thoughts
Standing	Maintain final position with expansion of awareness	Expansion in the abdominal areas while balancing vital life force
Sitting		Compression and twisting of the abdominal region relieving any discomfort
Prone		Compression and stretching of abdominal muscles
Supine		Enhancing blood flow in the inverted postures
Relaxations	Deep relaxation to all body parts	Stress reduction while resting with awareness
Kriya (*Uddiyana bandha* and *agnisāra*)	Rigorous movement of abdominal region	Stimulating the associated nerves and massages the abdominal region. Improves blood circulation and helps in constipation, indigestion.
Prāṇāyāma	Slowing down the breath, reducing the erratic breathing	Stress reduction, slowing down of thoughts
Kapalabhāti	Activates and cleanses lungs, brain	Vitalizes and releases constrictions in the *Prāṇamaya Kośa*
Sectional breathing	Preparation for full yogic breathing	Complete utilization of all lobes of the lungs

Nādi śuddhi Prāṇāyāma	Balances both right and left nostril airways	Balances *prāṇā*, enhances parasympathetic dominance
Cooling *Prāṇāyāma*	Induces cooling effect and muscular relaxation in the facial region	Quenches thirst, taste buds are sensitized. It helps reduce acidity and indigestion
Bhrāmari	Creates a soothing effect on the nervous system	Relieves stress and tension. Helps in reducing anxiety, anger
Meditation	Stress reduction, slowing down of thoughts	Increased mental alertness, deep rest to all body parts, inner silence

The Remedial *Yoga* Module (**Table 5**, Chapter 2) incorporating all of the above components is arranged in the following structure: opening the session – 2 min; breathing practices – 5 min; instant relaxation technique – 2 min; loosening practices – 6 min; quick relaxation technique – 3 min; *āsanās* – 18 min; deep relaxation technique – 6 min; *kriyās* and *Prāṇāyāma* – 11 min; meditation – 6 min; closing the session – 1 min.

Yogic counselling was given about 2 to 3 minutes to the whole group during the relaxation and Meditation in each session. Usually the topics counseled were acceptance, not reacting to situations; happiness is inside and not outside of us. Some of the techniques (karma *yoga*, bhakti *yoga*) were not used due to the nature of our patient base.

5.8.2 *Yoga* sessions

Six certified *Yoga* instructors were trained, instructed and monitored by the lead *Yoga* instructor under the overall study Principal Investigator (Senthamil R. Selvan, Ph.D.,

Research Director, Vivekananda *Yoga* Research Foundation, Norwalk, California, USA) to follow the module exactly in order to ensure there were no differences in the intervention received by the patients from different *Yoga* instructors. The *Yoga* instructors were blind to the group allocation of the patients.

Each *Yoga* session lasted for an hour, had a gradual pace, starting with simple breathing practices, loosening practices and simple postures with relaxations in between. The session ended with regulated breathing and meditation. Occasionally the sessions lasted an extra 5-10 minutes as some new patients required more attention. The *Yoga* sessions were held three days a week (evening) and one weekend morning class, which served as an alternate option/makeup class. Adherence to the *Yoga* module was monitored by research staff regularly, and there were no deviations noted from the protocol. The *Yoga* session for intervention was followed (as listed in **Table 5)** as depicted in **Figure 7** below.

All the *Yoga* sessions were held in a large conference hall of the research center and all appraisals were held in a temperature and noise controlled suite within the research center of White Memorial Medical Center, Los Angeles, California, USA (**Plate 5**).

Plate 5. Image of White Memorial Medical center, Los Angeles, California.

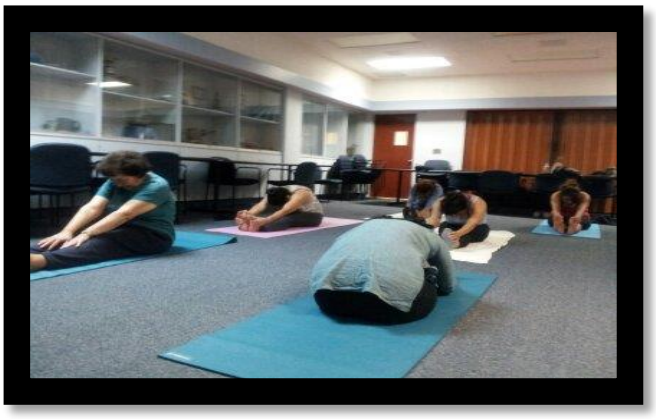
5.9 Wait-list Control group

Patients in the Wait-list Control group were asked to continued their medications if any, under the guidance of their physician, and were suggested to maintain their lifestyle. They were also advised to walk for an hour three times a week, but there was not a follow up by the research team. The Controls were contacted and were reminded one week before their next assessment interval at Week 6 and 12. After 12 weeks of waiting, interested controls were given the same RYM intervention, thrice a week, for 12 weeks. The WL-*Yoga* group was assessed one more time after the completion of the 12-week RYM intervention. They were given $20 for each of the three assessments, to keep them motivated to participate in the study. A *Yoga* mat and an exercise journal were given to all patients.

5.10 Follow-up group

Patients from all three groups that completed the 12 weeks of RYM intervention were invited to participate in a once a week, one hour RYM maintenance intervention for 12 more weeks. The Follow-up group was measured one more time at the end of 24 weeks.

Plate 6 has the images of RYM practices by the patients enrolled in this study.



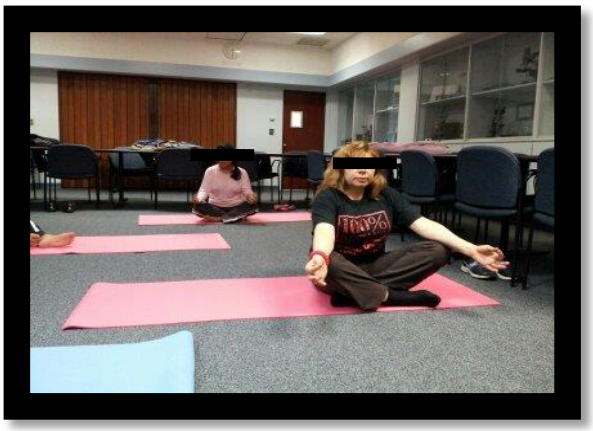


Plate 6. Images of intervention - Remedial *Yoga* Module.

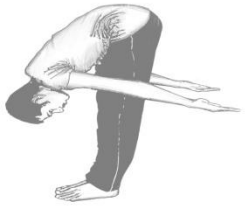
Hand stretch breathing

Moon pose breathing

Tiger breathing

Straight leg raise breathing

Instant Relaxation Technique



Forward-backward bend

Side bending

Spinal Twisting

Wind relieving loosening

Quick Relaxation Technique

Half wheel pose

Hands to feet pose

Half waist wheel pose

Triangle pose

Revolved triangle pose

Tree pose

Half spinal twist pose

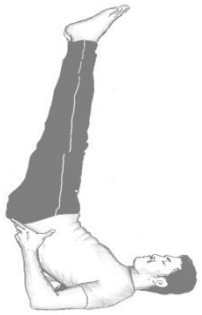
Seated forward bend pose

Cobra pose

Locust pose

Fish pose

Shoulder stand



Legs up the wall pose

Deep relaxation technique

Abdominal lock/ rigorous movement of the abdomen

Foceful exhalation

Controlled Breathing

Cooling Breath - Shitali

Cooling Breath - Shitkari

Meditation

Figure 7. Schematic representation of RYM practices

CHAPTER-6

DATA COLLECTION & ANALYSIS

6. DATA COLLECTION AND ANALYSIS

6.1 DATA COLLECTION

All data were collected from November 2012 to September 2014. All the patients were given appointment for the first appraisal, according to their convenience and that of the research staff's. All the appraisals took place in the research center of White Memorial Medical Center, Los Angeles, California, USA. The patients were seated comfortably and the case report form that included demographic information, family history, medical history, medicines/supplements used for IBS symptom relief, Global assessment of Improvement, was duly filled by the research staff after enquiring about the details of the patient such as date of birth, education, employment, and their medical history. The patient's physical measurements were recorded and all four questionnaires (IBS-SSS, IBS-QOL, HADS, and Autonomic Symptom Score) were given to the patient to answer either in English or Spanish. If the patients had difficulty understanding any questions, a bilingual research staff was always available to clarify their doubts. After the questionnaires were completed, the sympathetic and parasympathetic tasks were administered. At the end of appraisal, the patients were given $5 (*Yoga* and Combination groups) and $20 (Control group) for completing the appraisal and an appointment time for their next visit. Patients were also provided refreshments and water. The total time for the whole procedure lasted for 70-75 minutes. *Yoga*, Combination and Control groups were appraised three times in the first 12 weeks (Week 0, Week 6 and Week 12). The

Control group, if participated in the 12-week RYM intervention was appraised one more time after the completion of the intervention.

The Follow-up group (patients that completed 12 Weeks of RYM and participating in long-term study) was assessed once more at the end of Week 24.

At the end of the study, in October 2014, all the questionnaires were assessed by research team not involved with data collection. Body Mass Index (BMI) was calculated with a calculator. All the ECG data was extracted with Kubios software, and 30:15 ratio was extracted with acknowledge software.

6.2 STATISTICAL ANALYSES

All the Statistical analyses were carried out using SPSS (Scientific Packages for Social Sciences, IBM Corporation, NY; version 20.0). The primary outcomes were changes in IBS-SSS and IBS-QOL scores from week 6 and week 12 visits compared to week 0. Changes in HADS, Autonomic Symptom Scores, IBS-GAI, Medicine and Supplement use, BMI, physical flexibility, and autonomic function tests were considered as secondary outcomes. Initial tests of ANOVA showed there were no baseline differences between *Yoga*, Combination, and Control groups on demographic and clinical variables, such as age, weight, and duration of IBS.

The baseline data of all the assessments were tested for normality and all the data were normal. Repeated measures analyses of variance (ANOVAs) were performed for each assessment with 2 factors; (1) Groups: *Yoga* group, Combination group and Control group; and (2) Time points: Week 0 (pre-intervention), Week 6 (mid-intervention) and Week 12 (post-intervention). Repeated measures ANOVAs were carried out separately

followed by *post hoc* analyses with Bonferroni adjustment for multiple comparisons between the mean values of different time points and all comparisons were made with respective week 0 (pre-intervention) values. For nominal data (Medicine and Supplement Use) McNemar's test was used to analyze "Between-group" differences.

In the Intention-to-treat analysis, missing data were filled by multiple imputation method and the results were presented as pooled means. For the responder analysis, t-tests were used to compare between responders and non-responders.

Paired samples t-test was performed to analyze the pre and post effect of RYM intervention on Waitlist Control that finished the RYM intervention (**WL-*Yoga* group**). One way ANOVA tests were performed to assess any "Between-group" differences (after intervention) in the improvements between *Yoga*, Combination and WL-*Yoga* groups.

To evaluate whether the 12 week "maintenance" RYM intervention on follow-up group had sustained improvements (from the improvements seen in all three groups at end of 12 week RYM intervention), Repeated Measures ANOVA was used to analyze changes from week 0 to week 12 and week 24. This allowed us to compare changes from week 0 to week 24, and also compare maintenance or regression of improvements from week 12 to week 24.

All the raw data used for analysis of this study is provided in **APPENDIX I**, **Tables 41-71**.

CHAPTER-7

RESULTS

7. RESULTS

7.1 SUBJECTS

A total of 97 patients, clinically diagnosed with IBS, were included in the study. Mean and median age and weight of randomized subjects (n = 97) is detailed in **Table 15.** Of which, 78 patients completed the study and were included in the per-protocol analysis. Subjects comprised of IBS-C (n = 28, median age 43 years; 35.9% of total completed), IBS-D (n = 23, median age 45 years; 29.5% of total completed), and IBS-M (n = 27, median age 45 years; 34.6% of total completed). The median duration of IBS from diagnosis before enrolling into the trial was eight years and medications were used for three years. The details of patient enrollment, dropouts, and the number of patients that completed the 12-Week trial are given in the flow chart (**Figure 8**) below. Details of the demographic data of 78 patients that completed the study are shown in **Table 15 A.**

Table 15: Mean and Median age and weight of randomized subjects (n = 97)

Group	Total enrolled /Female / Male	Mean Age in years / Weight in lbs	Median Age in years / Weight in lbs
Yoga	33 / 31 / 2	44.06 ± 13.42 / 155.48 ± 26.39 44.06 ± 13.42 / 155.48 ± 26.39 45.8 ± 12.71 / 159 ± 29.95	45 / 156 45 / 156 42 / 147
Combination	33 / 28 / 5	44.27 ± 13.59 /159.36 ± 29.88 44.27 ± 13.59 / 159.36 ± 29.88 41.18 ± 12.75 / 159.68 ± 34.62	46 / 157 46 / 157 42.5 / 155
Control	31 / 25 / 6	45.08 ± 13.28 / 168.61 ± 31 44.07 ± 13.68 / 169.77 ± 32.65 45.77 ± 12.88 / 167.73 ± 31.52	46 / 165 46 / 165 46 / 164

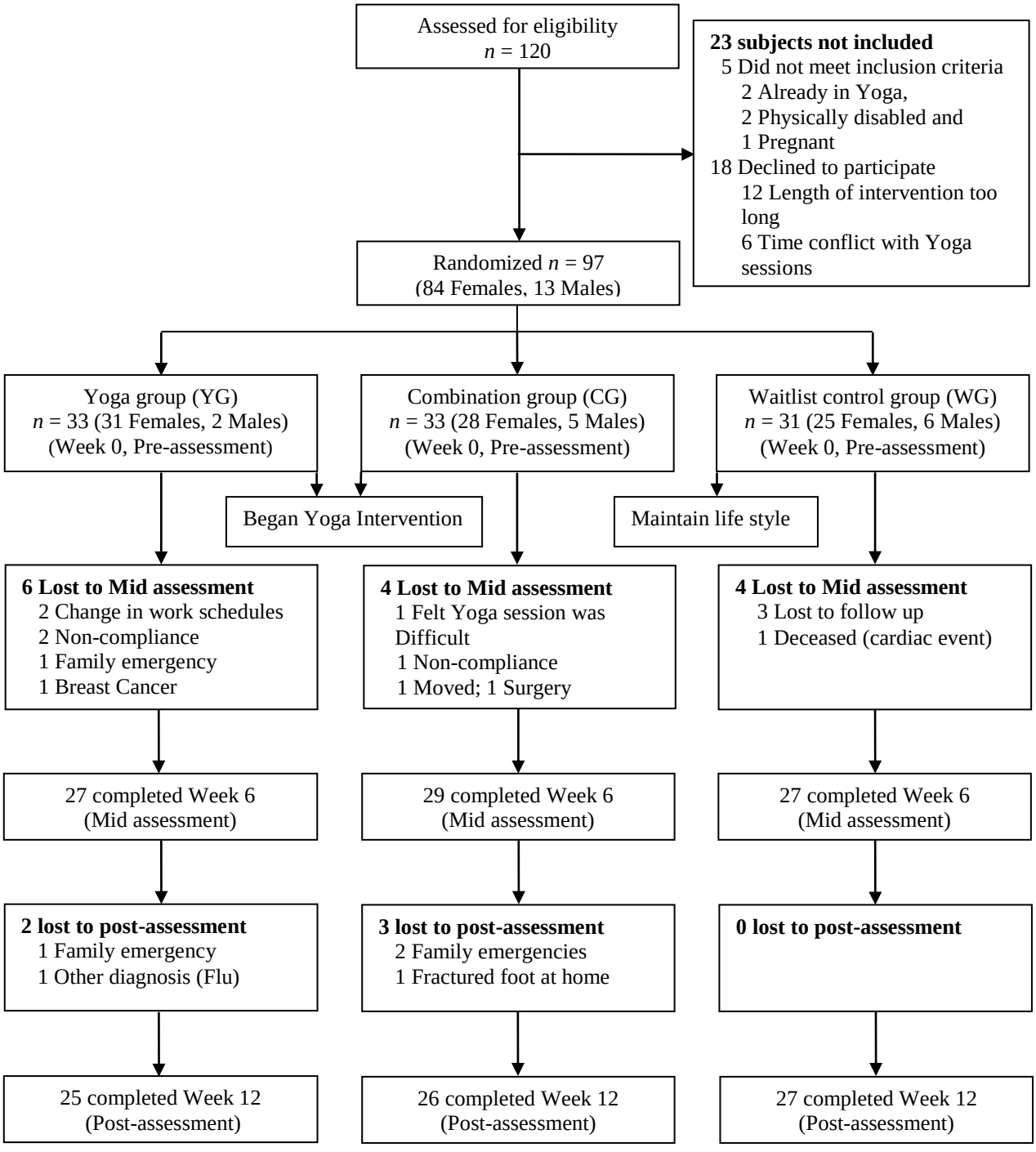


Figure 8. Flow of patients from randomization to completion of 12 week trial.

Table 15 A. Characteristics of 78 subjects that completed the study.

	Total (78)	Yoga group (25)	Combination group (26)	Waitlist (Control) group (27)
		Marital Status		
Married/Cohabitant	44 (56.4%)	17 (68.0%)	12 (46.2%)	15 (55.6%)
Single	26 (33.3%)	6 (24.0%)	11 (42.3%)	9 (33.3%)
Divorced	7 (9.0%)	1 (4.0%)	3 (11.5%)	3 (11.1%)
Widowed	1 (1.3%)	1 (4.0%)	0	0
		Ethnicity		
Hispanic	56 (71.8%)	15 (60.0%)	19 (73.1%)	22 (81.5%)
Non-Hispanic	22 (28.2%)	10 (40.0%)	7 (26.9%)	5 (18.5%)
		Education		
Middle school	4 (5.1%)	2 (8.0%)	1 (3.9%)	1 (3.7%)
High School	33 (42.3%)	5 (20.0%)	11 (42.3%)	17 (63.0%)
College	41 (52.6%)	18 (72.0%)	14 (53.8%)	9 (33.3%)
		Employment		
Full-time	51 (65.4%)	19 (76.0%)	14 (53.9%)	18 (66.7%)
Part-time	15 (19.2%)	1 (4.0%)	8 (30.8%)	6 (22.2%)
Home-maker	3 (3.9%)	1 (4.0%)	1 (3.8%)	1 (3.7%)
Unemployed	4 (5.1%)	2 (8.0%)	1 (3.8%)	1 (3.7%)
Retired	5 (6.4%)	2 (8.0%)	2 (7.7%)	1 (3.7%)
		Economic Status		
<30k	39 (50.0%)	9 (36.0%)	15 (57.7%)	15 (55.6%)
30-60k	26 (33.3%)	10 (40.0%)	8 (30.8%)	8 (29.6%)
60-100k	9 (11.6%)	5 (20.0%)	2 (7.7%)	2 (7.4%)
>100k	4 (5.1%)	1 (4.0%)	1 (3.8%)	2 (7.4%)
		IBS Subgroups		
IBS - Constipation	28 (35.9%)	8 (32.0%)	10 (38.5%)	10 (37.0%)
IBS – Diarrhea	23 (29.5%)	10 (40.0%)	6 (23.0%)	7 (26.0%)
IBS - Mixed	27 (34.6%)	7 (28.0%)	10 (38.5%)	10(37.0%)
		General		
Age	43.45 ± 13.51	44.88 ± 13.42	42.77 ± 13.69	42.78 ± 13.79
Years with IBS	7.72 ± 6.68	7.52 ± 6.22	7.67 ± 7.03	7.33 ± 5.83
Years Medicine /Supplement Use	2.85 ± 3.21	2.48 ± 2.61	3.25 ± 3.89	2.81 ± 3.1

Percent in parentheses represents value of the total in a given category

7.1.1 Yoga Practice

It was required that both *Yoga* and Combination groups attend at least 75% (27 out of 36) of the *Yoga* sessions. On an average, subjects in *Yoga* and Combination groups attended 33 of the *Yoga* intervention classes out of a total of 36 classes given in 12 weeks, about 90% attendance. About 10% of the subjects reported to have practiced few postures for about 10 minutes to relieve the discomfort during painful episodes at home.

7.2 PER-PROTOCOL ANALYSIS

Repeated measures ANOVA were performed for each assessment with two factors: time points (week 0, week 6 and week 12) and groups (*Yoga*, Combination and Wait-list Control). Significant main effects of time points and assessments, and the interaction between time points, groups and assessments are given in **Table 16.**

Table 16. Summary of ANOVA showing statistically significant results in primary and secondary outcomes.

Variables	Factor	F Value	*Df*	Huynh -Feldt epsilon	Level of significance	$p\eta^2$
IBS - SSS	Time point	184.68	1.83, 150.00	0.92	<0.001	0.71
	Group x Time point	50.52	3.67, 137.47	0.92	<0.001	0.57
IBS-QOL	Time point	103.09	1.58, 118.39	0.79	<0.001	0.58
	Group x Time point	29.58	3.16, 118.39	0.79	<0.001	0.44
IBS-SS – 5 Scales	Time point	184.68	1.83, 137.47	0.92	<0.001	0.71
	Assessment	25.77	3.62, 271.68	0.91	<0.001	0.26
	Time point x Group	50.52	3.67, 137.47	0.92	<0.001	0.57
	Time point x Assessment	6.49	7.18, 538.83	0.89	<0.001	0.08
IBS-QOL 8 dimensions	Assessment	944.95	7,00, 525.00	0.41	<0.001	0.93
	Time point	103.09	2.00, 150.00	0.79	<0.001	0.58
	Assessment x Group	6.56	5.67, 212.48	0.41	<0.001	0.15
	Group x Time point	29.58	3.16, 118.39	0.79	<0.001	0.44
	Assessment x Time point	35.72	6.98, 523.76	0.41	<0.001	0.32
	Assessment x Time point x Group	10.29	13.97, 523.76	0.41	<0.001	0.22
HADS - Anxiety	Time point	37.00	1.93, 144.73	0.97	<0.001	0.33
	Time point x Group	25.54	3.86, 144.73	0.97	<0.001	0.41
HADS - Depression	Time point	35.52	1.86, 139.64	0.93	<0.001	0.32
	Time point x Group	18.81	3.72, 139.64	0.93	<0.001	0.33
ANS-SS	Time point	16.89	1.98, 148.60	0.99	<0.001	0.18
	Time point x Group	11.2	3.97, 148.60	0.99	<0.001	0.23
IBS-GAI	Time point	891.19	1.85, 130.69	0.87	<0.001	0.92
	Time point x Group	217.76	3.49, 130.69	0.87	<0.001	0.85
Medication score	Time point	57.76	1.49, 111.35	0.74	<0.001	0.44

	Time point x Group	9.73	2.97, 111.35	0.74	<0.001	0.21
Flexibility - Hip	Time point	69.62	1.70, 127.40	0.85	<0.001	0.48
	Time point x Group	8.89	3.40, 127.40	0.81	<0.001	0.19
Flexibility – Right shoulder	Time point	40.61	1.63, 122.95	0.82	<0.001	0.35
	Time point x Group	6.05	3.28, 122.95	0.82	<0.001	0.14
Flexibility – Left shoulder	Time point	50.56	1.83, 137.32	0.92	<0.001	0.4
	Time point x Group	9.64	3.66, 137.32	0.92	<0.001	0.2
Deep Breathing HRV	Assessment	185.53	2.34, 175.77	0.26	<0.001	0.71
30-15 ratio	Time point	7.34	1.90, 142.38	0.95	<0.001	0.09
Handgrip- Dias BP	Group	133.85	1.71, 128.06	0.85	<0.001	0.64
	Time point	5.11	2.00, 150.00	1	<0.01	0.06
Handgrip - Strength	Time point	88.79	1.92, 143.88	0.96	<0.001	0.54
	Time point x Group	8.73	3.84, 143.88	0.96	<0.001	0.19
Math - BP	Assessment	1,214.37	1.66, 124.59	0.33	<0.001	0.94
	Time point	5.22	2.00, 150.00	1	<0.01	0.07
	Time point x Assessment	2.81	8.63, 647.01	0.86	<0.01	0.04
Math – Speed and accuracy	Assessment	135.26	1.00, 75.00	1	<0.001	0.64
	Time point	14.25	2.00, 150.00	1	<0.001	0.16

Df: Degrees of freedom; X shows interaction

7.3 PRIMARY OUTCOME ASSESSMENTS

7.3.1 IBS-SSS and IBS-QOL

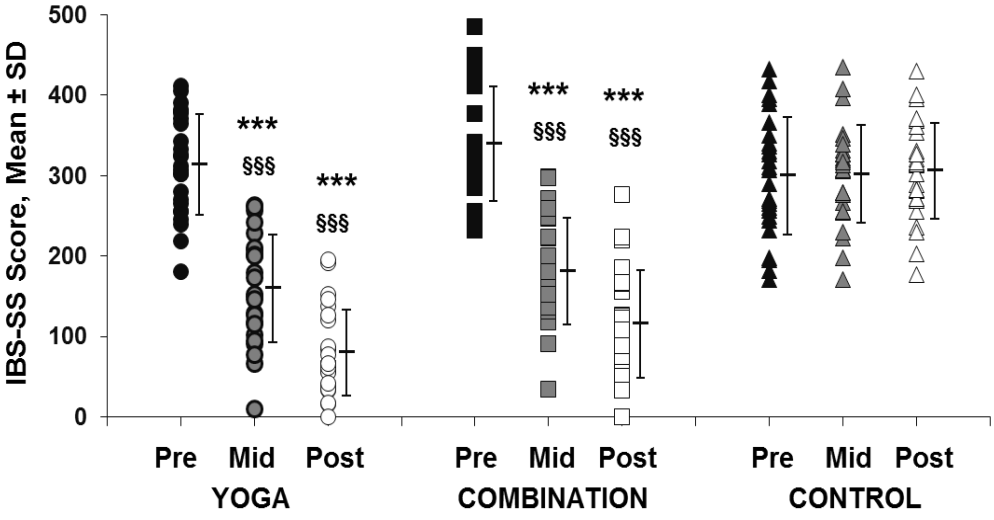
Post hoc analysis with Bonferroni correction of IBS – SSS showed a significant improvement in *Yoga* and Combination groups when compared to Control group. **Figure 9a** (IBS-SSS) and **9b** (IBS-QOL) illustrates the changes between groups and time points. There was a significant difference between *Yoga* and Control groups at week 6 ($p<0.001$), and at week 12, the mean difference was 226.31 ± 16.8; [185.17, 267.44], ($p<0.001$). There was a significant difference between Combination and Control groups at week 6 ($p<0.001$) and at week 12, the mean difference was 189.72 ± 16.63 [149.01, 230.44], ($p<0.001$). There were no significant differences between *Yoga* and Combination groups. **Table 17** shows between group differences and within group changes of the primary outcomes.

Table 17. Analysis of between group differences and within group changes of primary outcomes in IBS patients.

	Assessment	Week 0	Week 6	95% CI	Week 12	95% CI
1	**IBS-SSS Scores**					
	Yoga (n = 25)	313.92 ± 62.55	160 ± 67.32 *** §§§ (49.03%)	134.46, 185.94	79.88 ± 53.08 *** §§§ (74.55%)	55.77, 103.99
	Combination (n = 26)	339.54 ± 71.02	181 ± 65.79 *** §§§ (46.69%)	155.76, 206.24	116.46 ± 67.32 *** §§§ (65.70%)	92.82, 140.1
	Control (n = 27)	300.33 ± 73.27	301.59 ± 60.78	276.82, 326.36	306.19 ± 60.04	282.99, 329.39
2	**IBS-QOL Scores**					
	Yoga (n = 25)	99 ± 28.24	136.4 ± 21.54 *** §§§ (37.78%)	126.91, 145.89	155.12 ± 11.69 *** §§§ (56.69%)	146.93, 160.31
	Combination (n = 26)	97.08 ± 30.8	128.46 ± 25.11 *** §§§ (32.32%)	119.15, 137.77	146.54 ± 21.8 *** §§§ (50.94%)	138.51, 154.57
	Control (n = 27)	99.93 ± 26.12	96.26 ± 24.56	87.13, 105.39	98.59 ± 25.21	90.71, 106.47

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to week 0; *: Represents mean change within groups when compared to week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; §§§ $p < 0.001$.

(A)



(B)

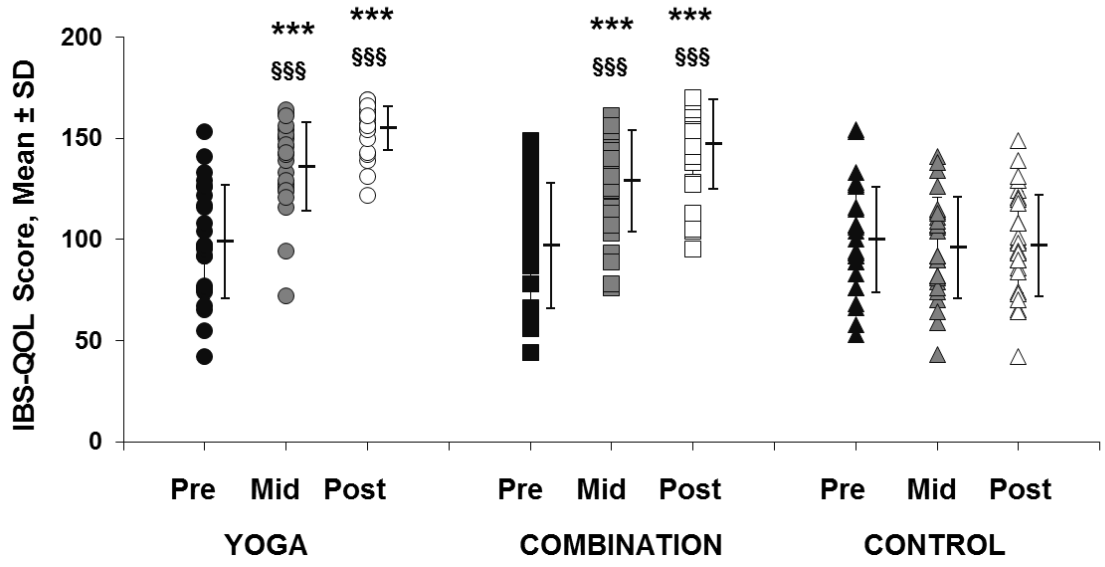


Figure 9. Changes in the primary outcomes in IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Control (n = 27). **(A)** IBS-SSS and **(B)** IBS-QOL at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents mean change within groups when compared to week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; §§§ $p < 0.001$.

7.3.1.1 The five sub-scales of IBS-SSS

The five sub-scales of IBS-SSS were analyzed in detail **(Figure 10** and **Table 18).** Significant improvements were observed in all five categories in *Yoga* ($p<0.001$) and Combination groups ($p<0.001$) when compared to Control group. Within group changes of *Yoga* and Combination showed significant improvements at week 6 ($p<0.001$) and at week 12 ($p<0.001$) when compared to week 0. There were no changes in the Control group.

Table 18. Analysis of between group differences and within group changes in IBS patients in the five sub-scales of IBS-SS Scores

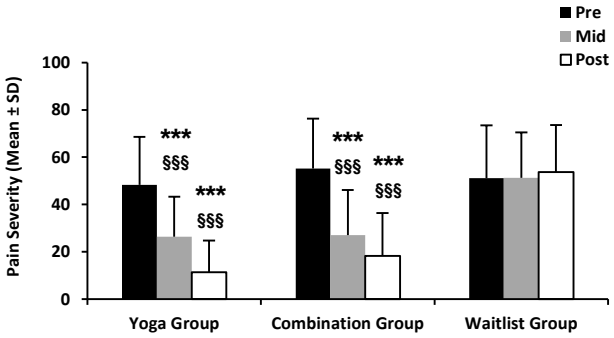
		Week 0	Week 6	95% CI	Week 12	95% CI
1	**IBS SSS - Severity of Pain**					
	Yoga (n = 25)	48.32 ± 20.21	26.4 ± 16.86 *** §§§ (45.36%)	19.05, 33.75	11.32 ± 13.46 *** §§§ (76.57%)	4.37, 18.27
	Combination (n = 26)	55.14 ± 21.11	27.04 ± 19.07 *** §§§ (50.96%)	19.83, 34.25	18.31 ± 18.02 *** §§§ (66.79%)	11.46, 25.12
	Control (n = 27)	51.11 ± 22.28	51.19 ± 19.24	44.11, 58.26	53.67 ± 19.94	46.98, 60.35
2	**IBS-SSS – Duration of Pain**					
	Yoga (n = 25)	68.4 ± 23.4	26 ± 23.63 *** §§§ (61.99%)	16.45, 35.55	9.6 ± 10.98 *** §§§ (85.96%)	3.24, 15.96
	Combination (n = 26)	75.77 ± 23.69	28.46 ± 27.81 *** §§§ (62.44%)	19.1, 37.83	15.39 ± 15.03 *** §§§ (79.69%)	9.15, 21.62
	Control (n = 27)	63.33 ± 26.02	57.04 ± 19.96	47.85, 66.23	57.04 ± 20.16	50.92, 63.16

	IBS-SSS – Abdominal Distension					
3	Yoga (n = 25)	53.52 ± 20.88	26.24 ± 20.48 *** §§§ (50.97%)	18.26, 34.22	12.96 ± 13.75 *** §§§ (75.78%)	5.57, 20.35
	Combination (n = 26)	60.81 ± 23.51	36.89 ± 19.69 *** §§ (39.34%)	29.06, 44.71	23.77 ± 23.32 *** §§§ (60.91%)	16.52, 31.02
	Control (n = 27)	58.04 ± 24.95	58.04 ± 19.9	50.36, 65.71	61.56 ± 17.2	54.44, 68.67
	IBS-SSS – Bowel Satisfaction					
4	Yoga (n = 25)	78.08 ± 17.18	43.76 ± 21.24 *** §§§ (43.95%)	36.59, 50.93	23.76 ± 19.14 *** §§§ (69.57%)	16.3, 31.22
	Combination (n = 26)	76.39 ± 18.27	45.46 ± 15 *** §§§ (40.49%)	38.43, 52.49	28.31 ± 18.43 *** §§§ (62.94%)	20.99, 35.63
	Control (n = 27)	66.89 ± 23.52	68.82 ± 17.35	61.92, 75.71	69.33 ± 18.63	62.15, 76.51
	IBS-SSS – Interference with life in general					
5	Yoga (n = 25)	65.6 ± 17.84	37.8 ± 15.62 *** §§§ (42.38%)	30.39, 45.21	22.24 ± 15.89 *** §§§ (66.1%)	15, 29.48
	Combination (n = 26)	71.42 ± 19.66	43.15 ± 18.7 *** §§§ (39.58%)	35.89, 50.42	30.69 ± 18.85 *** §§§ (57.03%)	23.59, 37.79
	Control (n = 27)	60.96 ± 20.8	66.52 ± 20.86	59.39, 73.65	64.59 ± 19.44	57.63, 71.56

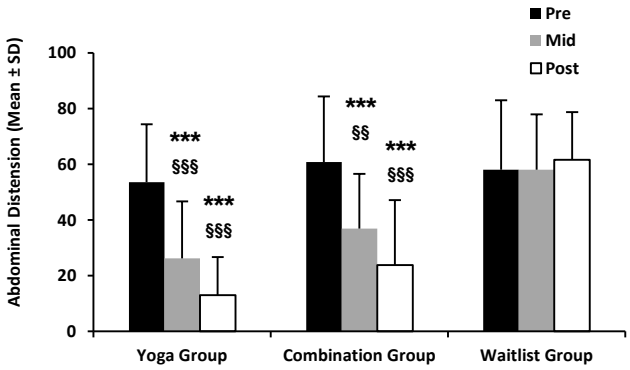
Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents within group changes when compared to week 0; *** $p < 0.001$;

§: Represents between group differences when compared to Control group; §§ $p < 0.01$; §§§ $p < 0.001$.

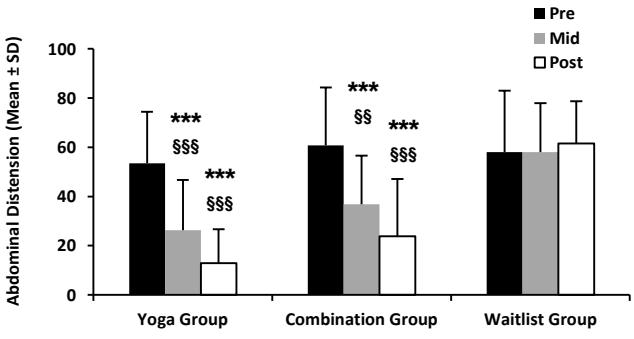
(A)


Pre
Mid
Post
Pain Severity (Mean ± SD)
100
80
60
40
20
0
***
§§§
***
§§§
***
§§§
***
§§§
Yoga Group
Combination Group
Waitlist Group

(B)


Pre
Mid
Post
Abdominal Distension (Mean ± SD)
100
80
60
40
20
0
***
§§§
***
§§§
***
§§
***
§§§
Yoga Group
Combination Group
Waitlist Group

(C)


Pre
Mid
Post
Abdominal Distension (Mean ± SD)
100
80
60
40
20
0
***
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***
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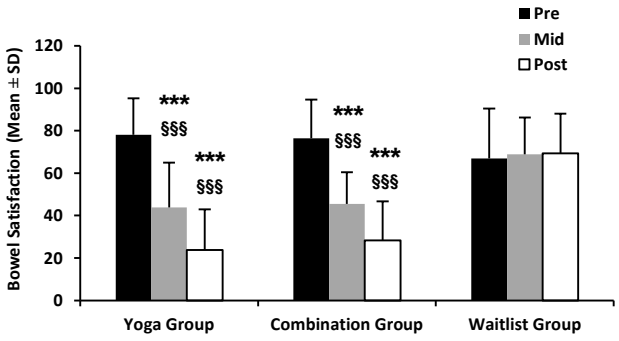
***
§§
***
§§§
Yoga Group
Combination Group
Waitlist Group

(D)



(E)

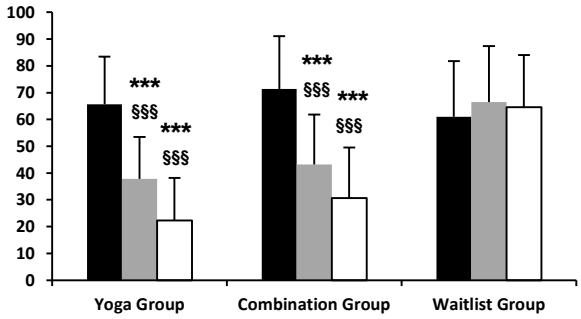


Figure 10. Changes in five sub-scales of IBS-SS in IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Waitlist (n = 27)**. (A)** Pain Severity, **(B)** Duration of Pain, **(C)** Abdominal distension, **(D)** Bowel Satisfaction and **(E)** Interference with life at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents mean change within groups when compared to week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; §§ $p < 0.01$; §§§ $p < 0.001$.

7.3.2 IBS-QOL

There was a significant difference between *Yoga* and Control group at week 6 ($p<0.001$), and at week 12, the mean difference was 56.53 ± 5.71 [42.56, 70.5]; ($p<0.001$). Similarly, a significant difference between Combination and Control group at week 6 ($p<0.001$) as well as at week 12, the mean difference of 47.95 ± 5.65 [34.12, 61.77]; ($p<0.001$), was observed (**Table 17 and Figure 9B**).

7.3.2.1 Eight dimensions of IBS-QOL

A similar detailed analysis of eight dimensions of IBS - Quality of Life assessments was carried out. As shown in **Figure 11 and Table 19**, there was a significant difference between *Yoga* and Control group ($p<0.001$) and Combination and Control group ($p<0.001$) in all eight dimensions. Within group changes were observed in dimensions of one to six and eight in *Yoga* and Combination groups at week 6 ($p<0.001$) and at week 12 ($p<0.001$) when compared to week 0 . There were no changes observed in the Control group.

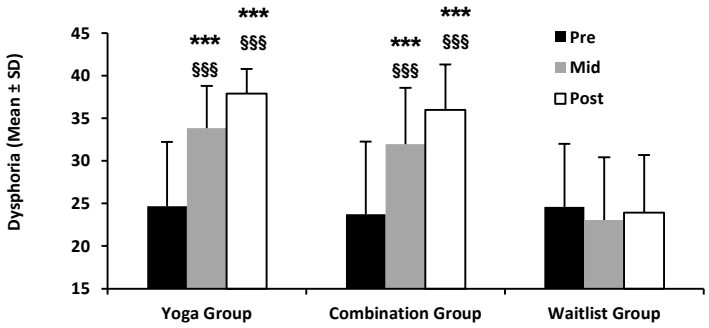
Table 19. Analysis of between group differences and within the group changes of the IBS patients in eight dimensions of IBS-QOL.

		Week 0	Week 6	95% CI	Week 12	95% CI
1	**Dysphoria**					
	Yoga (n = 25)	24.68 ± 7.55	33.84 ± 4.97 *** §§§ (37.11%)	31.29, 36.4	37.9 ± 2.91 *** §§§ (53.57%)	35.81, 40.03
	Combination (n = 26)	23.73 ± 8.54	31.96 ± 6.62 *** §§§ (34.68%)	29.45, 34.47	36 ± 5.31 *** §§§ (51.71%)	33.93, 38.07
	Control (n = 27)	24.59 ± 7.41	23.07 ± 7.36	20.61, 25.54	23.92 ± 6.76	21.9, 25.95
2	**Interference**					
	Yoga (n = 25)	19.68 ± 7.18	28.84 ± 5.18 *** §§§ (46.54%)	26.63, 31.05	32.12 ± 2.76 *** §§§ (63.21%)	30.26, 33.98
	Combination (n = 26)	19.85 ± 6.6	25.65 ± 5.96 *** §§§ (29.22%)	23.49, 27.82	30.04 ± 4.79 *** §§§ (51.33%)	28.22, 31.86
	Control (n = 27)	21.04 ± 6.14	21.18 ± 5.48	19.06, 23.31	21.44 ± 5.8	19.66, 23.23
3	**Body Image**					
	Yoga (n = 25)	10.12 ± 2.95	14.88 ± 3.54 *** §§§ (47.04%)	13.54, 16.22	17.52 ± 2.49 *** §§§ (73.12%)	16.34, 18.7
	Combination (n = 26)	9.62 ± 3.87	13.81 ± 3.24 *** §§§ (43.55%)	12.5, 15.12	16.27 ± 2.93 *** §§§ (69.13%)	15.11, 17.43
	Control (n = 27)	10.33 ± 3.54	10.07 ± 3.3	8.79, 11.36	10.63 ± 3.39	9.49, 11.77
4	**Health worry**					
	Yoga (n = 25)	8.04 ± 2.25	11.88 ± 2.54 *** §§§ (47.76%)	10.83, 12.93	13.44 ± 1.42 *** §§§ (67.16%)	12.57, 14.32
	Combination (n = 26)	7.73 ± 3.13	11.15 ± 2.85 *** §§§ (44.24%)	10.12, 12.19	12.77 ± 2.5 *** §§§ (65.2%)	11.91, 13.63
	Control (n = 27)	7.85 ± 2.41	7.48 ± 2.52	6.47, 8.5	7.51 ± 2.46	6.68, 8.36
5	**Food avoidance**					
	Yoga	6.32 ± 2.59	8.76 ± 2.95 *** §	7.59, 9.93	11.44 ± 1.53 ***	10.5, 12.83

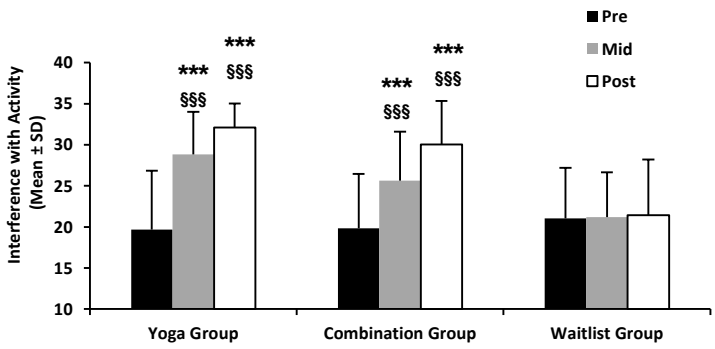
	(n = 25)		(38.61%)		§§§ (81.01%)	
	Combination (n = 26)	6.12 ± 2.82	8.46 ± 3.06 *** (38.24%)	7.31, 9.61	10.73 ± 2.51*** §§§ (75.33%)	9.81, 11.66
	Control (n = 27)	6.19 ± 2.39	6.59 ± ± 2.8	5.47, 7.72	6.44 ± 2.82	5.54, 7.35
	Social reaction					
	Yoga (n = 25)	13.56 ± 4.72	17 ± 3.35 *** §§§ (25.37%)	15.65, 18.35	19.08 ± 1.63*** §§§ (40.71%)	17.87, 20.29
6	Combination (n = 26)	12.23 ± 4.65	16.04 ± 3.38 *** §§§ (31.15%)	14.72, 17.36	17.65 ± 3.07*** §§§ (44.32%)	16.47, 18.84
	Control (n = 27)	13.15 ± 4.17	12.3 ± 3.42	11, 13.59	12.52 ± 3.4	11.35, 13.69
	Sexual					
	Yoga (n = 25)	6.64 ± 3.28	8.24 ± 1.96 ** § (24.1%)	7.39, 9.09	9.48 ± 1.16 *** §§§ (42.77%)	8.83, 10.13
7	Combination (n = 26)	7.77 ± 2.86	8.69 ± 1.98 §§	7.86, 9.53	9.46 ± 1.21 ** §§§ (21.75%)	8.82, 10.1
	Control (n = 27)	7.04 ± 2.24	6.55 ± 2.42	5.74, 7.38	7.04 ± 2.24	6.41, 7.66
	Relationships					
	Yoga (n = 25)	9.96 ± 3.12	12.96 ± 2.47 *** §§§ (30.12%)	11.94, 13.98	14.12 ± 1.01 *** §§§ (41.77%)	13.26, 14.98
8	Combination (n = 26)	10.04 ± 3.63	12.69 ± 2.46 *** §§§ (26.39%)	11.69, 13.69	13.62 ± 2.06 *** §§§ (35.66%)	12.77, 14.46
	Control (n = 27)	9.74 ± 3.34	9 ± 2.72	8.02, 9.98	9.07 ± 2.92	8.24, 9.91

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents within group changes when compared to week 0; ** $p < 0.01$; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$; §§§ $p < 0.001$.

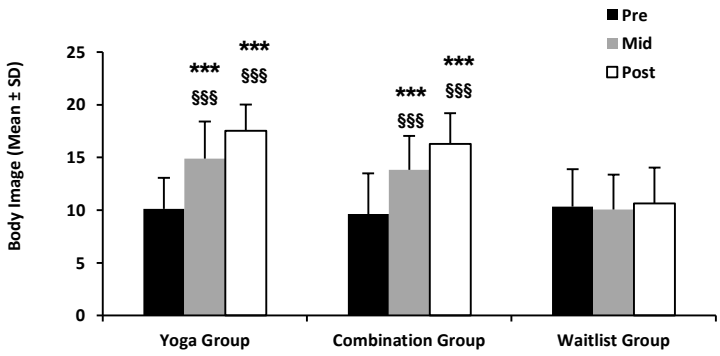
(A)


Dysphoria (Mean ± SD)
45
40
35
30
25
20
15
*** §§§
*** §§§
*** §§§
*** §§§
Pre
Mid
Post
Yoga Group
Combination Group
Waitlist Group

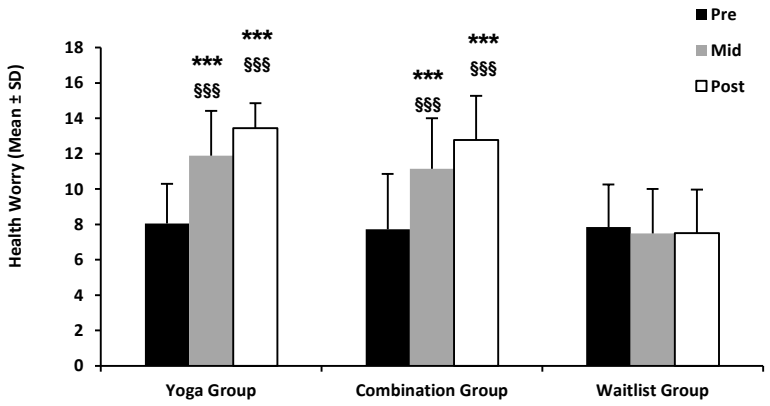
(B)


Interference with Activity (Mean ± SD)
40
35
30
25
20
15
10
*** §§§
*** §§§
*** §§§
*** §§§
Pre
Mid
Post
Yoga Group
Combination Group
Waitlist Group

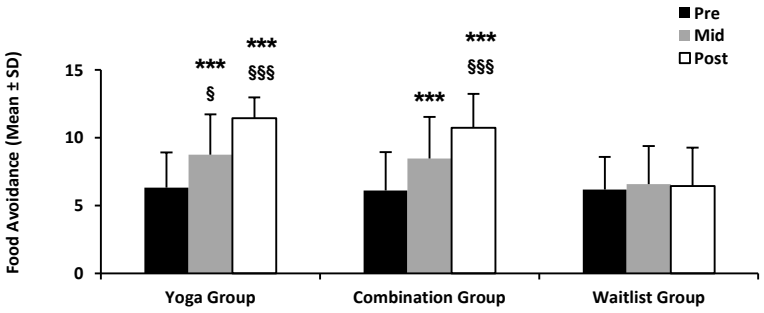
(C)


Body Image (Mean ± SD)
25
20
15
10
5
0
*** §§§
*** §§§
*** §§§
*** §§§
Pre
Mid
Post
Yoga Group
Combination Group
Waitlist Group

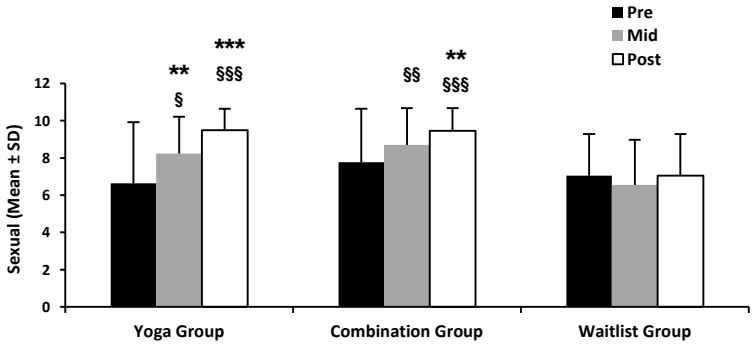
(D)


Pre
Mid
Post
Health Worry (Mean ± SD)
18
16
14
12
10
8
6
4
2
0
*** §§§
*** §§§
*** §§§
*** §§§
Yoga Group
Combination Group
Waitlist Group

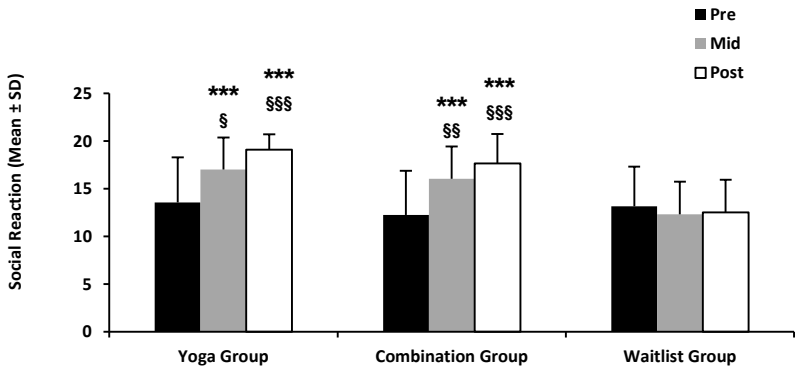
(E)


Pre
Mid
Post
Food Avoidance (Mean ± SD)
15
10
5
0
*** §
*** §§§
*** §§§
*** §§§
Yoga Group
Combination Group
Waitlist Group

(F)


Pre
Mid
Post
Sexual (Mean ± SD)
12
10
8
6
4
2
0
** §
*** §§§
§§
** §§§
Yoga Group
Combination Group
Waitlist Group

(G)



(H)

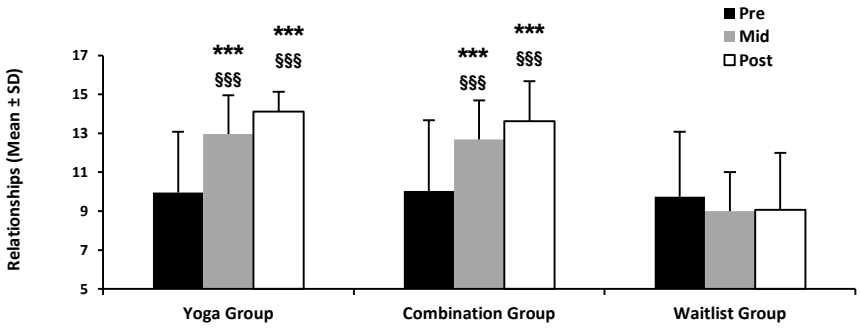


Figure 11. Changes in eight dimensions of IBS-QOL in IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Waitlist (n = 27). **(A)** Dysphoria, **(B)** Interference with Activity, **(C)** Body Image, **(D)** Health Worry, **(E)** Food Avoidance, **(F)** Sexual Relations, **(G)** Social Reaction, and **(H)** Relationships at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using repeated measures of ANOVA followed by Post hoc analysis with Bonferroni adjustment. *: Represents mean change within groups when compared to week 0; ** $p < 0.01$; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$; §§§ $p < 0.001$.

7.4 SECONDARY OUTCOME ASSESSMENTS

7.4.1 Hospital Anxiety and Depression Scale (HADS), Autonomic Symptom Score and IBS-Global Assessments of Improvement (IBS-GAI)

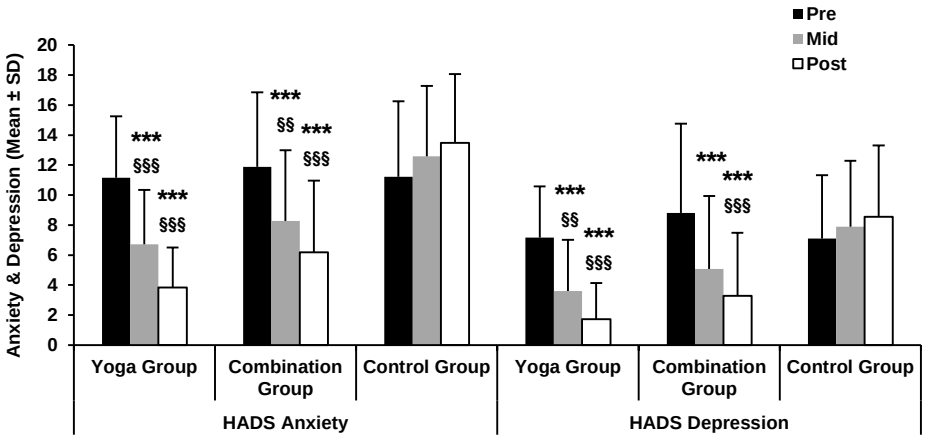
Figure 12 (A, B, C) depicts the comparison of all these assessments, between group differences and within group changes from week 0 to week 6 and week 12. There were significant improvements in both *Yoga* and Combination groups in HADS and IBS-GAI assessments when compared to Control group, at week 6 ($p < 0.001$) and at week 12 ($p < 0.001$). In the assessment of Autonomic Symptom Score, a significant difference between *Yoga* and Control groups ($p < 0.01$); Combination and Control groups ($p < 0.05$) at week 12 was observed. The details of changes between groups and within group are given in **Table 20**.

Table 20. Analysis of between group differences and within group changes in the secondary outcomes of IBS patients.

	Assessment	Week 0	Week 6	95% CI	Week 12	95% CI
1	**HADS-A**					
	Yoga (n = 25)	11.16 ± 4.09	6.72 ± 3.63 *** §§§ (39.78%)	4.97, 8.47	3.84 ± 2.67 *** §§§ (65.59%)	2.19, 5.49
	Combination (n = 26)	11.89 ± 4.96	8.27 ± 4.72 *** §§ (30.45%)	6.56, 9.98	6.19 ± 4.78 *** §§§ (47.94%)	4.57, 7.81
	Control (n = 27)	11.22 ± 5.04	12.59 ± 4.68	10.91, 14.27	13.48 ± 4.59	11.89, 15.07
2	**HADS-D**					
	Yoga (n = 25)	7.16 ± 3.42	3.6 ± 3.41 *** §§ (49.72%)	1.9, 5.3	1.72 ± 2.42 *** §§§ (75.98%)	.15, 3.3
	Combination (n = 26)	8.81 ± 5.95	5.08 ± 4.86 *** (42.34%)	3.41, 6.75	3.27 ± 4.21*** §§§ (62.88%)	1.73, 4.81
	Control (n = 27)	7.11 ± 4.22	7.89 ± 4.39	6.25, 9.53	8.56 ± 4.75	7.04, 10.07
3	**Autonomic Symptom Score**					
	Yoga (n = 25)	3.56 ± 1.87	3 ± 2	2.25, 3.75	2.12 ± 1.81 *** §§ (40.45%)	1.34, 2.9
	Combination (n = 26)	4.69 ± 2.36	3.46 ± 2.08 *** (26.22%)	2.73, 4.2	2.77 ± 2.08 *** § (40.94%)	2, 3.54
	Control (n = 27)	3.74 ± 1.65	4.15 ± 1.54	3.43, 4.87	4.26 ± 1.99	3.51, 5.01
4	**IBS-GAI**					
	Yoga (n = 25)	1.88 ± 0 .72	5.88 ± 0.53 *** §§§ (212.03%)	5.63, 6.13	6.72 ± 0.46 *** §§§ (257.45%)	6.45, 6.99
	Combination (n = 26)	1.65 ± 0.74	5.73 ± 0.53 *** §§§ (247.27%)	5.48, 5.98	6.42 ± 0.58 *** §§§ (289.1%)	6.16, 6.69
	Control (n = 27)	2.07 ± 0.73	2.19 ± 0.79	1.94, 2.43	2.11 ± 0.89	1.85, 2.37

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment.Values are group mean ± S.D.; (%): Percent change when compared to week 0; *: Represents mean change within group when compared to week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$; §§§ $p < 0.001$.

(**A)**


Pre
Mid
Post
Anxiety & Depression (Mean ± SD)
20
18
16
14
12
10
8
6
4
2
0
***
§§§
***
§§§
***
§§
***
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§§
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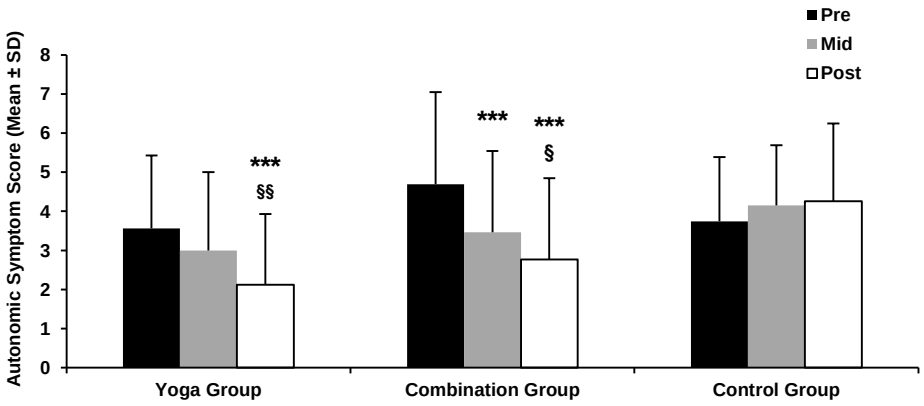
§§§
Yoga Group
Combination Group
Control Group
Yoga Group
Combination Group
Control Group
HADS Anxiety
HADS Depression

(B)


Pre
Mid
Post
Autonomic Symptom Score (Mean ± SD)
8
7
6
5
4
3
2
1
0
***
§§
***
***
§
Yoga Group
Combination Group
Control Group

(C)

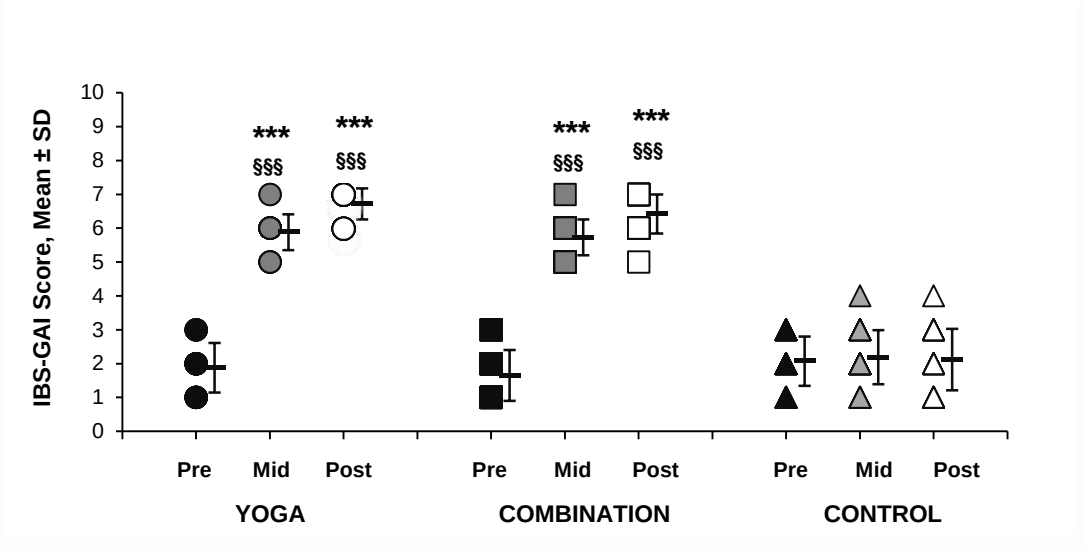


Figure 12. Changes in secondary assessments in IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Control (n = 27). **(A)** HADS (anxiety and depression); **(B)** Autonomic Symptom Score; and **(C)** IBS-GAI at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents mean change within groups when compared to week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$; §§§ $p < 0.001$.

7.4.2 Medicine and Supplement Use

At the baseline appraisal, medicine / supplements for relieving IBS symptoms were used by 19 out of the 25 subjects in the *Yoga* group, 21 out of the 26 in the Combination group and 22 out of the 27 in the Control group. There were a total of 16 subjects (6 in *Yoga*; 5 in Combination and 5 in Control group) that did not use any medicine / Supplements. Most commonly used medicine / supplements (by all the groups) were Dicyclomine, Bentyl, Amitiza, Linzess, Loperamide, psyllium, fiber drinks, herbal teas and probiotics. Medicine and supplement use reported during week 6 assessment decreased significantly

in the *Yoga* and Combination groups compared to the Control group ($p<0.001$). Upon completion of the intervention of 12 weeks, significant differences between groups ($p<0.001$) continued and almost all of the *Yoga* and Combination group subjects reported either stopping or reducing the medications. There were no significant differences between *Yoga* and Combination groups **(Table 21)**.

Table 21. Comparison of changes in IBS medicine and supplement use in the yoga, combination and control groups at week 6 and week 12 assessments.

Measurement	Outcome	Groups			Significance
		Yoga (n = 25)	Combination (n = 26)	Control (n = 27)	
Week 6 (Mid-Intervention)	Success	19	20	4	*** §§§
	Failure	0	1	18	
	No Medication used	6	5	5	
Week 12 (Post-intervention)	Success	19	20	7	*** §§§
	Failure	0	1	15	
	No Medication used	6	5	5	

Data were analyzed using McNemar's test. *: Represents significant differences between Yoga and Control groups; *** $p < 0.001$; §: Represents significant differences between Combination and Control groups; §§§ $p < 0.001$. Success- stopped or decreased medication use; Failure- no change or increased medication use; No Medication Used: Not used any medication at baseline.

7.5 PHYSICAL MEASUREMENTS

7.5.1 BMI and Physical Flexibility

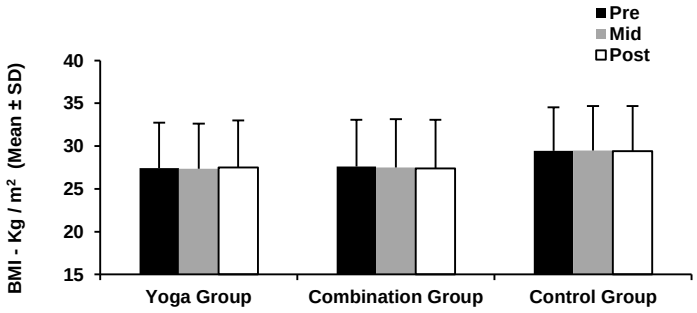
There were no changes observed in the Body Mass Index (**Table 22** and **Figure 13A**) in any of the groups. Hip-trunk flexibility (**Figure 13B**), right and left shoulder flexibility showed significant improvements in the *Yoga* and Combination groups at week 6 and at week 12 ($p<0.001$) when compared to week 0 (**Figure 13C1 and 13C2**). There were no improvements in the physical flexibility of the Control group. Between group analyses showed no differences between *Yoga* and Combination groups. There was a significant difference between *Yoga* and Control groups in the hip-trunk flexibility, ($p<0.001$), right ($p<0.05$) and left shoulder flexibility ($p<0.05$) at week 12. When Combination and Control groups were compared, there were significant differences in the trunk flexibility ($p<0.001$), right ($p<0.01$), and left shoulder flexibility ($p<0.05$), at week 12.

Table 22. Analysis of between group differences and within group changes of body mass index, hip trunk; right and left shoulder flexibility in IBS patients.

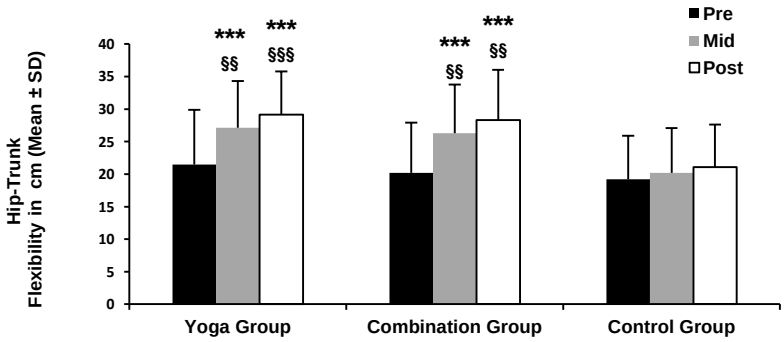
		Week 0	Week 6	95% CI	Week 12	95% CI
	Body Mass Index					
1	Yoga (n = 25)	27.44 ± 5.28	27.36 ± 5.26	25.22, 29.5	27.52 ± 5.48	25.33, 29.71
	Combination (n = 26)	27.62 ± 5.45	27.5 ± 5.65	25.4, 29.6	27.38 ± 5.7	25.24, 29.53
	Control (n = 27)	29.44 ± 5.1	29.48 ± 5.22	27.42, 31.54	29.41 ± 5.29	27.3, 31.51
	Hip Trunk Flexibility					
2	Yoga (n = 25)	21.48 ± 8.41	27.12 ± 7.18 ***§§ (20.79%)	24.25, 29.99	29.16 ± 6.61***§§§ (26.34%)	26.38, 31.94
	Combination (n = 26)	20.19 ± 7.72	26.27 ± 7.52 ***§§ (23.14%)	23.46, 29.08	28.31 ± 7.74***§§ (28.68%)	25.58, 31.04
	Control (n = 27)	19.22 ± 6.66	20.19 ± 6.88	17.43, 22.94	21.07 ± 6.56	19.4, 23.75
	Right Shoulder Flexibility					
3	Yoga (n = 25)	-4.52 ± 9.20	-1.56 ± 9.02*** (65.49%)	-4.73, 1.61	-0.20 ± 9.07 ***§§ (95.58%)	-3.32, 2.92
	Combination (n = 26)	-2.77 ± 7.11	-0.35 ± 7.18 ***§ (87.36%)	-3.46, 2.76	1.62 ± 6.71 ***§§ (165.75%)	-1.44, 4.67
	Control (n = 27)	-7.48 ± 8.25	-6.76 ± 7.61	-9.83, -3.74	-6.74 ± 7.58	-9.74, -3.74
	Left Shoulder Flexibility					
4	Yoga (n = 25)	-11.04 ± 9.05	-7.36 ± 8.41 *** (33.33%)	-10.85, -3.87	-4.96 ± 8.85 ***§ (55.07%)	-8.45, -1.47
	Combination (n = 26)	-7.81 ± 8.50	-5.08 ± 8.44 ***§ (34.96%)	-8.5, -1.65	-3.08 ± 7.76 ***§§ (60.56%)	-6.5, .35
	Control (n = 27)	-11.70 ± 9.13	-11.74 ± 9.38	-15.1, -8.38	-11.04 ± 9.57	-14.4, -7.68

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to week 0; *: Represents mean change within group when compared to Week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$; §§§ $p < 0.001$.

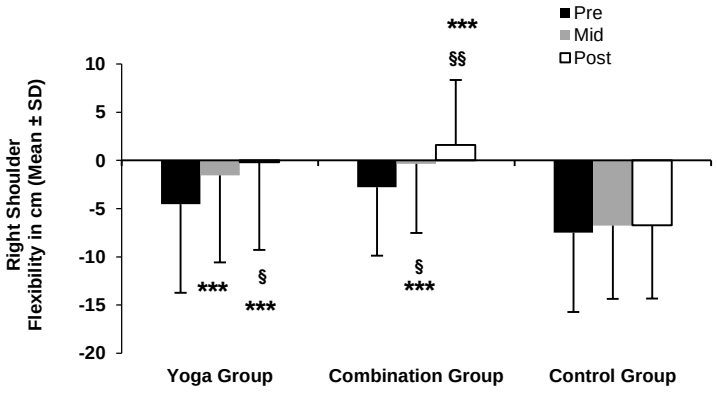
(A)


Pre
Mid
Post
BMI - Kg / m2 (Mean ± SD)
40
35
30
25
20
15
Yoga Group
Combination Group
Control Group

(B)


Pre
Mid
Post
Hip-Trunk Flexibility in cm (Mean ± SD)
***
§§
***
§§§
***
§§
***
§§
40
35
30
25
20
15
10
5
0
Yoga Group
Combination Group
Control Group

(C1)



(C2)

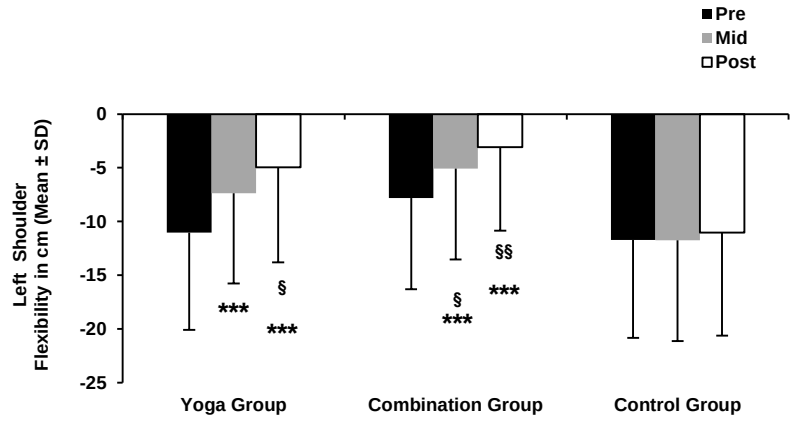


Figure 13. Changes in body mass index and physical flexibility in IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Control (n = 27). **(A)** Body Mass Index; **(B)** Hip-Trunk Flexibility; **(C1)** Right Shoulder Flexibility and **(C2)** Left Shoulder Flexibility at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents mean change within group when compared to week 0; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$; §§§ $p < 0.001$.

7.6 AUTONOMIC FUNCTION TESTS

7.6.1 Sympathetic reactivity tasks

In the sympathetic reactivity tests of hand grip and mental arithmetic tasks, there were no changes between the groups in the diastolic blood pressure (measured in handgrip task), and no changes were observed within *Yoga* or Combination groups. As shown in **Table 23 A**, there was significant decrease (p<0.05) in the Control group at week 12 when compared to week 0. In the mental arithmetic task, there were no changes observed either within groups or between groups in the heart rate, systolic and diastolic blood pressure (measured in mental arithmetic task), and is detailed in **Table 23 B**.

Table 23 A. Analysis of between group differences and within group changes of diastolic blood pressure during hand grip task in IBS patients.

Hand grip – Diastolic Blood Pressure		**Week 0**	**Week 6**	**Week 12**
Hand grip Pre	Yoga (n = 25)	74.80±6.56	74.20±6.73	75.00±7.57
	Combination (n = 26)	76.62±7.69	75.96±9.22	76.42±8.84
	Waitlist (n = 27)	76.33±9.06	75.22±9.18	73.04±7.96
Hand grip 1 min	Yoga (n = 25)	80.44±7.90	80.72±8.89	78.68±9.45
	Combination (n = 26)	81.50±6.63	83.12±9.28	80.38±8.76
	Waitlist (n = 27)	84.59±11.62	82.00±10.55	81.04±9.53
Handgrip 4 min	Yoga (n = 25)	84.76±9.58	81.68±8.90	82.12±9.54
	Combination (n = 26)	86.04±8.12	83.46±9.81	84.58±9.61
	Waitlist (n = 27)	88.81±13.11	86.19±11.68	83.30±11.56*(6.2%)

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents mean change within group when compared to week 0; * $p < 0.05$.

Table 23 B. Analysis of between group differences and within group changes of heart rate, systolic and diastolic blood pressure during mental arithmetic task in IBS patients.

Mental Arithmetic Task		Week 0	Week 6	Week 12
Heart rate				
Heart rate Pre	Yoga (n = 25)	69.80 ± 7.97	69.64 ± 8.96	70.76 ± 8.02
	Combination (n = 26)	73.00 ± 8.60	69.62 ± 9.29	68.92 ± 11.33
	Waitlist (n = 27)	69.22 ± 7.40	71.04 ± 9.85	69.85 ± 8.22
Heart rate 1 min	Yoga (n = 25)	71.92 ± 9.93	69.88 ± 9.70	70.12 ± 9.71
	Combination (n = 26)	74.69 ± 7.89	70.54 ± 8.73	70.08 ± 10.19
	Waitlist (n = 27)	70.44 ± 9.59	70.33 ± 9.67	69.56 ± 9.09
Heart rate 5 min	Yoga (n = 25)	71.84 ± 8.20	69.74 ± 11.16	69.61 ± 8.96
	Combination (n = 26)	73.04 ± 7.61	72.02 ± 10.02	69.05 ± 9.13
	Waitlist (n = 27)	72.78 ± 9.19	71.72 ± 9.77	69.81 ± 8.46
Systolic Blood Pressure				
Mental Arithmetic task Pre	Yoga (n = 25)	115.04 ± 14.49	111.84 ± 11.84	112. 04 ± 15.79
	Combination (n = 26)	118.08 ± 13.41	116.42 ± 13.95	118.04 ± 13.67
	Waitlist (n = 27)	120.19 ± 13.89	119.81 ± 15.18	117.70 ± 15.45
Mental Arithmetic task 1 min	Yoga (n = 25)	119.60 ± 15.34	116.56 ± 14.79	114.72 ± 15.69
	Combination (n = 26)	120.31 ± 11.81	120.62 ± 14.17	117.92 ± 13.57
	Waitlist (n = 27)	127.48 ± 13.05	124.04 ± 15.90	119.00 ± 16.81
Mental Arithmetic task 5 min	Yoga (n = 25)	119.32 ± 17.03	117.12 ± 14.35	116.72 ± 16.02
	Combination (n = 26)	120.31 ± 13.10	121.69 ± 14.08	120.73 ± 12.96
	Waitlist (n = 27)	125.26 ± 13.81	124.56 ± 16.07	120.26 ± 15.87
Diastolic Blood Pressure				
Mental Arithmetic task Pre	Yoga (n = 25)	77.80 ± 9.29	75.16 ± 8.87	76.12 ± 8.87
	Combination (n = 26)	78.81 ± 9.01	77.69 ± 8.33	78.00 ± 7.81
	Waitlist (n = 27)	77.15 ± 9.40	75.19 ± 8.19	76.37 ± 9.01
Mental Arithmetic task 1 min	Yoga (n = 25)	79.32 ± 7.79	77.44 ± 9.80	77. 56 ± 8.32
	Combination (n = 26)	80.73 ± 7.50	79.65 ± 9.47	78.92 ± 7.61
	Waitlist (n = 27)	83.26 ± 9.55	80.52 ± 8.36	76.74 ± 9.80
Mental Arithmetic task 5 min	Yoga (n = 25)	78.56 ± 9.39	78.76 ± 7.61	78.88 ± 7.60
	Combination (n = 26)	80.69 ± 9.87	80.65 ± 8.48	80.00 ± 7.93
	Waitlist (n = 27)	83.11 ± 9.94	80.44 ± 8.90	77.26 ± 9.33

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.

However, handgrip strength increased significantly within *Yoga* and Combination groups at week 12 ($p<0.001$) when compared to week 0, but there were no significant differences observed between the three groups **(Table 24 A and Figure 14 A)**.

Significant improvements in speed (measured by number of attempted responses) and accuracy (measured by number of correct responses) were observed at week 12 in *Yoga* ($p<0.05$) and in Combination groups ($p<0.001$). There were no differences observed between groups **(Table 24 B and Figure 14 B)**.

Table 24 A. Analysis of between group differences and within group changes of hand grip strength in IBS patients.

	Week 0	Week 6	95% CI	Week 12	95% CI
Handgrip Strength					
Yoga (n = 25)	34.80 ± 9.39	38.92 ± 9.46 *** (10.56%)	34.63, 43.21	42.44 ± 10.28*** (18%)	38.04, 46.84
Combination (n = 26)	35.81 ± 8.14	38.31 ± 8.55** (6.53%)	34.1, 42.5	41.46 ± 8.46*** (13.63%)	37.14, 45.78
Control (n = 27)	36.30 ± 12.71	37.70 ± 13.46	33.58, 41.83	38.48 ± 13.65* (5.67%)	34.24, 42.72

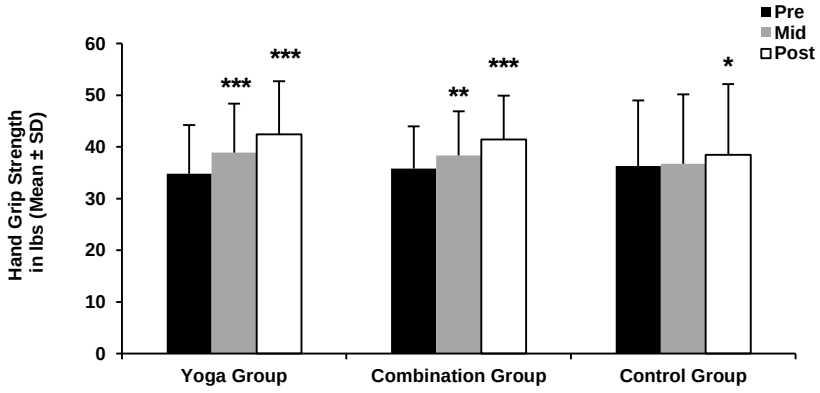
Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents mean change within group when compared to Week 0; *** $p < 0.001$.

Table 24 B. Analysis of between group differences and within group changes of speed and accuracy-mental arithmetic task in IBS patients.

		Week 0	Week 6	95% CI	Week 12	95% CI
1	**Mental Arithmetic – Speed**					
	Yoga (n = 25)	37.96 ± 20.53	42.20 ± 20.22	33.38, 51.02	46.84 ± 25.06* (18.96%)	37.49, 56.19
	Combination (n = 26)	38.35 ± 17.44	46.88 ± 24.26* (18.2%)	38.24, 55.53	52.42 ± 23.75 *** (26.84%)	43.26, 61.59
	Control (n = 27)	46.37 ± 22.53	49.30 ± 21.69	40.81, 57.78	49.93 ± 21.59	40.93, 58.92
2	**Mental Arithmetic - Accuracy**					
	Yoga (n = 25)	34.16 ± 21.15	38.36 ± 21.95	28.87, 47.85	43.80 ± 25.89* (22.01%)	33.88, 53.72
	Combination (n = 26)	34.69 ± 18.82	43.27 ± 26.00* (19.83%)	33.96, 52.58	48.50 ± 25.23** (28.47%)	38.77, 58.23
	Control (n = 27)	42.19 ± 23.53	46.00 ± 23.30	36.87, 55.14	46.07 ± 23.65	36.53, 55.62

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents mean change within group when compared to week 0; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

(A)



(B)

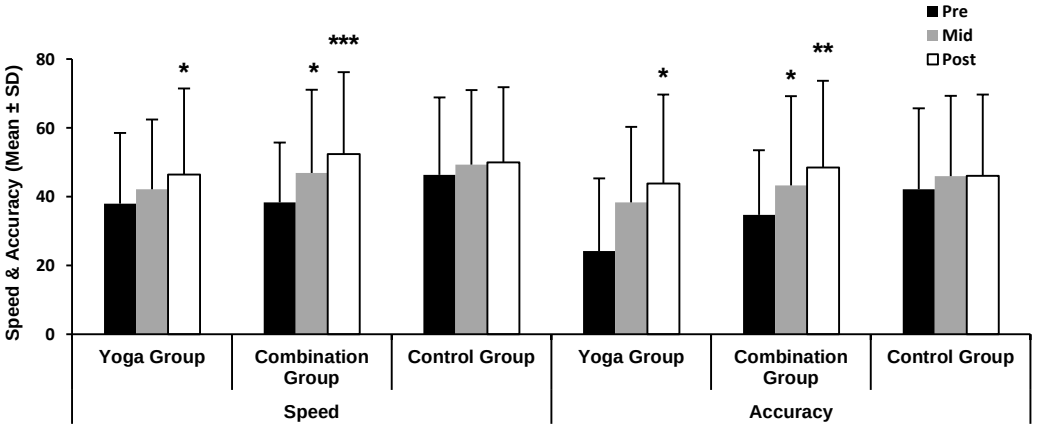


Figure 14. Changes in sympathetic reactivity tasks of IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Control (n = 27). **(A)** Hand Grip Strength and **(B)** Mental arithmetic-Speed and Accuracy at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents mean change within group when compared to Week 0; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

7.6.2 Parasympathetic reactivity tasks

In the parasympathetic reactivity tasks, there were no changes or differences within or between groups in the time domain of heart rate variability of deep breathing (**Table 25 A**). In the frequency domain of heart rate variability, there was no difference between *Yoga* and Control groups, but there were significant differences between Combination and Control groups at week 12, in LF ($p<0.05$), HF ($p<0.01$) and LF/HF ratio ($p<0.01$). Combination group showed decreased LF ($p<0.001$), increased HF ($p<0.001$) and the LF/HF ratio had increased ($p<0.01$) at week 12 when compared to week 0 (**Table 25 B** and **Figure 15, A1-A4**).

Table 25 A. Analysis of between group differences and within group changes of heart rate variability (time domain) during deep breathing task in IBS patients.

	Week 0	**Week 6**	**Week 12**
Heart rate			
Yoga (n = 25)	67.16 ± 7.84	66.64 ± 10.90	67.41 ± 9.73
Combination (n = 26)	70.88 ± 8.84	69.27 ± 9.61	69.04 ± 11.34
Waitlist (n = 27)	65.63 ± 9.84	65.96 ± 9.84	65.05 ± 8.46
SDNN			
Yoga (n = 25)	62.88 ± 38.06	77.52 ± 38.35	77.32 ± 28.02
Combination (n = 26)	63.69 ± 28.03	70.42 ± 36.10	68.66 ± 31.14
Waitlist (n = 27)	90.00 ± 76.32	85.52 ± 63.07	79.49 ± 61.22
RMSSD			
Yoga (n = 25)	52.88 ± 61.88	66.12 ± 61.61	56.36 ± 40.23
Combination (n = 26)	44.04 ± 26.82	50.04 ± 41.13	50.54 ± 35.70
Waitlist (n = 27)	89.48 ± 111.52	84.44 ± 100.80	66.87 ± 75.35
NN50			
Yoga (n = 25)	29.04 ± 24.47	35.08 ± 44.13	31.24 ± 29.89
Combination (n = 26)	21.77 ± 23.50	27.19 ± 27.11	27.15 ± 29.42
Waitlist (n = 27)	40.30 ± 28.22	34.04 ± 25.68	32.33 ± 24.34
pNN50			
Yoga (n = 25)	15.92 ± 14.53	21.44 ± 27.51	18.60 ± 19.32
Combination (n = 26)	11.92 ± 13.68	14.38 ± 16.47	14.96 ± 17.91
Waitlist (n = 27)	25.59 ± 18.93	22.04 ± 17.29	19.96 ± 15.93
TINN			
Yoga (n = 25)	198.00 ± 118.53	222.20 ± 130.19	240.40 ± 139.51
Combination (n = 26)	232.50 ± 115.14	223.27 ± 123.77	211.73 ± 120.76
Waitlist (n = 27)	208.33 ± 143.09	178.52 ± 98.17	179.44 ± 87.14

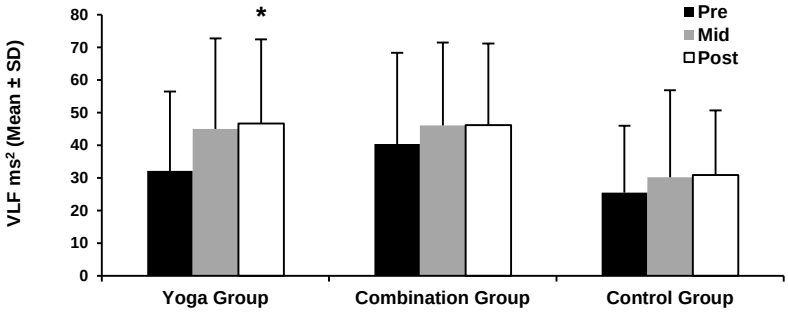
Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.

Table 25 B. Analysis of between group differences and within group changes of heart rate variability (frequency domain) during deep breathing task in IBS patients.

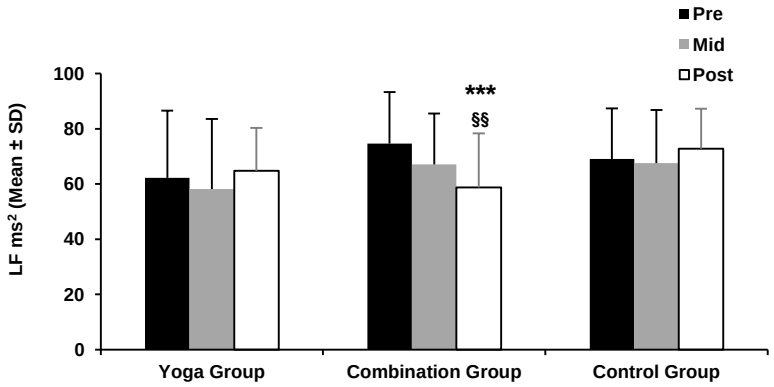
	Week 0	Week 6	Week 12
VLF			
Yoga (n = 25)	32.2 ± 24.33	45 ± 27.82	46.72 ± 25.77* (31.07%)
Combination (n = 26)	40.38 ± 27.97	46.15 ± 25.32	46.19 ± 25
Waitlist (n = 27)	25.52 ± 20.5	30.26 ± 26.6	30.89 ± 19.86
LF			
Yoga (n = 25)	62.24 ± 24.31	58.12 ± 25.48	64.76 ± 15.57
Combination (n = 26)	74.62 ± 18.64	67.12 ± 18.46	58.73 ± 19.56*** (21.29%)
Waitlist (n = 27)	69.07 ± 18.26	67.56 ± 19.3	72.78 ± 14.5
HF			
Yoga (n = 25)	37.72 ± 24.23	39.64 ± 23.15	35.20 ± 14.59
Combination (n = 26)	25.35 ± 18.67	32.69 ± 18.43	41.15 ± 19.49*** (38.4%)
Waitlist (n = 27)	30.96 ± 18.27	32.41 ± 19.27	27.15 ± 14.54
LF/HF			
Yoga (n = 25)	3.52 ± 3.95	2.52 ± 2.26	2.48 ± 2.12
Combination (n = 26)	5.38 ± 5.15	3.77 ± 4.15	2.12 ± 2.01** (60.6%)
Waitlist (n = 27)	4.81 ± 5.94	3.81 ± 3.98	4.11 ± 3.53

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents mean change within group when compared to Week 0; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

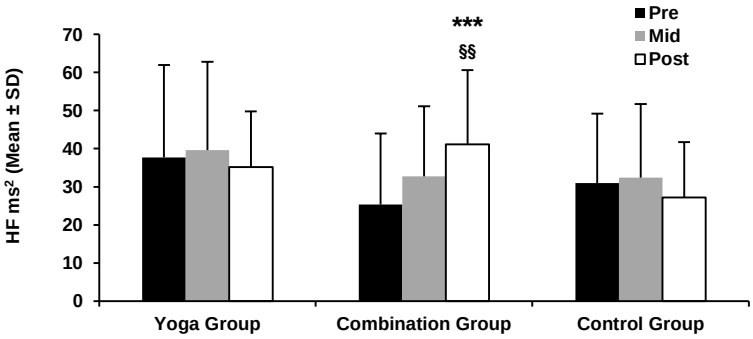
(A1)


VLF ms² (Mean ± SD)
80
70
60
50
40
30
20
10
0
*
Pre
Mid
Post
Yoga Group
Combination Group
Control Group

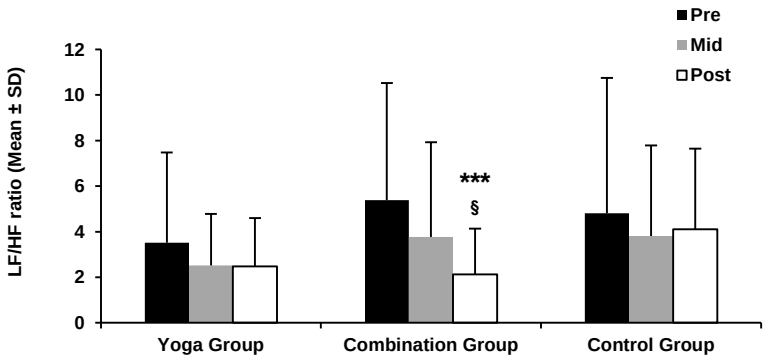
(A2)


LF ms² (Mean ± SD)
100
80
60
40
20
0
***
§§
Pre
Mid
Post
Yoga Group
Combination Group
Control Group

(A3)


HF ms² (Mean ± SD)
70
60
50
40
30
20
10
0
***
§§
Pre
Mid
Post
Yoga Group
Combination Group
Control Group

(A4)



(B)

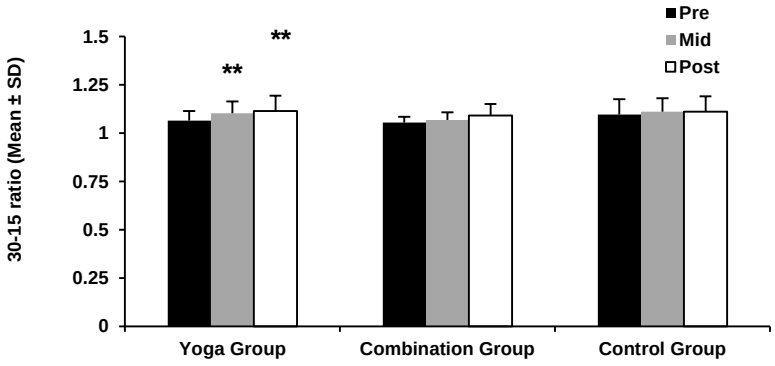


Figure 15. Changes in parasympathetic reactivity tasks in IBS patients enrolled in the randomized controlled trial of yoga therapy, Yoga (n = 25), Combination (n = 26), Control (n = 27). **(A1)** HRV-Very Low Frequency in Deep Breathing, **(A2)** HRV-Low Frequency, **(A3)** HRV-High Frequency, and **(A4)** HRV-LF/HF Ratio; **(B)** Supine to Upright posture (30:15 ratio) at Week 6 (Mid-intervention) and Week 12 (Post-intervention) from Week 0 (Pre-intervention). Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents mean change within group when compared to Week 0; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; §: Represents between group differences when compared to Control group; § $p < 0.05$; §§ $p < 0.01$.

In the supine to upright posture (30-15 ratio), there were no differences between the three groups at the end of intervention. There were no changes within Combination group when compared to week 0. However, in the *Yoga* group, there were significant improvements in the parasympathetic dominance at week 6 ($p<0.01$) and at week 12 ($p<0.01$) when compared to week 0 **(Table 25C** and **Figure 15 B)**.

Table 25 C. Analysis of between group differences and within group changes of supine to upright task (30-15 ratio) in IBS patients.

30:15 ratio	**Week 0**	**Week 6**	**Week 12**
Yoga (n = 25)	1.064 ± 0.05	1.103 ± 0.06** (3.54%)	1.114 ± 0.08** (4.49%)
Combination (n = 26)	1.054 ± 0.03	1.068 ± 0.04	1.09 ± 0.06
Waitlist (n = 27)	1.095 ± 0.08	1.11 ± 0.07	1.11 ± 0.08

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group mean ± S.D.; (%): Percent change when compared to Week 0; *: Represents mean change within group when compared to Week 0; ** $p < 0.01$.

7.7.1 Intention-To-Treat Analysis

All randomized patients (N = 97, *Yoga* = 33; Combination = 33; Control = 31) were included in this analysis. There were 19 dropouts who attended the baseline measurements, and 5 of the 19 also attended the mid-intervention (week 6) appraisal. The missing data were analyzed with multiple imputation method. The values below represent pooled means ± S.D. [min, max values]. The significant changes found in per-protocol analysis were also found in the intention-to-treat analysis. There was a significant difference in the improvement in the IBS-SS scale between *Yoga* and Control group at week 6 ($p<0.001$) and at week 12 ($p<0.001$); and Combination and Control groups ($p<0.001$) at both time points. There were no differences between *Yoga* group and Combination group (p=Not Significant). The *Yoga* group changed from 321.73 ± 62.71 [181, 445] at week 0, to 81.23 ± 51.89 [0, 199] at week 12 ($p<0.001$). The Combination group changed from 334.27 ± 72.63 [202, 485] at week 0 to 111.78 ± 65.15 [0, 277] at week 12 ($p<0.001$). Control group changed from 303.81 ± 70.87 [171, 433] at week 0 to 305.64 ± 58.91 [177, 430] at week 12 (p = Not Significant).

There was a significant difference between Intervention groups and Control group at both time points of mid-intervention and post-intervention ($p<0.001$) in the quality of life assessment. Quality of Life improved in *Yoga* group from 98.06 ± 26.94 [44, 149] at week 0, to 154.81 ± 11.65 [117, 170] at week 12 ($p<0.001$). Combination group showed an increased QOL from 95.82 ± 28.91 [44, 149] at week 0, to 146.32 ± 20.36 [95, 170] at week 12 ($p<0.001$). In contrast, Control group did not improve, it changed from 98.35 ± 25.41 [53, 154] at week 0, to 98.55 ± 24.09 [42, 149] at week 12 (p=Not Significant).

Similar trends of between group differences were observed in all the assessments. In autonomic function tasks, there were no differences observed between Yoga, Combination and Control groups.

7.7.2 Responder Analysis

78 patients were included in the responder analysis. In the assessment of IBS-SSS, 65% were responders (≥50 point improvement) at week 6, and 73% at week 12. The intervention groups (n=51) had 94% responders at week 6 and 100% at week 12. The Wait-list Control group had 22% responders at week 6 and at week 12. Baseline IBS-SSS score for all patients was (317.75 ± 70.29). There was a significant improvement in the responders of IBS-SSS from week 6 (175.22 ± 75.38), to week 12 (117.82 ± 82.82; $p<0.001$). There were no changes observed in non-responders at the two time points.

In IBS-QOL, 47% were responders (≥14% improvement) at week 6, and 64% at week 12. The intervention groups (n=51) had 64% responders at week 6, and 92% at week 12. The Wait-list Control group had 15% and 11% responders at week 6 and week 12, respectively. Baseline IBS-QOL score for all patients was (98.68 ± 28.08). A significant change was observed in the quality of life of responders from week 6 (134.27 ± 19.25) to week 12 (149.02 ± 18.74; $p<0.001$). There were no changes observed in the non-responders at both time points.

7.8 POST-12 WEEK RYM INTERVENTION IN WAIT-LIST (WL-*YOGA*) GROUP

27 patients completed the waiting period of 12 weeks and were offered RYM intervention. Seven patients could not attend the *Yoga* intervention mostly due to changes in schedules at work. A total of 20 patients were able to start the *Yoga* intervention. After few weeks of *Yoga* intervention, 11 patients had dropped either due to interference with their family – four due to children's activities, three due to work-related problems and four found the *Yoga* sessions difficult. Two patients left due to pregnancy. **Figure 16** illustrates the flow of patients from the start of the study through the 3 month follow-up.

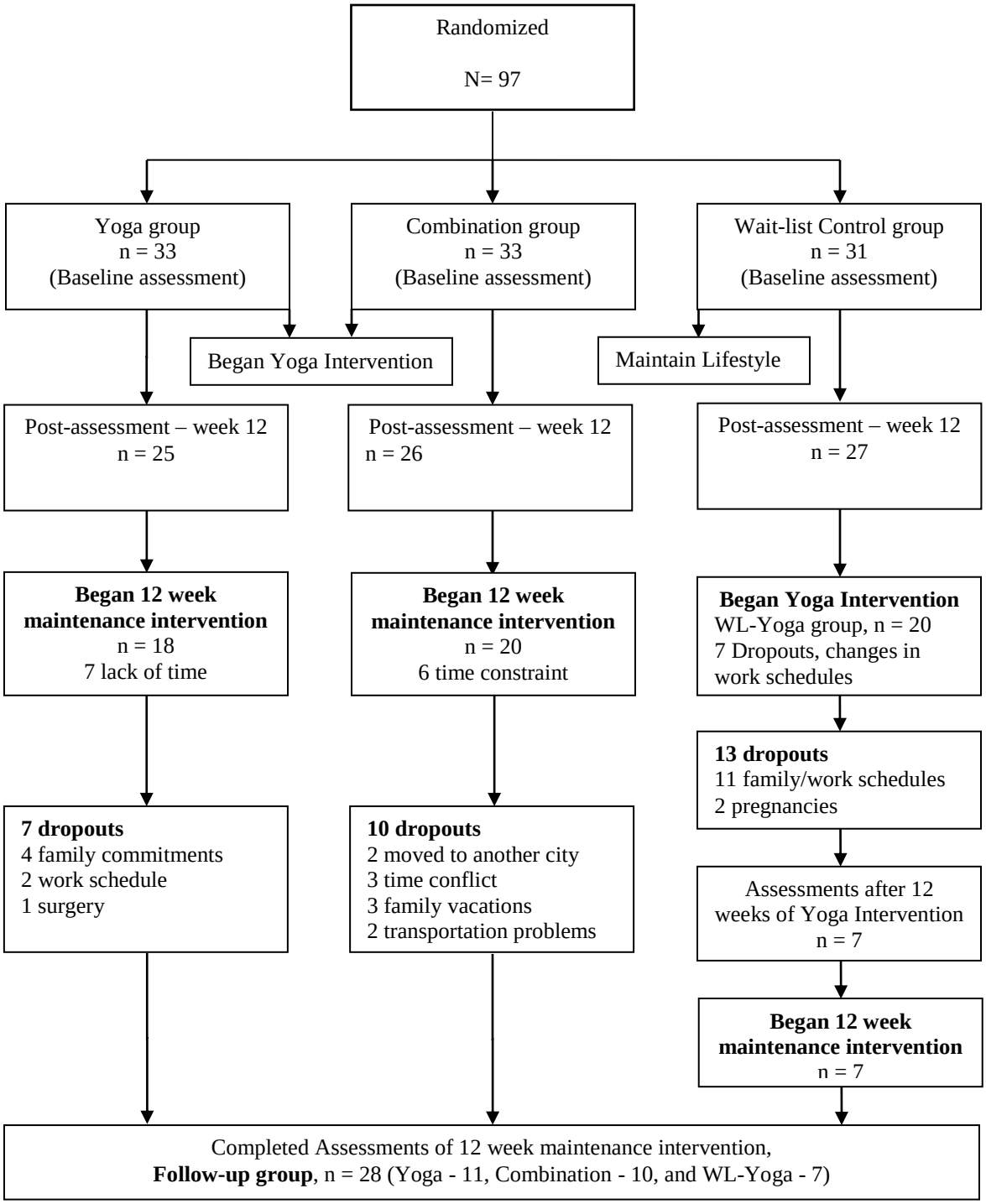


Figure 16. Flow of Yoga intervention study participants in the Follow-up group.

Seven patients completed the 12 week RYM intervention. Even though, three RYM sessions per week for 12 weeks were offered, subjects of the WL-Yoga group attended on an average 23 sessions (64%) out of 36 sessions offered. Since there were no changes in the wait-list Control group in the primary and secondary assessments, week-12 data (before starting Yoga intervention) of the seven patients was considered as baseline data for the WL-Yoga group. Data was confirmed to be normal by Shapiro Wilke's test. Paired samples t-test revealed the efficacy of Yoga intervention on the WL-Yoga subjects. In the primary outcome assessments of IBS-SS scores, a 56% reduction in symptoms was observed ($p<0.001$); and a 45% improvement in the quality of life ($p<0.01$) (**Table 26A** and **Figure 17A**). The secondary outcome assessments of HADS ($p<0.01$), Autonomic Symptom Score ($p<0.01$), IBS-GAI ($p<0.001$) have all shown significant improvements with 12 weeks of RYM intervention (**Table 26B** and **Figure 17B**). Similarly, in the Medicine and Supplement Use, there was a significant improvement ($p<0.05$), four patients have reported reduced usage of medicine/supplements and one patient was still using the same amount of dosage, and two patients were not using any medicine / supplements for the relief of IBS symptoms at baseline. There were no changes observed either in the BMI or Physical flexibility of the WL-Yoga group (**Table 26B**).

Table 26A. Comparison of primary outcomes – IBS-SSS & IBS-Quality of Life at week 12 with week 0 in the WL-Yoga group (n = 7) IBS patients.

Assessments	Week 0	Week 12	Change (95% CI)	t-value
IBS-SSS	266 ± 54.22	117.86 ± 74.73*** (55.64%)	148.14(97.58, 198.58)	7.169
IBS-QOL	100.71 ± 27.23	146.14 ± 14.67** (46%)	-45.43 (-68.54, -22.31)	-4.81

Data were analyzed with paired samples t-test. Values are means ± S.D. (%): Percent change when compared to Week 0; *: Represents changes at Week 12 when compared to Week 0; ** $p < 0.01$; *** $p < 0.001$.

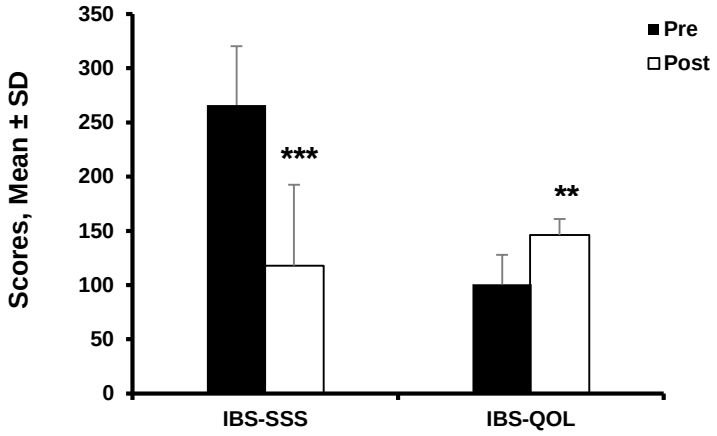


Figure 17A. Changes in the primary outcomes, IBS-SS scores and IBS-QOL in WL-Yoga group (n= 7) **IBS patients** after RYM intervention (post-intervention) from week 0 (pre-intervention). Data were analyzed using paired samples t test. *: Represents mean change when compared to week 0; ** $p < 0.01$; *** $p < 0.001$.

Table 26B. Comparison of secondary outcomes – HADS, Autonomic Symptom Score and IBS-GAI at week 12 with week 0 in the WL-Yoga group (n = 7) IBS patients.

Assessments	Week 0	Week 12	Change (95% CI)	t-value
HADS - A	11.29 ± 4.46	6.14 ± 2.34** (45.62%)	5.14 (2.25, 8.04)	4.34
HADS - D	8.14 ± 3.02	4.71 ± 2.22** (42.14%)	3.43 (1.75, 5.11)	5
ANS – SS	4.57 ± 1.72	2.43 ± 1.72** (46.83%)	2.14 (1.15, 3.13)	5.30
IBS - GAI	2.71 ± .49	6.14 ± .69*** (126.57%)	-3.43 (-4.33, -2.53)	-9.3
BMI	28.14 ± 2.8	28.14 ± 2.73	No change	N/A
Hip-Trunk Flexibility	23 ± 6.03	26 ± 7.44	No change	N/A
Right Shoulder Flexibility	-7.43 ± 4.83	-3.71 ± 4.23	No change	N/A
Left Shoulder Flexibility	-10.57 ± 7.48	-7.43 ± 5.97	No change	N/A

Data were analyzed with paired samples t-test. Values are means ± S.D. (%): Percent change when compared to Week 0; *: Represents changes at week 12 (post) when compared to week 0 (pre); ** $p < 0.01$; *** $p < 0.001$.

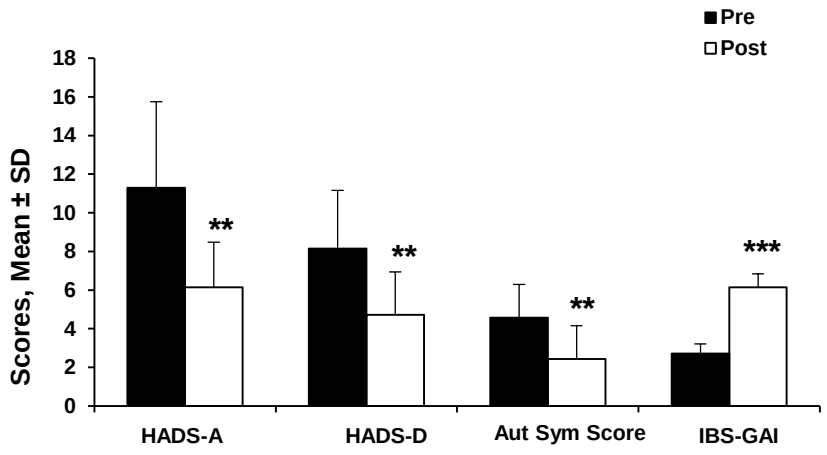


Figure 17B. Changes in the secondary outcomes, HADS-Anxiety, HADS-Depression, Autonomic Symptom Score, IBS-Global Assessment of Improvement in WL-Yoga group (n = 7) IBS patients after RYM intervention; Data were analyzed using paired samples t test.
*: Represents mean ± SD change when compared to Pre-intervention; ** $p < 0.01$; *** $p < 0.001$.

The autonomic function tests of sympathetic reactivity (handgrip and mental arithmetic tasks) showed no changes in blood pressure or the heart rate after 12 weeks of intervention. But a significant improvement in the handgrip strength ($p<0.01$) was observed (**Tables 27 A, B, C**).

Table 27A. Comparison of handgrip strength, mental arithmetic speed and accuracy at week 12 with week 0 in the WL-Yoga group (n = 7) IBS patients.

	Week 0	**Week 12**	**Change (95% CI)**	**t-value**
Handgrip strength	39.43 ± 19.62	43.29 ± 19.81** (9.79%)	-3.86 (-5.95, -1.76)	-4.5
Math Speed	41.86 ± 25.08	51.57 ± 30.02		
Math Accuracy	38.57 ± 26.89	47 ± 32.91		

Data were analyzed with paired samples t-test. Values are means ± S.D.

*: Represents changes at Week 12 (post) when compared to Week 0 (pre); ** $p < 0.01$.

Table 27B. Comparison of handgrip – diastolic blood pressure at week 12 with week 0 in the WL-Yoga group (n = 7) IBS patients.

HAND GRIP - BP	**Week 0**	**Week 12**
HG Pre Dias	71.14 ± 4.6	70.71 ± 4.65
HG 1 m Diastolic	80.29 ± 11.04	74.57 ± 9.34
HG 4 m Diastolic	83.29 ± 16.14	81 ± 12.21

Data were analyzed with paired samples t-test. Values are means ± S.D.

Results: NOT SIGNIFICANT.

Table 27C. Comparison of mental arithmetic – blood pressure and heart rate at week 12 with week 0 in the WL-Yoga group (n = 7) IBS patients.

MATH – BP, HR	Pre		1 minute		5 min	
	Week 0	Week 12	Week 0	Week 12	Week 0	Week 12
Heart Rate	69.57 ± 2.82	72.86 ± 6.84	69.71 ± 9.39	73.43 ± 5.91	70.7 ± 8.73	69.24 ± 8.34
BP - Systolic	114.14 ± 13.73	113.14 ± 12.32	118.14 ± 19.72	116.14 ± 17.05	120.71 ± 19.91	118.57 ± 14.07
BP - Diastolic	70.14 ± 6.26	72.14 ± 3.98	75 ± 10.31	74.14 ± 6.62	72.43 ± 8.9	75.14 ± 9.67

Data were analyzed with paired samples t-test. Values are means ± S.D.

Results: NOT SIGNIFICANT.

In the parasympathetic tasks of deep breathing and supine to upright position (30:15), no significant changes were observed when compared to baseline values (**Tables 28 A, B**).

Table 28A. Comparison of heart rate variability in deep breathing – time domain & frequency domain at week 12 with week 0 in the WL-Yoga group (n = 7) IBS patients.

HRV	Week 0	Week 12
Time Domian		
HR	66 ± 4.48	68.34 ± 6.44
SDNN	61.27 ± 30.29	70.43 ± 16.42
RMSSD	51.64 ± 39.26	53.41 ± 29.16
NN50	24.86 ± 30.61	23.43 ± 17.73
pNN50	14.86 ± 19.14	12.71 ± 10.63
TINN	190 ± 84.9	260.71 ± 95.19
Frequency Domain		
VLF	23.57 ± 11.7	32 ± 27.71
LF	76.29 ± 12.13	67 ± 15.42
HF	23.43 ± 12.29	28.86 ± 15.04
LF/HF	4.43 ± 3.31	3.57 ± 3.46

Data were analyzed with paired samples t-test. Values are means ± S.D.

Results: NOT SIGNIFICANT.

Table 28B. Comparison of Supine to upright position (30-15 ratio) at Week 12 with Week 0 in the WL-Yoga group (n = 7) IBS patients.

Week 0	Post (week12)
1.107 ± 0.073	1.111 ± 0.054

Data were analyzed with paired samples t-test. Values are means ± S.D.

Results: NOT SIGNIFICANT.

We reported that after 12 weeks of RYM intervention, there were no differences between *Yoga* and Combination groups, they both had improved equally. To assess if there were any post-intervention differences between all three groups (*Yoga*, Combination and WL-*Yoga*), the data (*Yoga*, n = 25; Combination, n = 26; and WL- *Yoga*, n = 7) was analyzed using one way ANOVA followed by post hoc analysis with Bonferroni adjustment. The results revealed no significant differences between groups in the primary outcome assessments, IBS-SSS, IBS-QOL (**Table 29, and Figure 18A**); and secondary outcome assessments of HADS, and Autonomic Symptom Score. In IBS-GAI, there was a significant difference between WL- *Yoga* group and *Yoga* group ($p<0.05$) and no differences were observed between WL- *Yoga* and Combination groups (**Table 29 and Figure 18B)**. The improvements observed with medicine and supplement use in WL-*Yoga* group were significantly less compared to both *Yoga* ($p < 0.01$) and Combination ($p < 0.05$) groups.

Table 29. Comparison of effect of 12 weeks of RYM intervention between Yoga and WL-Yoga group; Combination and WL-Yoga Group.

Assessments	Yoga (n = 25)	Combination (n=26)	WL-Yoga (n=7)	P value
IBS - SSS	79.88 ± 53.08	116.46 ± 67.32	117.86 ± 74.73	NS*§
IBS - QOL	155.12 ± 11.69	146.54 ± 21.80	146.14 ± 14.67	NS*§
Autonomic Symptom Score	2.12 ± 1.81	2.77 ± 2.08	2.43 ± 1.72	NS*§
HADS - Anxiety	3.84 ± 2.67	6.19 ± 4.78	6.14 ± 2.34	NS*§
HADS - Depression	1.72 ± 2.42	3.27 ± 4.21	4.71 ± 2.21	NS*§
IBS-GAI	6.72 ± 0.46	6.42 ± 0.58	6.14 ± 0.69*	NS§
Handgrip strength	42.44 ± 10.28	41.46 ± 8.46	43.29 ± 19.81	NS*§

One way ANOVA followed by Post hoc analysis with Bonferroni adjustment; Values are group means ± S.D.*: represents significant difference between Yoga and Control group; * $p < 0.05$; ** $p < 0.01$; §: represents significant difference between Combination and Control group; § $p < 0.05$.

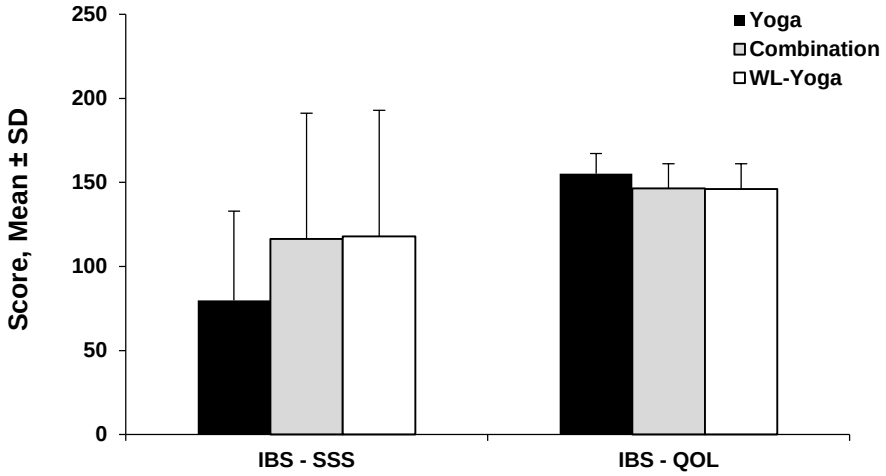


Figure 18A. Comparison of primary outcome measures, IBS-SS scores and IBS-QOL in IBS patients (Yoga (n = 25), Combination (n = 26) and WL-Yoga (n = 7) groups) after 12-week RYM intervention. Data were analyzed using one way ANOVA followed by *Post-hoc* analysis with Bonferroni adjustment.

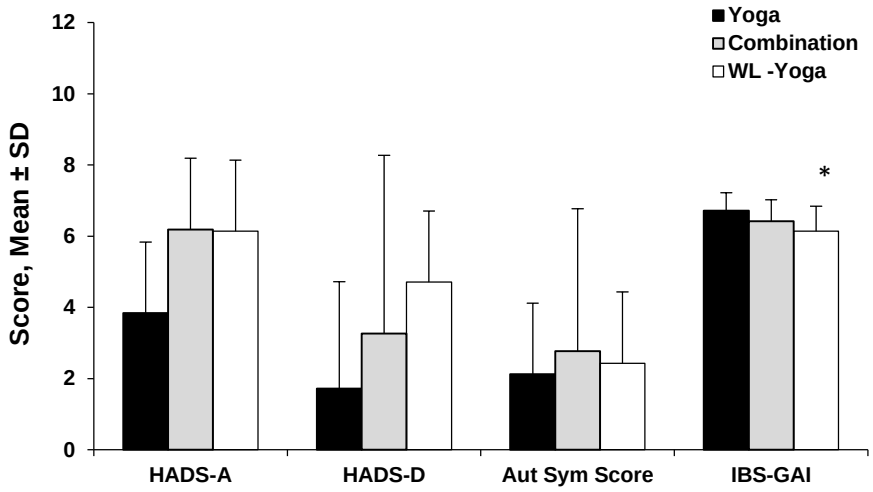


Figure 18B. Comparison of secondary outcome measures, HADS-Anxiety, HADS-Depression, Autonomic Symptom Score, and IBS-Global Assessment of Improvement in IBS patients (Yoga (n = 25), Combination (n = 26) and WL-Yoga (n = 7) groups) after 12-week RYM intervention. Data were analyzed using one way ANOVA followed by *Post hoc* analysis with Bonferroni adjustment; *: Represents significant difference between Yoga and WL-Yoga group; * $p < 0.05$.

7.9 FOLLOW-UP GROUP

7.9.1 Subjects

Among the 58 patients (25 in *Yoga*, 26 in Combination and 7 in WL- *Yoga* groups) that completed the RYM intervention, 28 qualified as per protocol participants, having completed all 24 weeks of intervention. Subjects comprised of IBS-C (n = 8, median age 46.5 years; 28.6% of total completed), IBS-D (n = 10, median age 46 years; 35.7% of total completed), and IBS-M (n = 10, median age 47.5 years; 35.7% of total completed). The median duration of IBS from diagnosis before enrolling to this clinical trial was five years and medications used were one year. **Table 30** details the characteristics of the 28 patients that volunteered for the 3 month follow up.

Table 30. Characteristics of follow-up group subjects completing the 12 Week maintenance intervention.

	Total (28)	Yoga group (11)	Combination group (10)	Waitlist (Control) group WL-Yoga (7)
Marital Status				
Married/Cohabitant	15 (53.7%)	8 (72.7%)	4 (40%)	3 (42.9%)
Single	11 (39.3%)	3 (27.3%)	5 (50%)	3 (42.9%)
Divorced	2 (7.1%)	0	1 (10%)	1 (14.2%)
Ethnicity				
Hispanic	20 (71.4%)	6 (54.5%)	8 (80%)	6 (85.7%)
Non-Hispanic	8 (28.6%)	5 (45.5%)	2 (20%)	1 (14.3%)
Education				
Middle school	3 (10.7%)	1 (9.1%)	1 (10%)	1 (14.3%)
High School	12 (42.9%)	4 (36.4%)	4 (40%)	4 (57.1%)
College	13 (46.4%)	6 (54.5%)	5 (50%)	2 (28.6%)
Employment				
Full-time	18 (64.3%)	9 (81.8%)	5 (50%)	4 (57.1%)
Part-time	7 (25%)	0	4 (40%)	3 (42.9%)
Retired	3 (10.7%)	2 (18.2%)	1 (10%)	0
Economic Status				
<30k	14 (50%)	5 (36%)	6 (60%)	3 (42.9%)
30-60k	9 (33.3%)	3 (40%)	3 (30%)	3 (42.9%)
60-100k	3 (11.6%)	2 (20%)	0	1 (14.2%)
>100k	2 (5.1%)	1 (4%)	1 (10%)	0
IBS Subgroups				
IBS - Constipation	8 (35.9%)	3 (27.3%)	3 (30%)	2 (28.6%)
IBS – Diarrhea	10 (29.5%)	5 (45.4%)	3 (30%)	2 (28.6%)
IBS – Mixed	10 (34.6%)	3 (27.3%)	4 (40%)	3 (42.9%)

Percent in parentheses represent value of the total in a given category

7.9.2 Per-protocol analysis

Repeated measures ANOVA were performed for each assessment with one factor of state. Significant main effects and interaction between time points and assessments are given in **Table 31.**

Table 31. Summary of ANOVA showing statistically significant results of primary and secondary outcomes.

Variables	Factor	F Value	*df*	Huynh-Feldt epsilon	Level of significance	$p\eta^2$
IBS - SSS	Time point	201.56	1.5, 40.42	0.75	< 0.001	0.88
IBS-QOL	Time point	98.62	1.34, 36.13	0.67	< 0.001	0.79
IBS-SSS – 5 sub-scales	Time point	168.44	1.4, 37.68	0.70	< 0.001	0.86
	Assessment	18.04	3.3, 89.12	0.83	< 0.001	0.40
	Time point x Assessment	5.72	5.85, 158.05	0.73	< 0.001	0.18
IBS-QOL 8 dimensions	Time point	58.62	1.34, 36.13	0.67	< 0.001	0.79
	Assessment	680.67	2.4, 64.77	0.34	< 0.001	0.96
	Time point x Assessment	37.18	6.05, 163.47	0.43	< 0.001	0.58
HADS - Anxiety	Time point	52.99	1.3, 35	0.65	< 0.001	0.66
HADS - Depression	Time point	31.8	1.76, 47.56	0.88	< 0.001	0.54
ANS-SS	Time point	13.87	1.94, 52.39	0.97	< 0.001	0.34
IBS-GAI	Time point	660.65	1.53, 41.31	0.77	< 0.001	0.96
Medicine and Supplement Use	State	29.95	1.12, 30.21	0.56	< 0.001	0.53
BMI	Time point	4.75	1.98, 53.52	0.99	< 0.05	0.15
Flexibility - Hip	Time point	46.12	1.9, 51.18	0.95	< 0.001	0.63
Flexibility – Right shoulder	Time point	21.09	1.63, 44.05	0.82	< 0.001	0.44
Flexibility – left shoulder	Time point	51.63	1.99, 53.98	1.00	< 0.001	0.66
Deep Breathing Frequency Domain HRV	Assessment	70.92	1.73, 46.78	0.58	< 0.001	0.72
	Assessment x Time point	6.76	6, 115.75	0.72	< 0.001	0.20
Deep Breathing Time Domain HRV	Assessment	122.39	1.59, 42.98	0.32	< 0.001	0.82
30:15	Time point	40.59	2, 54	1.00	< 0.001	0.60
Handgrip- Dias BP	Assessment	46.47	1.33, 35.98	0.67	< 0.001	0.63
Handgrip - Strength	Time point	89.86	2, 54	1.00	<.0.001	0.77
Math - BP	Time point	13.87	1.94, 52.39	0.97	< 0.001	0.34
Math – Speed and accuracy	Assessment	52.29	1, 27	1.00	< 0.001	0.66
	Time point	19.69	2, 54	1.00	< 0.001	0.42

Df: Degrees of freedom; X shows interaction

7.9.3 Primary Outcome Assessments

7.9.3.1 IBS-SSS and IBS-QOL

Post hoc analysis with Bonferroni adjustment of IBS-Symptom severity and Quality of Life showed significant improvements at week 12 ($p<0.001$) and were maintained at week 24 ($p<0.001$), when compared to week 0. Furthermore, there was a significant reduction in IBS-Symptom severity at week 24 (28%; $p<0.01$) when compared to week 12 (**Table 32** and **Figure 19**).

Table 32. Comparison of IBS-SSS and IBS-QOL, in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

Primary Outcomes	Week 0	Week 12	95% CI	Week 24	95% CI
IBS-SSS	305.93 ± 63.09	96.29 ± 74.89*** (68.53)	67.25, 125.32	69.07 ± 58.08***§§ (77.42%) [28.27%]	46.55, 91.59
IBS-QOL	101.86 ± 29.16	149.43 ± 17.15*** (31.84%)	142.78, 156.08	153.46 ± 17.84*** (33.62%)	146.55, 160.38

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to Week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; *** $p < 0.001$;
§: Represents changes when compared to week 12; §§ $p < 0.01$.

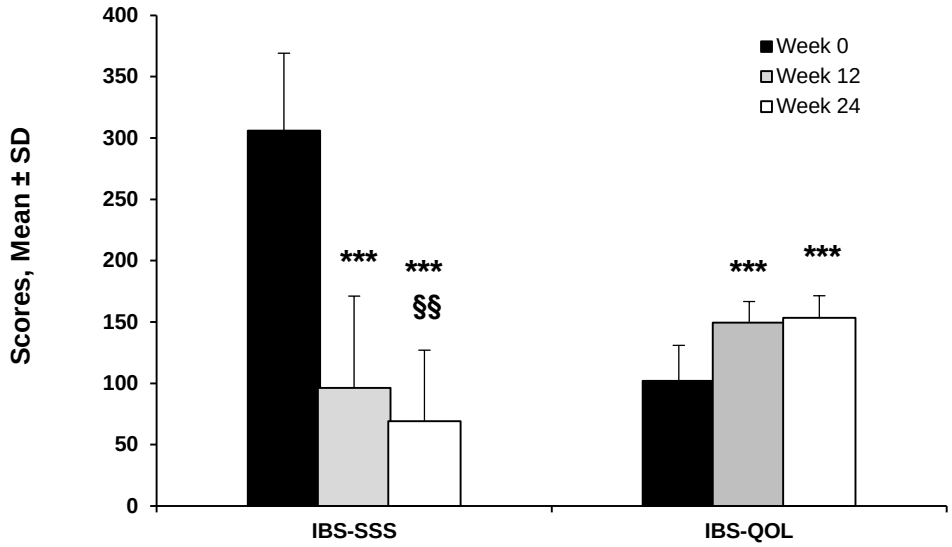


Figure 19. Changes in the primary outcomes, IBS-SSS and IBS-QOL, in the follow-up group (n = 28) at week 12 and week 24 when compared to week 0, Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment.
*: Represents changes at week 12 and week 24 when compared to week 0; *** $p < 0.001$;
§: Represents changes at week 24 when compared to week 12; §§ $p < 0.01$.

A detailed analysis of the five sub-scales of IBS-SSS and eight dimensions of IBS-QOL showed no regression of improvements from week 12 to week 24. In fact, there were significant further improvements observed in two sub-scales of IBS-SSS, severity of pain ($p<0.05$) and interference with life in general ($p<0.05$); and body image dimension of IBS-QOL ($p<0.01$) (**Tables 33A** and **33B).**

Table 33A. Comparison of IBS-SSS –five subscales, in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

5 items of IBS-SSS	Week 0	Week 12	95% CI	Week 24	95% CI
Severity of Pain	44.89 ± 20.24	14.86 ± 15.42*** (66.89%)	8.88, 20.84	8.32 ± 13.56 ***§ (81.47%) [44.01%]	3.07, 13.58
Duration of Pain	72.5 ± 23.67	12.14 ± 11.97*** (83.26%)	7.5, 16.79	9.64 ± 15.27*** (86.7%)	3.72, 15.56
Abdominal Distension	51.89 ± 22.85	16.39 ± 18.59*** (68.41%)	9.19, 23.6	10.39 ± 13.68*** (79.98%)	5.09, 15.7
Bowel Satisfaction	72.68 ± 20.91	24.82 ± 21.33*** (65.85%)	16.55, 33.09	21.61 ± 22.14*** (70.27%)	13.02, 30.19
Interference with Life in general	66.04 ± 20.35	28.07 ± 20.06*** (57.5%)	20.29, 35.85	19.11 ± 17.61***§ (71.06%) [31.67%]	12.28, 25.93

Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to Week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; *** $p < 0.001$;
§: Represents changes when compared to week 12; § $p < 0.05$.

Table 33B. Comparison of IBS-QOL–eight dimensions, in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

8 dimensions of IBS-QOL	Week 0	Week 12	95% CI	Week 24	95% CI
Dysphoria (DY)	25.39 ± 7.61	36.54 ± 4.36*** (43.91%)	34.85, 38.23	37.25 ± 4.11 *** (46.71%)	35.66, 38.84
Interference with Activity (IN)	20.29 ± 6.52	30.79 ± 3.71*** (51.74%)	29.35, 32.22	31.32 ± 4.6 *** (54.36%)	29.54, 33.11
Body Image (BI)	10.71 ± 3.73	16.93 ± 2.69*** (58.08%)	15.88, 17.97	18.5 ± 1.99 *** §§ (42.11%) [9.27%]	17.73, 19.27
Health Worry (HW)	8.07 ± 2.67	12.89 ± 2.11*** (59.73%)	12.07, 13.71	13.43 ±1.89 *** (66.42%)	12.69, 14.16
Food Avoidance (FA)	6.07 ± 2.96	11.07 ± 1.84*** (82.37%)	10.36, 11.79	11.39 ±2.97 *** (87.64%)	10.24, 12.55
Social Reaction (SR)	13.14 ± 4.39	18.14 ± 2.65*** (38.05%)	17.12, 19.17	18.04 ±2.76 *** (37.29%)	16.97, 19.1
Sexual (SX)	8.04 ± 2.73	9.46 ± 1.29* (17.66%)	8.96, 9.97	9.46 ± 1* (17.66%)	9.08, 9.85
Relationships (RL)	10.14 ± 3.37	13.61 ± 1.45*** (34.22%)	13.05, 14.17	14.07 ±1.33 *** (38.76%)	13.56, 14.59

Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; * $p < 0.05$; *** $p < 0.001$; §: Represents changes when compared to eek 12; §§ $p < 0.01$.

7.9.4 Secondary Outcome Assessments

7.9.4.1 Hospital Anxiety and Depression Scale (HADS), IBS-Global Assessment of Improvement (IBS-GAI), Autonomic Symptom Score

There were significant improvements in all the secondary outcomes, HADS, Autonomic Symptom score, IBS-GAI, at week 12 and week 24 when compared to week 0 ($p<0.001$). The improvements were sustained in all the secondary outcome assessments from week 12 to week 24, furthermore, in IBS-GAI, there was significant improvement ($p<0.05$) (**Table 34 A** and **Figure 20**).

Table 34A. Comparison of Secondary Outcomes – HADS, Autonomic Symptom Score, IBS-GAI, in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

Secondary Outcomes	Week 0	Week 12	95% CI	Week 24	95% CI
HADS - Anxiety	10.75 ± 4.44	4.79 ± 3.84*** (55.44%)	3.3, 6.28	4.43 ± 3.47*** (58.79%)	3.08, 5.77
HADS - Depression	8 ± 5.16	3.04 ± 3.59*** (62%)	1.65, 4.43	3.04 ± 3.54*** (62%)	1.66, 4.41
Autonomic Symptom Score	3.93 ± 2.05	2.32 ± 1.83*** (40.97%)	1.61, 3.03	2.29 ± 1.92*** (41.73%)	1.54, 3.03
IBS-GAI	1.93 ± 0.6	6.54 ± 0.58*** (70.49%)	6.31, 6.76	6.79 ± 0.42***§ (71.58%) [3.68%]	6.62, 6.95

Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; *** $p < 0.001$;
§: Represents changes when compared to week 12; § $p < 0.05$.

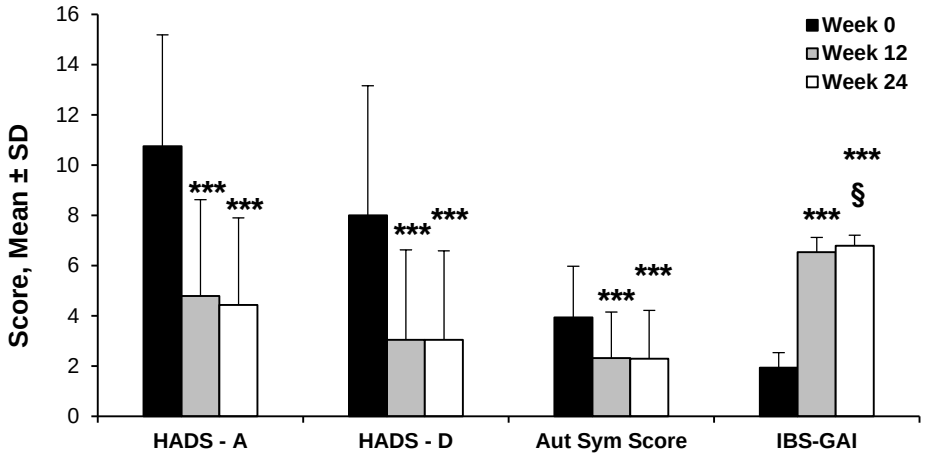


Figure 20. Changes in the secondary outcomes, HADS-Anxiety, HADS-Depression, Autonomic Symptom Score, IBS-GAI in IBS patients enrolled in the follow-up group (n = 28) at week 12 and week 24 when compared to week 0. Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents significant changes at week 12 and week 24 when compared to week 0; *** $p < 0.001$; §: Represents significant changes at week 24 when compared to week 12; § $p < 0.05$.

7.9.4.2 Medicine and Supplement Use

At the baseline appraisal, 21 out of the 28 subjects in the Follow-up group reported medicine and supplement use and seven subjects did not use any medicine / supplements. Most commonly used medicine / supplements were Dicyclomine, Bentyl, Amitiza, Linzess, Loperamide, psyllium, fiber drinks, herbal teas and probiotics. There were significant improvements in the medicine and supplement use at week 12 and week 24 ($p<0.001$) when compared to week 0. And the improvements were sustained from week 12 to week 24. All 21 patients either stopped or reduced medicine and supplement use at week 12, and at week 24, 20 patients reported to have stopped all medicine / supplement use. Only one patient was on reduced medicine at the end of week 24. **Table 34 B** has the details.

Table 34B. Changes in IBS medicine and supplement use in the Follow-up (n = 28) group at week 12 and week 24 assessments when compared to week 0.

Assessment	Outcome	Follow-up Group	P-Value
Week 12	Success	21	***
	Failure	0	
	No Medication used	7	
Week 24	Success	21	***
	Failure	0	
	No Medication used	7	

Data were analyzed using McNamara's test. *: Represents significant changes at Week 12 and Week 24 when compared to week 0; *** $p < 0.001$; Success - stopped or decreased medication use; Failure - no change or increased medication use; No Medication Used: Not used any medication at baseline.

7.9.5 Physical Measurements

7.9.5.1 BMI and Physical Flexibility

There was a reduction in BMI at week 24 ($p<0.05$) when compared to week 0 which was not observed at week 12. Hip-trunk ($p<0.001$), and left ($p<0.001$) and right shoulder ($p<0.01$) flexibility were significantly improved at week 12 when compared to week 0. There was a trend of further improvements at week 24; shoulder flexibility improved ($p<0.05$) from week 12 to week 24 (**Table 35** and **Figure 21**).

Table 35. Comparison of BMI; Physical Flexibility – hip trunk, right and left shoulder, in the follow-up group (n = 28) IBS patients at Week 12 and Week 24 with Week 0.

Physical Flexibility	Week 0	Week 12	95% CI	Week 24	95% CI
BMI	27.14 ± 5.28	26.96 ± 5.39	24.88, 29.05	26.71 ± 5.08* (1.58%)	24.75, 28.68
Hip-Trunk	21.32 ± 8.03	28.11 ± 7.13*** (24.16%)	25.34, 30.87	29.54 ± 7.57*** (27.83%)	26.6, 32.47
Right Shoulder	-3.68 ± 7.94	0.21 ± 6.89** (94.29%)	-2.46, 2.89	1.71 ± 5.78***§ (120.9%) [87.72%]	-0.53, 3.96
Left Shoulder	-9.86 ± 8.45	-4.29 ± 7.07*** (56.49%)	-7.03, -1.55	-2.43 ± 6.2***§ (75.35%) [43.6%]	-4.83, -0.03

Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$;
§: Represents changes when compared to week 12; § $p < 0.05$.

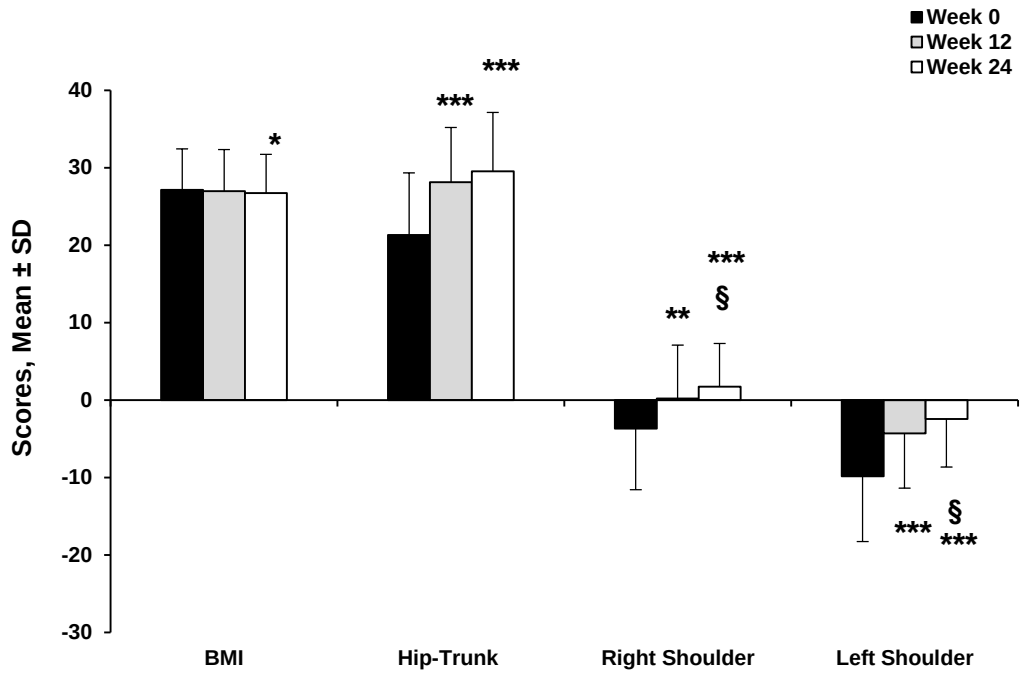


Figure 21. Changes in the secondary outcomes, BMI, hip-trunk flexibility, right shoulder and left shoulder flexibility in the follow-up group (n = 28) at week 12 and week 24 when compared to week 0. Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents changes at week 12 and week 24 when compared to week 0; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; §: Represents changes at week 24 when compared to week 12; § $p < 0.05$.

7.9.6 Autonomic changes

7.9.6.1 Sympathetic Reactivity Tasks

Figure 22 (**Table 36 A**) illustrates the changes in the sympathetic reactivity tasks. The handgrip strength (handgrip task) had improved significantly from week 0 to week 12 ($p<0.001$) and from week 12 to week 24 ($p<0.001$). In the mental arithmetic task, the speed and accuracy, both have improved ($p<0.01$) at week 12 and continued to improve at week 24 ($p<0.001$) when compared to week 0. There was a significant improvement in the accuracy from week 12 to week 24 ($p<0.05$).

Although there were no significant improvements in the diastolic blood pressure during the handgrip task, a trend of lowered diastolic blood pressure was observed (**Table 36 B**). A similar trend of lowered systolic and diastolic blood pressure was observed in the mental arithmetic task. There were no changes in heart rate during this task (**Table 36 C**).

Table 36A. Comparison of hand grip strength and mental arithmetic speed and accuracy in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

	Week 0	Week 12	95% CI	Week 24	95% CI
Handgrip Strength	35.68 ± 12.29	42.61 ± 11.7*** (16.26%)	38.07, 47.14	46.07 ± 11.9***§§§ (22.55%) [7.51%]	41.46, 50.69
Mental Arithmetic - Accuracy	34.79 ± 21.82	47.75 ± 28.95** (27.14%)	36.53, 58.98	55.18 ± 34.15***§ (36.95%) [13.47%]	41.94, 68.42
Mental Arithmetic - Speed	37.93 ± 21.33	51.39 ± 27.63** (26.19%)	40.68, 62.11	57.86 ± 32.96*** (34.4%)	45.08, 70.64

Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; ** $p < 0.01$; *** $p < 0.001$; §: Represents changes when compared to week 12; § $p < 0.05$; §§§ $p < 0.001$.

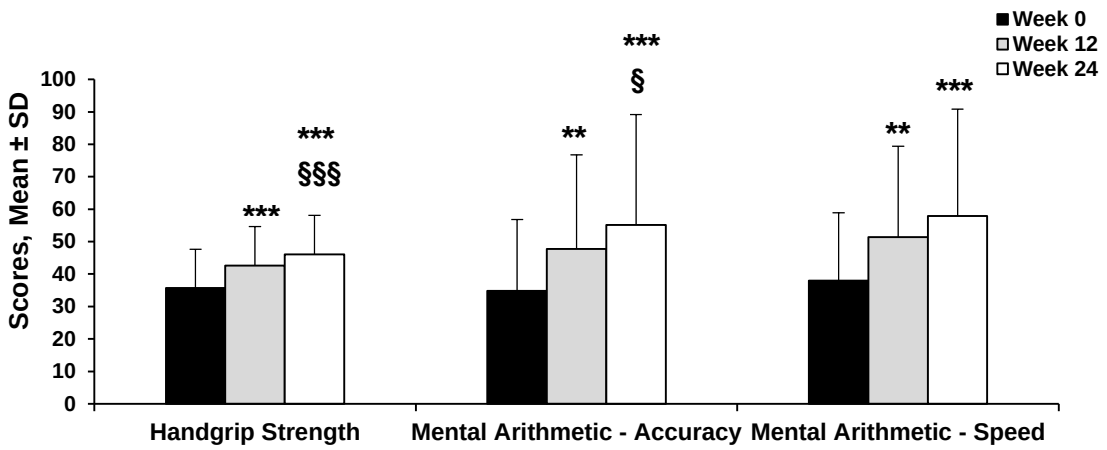


Figure 22. Changes in sympathetic reactivity tasks- hand grip strength, mental arithmetic-accuracy and speed in the follow-up group (n = 28) at week 12 and week 24 when compared to week 0. Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents changes at week 12 and week 24 when compared to week 0; ** $p < 0.01$; *** $p < 0.001$; §: Represents changes at week 24 when compared to week 12; § $p < 0.05$.

Table 36B. Comparison of diastolic blood pressure during hand grip task, in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

	Week 0	**Week 12**	**95% CI**	**Week 24**	**95% CI**
HG Pre	73.46 ± 6.2	72.64 ± 7.27	69.82, 75.46	70.64 ± 6.44	68.45, 73.14
HG 1 min	79.18 ± 7.08	76.25 ± 7.95	73.17, 79.33	77.25 ± 7.93	74.17, 80.33
HG 4 min	84.82 ± 9.54	81.18 ± 9.73* (4.48%)	77.4, 84.95	80.71 ± 10.37	76.69, 84.74

Data were analyzed using Repeated Measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; *: Represents changes at week 12 when compared to week 0; * $p < 0.05$.

Table 36C. Comparison of heart rate and blood pressure during mental arithmetic task, in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

	Systolic blood pressure			Diastolic blood pressure			Heart rate		
	Week 0	**Week 12**	**Week 24**	**Week 0**	**Week 12**	**Week 24**	**Week 0**	**Week 12**	**Week 24**
Math Pre	116.11 ± 14.86	114 ± 16.42	113.04 ± 14.24	75.14 ± 7.37	74.14 ± 7.88	74.11 ± 6.7	71.21 ± 7.66	68.89 ± 6.6	70.36 ± 10.23
Math 1 min	121.11 ± 14.03	115.79 ± 16.75	116.43 ± 15.22	79.14 ± 5.94	75.79 ± 7.42	76.36 ± 6.89	71.54 ± 8.45	67.82 ± 9.11	71.64 ± 8.65
Math 5 min	120.89 ± 15.9	118.5 ± 15.97	116.75 ± 15.03	77.68 ± 8.65	76.64 ± 7.99	75.79 ± 9.98	71.61 ± 7.77	68.57 ± 8.03	72.79 ± 10.35

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D. Results: Not Significant.

7.9.6.2 Parasympathetic Reactivity Tasks

There were significant improvements in the frequency domain of heart rate variability during deep breathing task from week 0 to week 24 but not from week 0 to week 12. There was a significant reduction in LF ($p<0.001$) from week 0 to week 24; but most of the improvement was seen from week 12 to week 24, a decrease of 20% ($p<0.05$). Even though HF increased significantly ($p<0.01$) from week 0 to week 24; most of the improvements, a 27% ($p<0.05$) increase, were observed from week 12 to week 24 (**Figure 23)**. In the LF/HF ratio, an indicator of parasympathetic activity, there was a trend of improvement at week 12, whereas significant improvements ($p<0.01$) were seen at week 24, when compared to week 0 (**Table 37 A)**. There were no changes observed in the time domain of heart rate variability during deep breathing (**Table 37 B**).

Table 37A. Comparison of heart rate variability (frequency domain) during deep breathing in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

Frequency Domain	Week 0	Week 12	95% CI	Week 24	95% CI
VLF	29.39 ± 23.12	43.75 ± 27.13* (48.86%)	33.23, 54.27	30.75 ± 25.03	21.04, 40.46
LF	68.04 ± 22.78	63.11 ± 15.57	57.07, 69.15	50.39 ± 20.83***§ (25.94%) [20.15%]	42.32, 58.47
HF	32 ± 22.73	35.79 ± 15.82	29.65, 41.92	49.21 ± 20.75**§ (53.78%) [37.49%]	41.17, 57.26
LF/HF ratio	4.36 ± 4.8	2.54 ± 2.2	1.68, 3.39	1.54 ± 1.43** (64.68%)	0.98, 2.1

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; * $p < 0.05$;** $p < 0.01$;*** $p < 0.001$; §: Represents changes when compared to week 12; § $p < 0.05$.

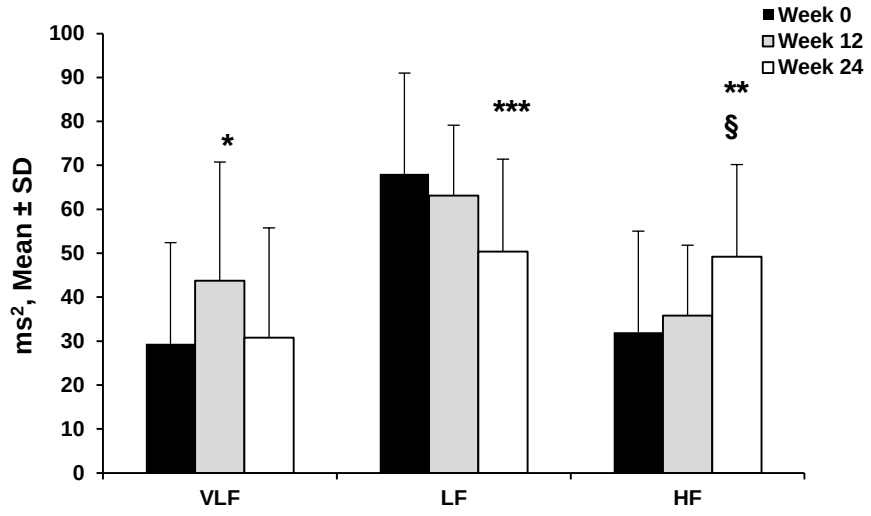


Figure 23. Changes in heart rate variability during deep breathing in the follow-up group (n = 28) at week 12 and week 24 compared to week 0. Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. *: Represents changes at week 12 and week 24 when compared to week 0; ** $p < 0.01$; *** $p < 0.001$; §: Represents changes at week 24 when compared to week 12; § $p < 0.05$.

Table 37B. Comparison of heart rate variability (time domain) during deep breathing in the follow-up group (n = 28) patients at week 12 and week 24 with week 0.

	Week 0	Week 12	95% CI	Week 24	95% CI
Heart rate	67.43 ± 7.2	66.44 ± 8.45	63.17, 69.72	67.57 ± 6.69	64.98, 70.16
SDNN	65.07 ± 40.08	72.29 ± 29.5	60.85, 83.73	68.36 ± 41	52.46, 84.26
RMSSD	56.21 ± 59.99	55.95 ± 42.86	39.33, 72.57	66.43 ± 55.53	44.9, 87.96
NN50	25.11 ± 24.85	28.18 ± 29.14	16.88, 39.48	19.25 ± 38.09	4.48, 34.02
pNN50	14.64 ± 14.19	15.86 ± 17.39	9.12, 22.6	17.93 ± 21.83	9.47, 26.39
TINN	214.82 ± 134.23	217.32 ± 126.08	168.43, 266.21	222.86 ± 155.33	162.63, 283.09

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D. Results: Not Significant.

In the second parasympathetic task of supine to upright posture (30-15 ratio), a trend of improvement was observed at week 12. But it was significantly improved ($p<0.01$) at week 24 when compared to week 0. The parasympathetic dominance in this task had improved significantly from week 12 to week 24 ($p<0.05$) (**Table 37C)**.

Table 37C. Comparison of supine to upright posture (30-15 ratio) in the follow-up group (n = 28) IBS patients at week 12 and week 24 with week 0.

	Week 0	Week 12	95% CI	Week 24	95% CI
30-15 ratio	1.077 ± 0.05	1.102 ± 0.07	1.07, 1.12	1.148 ± 0.08**§ (6.18%) [4.01%]	1.11, 1.18

Data were analyzed using repeated measures of ANOVA followed by *Post hoc* analysis with Bonferroni adjustment. Values are group means ± S.D.; (%): Percentage change when compared to week 0; [%]: Percentage change when compared to week 12; *: Represents changes at week 12 and week 24 when compared to week 0; ** $p < 0.01$; §: Represents changes when compared to week 12; § $p < 0.05$.

7.10 ADVERSE EVENTS

Participants were encouraged to contact study investigators/staff regarding any potential problems/concerns. Three patients, two in *Yoga* group and one in Combination group had complained of low back pain that was aggravated. The instructors took special care in monitoring and suggesting certain modified practices for these three patients. All of them reported being relieved of back pain within a week and completed the program. These complaints were not recorded as adverse events. There were other reported adverse events such as flu, cataract surgery, and other diagnoses, which prompted the patients to discontinue the study. These events were self-limited and deemed by the investigators and the data safety monitoring board to not be serious. Death of a waitlist control group patient was also reported, due to massive cardiac arrest which happened at home in sleep, which was deemed unrelated to the study.

CHAPTER-8

DISCUSSION

8. DISCUSSION

The present study was a randomized, wait-list controlled, Yoga interventional trial on 97 Irritable bowel syndrome (IBS) patients, ages 18 years and older. This study compared the changes within and between groups after 12 week intervention of Remedial Yoga Module (RYM) on IBS symptom severity, quality of life, psychological, anthropometric, and autonomic variables. Repeated measures ANOVAs were used to assess the differences, and the results showed significant improvement after yoga intervention in all the parameters tested. There was remarkable reduction in severity of IBS symptoms, significantly improved QOL, global assessment of improvement, and substantially lowered Anxiety, Depression, and Autonomic symptom scores in both Yoga and Combination groups. Significant improvements were observed in physical flexibility and Medicine and Supplement Use in the intervention groups when compared to Control group. There was a reduction in the sympathetic dominance and an increase in parasympathetic dominance in the Combination group and Yoga groups when compared to Control group.

In the wait-list group that completed 12 weeks of RYM intervention (WL-Yoga), there was a replication of results; the improvements were similar to those of Yoga and Combination groups. The results of the follow-up group, maintenance intervention of once a week RYM for 12 more weeks following the trial, showed that not only all the improvements in all assessments were sustained, but some assessments showed further significant improvements.

8.1 PRIMARY OUTCOMES

8.1.1 Irritable Bowel Syndrome –Symptom Severity Scale (IBS-SSS)

The baseline values for IBS-SSS indicated that the patients in all groups had severe IBS with a mean score of 315 ± 68.95 (>300 severe; 175-300 moderate and 75-175 mild). At the end of 12 weeks RYM intervention, the severity in Yoga and Combination groups had reduced to 80 ± 53.08 and 116 ± 67.332 respectively, and Control group remained at a score of 306 ± 60.04.

RYM intervention thrice a week, for 12 weeks had a reduction of 200 points at the end of 12 weeks, and further reductions were observed at the end of 24 weeks. Johannesson et al. (Johannesson, Simrén, Strid, Bajor, & Sadik, 2011) studied IBS adult population for 12 weeks with physical exercise as intervention. They reported a reduction of 51 points in IBS-SSS (p=0.003). Only 43% had an improvement of 50 points at the end of three months whereas our study reported 100% of the intervention patients improving over 50 points. Brands et al. (Brands, Purperhart, & Deckers-Kocken, 2011; Kuttner et al., 2006) reported a 29% reduction in pain frequency and a 22% reduction in pain intensity at the end of 26 weeks where as with RYM intervention, there was a 76% reduction in intensity and a 85% reduction in duration of pain at the end of 12 weeks. Earlier study investigated mindfulness based stress reduction (MBSR) on 90 IBS patients for 8 weeks and reported no meaningful changes in IBS-SSS (Zernicke et al., 2012). Gerson et al. studied 75 IBS patients with group hypnotherapy as an intervention for 7 weeks and reported a reduction of 50 points in IBS-SSS (Gerson, Gerson, & Gerson, 2013). Roberts et al. in a probiotics for IBS study concluded that there were no significant differences between groups and all groups had improved their IBS-SSS by 50 points at end of 4 weeks and maintained at the

end of 12 weeks (Roberts, McCahon, Holder, Wilson, & Hobbs, 2013). Compared to all these studies, the results of our study far outweigh the results of all the above investigations.

A further analysis of the five sub-scales of IBS-SSS showed significant changes, which were not reported by any other study of Yoga/meditation for IBS patients. We observed significant improvements in all five subscales at Week 12 and Week 24.

8.1.2 Irritable Bowel Syndrome – Quality Of Life (IBS-QOL)

In the current study, the baseline quality of life for all patients was 98.65 ± 28.04 on average for all patients. The Yoga and Combination groups had an improvement in their QOL of about 52% (149 ± 15.6). A 14% increase is considered a clinically significant change in QOL (Patrick, Drossman, Frederick, DiCesare, & Puder, 1998), and our study has shown greater improvements.

Johannesson et al., (Johannesson et al., 2011) reported significant improvements in QOL - a change of about 14% at the end of 12 weeks. A probiotic study by Zuniga et al., (Lorenzo-Zúñiga, 2014) observed an improvement of 20% in QOL of IBS patients after 6 weeks of probiotic intervention. Kearney et al., (Kearney, McDermott, Martinez, & Simpson, 2011) reported there were no changes in IBS-QOL after 12 weeks of mind based stress reduction (MBSR) intervention. Other Yoga interventions for IBS did not measure QOL in these patients. Compared with these studies, RYM had shown greater improvements.

An extensive analysis on the eight dimensions of IBS-QOL (dysphoria, interference, body image, health worry, food avoidance, social reaction, sexual, and relationships)

revealed that each and every facet of these eight dimensions improved ($p<0.001$) at the end of 12 weeks. Furthermore, these improvements continued at the end of 24 weeks. Johannesson et al., (2011) found significant improvements in a few dimensions of IBS-QOL. It could be inferred that all components of RYM - postures, regulated breathing, and meditation are a superior alternative than just meditation (Zernicke et al., 2012; Gaylord et al., 2011; Kearney et al., 2011) or postures alone (Brands, Purperhart, & Deckers-Kocken, 2011; Kuttner et al., 2006) and a better intervention option for reducing the symptom severity and increasing the quality of life of IBS patients. These improvements continued at 24 weeks as experienced by the subjects of Follow-up group.

8.2 SECONDARY OUTCOMES

8.2.1 Hospital Anxiety and Depression Scale (HADS)

The baseline values of IBS patients in this study represented borderline-abnormal levels of anxiety (11.50 ± 4.96). With RYM intervention, Yoga and Combination groups had significant improvements with normal scores at the end of 12 weeks (5.01 ± 3.75). The Control group had worse scores at the end of 12 weeks (13.48 ± 4.59). The baseline values for depression were normal to borderline (7.61 ± 4.22). However, at the end of 12 weeks, both the intervention groups reported significantly lower levels of depression, (2.54 ± 3.3) and there were no changes observed in Control group. When the Control group (WL-Yoga) completed the 12 week RYM intervention, we observed reduction in anxiety from (11.29 ± 4.46) to (6.14 ± 2.34) and depression from (8.14 ± 3.02) to (4.71 ± 2.22) in that group. The Follow-up group revealed reduced level of anxiety/depression ($p<0.001$) even with once a week, one hour RYM intervention.

Taneja et al. (Taneja et al., 2004) reported at one month of Yogic practices, there were significant improvements, a reduction of 21%, in anxiety of IBS patients and at two month appraisal, the reduction was 15% from baseline. In the present study, there was a reduction of 39% after six weeks of RYM, and a 65% reduction in anxiety after 12 weeks of intervention. Johannesson et al., (2011) reported that after three months of physical exercise, there were no significant changes in either anxiety or depression. When compared to earlier reports on meditation for IBS (Gaylord et al., 2011; Kearney et al., 2011) which also measured HADS as an outcome, RYM intervention exhibited significant improvements at week 12 and that continued to the end of study period of week 24.

8.2.2 Autonomic symptom Score

The baseline values for our sample was (4.00 ± 1.87) and after 12 weeks, the intervention groups had improved significantly (2.45 ± 1.87; $p<0.001$), a change of about 38%. Even though Taneja et al., (2004) observed the same improvements in this assessment, RYM had a bigger impact because the intervention period was smaller in this study, as compared to Taneja et al.'s 60 day twice a day practice of *Yoga*. It is noteworthy to point out that 80% of the subjects in the intervention groups reported less severe or less frequent episodes of headache (one of the items of this questionnaire), and these results are in line with another observation (John et al. 2007).

8.2.3 Irritable Bowel Syndrome – Global Assessment of Improvement (IBS-GAI)

At baseline, all the patients in our study reported as either feeling terrible or worse (1.88 ± 0.72). After 12 weeks, GAI in Yoga and Combination groups was significant (6.56 ± 0.52). The reported results of IBS-GAI score of an earlier report involving Iyengar Yoga strategy on adolescents and young adults (Evans et al., 2014) were significant but most of the reported results were either slightly improved and moderately improved whereas our reported results were all substantially improved. Also, in contrast to that study, our study was also able to show sustained improvements at a 3 month follow-up.

8.2.4 Medicine and Supplement Use

At baseline, out of the 78 patients, 16 (6 in Yoga, 5 in Combination and 5 in Control group) were not using any medicine/supplements to relieve their IBS symptoms. At the end of 12 weeks, 100% of the (40 of the 51 (11 patients did not take any medicines at baseline)) patients in Yoga and Combination groups have reported to have stopped / reduced the usage of medicine/supplements, In the WL-Yoga group, there was a significant reduction in the use of Medicine/Supplement Use. This reduction/cessation of medicine/supplement use continued at 24 weeks for the Follow-up group. Our results are analogous to several studies that have reported that Yoga reduces the medication usage (Moliver et al., 2011; Woodyard, 2011; Field, 2011; Williams et al., 2005). However, Williams et al. (2005), in a study of Iyengar yoga for back pain, have reported that 88% of the patients were able to reduce medicine/supplement use after 12 weeks of yoga. Almost about 93% of the patients in the present study were able to stop, and about 7% were using reduced dosage of medicines / supplements for their IBS symptoms. However, at the end of 24 weeks of RYM intervention, even though all the patients

reported to have stopped using any medicine / supplements for IBS, one patient reported using prescription medication for IBS symptoms at a reduced level, once every other day.

8.3 PHYSICAL MEASUREMENTS

8.3.1 Body Mass Index

Body mass index did not show any significant improvements with 12 weeks of RYM in the intervention groups, including WL-*Yoga* group. But a statistically significant improvement ($p<0.05$) in BMI was observed at the end of 24 weeks in the follow-up group. The reported results of BMI in this study are in concurrence with a survey that reported long-term *Yoga* practitioners had reduced BMI (Moliver et al., 2011).

8.3.2 Hip-Trunk and Shoulder Flexibility

We observed significant changes in the hip trunk flexibility at Week 12 in the intervention groups, and the improvements continued at Week 24. Both right and left shoulder flexibility improved significantly at 12 weeks and 24 weeks of intervention in the *Yoga* and Combination groups. In a study of 5 months of *Hatha Yoga* practices to increase physical flexibility, Petrič et al. found that there was a significant improvement in all muscle/joint groups of the study participants (Petrič, et al., 2014). Improved hip-trunk and shoulder flexibility findings of this study support the conclusion of the above investigation of *Yoga* for flexibility, but our study was able to show improvements in 12 weeks. Our study concurs with the conclusion of a review by Ross and Thomas that *Yoga*

may be as effective as or better than exercise in improving a variety of health related outcome measures (Ross & Thomas, 2010).

8.4 AUTONOMIC FUNCTION TASKS

Several studies have concluded that there is an autonomic imbalance toward sympathetic dominance and vagal withdrawal or a parasympathetic dominance in IBS patients (Pellissier, Dantzer et al., 2010; Waring, et al., 2004; Punyabati, et al., 2000; Karling et al., 1998).

8.4.1 Sympathetic reactivity tasks

8.4.1.1 Handgrip task

There were no significant changes observed in the diastolic blood pressure of the intervention groups at the end of 12 weeks or 24 weeks. We also measured the handgrip strength, which was significantly improved in the intervention groups at week 12 and week 24. The significant improvements observed in the handgrip strength of the present study with about 36 - 48 hours of RYM practices are comparable to another study of rigorous *Yoga* practices of about 100 sessions (Dash & Telles, 2001). Similar to what was observed in the present study in 12 weeks of intervention; a previous study reported the same result of increased hand grip strength in a 6-month *Yoga* program (Mandanmohan, et al., 2003).

8.4.1.2 Mental Arithmetic task

There were no significant improvements in the heart rate or the blood pressure of intervention groups during this task at 12 weeks or 24 weeks of intervention. In a 15-week *Yoga* study, Hagins and colleagues found that the heart rate and blood pressure are

unchanged during the mental arithmetic task, and our study observed similar statistically non-significant trend (Hagins, et al., 2013). The significant changes in heart rate and blood pressure after six months of every day *Yoga*, reported by Indla and Narhare (Indla & Narhare, 2011) on healthy adults were not replicated in our study, and this could be due to the fact that our subjects had an unhealthy condition (IBS). Nonetheless, a trend of lowered heart rate and blood pressure was observed. *Yoga* and Combination groups had elevated levels of speed and accuracy in the mental arithmetic task, and the results are consistent with other reports (Nagendra, et al., 2015; Field, et al., 2010).

8.4.2 Parasympathetic reactivity tasks

8.4.2.1 Deep breathing

A significant improvement in Heart Rate Variability during deep breathing task was observed in the Combination group at the end of 12 weeks. These improvements continued at week 24 with the follow-up group suggesting that the parasympathetic dominance has increased with RYM intervention.

8.4.2.2 Supine to upright position (30-15ratio)

In the orthostatic test of supine to upright task, there was a significant improvement of parasympathetic tone in the *Yoga* group, and this trend continued at 24 weeks with the intervention. Our results of parasympathetic dominance in deep breathing (frequency domain) and supine to upright posture (30:15) extend support to observations of other *Yoga* investigations (Nagendra, Kumar, & Mukherjee, 2015; Rocha et al., 2012;

Woodyard, 2011). This could suggest that *Yoga* intervention has influenced the autonomic imbalance in IBS patients.

After 12 weeks of RYM intervention, both *Yoga* and Combination groups showed significant improvements in all assessments (except blood pressure and heart rate). The Control group did not show any changes and in fact, worsened in most of the assessments. Comparisons between *Yoga* and Combination groups revealed that there were no differences between these two groups in any of the assessments. In the subjective assessments of IBS-SSS, QOL, GAI, HADS, and Autonomic Symptom score, *Yoga* group fared better than Combination group. In objective tasks, especially in parasympathetic reactivity tasks, Combination group improved whereas in 30-15 ratio task, *Yoga* group has shown improvements. We also wanted to see if *Yoga* group (*Yoga* with limited Medicine/Supplement use) had at least the same impact as Combination group (*Yoga* with Medicine/Supplement use). At the end of the study period of 12 weeks, we could positively conclude that *Yoga* group fared equally well, if not better than the Combination group.

8.5 DISTINCT FEATURES OF THE PRESENT STUDY

The present study is distinct from earlier *Yoga* /Meditation literature for IBS in many ways.

a) **Sample size**: The previous studies of *Yoga* intervention for IBS had lower sample size than the current study.

b) **Duration of Intervention**: Previous studies of physical exercise, and meditation for IBS, had similar duration of 12 weeks, but our study had a follow-up of 12 more weeks.

c) ***Yoga* as an Intervention**: There are several studies that focused on hypnotherapy, cognitive behavioral therapy, acupuncture, probiotics, and peppermint oil as CAM interventions for IBS. Six studies focused on *Yoga* /Meditation. Of which, four studies have used different *Yoga* forms (*Hatha Yoga* and *Iyengar Yoga*) and two mind-based stress reduction (mindfulness meditation) as an intervention for IBS patients. RYM is based on PK-BAYT (*Pañca Kośās* Based Approach of *Yoga* Therapy). *Pañca Kośās* is a concept from the traditional scriptures and *Yoga* texts, and this is the uniqueness of RYM and the present study. PK-BAYT based RYM module is a holistic approach with multidimensional interventions at physical, mental, emotional, intellectual, and spiritual levels, in line with the definition of health of WHO.

d) **Duration of practice:** The other *Yoga* /Meditation intervention studies had anywhere from 10 minutes to 2 hours of *Yoga* /Meditation sessions. Our study is the first to incorporate a one hour module intervention integrating all facets of *Yoga* (Postures, Breathing, and Meditation).

e) **Monitoring:** Unlike few other studies, where *Yoga* modules were provided to be practiced at home, all our *Yoga* sessions were instructed, supervised, and monitored by trained and certified VYASA-LA (VYRF-LA) instructors. This facilitated similar teaching methods by all teachers.

f) **Objective Outcomes:** This is the first study in the USA that measured autonomic functions with *Yoga* on IBS patients.

We believe that the remarkable and significant improvements seen in our study when compared to other studies could be due to:

(i) **Holistic approach**: The Remedial *Yoga* Module used in this study included Asanas, Pranayama, meditation, deep relaxation, and interaction with patients. On the whole, RYM not only addressed the physical component to relieve pain, constipation, diarrhea, but also emotional and intellectual components to calm down the mind and relieve stress, which is one of the causative factors of IBS.

(ii) **Supervised sessions:** Supervised sessions provided motivation, and absences from classes were monitored and followed up with the patient. The patients responded to the phone calls and reported to being happy with the follow-up on their nonattendance to the sessions. This most likely contributed to the 90% adherence to the RYM sessions.

(iii) **Group effect:** Group effect was another component that added value to this study. There was comradery between the patients, helping to develop a sense of belonging. The *Yoga* instructors observed that the patients motivated each other in coming to the *Yoga* sessions.

It could be concluded that the cumulative effect of a one hour holistic module with supervised, monitored sessions, and a group setting for IBS patients would be a far superior intervention.

8.6 MECHANISMS AT PAÑCA KOŚĀS

8.6.1 *Annamaya Kośa* Mechanisms

8.6.1.1 Exercise effect

Physical exercise has been associated with a significant improvement in functional bowel disorders, especially in the IBS patients. Investigations involving physical exercise and diet therapies have demonstrated significant changes in abdominal pain, constipation in IBS patients. Nonetheless, those changes were short lived. It is recommended that adults engage in moderate physical activity of 20-60 minutes a day for 3-5 days per week to promote/maintain health (Garber et al., 2011; Johannesson et al., 2011). RYM, comparable to low-moderate activity, could be proposed as an easy and effective intervention. Even though changes in BMI were not observed at 12 weeks, physical flexibility (hip-trunk and shoulder) was improved. The changes in abdominal pain, bowel habits, and quality of life were significantly improved in our study, irrespective of BMI changes. These observations suggest that there are more mechanisms involved in *Yoga* besides exercise benefits. Prior studies suggests that apart from the psychological benefits of *Yoga*, the stretching and strengthening of muscles would have improved the feeling of well-being (Woodyard, 2011; Oken et al., 2006).

8.6.1.2 Deep Relaxation Effect

According to Yogic texts, deep relaxation to all the systems and the physical body is the healer for all *Ādhija Vyādhi* (mind originated/psychosomatic diseases). Though *Yoga* postures are comparable to physical exercises, there are fundamental differences. When done with awareness and maintained with ease, these postures not only stretch the muscles, but also bring about calmness in the mind through the bridge of breathing. According to *Patañjalī Yoga Sūtrās*, two clear instructions were specified to attain the final goal of *Yoga*, which is mastery over the modifications of mind.

स्थिरसुखम् आसनम् ॥ प यो सु ।२ ।४६ ॥

sthirasukham āsanam ||*PYS*|2|46||

Meaning: Steady and comfortable should be the posture.

प्रयत्नशैथिल्यानन्तसमापत्तिभ्याम् ॥ प यो सु ।२ ।४७ ॥

prayatnaśaithilyānantasamāpattibhyām || *PYS*|2|47||

Meaning: By loosening of effort and by meditation on the serpent ananta (endless kundalini power), asana is mastered.

ततो द्वन्द्वानभिघातः ॥ प यो सु ।२ ।४८ ॥

tato dvandvānabhighātaḥ || *PYS* |2|48||

Meaning: Thereby, the pairs of opposites cease to have any impact.

Conscious relaxation in the stretch and feeling of unlimited expansion (*Anantasamāpatti*) in the stretch helps relax in a *Yoga* posture and reach a state of balance where the pairs of opposites cease to have impact (Saraswati, 2002). Thus, *Yoga* postures are different from physical exercises in that they offer deep and voluntary meditative relaxation.

8.6.1.3 Balancing Effect

According to *Yoga* texts, balance between stimulation and relaxation is very important and is essential for healing. Stretching and relaxing with complete awareness is a technique that helps develop mastery over local cellular functions. From the attainment of a perfected posture, there arises an unassailable, unimpeded freedom from suffering due to the pairs of opposites, such as heat and cold, good and bad, or pain and pleasure. That perfected posture comes from two means - loosening of effort, and focusing attention on the infinite. This is achieved in all postures as an alternation between effort and effortlessness is emphasized; and when done with internalized awareness brings about mastery of the body and the mind. **Table 38** enlists the practices at this *Kośa* and **Figure 24** depicts the balancing effect of *Yoga* - effort (*Prayatna*) with awareness, becomes effortless (*Prayatnaśaithilya),* and when relaxed, can end in unlimited expansion (*Anantasamāpatti)*, taking to greater heights of bliss. These four steps can be applied to all *Kośās*.

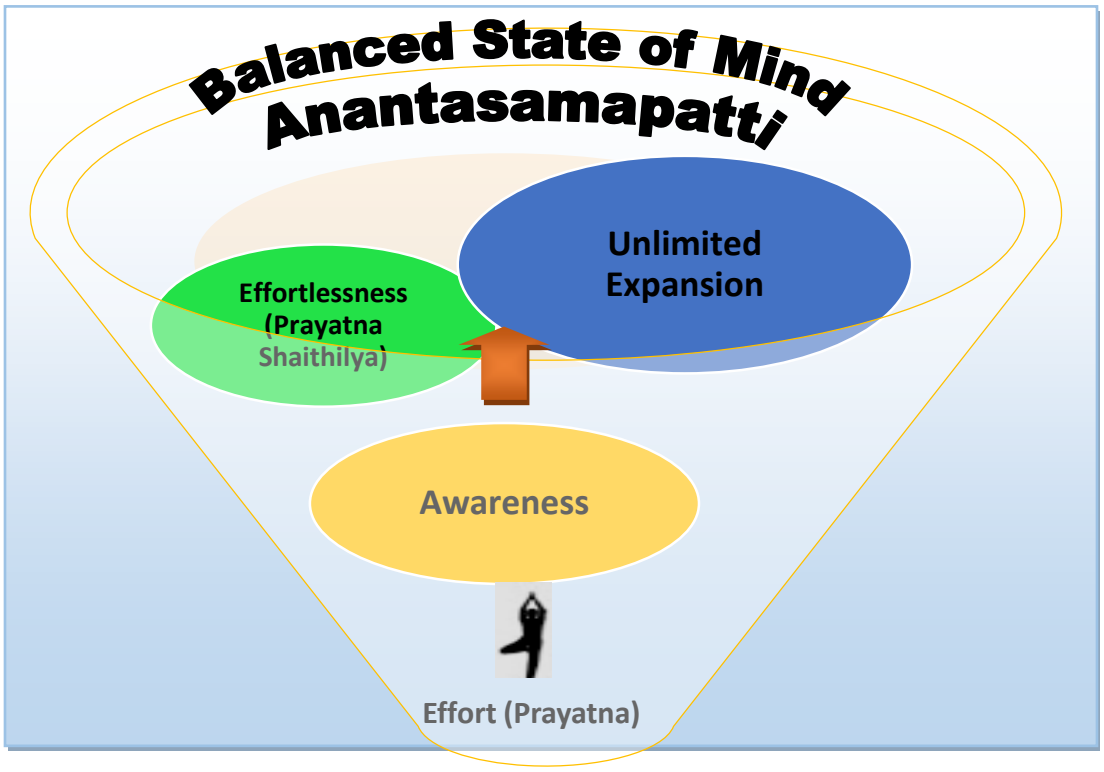


Figure 24. Balancing effect of Yoga: Effort and awareness leads to effortlessness and when relaxed unlimited expansion is attained where all the systems are at rest and healing starts.

Table 38. Practices at *Annamaya Kośa*

Breathing	Expanding lung capacity; normalizing the breath
Loosening	Loosen the joints and muscles; develop stamina
Postures	Physical revitalization, deep relaxation, mental calmness, healing from within
Kriyas	Cleansing; Activating and revitalizing the organs; Deep internal awareness

8.6.2 *Prāṇamaya kośa* Mechanisms

Prāṇa is the subtle vital energy that facilitates all cellular functions in a living body. There are five main channels of *Prāṇa* **(**discussed in **Chapter 2)**. Homeostasis in the human system is maintained by a balanced and steady supply of the *Prāṇa*, which can increase or decrease based on demands of the system, such as stress. A breakdown in any of the five life forces leads to ill-health, primarily caused due to lack of mastery over the flow of *Prāṇa* and results in blockages in the channels in which they flow. A disorganized *Prāṇa* causes blockages, but this phenomenon is an outcome of high demand from the mind (*Manomaya kośa*). When the mind is caught in an uncontrolled speed of thoughts due to the habituated, negative emotional suppressions and responses, (which is nothing but stress) this poses a high demand on the *Prāṇa*. Since the physiological functions are a manifestation of *Prāṇa*, the imbalances in the *Prāṇamaya Kośa* would reflect on the autonomic nervous system and hence on the dysregulation of brain-gut axis.

The etiology of IBS is still unclear, involving multiple pathophysiological mechanisms. One of the mechanism points out bidirectional brain-gut interactions. In health, brain-gut interactions are crucial in the regulation of digestive processes (including appetite and food intake), in the modulation of the gut-associated immune system, and in the coordination of the overall physical and emotional state of the organism (sleep, stress, and anxiety) with activity in the gastrointestinal (GI) tract. In disease, peripheral and central alterations in brain-gut interactions are likely to underlie symptoms of chronic

abdominal pain and associated GI dysfunction (Mayer & Tillisch, 2011). Another model proposed by Konturek et al. (Konturek, Brzozowski, & Konturek, 2011) relates stress and gut dysfunction.

Yoga proposes a model of *Prāṇa* imbalance **(**discussed in detail in **Chapter 2**) and its effects on the gut. *Hatha Yoga Pradipika* (Saraswati, 2002) emphasizes on the connection between breath and mind in the following sutra:

चले वाते चलं चित्तं निश्चले निश्चलं भवेत्॥

योगी स्थाणुत्वमाप्नोति ततो वायुं निरोधयेत्॥ ह यो प्र।२।२॥

cale vāte calaṁ cittaṁ niścale niścalaṁ bhavet||

yogī sthāṇutvamāpnoti tato vāyuṁ nirodhayet || *HYP* |2|2||

Meaning: When the breath is restless, the mind is restless. When the breath is still, the mind is still. By breath-control, the yogi becomes realized. Therefore, control the breath.

Internal awareness and focusing followed by relaxaton in the stretched parts in an *Āsana* helps in releasing blockages and restores a free flow of *Prāṇa* (Swami Venkatesananda, 1985). Based on this understanding, RYM included a sequence of *āsanas* that were most beneficial to the abdominal region. One of the *Yogic* texts, *Siva Samhita* (Srisa, 1914) describes the two major energy channels, right (*pingala*/sun) and left (*ida*/moon) nostrils through which the *prāṇa* is drawn in/out for all the physiological functions. It is believed that when there is perfect health/homeostasis, there would be a balance in the functioning

of right and left channels / *nādis*. When there is an imbalance such as a stress response, the *Prāṇa* rushes through the right channel, and when there is a restful basal functions, *Prāṇa* flows through the left channel. This can be equated to right and left nostril breathing. Several studies attest to these facts, Telles et al. studied the effects of uni nostril breathing and concluded that right nostril breathing activates sympathetic dominance and increases metabolism (Telles, Nagarathna, & Nagendra, 1994). Another study concluded that left nostril breathing activates parasympathetic dominance and reduces heart rate and blood pressure (Bhavanani, Madanmohan, & Sanjay, 2012). Based on these findings and the autonomic imbalance experienced by IBS patients (either sympathetic or parasympathetic dominance), we included *Prāṇayāma* techniques most appropriate for IBS patients in the RYM. In this regard, we reasoned a balanced approach (alternate nostril breathing) with few cooling *Prāṇayāma* practices would be best to bring down the sympathetic tone and balance the autonomic nervous system. **Table 39** has the list of practices at this *Kośa*.

Table 39. Practices at *Prāṇamaya Kośa*

Kriyās - Kapālabhāti	Development of inner awareness; massages the abdominal organs; build stamina; stimulate and relax
Sectional breathing	Expanding the lung capacity and slow down the breath
Alternate nostril breathing	Promotes balance between the two nostrils; lowers stress and anxiety levels
Cooling *prāṇayāma– sitali* and *sitkari*	Helps in acidity, indigestion; helps in reducing stress
Bhrāmari	Creates a soothing effect on the nervous system

8.6.3 *Manomaya Kośa* Mechanisms

As addressed in **Chapter 2,** according to *Yoga*/ancient scriptures, IBS is a mind-body disorder originating as a disturbed *Manomaya Kośa* between heightened arousal and restful mind. Excessive uncontrolled speed of mind causes the heightened state of arousal (Nagarathna & Nagendra, 2002). *Yoga* as a therapy brings about a reversal (*Pratiprasava*, **Chapter 2, Figure 5**) by correcting the imbalances at physical body level (*Annamaya Kośa*) and at each *Kośa* to finally reach a blissful state (*Ānandamaya kośa*). A detailed mechanism in *Manomaya Kośa* in any mind-body disorder is given elsewhere by Choudhary (Choudhary, 2013).

A balance at each level is achieved by a systematic process that involves intellect, mind, breath, and body by several practices at each layer of *Pañca Kośās*. The *Manomaya Kośa* practices include meditation (*Dhāraṇa* / focusing and *Dhyāna* / effortless focusing).

Dhāraṇa may be translated as 'holding steady', and 'concentration'. It is the initial step of deep concentrative meditation, where the object being focused upon is held in the mind with awareness. This evolves into the subsequent stage of *Dhyāna*, where the meditator and act of meditation disappears, and only the consciousness of being/existing and the object of concentration exists (in the mind). This effortless focusing helps in providing deep rest through slowing down of the mental modifications (*citta vritti*) (Nagendra & Nagarathna, 1997). A slow and rested mind can provide a congenial atmosphere for healing from within quickly and on the contrary, as emphasized in

Chapter 2, negative emotions or a stressed mind is the root cause for modern day psychosomatic disorders.

At the *Manomaya Kośa*, RYM used Om meditation (A, U, M and OM) for IBS patients as part of the one hour module in order to instigate an experience of the inner healer within. The improved quality of life (reduced negative emotions) and reduced anxiety in these patients attests to this fact. Almost all patients reiterated that the *Yoga* program was highly enjoyable and benefited their lives. About 80% of the patients self-reported that they had better energy levels, and better sleep, associating with *Yoga* sessions. The benefits of RYM intervention enjoyed by the IBS patients in our study are far reaching. Patients self-reported that *Yoga* had helped in relieving other health issues that they suffered from, such as headaches, arthritis, inflexibility. They also stated that they regained positivity, calmness, and energy, and feeling relaxed when under stressful situations. *Yoga* therapy reportedly helped them regain control of their lives from IBS with little effect of IBS on their quality of life. The patients felt completely revitalized with the *Yoga* therapy and planned to continue practicing *Yoga* regularly **(patient testimonials, Appendix X).** Some of the other practices like devotional singing to culture emotions were not implemented due to the place and nature of our patient population.

Table 40. Practices at *Manomaya Kośa*

Dharana	Focusing on the sounds of A, U, M and Om, culturing of mind and emotions
Dhyana	Relaxed, effortless dwelling on a single thought for longer durations leading to deep rest to the sense organs

8.6.4 *Vijnānamaya Kośa* Mechanisms

Layer of intellect is characterized by the accurate information that directs the mind towards correct actions. We did not counsel our sample of IBS patients as this population was naïve to *yoga* and due to cultural and religious differences/concerns. Before every session, instructors checked with the patients if they had any concerns about their health, *Yoga* sessions etc. and this interaction, as reported by patients, had served as a personal counseling. However, there was one patient who dropped out from the study, after her parents insisted that *Yoga* had a 'Pagan' origin. We could not convince them otherwise. The other incident involved 'OM' chanting, when one patient stated to the instructor that chanting 'OM' is against her religion. These were very few incidents and majority of the patient population did cooperate and finish the study without any issues.

8.6.5 *Ānandamaya Kośa* Mechanisms – Balance and rest

This layer represents state of happiness and bliss. All human beings strive for happiness. When the desire for happiness is driven with right knowledge, a balanced state of mind (neither excited nor depressed), a balanced breathing, and a healthy body, all the actions result in efficiency and happiness as the fruits of the actions are not awaited or expected.

This harmony of being in a blissful state is incorporated in all the other *Kośa* practices. In the *Annamaya Kośa*, during Yogic postures, it was emphasized that the final position is to be enjoyed in total relaxation and observe the silence from within. During the deep relaxation technique, the patients were instructed to relax with total awareness while resting each and every organ. During controlled regulated breathing, it was emphasized

on slowing down the breath, observing the relaxed mind and focusing on the automatic cessation of breath (*kevala kumbhaka*). During OM meditation, patients were instructed to focus on the sounds, vibrations, and the relaxation to the body-mind complex. All these instructions have helped the IBS patients in our study, and it showed a positive effect on their quality of life, improved severity of symptoms, and every patient reported of being relaxed and energized after the session. **Figure 25** shows a schematic depiction of the possible role of *Yoga* for IBS patients in improving their symptoms.

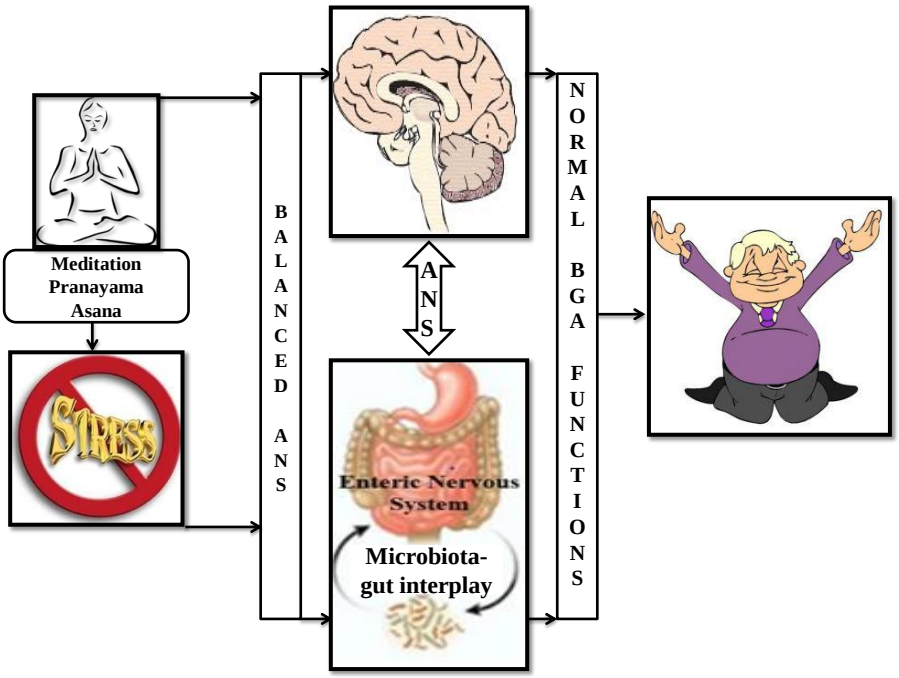


Figure 25. Role of Yoga on Stress in the amelioration of IBS

(*Source of various images:* Yoga – http://www.clipartpanda.com/; Stress- http://www.atlanticapotheracary.com/; Brain- http://lifehacker.com/ ; Stomach/intestines - http://www.rechildrens.org/blog/gut-brain-axis/; Happy person – http://www.itimes.com/.)

The mechanism of *Yoga* is not completely known. *Yoga*, from various studies, helps de-stress and relax (Woodyard, 2011; Satyapriya, et al., 2009). *Yoga* helps in improving anxiety (McCall, 2014; Woolery, Myers, Sternlieb, & Zeltzer, 2004). Yoga stretches helps the abdominal region (Ducrotté, 2007), and *Yoga* studies for IBS have established a reduction in abdominal pain and bloating, which is the immediate line of treatment (Kanojia et al., 2013; Brands et al., 2011). Autonomic imbalance is improved with relaxation, controlled regulated breathing, and meditation (Jerath, et al., 2006; Sarang & Telles, 2006). Results of the present study showed improvements in all of the areas in ameliorating IBS and its related symptoms.

In conclusion, RYM could be a valuable, effective, and feasible treatment option for IBS. RYM intervention could be a comprehensive technique to develop awareness, transition towards better health at physical, emotional, mental, and spiritual levels. The pathophysiology points out to stress as an important factor in exacerbating IBS. Stress according to *Yoga* is uncontrolled speed of thoughts, percolating to the physical body through haphazard, irregular breathing and ultimately settling as a disease/disorder in the body. *Yoga* is an easy and effective intervention to address and correct all these imbalances. As presented, RYM is an easy module with precise number of rounds and duration of each practice. We believe the given module would allow other researchers to replicate the study. The group setting with personalized attention given by the instructor could have facilitated group dynamics and support amongst the patients motivating them to adhere to the program (90% attendance). RYM was found to be a safe intervention without any major adverse events associated with the intervention. RYM could be

recommended to IBS sufferers without prior exposure to *Yoga*, since our sample size consisted largely of Hispanic population who were naïve to *Yoga*. Our study provides a potential evidence for the continuation and replication of RYM's effects on IBS. More rigorous and longer-term trials with larger sample size are warranted to strengthen the efficacy of RYM for IBS seen in the present study. With the results presented, it can be concluded that RYM alone or RYM combined with conventional care as implemented could be a safe, efficient long term solution for IBS symptoms.

C H A P T E R - 9

A P P R A I S A L

9. APPRAISAL

9.1 SUMMARY

The efficacy of 12 weeks of RYM intervention was assessed, through a randomized controlled trial, on symptom severity, quality of life, anxiety, depression, global assessment of improvement, Medicine and Supplement Use, BMI, physical flexibility and autonomic functions of IBS patients (18 years and older). The replication of the results was assessed with the intervention given to the Wait-list Control group. Also, the efficacy of a maintenance intervention of once a week, one hour RYM, was assessed on all of the above variables. 97 IBS patients, predominantly females, satisfying Rome III criteria were randomized into three groups, 33 in the *Yoga* group, 33 in the Combination group and 31 in the Wait-list Control group.

The intervention was one hour RYM session, thrice a week for 12 weeks. RYM entailed postures designed for IBS, *Prāṇāyāma* (regulated breath control), and meditation, all derived from the philosophical concepts of Indian scriptures and *Yogic* literature. RYM intervention was administered for *Yoga* and Combination groups, while the Wait-list Control group maintained their current lifestyle. At the end of 12 weeks of waiting, the Control group (WL- *Yoga* group) was offered the same RYM intervention of one hour sessions, three times a week for 12 weeks. For the long term study, all three groups were combined as 'Follow-up' group. 78 patients completed the study of 12 weeks; 25 in the *Yoga* group, 26 in the Combination group and 27 in the Wait-list Control group. 7 patients from the Wait-list Control group (WL- *Yoga* group) completed the 12 weeks

RYM intervention and 28 patients from all three groups completed the once a week, one hour RYM maintenance intervention.

A twelve week intervention of Remedial *Yoga* Module (RYM) significantly decreased the severity of IBS symptoms, improved the quality of life, and lowered Anxiety, Depression, and Autonomic symptom scores in both *Yoga* and Combination groups. Global Assessment of Improvement was significantly higher in the intervention groups when compared to Control group. Significant improvements were observed in physical flexibility and Medicine and Supplement Use of *Yoga* and Combination groups when compared to Control group. *Yoga* has decreased the sympathetic dominance and increased parasympathetic dominance in the Combination group. The WL- *Yoga* group replicated most of the improvements that were observed in the *Yoga* and Combination groups. In the long-term study, the improvements from week 12 were either sustained or further enhanced at week 24, with a limited intervention, once a week onsite *Yoga* practices.

9.2 UNIQUENESS OF THE STUDY

This is the first comprehensive one hour Remedial *Yoga* Module based on holistic approach with multidimensional interventions at physical, mental, emotional, intellectual and spiritual levels (WHO definition of health). The intervention of one hour was set with specific number of rounds for each practice, number of minutes, and a sequence unlike previous studies. The RYM sessions were monitored and supervised by trained, certified

Yoga instructors unlike previous studies where the *Yoga* routines were either not specified, too long, not supervised or were to be practiced at home.

9.3 CONCLUSION

This RCT has shown an improvement in the primary and secondary assessments of IBS after 12 weeks of holistic integrated RYM intervention in adult IBS patients when compared to Control group. With the intervention administered to WL- *Yoga* group, the study has provided evidence that the results of this RYM intervention study are replicable. After 24 weeks of RYM intervention, it was substantiated that this intervention was safe, feasible, efficient, precise, and easy to replicate. The group setting appeared to have facilitated group dynamics, and the support amongst patients, motivated these patients to adhere to the program (90% attendance). RYM was a safe intervention without any major adverse events. The study suggests that supervised *Yoga* sessions are the best option to motivate and monitor the patients.

9.4 STRENGTH OF THE STUDY

a) The results of the present study demonstrate that RYM is a valuable, effective and feasible treatment option for IBS patients in improving symptom severity, QOL, and reducing psychological distress, headaches, and autonomic imbalance among other benefits.

b) We presented an easy module of precision, the number of rounds of each practice, and the number of minutes for each practice. RYM consists of different poses and every pose focuses on either the contraction or the expansion of the abdominal viscera.

c) We believe the given module would allow other researchers to replicate the study.

9.5 LIMITATIONS OF THE STUDY

a) Blinding the subjects was not possible due to the nature of the intervention.

b) This study lacked an active control group.

c) With adequate funding, we could have measured the gastric motility to assess the effects of RYM on vagal cholinergic reactivity.

d) We did not assess which IBS subgroup (IBS-C, D or M) fared the best with the RYM intervention, as the numbers were too small in each group.

e) Due to inherent challenge with adherence to special dietary guidelines, especially in the majority of study participants, we did not give emphasis on diet.

9.6 IMPLICATIONS OF THE STUDY

a) The significant improvements observed in all the primary and secondary assessments of IBS encourage the acceptability of the RYM intervention for treatment of IBS symptoms.

b) The RYM intervention could be cost effective compared to conventional medical management, thus reducing the economic burden of treating IBS.

c) RYM intervention has demonstrated its positive impact on anxiety and depression which could contribute to positive attitude and better functioning.

d) RYM intervention improved quality of life which could help in coping skills and fostering a better sense of well-being.

e) Our sample size consisted largely of Hispanic population who were naïve to *Yoga* for the most part, and the positive outcome from this study suggests that RYM could be applied to IBS sufferers of any population without prior exposure to *Yoga*. It may also suggest that there may not be placebo effects of *Yoga* especially with the population tested in our study.

9.7 SUGGESTIONS FOR FUTURE WORK

a) Future studies could explore the benefits of RYM on each subgroup of IBS separately.

b) Diet, *Ayurveda* and RYM for IBS patients could be investigated in a three arm study.

c) Longer duration of follow-up with continued maintenance intervention for about one year could be investigated.

d) Future studies may be designed to conduct multicenter clinical trials to extend the benefits to large IBS sufferers from various social backgrounds.

e) An investigation could be planned to study RYM's impact on vagal cholinergic reactivity by assessing gastric motility.

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