CURRENT DIETARY PRACTICE OF SOUTH AFRICAN DIETITIANS IN THE TREATMENT OF SYMPTOMATIC UNCOMPLICATED DIVERTICULAR DISEASE

BY

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ABSTRACT

Introduction: There is a global rise in diverticular disease (DD) in Westernized countries although the prevalence in South Africa (SA) is unknown. This has a significant effect, not only on the quality of life but also economically as the requirement for surgical interventions and hospital admissions have increased, putting additional pressure on healthcare systems. Dietary approaches to the treatment of DD differ and are contradictory. The traditional restrictive low fiber diet approach recommends the avoidance of insoluble fiber including nuts, seeds, popcorn and corn while the International Current Consensus Guidelines (ICCG) from a number of countries such as Italy, Poland, Denmark, America, Great Britain, advocate a liberal unrestricted high fiber diet (HFD). Although the ICCG have concluded that the consumption of nuts, seeds and popcorn does not appear to exacerbate DD symptoms and complications, there has been anecdotal evidence that their inclusion may worsen symptoms and provoke attacks in some patients suffering with symptomatic uncomplicated DD (SUDD). There are also conflicting views as to whether fiber supplementation is necessary in SUDD.

Aim: The aim was to determine dietary treatment methods used by registered dietitians (RDs) practicing in SA when treating SUDD and to determine their beliefs regarding the ICCG for SUDD, trigger foods and the use of fiber, prebiotic and probiotic supplements.

Methods: Snowball sampling was used in this quantitative descriptive study to identify 155 RDs in SA who treated SUDD. The RDs completed a closed and open-ended self-administered questionnaire.

Results: Diverticular disease was treated by 75% of dietitians in the private sector compared to 25% in the government sector. A third of the dietitians treated less than five patients per year and a third treated two or more patients per month. Their approach to treatment was not significantly different. A significant portion (77%) disagreed with the ICCG and 79% identified foods (including seeds, nuts, pips, wheat, popcorn and fruits), which they believed triggered symptoms. None supplemented with bran and only 1.3% recommended insoluble fiber. Supplementation with prebiotics was considered least beneficial (20%) compared to 74% who routinely prescribed

probiotics. The main probiotic species prescribed were *Lactobacillus acidophilus, Bifidobacterium lactis, Bifidobacterium longum, Bifidobacterium bifidum, Lactobacillus casei, Lactobacillus rhamnosous, Lactobacillus plantarum* and *Streptococcus thermophiles.* Only 7%, however, prescribed an evidence based strain. Many RDs (74%) felt that patients responded well to their treatment with significant improvement in symptoms and had a decreased relapse rate.

Conclusion: The majority of dietitians practicing in SA do not support the ICCG advocating a liberal, unrestricted HFD as the appropriate dietary approach for the treatment of SUDD. An individual treatment approach for each patient was reported throughout the study. Practice regarding the use of prebiotics and probiotics was not evidence-based.

PREFACE

The research contained herein was completed by the candidate who is a scholar of the Discipline of Dietetics and Human Nutrition, School of Agricultural, Earth and Environmental Sciences, College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa from June 2015 to December 2016, under the supervision of Dr Chara Biggs.

The contents of this work have not been submitted in any other form to another university, and the results reported are due to investigations by the candidate, except where the work of others is acknowledged in the text.

I, Chara Biggs, agree to the release of this thesis for examination.

Signed: _____ Date: 5/01/2017

Dr Chara Biggs (supervisor)

DECLARATION

I, Tanya Leesa March, declare that:

(i) the research reported herein has been composed solely by myself, except where stated otherwise by reference or acknowledgement;

(ii) this dissertation has not been submitted, in whole or in part, in any previous application for a degree or examination to another university;

(iii) the tables and figures used in this dissertation are my own and if sourced by other people, have been specifically acknowledged.

Signed: _____ Date: _____

Tanya Leesa March (candidate)

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Thank you mum and dad for investing and believing in me. Finally, to my husband Alex and my sons, Daniel and Ethan, you all stood by my side throughout this journey, thank you

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1. INTRODUCTION, THE PROBLEM AND ITS SETTING

1.1 IMPORTANCE OF THE STUDY

The incidence of DD has risen in industrialized countries (Tursi 2010). Diverticular disease results in a significant loss of quality of life (abdominal pain, bloating, constipation, diarrhoea, nausea, flatulence) and in severe cases, mortality (Commane, Arasaradnam, Mills, Mathers & Bradburn 2009; Tursi 2010). Over the last 10 to 20 years, there has been an increase in hospital admissions, (Tursi 2010; Cuomo, Barbara, Pace, Annese, Bassotti, Binda, Casetti, Colecchia, Festi, Fiocca, Laghi, Maconi, Nascimbeni, Scarpignato, Villanacci & Annibale 2014) costing the health care system of the United States of America (USA) an estimated 2.7 billion dollars per year. Annually, approximately 313 000 patients with DD require surgical intervention or hospitalization (Peery, Barrett, Park, Rogers, Galanko, Martin & Sandler 2012; Peery & Sandler 2013***).*** In SA, an increased prevalence of DD has been noted in the urbanized SA black population, compared to the rural SA black population (Weizmen and Nguyen 2011).

Although diet plays an important role in the management of DD, the two dietary approaches are completely opposed (Tarleton & DiBaise 2011). The traditional restrictive low fiber diet recommends the avoidance of insoluble fiber including nuts, seeds, popcorn and corn while the ICCG (Tarleton & DiBaise 2011; Andersen, Bundgaard, Elbrønd, Laurberg, Walker, Støvring 2012; Pietrzak, Mik, Bartnik, Dziki & Krokowicz 2013; Cuomo *et al* 2014; Royal College of Surgeons Advancing Surgical Standards 2014) advocate a liberal unrestricted (HFD) (Crowe, Balkwill, Cairns, Appleby, Green, Reeves, Key & Beral 2014). Although the ICCG have concluded that the consumption of nuts, seeds and popcorn does not appear to exacerbate DD symptoms/complications (Strate, Liu, Syngal, Aldoori & Giovannucci 2008), there has been anecdotal evidence that their inclusion may worsen symptoms and provoke attacks in some (National Health Service 2015). This raises the question of whether the ICCG advocating a liberal HFD, are appropriate for all those with DD, as Salzman & Lillie (2015) commented that patients with SUDD often mention that eating food may precipitate an attack.

The favorable manipulation of the gut bacteria via the prebiotic impact of fiber may offer an important benefit (Donini, Savina & Cannella 2009), as probiotics may play an important role in reducing localized inflammation in SUDD, possibly preventing attacks of diverticulitis (Tursi, Brandimarte, Giorgetti & Elisei 2006; Quigley 2010).

It was important to establish the beliefs and practices of dietitians treating SUDD to determine whether, based on their experience, they agreed with the ICCG despite anecdotal evidence which suggested that the liberal HFD may not benefit all. As the use of both prebiotics and probiotics is currently not addressed by the ICCG, it was important to determine whether, based on practical experience, RDs felt that these offered a therapeutic advantage.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Current approaches to the dietary treatment of SUDD are contradictory as outlined below:

1.2.1 the consensus statements have concluded that the consumption of nuts, corn and popcorn does not appear to exacerbate SUDD (Strate *et al* 2008)

1.2.2 anecdotal evidence indicates that the inclusion of insoluble fiber including nuts, popcorn and corn, in the diet of a patient with SUDD may worsen symptoms and provoke attacks in some (National Health Service 2015).

1.2.3 the favorable manipulation of the gut bacteria via the prebiotic impact of fiber may offer an important benefit (Donini, Savina & Cannella 2009) as probiotics may play an important role in reducing localized inflammation in SUDD possibly preventing attacks of diverticulitis (Tursi *et al* 2006; Quigley 2010).

This raises the question of whether the ICCG, advocating a liberal HFD, are appropriate for all those with SUDD as Salzman & Lillie (2005) commented that patients with SUDD often mention that eating food triggers attacks.

1.3 RESEARCH OBJECTIVES

1.3.1 To determine whether RDs in SA agreed with the ICCG.

1.3.2 To determine whether RDs in SA supplemented with fiber in the treatment of SUDD.

1.3.3 To determine whether RDs in SA identified specific foods believed to trigger attacks in SUDD.

1.3.4 To determine whether RDs in SA supplemented with prebiotics and/or probiotics and other nutritional supplements.

1.3.5 To determine whether RDs in SA believed that their dietary approach was successful.

1.4 NULL HYPOTHESIS

1.4.1 Registered dietitians in SA would not agree with the ICCG in treating SUDD.

1.4.2. Registered dietitians in SA would recommend a liberal unrestricted HFD in SUDD patients.

1.4.3. Registered dietitians in SA did not believe in specific trigger foods in SUDD.

1.4.4. Registered dietitians in SA would not supplement with prebiotics and/or probiotics and other nutritional supplements.

1.4.5. Registered dietitians in SA would not believe that their dietary approach was successful.

1.5 STUDY PARAMETERS

1.5.1 Inclusion criteria

All RDs who had treated or who were currently treating SUDD in SA.

1.5.2 Exclusion criteria

Dietitians who had never treated SUDD and those who were based outside of SA.

1.6 ASSUMPTIONS

1.6.1 Registered dietitians treated SUDD in SA according to the ICCG.

1.6.2 Registered dietitians had access to the internet.

1.6.3 Registered dietitians were fluent in English.

1.6.4 The DD letter (Appendix B), which consisted of information regarding the study and a consent note, was sent out via the Association for Dietetics in South Africa (ADSA) webmail newsletter and it was assumed that all ADSA members would read the letter.

1.6.5 Registered dietitians would respond to and answer the questionnaire honestly.

1.7 DEFINITION OF TERMS

Acute diverticulitis	An acute episode of severe, prolonged, lower abdominal pain (usually on the left side), change in bowel movement, low-grade fever and leukocytosis (Cuomo *et al* 2014).
Arabinogalactan	A polysaccharide that acts as a prebiotic in the gut (Kelly 1999).
Asymptomatic diverticulosis	Patients with diverticula and the absence of any sign or symptoms of diverticular inflammation (Tursi 2010).
Balsalazide	An anti-inflammatory drug converted to mesalazine in the body (Tursi, Brandimarte, Giorgetti, Elisei & Aiello 2007).
Complicated diverticulitis	Patients with diverticula who experience symptoms and demonstrate signs of diverticular inflammation with further complications (hemorrhage, abscess, perforation, fistulas, strictures (Tursi 2010).
Current dietary practice	The current treatment prescribed by RDs in the treatment of DD.

Dietitian	A dietitian prescribes a healthy diet which may help prevent or treat diseases or illnesses (Medical-dictionary 2016).
Diverticula	Herniation of the mucosa through weak areas of the colonic wall (Peery *et al* 2012).
Diverticular disease	Diverticula associated with symptoms (Janes, Meagher & Frizelle 2006).
Diverticulitis	Evidence of diverticular inflammation (fever, tachycardia) with or without localized symptoms and signs (Janes *et al* 2006).
Diverticulosis	The presence of colonic diverticula within the colon (Murphy, Hunt, Fried & Krabshuis 2007; Elisei & Tursi 2016), these may become symptomatic or complicated (Cuomo *et al* 2014).
Faecal stasis	Faecal material stagnating or not moving through the intestine (Sheth & Floch 2009).
High fiber diet	A high dietary intake of insoluble and soluble fiber foods that are resistant to digestion in the gut (Anderson, Baird, Davis, Ferreri, Knudtson, Koraym, Waters & Williams 2009).
Incidence	The probability of a person being diagnosed with a new disease within a given period of time (New York State Department of Health 1999).
Insoluble fiber	Insoluble fiber is indigestible fiber that is unable to be broken down by digestive enzymes and juices in the human gut. Insoluble fiber passes through the small intestine and colon undigested, increasing faecal mass. Examples include: corn fiber, wheat bran (Petruzziello, Iacopinin, Bulajic, Shah & Costamagna 2006).

Xylo-oligosaccharides	A mixture of oligosaccharides and xylose residue that act as a prebiotic in the gut (Aachary & Prapulla 2010).
Prebiotic	A non-digestible food ingredient that acts as a substrate for desirable bacteria helping to stimulate their growth and/or activity thereby improving the health of the host (Slavin 2013).
Probiotic	Viable micro-organisms which, when ingested, might exert beneficial effects in the prevention and treatment of a number of specific pathological disorders (Lamiki, Tsuchiya, Pathak, Okura, Solimene, Jain, Kawakita & Marotta 2010).
Recurrent symptomatic diverticular disease	Patients with diverticula who experience recurrent symptoms (more than one attack per year) but without signs of diverticular inflammation (Tursi 2010).
Rifaximin	A broad spectrum, poorly absorbable antibiotic that is able to act on Gram-negative and Gram-positive bacteria, both aerobic and anaerobic (Elisei & Tursi 2016).
Soluble fiber	Soluble fiber contains viscous fibers that are able to dissolve in water, forming a gel like substance and most are able to ferment in the colon. Examples are: psyllium, ispaghula, calcium polycarbophil (Petruzziello *et al* 2006; Slavin 2013).
Symptomatic uncomplicated diverticular disease	Patients with diverticula who experience symptoms such as abdominal pain (bloating, change of bowel habits and constipation/diarrhea) without microscopic evidence of inflammation (Tursi 2010).

1.8 ABBREVIATIONS

ADSA	Association for Dietetics in South Africa
AGA	American Gastroenterological Association
AIDS	Acquired immunodeficiency syndrome
DD	Diverticular Disease
DNA	Deoxyribonucleic acid
FODMAP	Fermentable, Oligo-, Di-, Mono-saccharides And Polyols
FOS	Fructo-oligosaccharides
GALT	Gut associated lymphoid tissues
GOS	Galacto-oligosaccharides (GOS),
HFD	High fiber diet
HIV	Human immunodeficiency disease
HPCSA	Health Professional Council of South Africa
IBD	Irritable Bowel Disease
ICCG	International Current Consensus Guidelines
KZN	KwaZulu-Natal
MCG	Millennium Criteria Goals
NHS	National Health Service
RCS	Royal College of Surgeons
RCT	Randomised control
RDs	Registered dietitians
SA	South Africa
SA DoH	South African Department of Health
SCFA	Short chain fatty acids
SUDD	Symptomatic Uncomplicated Diverticular Disease
TB	Tuberculosis
UKZN	University of KwaZulu-Natal
USA	United States of America
WGO	World Gastroenterology Organisation
XOS	Xylooligosaccharides

1.9 SUMMARY

The dietary approach used in the treatment of DD patient's in-between acute attacks is confounding as the paucity of good quality evidence is lacking. The current dietary ICCG recommend a HFD that includes insoluble fiber compared to the traditional guidelines where a low insoluble fiber diet was promoted. Anecdotal evidence contradicts the new dietary guidelines as internet support groups have patients reporting that their symptoms regress when changing from the traditional to current approach. As there are diametrically opposed treatment guidelines, it was important to establish what dietary approaches dietitians used to treat DD in-between acute attacks, if they believed their approach to be beneficial and to determine if there are trigger foods that may aggravate symptoms.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Diverticular disease is one of the most common colon diseases experienced in Westernized countries (Naidoo 2009; Tursi 2013; Pisanu, Vacca, Reccia, Podda & Uccheddu 2013) and effects the elderly population with the prevalence being common in approximately 65% of people over the age of 65 (Guslandi 2013). In the last 20 years, 313 000 diverticular patients have been hospitalized in the United States of America (USA) (Peery *et al* 2012**)** resulting in a 16% increase in surgical interventions, hospital admissions (Janes *et al* 2006) and costing 2.7 billion dollars (Peery & Sandler 2013). The devastating impact on health includes life threatening complications such as perforation, obstruction and haemorrhaging (Tarleton & DiBaise 2011; Peery *et al* 2012). Although the current prevalence in SA is unknown, Weizmen & Nguyen (2011) showed that urbanized SA black men had an increased risk of developing the disease.

In the management of SUDD, there is consensus that the best therapeutic approach is to prevent relapse (Tursi 2013; Mosadeghi, Bhuket & Stollman 2015), however, the dietary management remains controversial (Tarleton & DiBaise 2011). Traditionally the avoidance of dietary fiber, including nuts, seeds, corn and popcorn was advocated (Tarleton & DiBaise 2011). Recent ICCG take an opposing stance by advocating the inclusion of large amounts of all types of fiber (Tarleton & DiBaise 2011; Andersen *et al* 2012; Pietrzak *et al* 2013; Cuomo *et al* 2014). Neither approach is based on substantial scientific literature (Tarleton & DiBaise 2011). Although the unrestricted approach includes the general benefits of a HFD, anecdotal evidence on the National Health Service (NHS) website (2015) suggests that some SUDD sufferers may experience severe discomfort (constipation, abdominal pain or discomfort, diarrhoea) and benefit from fiber exclusion.

The scope of this review includes the spectrum and pathophysiology of DD, the controversy surrounding the dietary treatment of SUDD and the potential therapeutic benefits of fiber (both soluble and insoluble) as well as prebiotics and probiotics. Complicated DD is not part of the scope of this dissertation.

2.2 SPECTRUM OF DIVERTICULAR DISEASE

The spectrum of DD initially begins with the development of diverticula. Colonic diverticula are out-pouching's or sac like protrusions found in weak areas in the circular muscle of the colon wall resulting in herniation (Marlett, McBurney & Slavin 2002; Peery & Sandler 2013; Elisei & Tursi 2016). Diverticulosis is the presence of asymptomatic diverticula without inflammation (Wilkins, Embry & George 2013) (Figure 2.1). Diverticular disease is a term used to signify diverticulosis with a complication (Peery & Sandler 2013) and diverticulitis refers to infected/inflamed diverticuli. Out of the 20% who develop symptomatic DD, 85% develop SUDD with the remainder developing complicated DD (Elisei & Tursi 2016). Symptomatic uncomplicated DD is usually characterized by abdominal bloating, nausea, changes in bowel habits, constipation and/or diarrhoea due to bacterial overgrowth (Petruzziello *et al* 2006; Elisei & Tursi 2016).

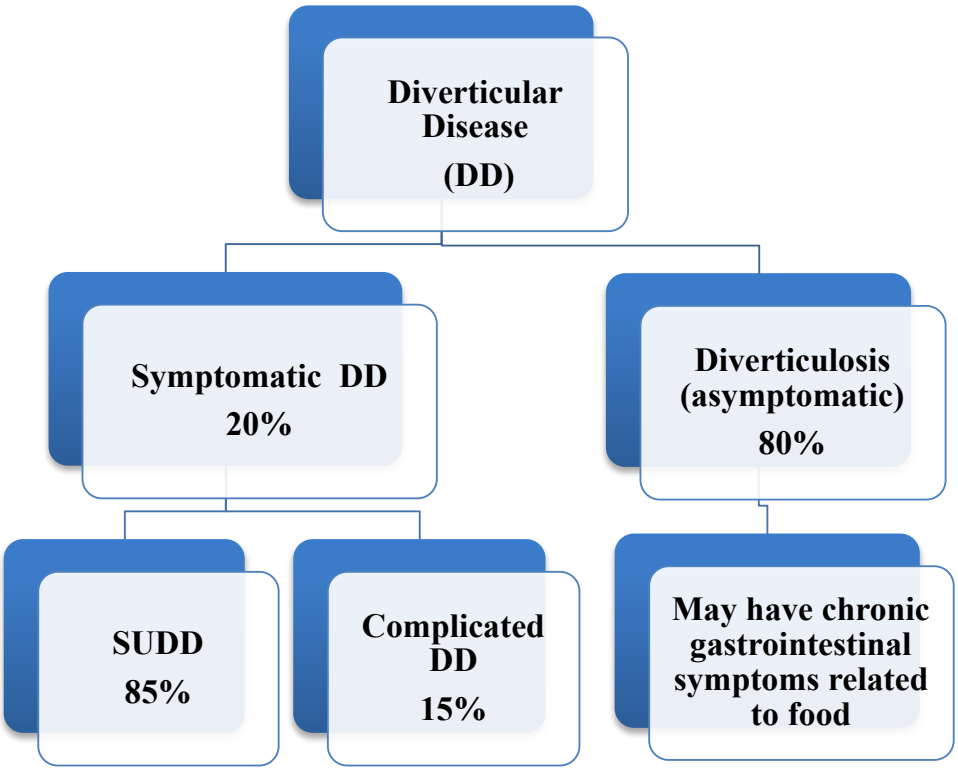

Figure 2.1: The spectrum of diverticular disease (after Tarleton & DiBaise 2011; Peery & Sandler 2013)

2.3 PATHOPHYSIOLOGY OF DIVERTICULAR DISEASE

Although the pathophysiology is unknown, potential contributing factors include increasing age, genetics, inflammation and dietary contributors such as a low intake of dietary fiber and altered colonic microbiota (Commane *et al* 2009; Tarleton & DiBaise 2011; Ünlü, Daniels, Vrouenraets & Boermeester 2012; Ulmer, Rosch, Mossdorf, Alizai, Binnebösel & Neumann 2014).

2.3.1 Dietary fiber

Painter (1974) suggested that DD is a disease of Westernized civilization due to the intake of dietary fiber from cereal grains in the Western diet being low, compared to developing countries such as Africa, India and rural Asia, where fiber consumption is high and the disease is rare. Similarly, vegetarians and people who consume high amounts of fiber have a lower incidence of diverticula (Salzman & Lillie 2015).

It has been hypothesized that a low fiber intake could increase the colonic intraluminal pressure and cause uneven thickening of the colonic muscular wall, leading to mucosal herniation resulting in diverticula formation (Painter 1974; Painter 1982; Janes *et al* 2006). A low fiber diet reduces stool volume and increases the risk of developing constipation which may be a common cause in the development of colonic diverticula (Sheth & Floch 2009; Raahave 2015). Constipation promotes bacterial overgrowth resulting in chronic inflammation (Raahave 2015), increased production of mucus as well as increased strain (Painter 1982; Janes *et al* 2006). A HFD, according to Painter (1974), produces less strain in the sigmoid colon and allows for the stools to pass through more easily. This improves constipation and reduces diverticula development.

The location of colonic diverticula vary in different parts of the world (Weizman & Nguyen 2011). In Western societies, 85% are located on the left side on the sigmoid and descending colon, supporting the theory that increased colonic intraluminal pressure plays an important role. However, diverticuli in Asian and Japanese Hawaiian communities are isolated on the right side (Petruzziello *et al* 2006; Martel & Raskin 2008; Wilkins *et al* 2013), where the faecal matter is

larger in volume and the stools are unformed (Commane *et al* 2009; Ulmer *et al* 2014). Interestingly, right sided diverticula seem more likely to occur when a diet rich in fiber is eaten (Petruzziello *et al* 2006). The high pressure hypothesis cannot explain why right sided diverticula develop in the proximal colon where muscular contraction is less and the bowel diameter is large (Peery *et al* 2012).

2.3.2 Gut microflora

Microflora homeostasis in the gut is critical as the microflora help to maintain the functioning and integrity of the epithelial lining in the gut, as well as promoting the development of gut associated lymphoid tissues (GALT) and gut motility (Quigley 2010). Faecal stasis[1] from prolonged colonic tranist time may cause bacterial overgrowth and alter the composition of the microflora in the diverticula (Narula & Marshall 2010). This may impair mucosal barrier functioning and upregulate inflammatory cytokine release resulting in intestinal inflammation (Sheth & Floch 2009; Narula & Marshall 2010). Inflammation from colonized bacteria or bacterial entrapment in the diverticula may cause symptoms in SUDD patients and could lead to acute diverticulitis (Quigley 2010).

2.4 CONSENSUS GUIDELINES

International Current Consensus Guidelines by respected organisations support the use of a HFD (Andersen *et al* 2012; Cuomo *et al* 2014; Pietrzak *et al* 2013; Royal College Services Advancing Surgical Standards 2014; Stollman, Smalley, Hirano & American Gastroenterological Association Institute Clinical Guideline Committee 2015). The type of fiber (soluble versus insoluble) was not stipulated in any of the guidelines, although a general "high fiber diet" had been recommended by most. The World Gastroenterology Organisation (WGO) (Murphy, Hunt, Fried & Krabhuis 2007) states that a diet low in dietary fiber may increase the risk of complications in DD. The Consensus Guidelines from the Danish National Guidelines (Andersen *et al* 2012), the American Gastroenterological Association (AGA) (Stollman, Smalley,

[1] Faecal material stagnating or not moving through the intestine (Sheth & Floch 2009).

Hirano & American Gastroenterological Association Institute Clinical Guideline Committee 2015), the Italian Consensus (Cuomo *et al* 2014), Polish Consensus (Pietrzak *et al* 2013) and Great Britain's Royal College Services (RCS) commissioning guide (Royal College Services Advancing Surgical Standards 2014) all advocate the use of a HFD for individuals with SUDD. These ICGG, recommend a HFD, but none of them gave actual prescriptions regarding the amount of fiber that would be beneficial in SUDD patients. The British National Health Services recommends a HFD (18g to 30g/day) including at least five vegetables and fruits a day (National Health Service 2015). The Italian Consensus advises the intake of nuts, corn and popcorn (Cuomo *et al* 2014) as does the AGA 2015 Consensus (Stollman *et al* 2015). Although the use of fiber supplements in SUDD has been mentioned in a few of the ICCG (Andersen *et al* 2012; Pietrzak *et al* 2013), the type of fiber to supplement with was not mentioned. The Italian Consensus (Cuomo *et al* 2014) and the AGA (Stollman *et al* 2015) Consensus stated that fiber supplements are controversial in the treatment of SUDD, while the RCS commissioning guide (Royal College of Surgeons Advancing Surgical Standards 2014) and the WGO (Murphy *et al* 2007) did not mention fiber supplementation at all.

2.5 DIETARY TREATMENT

Dietary approaches for the treatment of DD includes manipulation of fiber as well as supplementation with prebiotics and/or probiotics to favourably alter the gut microbiota (Donini *et al* 2009). It is accepted that dietary fiber plays a role in the treatment of DD, although the type of fiber advocated is more controversial.

2.5.1 Use of dietary fiber

Dietary fiber is the undigested portion of food which passes into the colon (Buttriss & Stokes 2008). Although there are many classifications of dietary fiber, the division of fiber into the categories of insoluble and soluble fiber is commonly used (Anderson *et al* 2009). As fiber increases stool bulk, decreases transit time, reduces intraluminal pressure and has a prebiotic effect on gut microflora (Tarleton & DiBaise 2011), different types of fiber may play an important role in the treatment of SUDD (Tarleton & DiBaise 2011).

2.5.1.1 Insoluble dietary fiber

Insoluble dietary fiber is relatively resistant to being broken down during the digestive process which then creates a bulking action in the colon (Anderson *et al* 2009), decreases intestinal transit time, modulates water absorption, improves stool weight (Ho, Tan, Daud & Seow-Choen 2012) and reduces constipation. Insoluble fibers include cellulose, lignin and some hemicelluloses (Buttriss & Stokes 2008; Tarleton & DiBaise 2011). Foods that are rich in insoluble fiber include flax, rye, wheat bran, nuts, vegetables, legumes, fruit and fruit skins (Aldoori, Giovannucci, Rockett, Sampson, Rimm & Willett 1998; Tarleton & DiBaise 2011).

2.5.1.2 Soluble dietary fiber

Unlike insoluble fiber, most soluble fibers are viscous and are able to be fermented in the colon (Anderson *et al* 2009; Slavin 2013). Fermentation in the colon is not exclusive to soluble fiber, as some insoluble fibers, such as resistant starch, may also be fermented in the colon although in general, insoluble fiber is fermented to a much lesser degree (Aldoori *et al* 1998; Buttriss & Stokes 2008). Specific soluble fibers, such as pectin, psyllium, gums, beta-glucan, fructo-oligosaccharide (FOS), galacto-oligosaccharide (GOS), wheat dextrin and inulin (Buttriss & Stokes 2008; Tarleton & DiBaise 2011; Slavin 2013) act as prebiotics, stimulating the growth of health producing bacteria such as *Bifidobacteria* and *Lactobacilli,* thereby favourably manipulating the microbiota. These probiotics are able to stimulate the immune system, decrease the intestinal pH via the release of short chain fatty acids (SCFA), balance the colonic microflora and prevent pathogenic metabolism which in turn could reduce inflammation in SUDD patients (Anderson *et al* 2009; Tursi 2010).

Foods that are rich in soluble fiber include legumes, oat bran, fruits (citrus fruit, apples, bananas, tomatoes), vegetables (onion, garlic, leeks, Jerusalem artichoke, asparagus), barley, psyllium and chicory (Aldoori *et al* 1998; Aldoori & Ryan-Harshman 2002; Floch & Hong-Curtiss 2002; Grajek, Olejnik & Sip 2005; Tarleton & DiBaise 2011; Slavin 2013). Most contain some degree of insoluble fiber i.e. legumes contain both insoluble fiber (cellulose) and soluble fiber (Aldoori

et al 1998; Aldoori & Ryan-Harshman 2002; Floch & Hong-Curtiss 2002; Grajek *et al* 2005; Tarleton & DiBaise 2011; Slavin 2013).

The term dietary fiber has been used throughout many DD ICCG documents without specification of the type of fiber that may be more beneficial in SUDD (Andersen *et al* 2012; Cuomo *et al* 2014).

2.5.2 Dietary fiber intake in symptomatic uncomplicated diverticular disease

Historically, low insoluble fiber diets were believed to be the best form of treatment for DD (Painter 1982). Patients were advised to eat a low insoluble fiber diet which excluded nuts, corn, popcorn and seeds as it was thought that these foods could become entrapped in the diverticula resulting in diverticulitis (Painter 1982). However, high quality evidence supporting this approach is lacking (Ünlü *et al* 2012; Peery *et al* 2012).

In a twenty-two month prospective uncontrolled intervention study by Painter, Almeida & Colebourne (1972), a HFD (All-Bran, Weetabix, wholemeal as opposed to brown bread, increased fruit and vegetables) supplemented with unprocessed bran (12 to 14g/day) with a low sugar intake, was initiated in SUDD patients (Table 2.1). Of the 70 patients, 88.6% of their symptoms (dyspeptic[2], lower or general abdominal pain, symptoms related to defecation, constipation) were relieved or abolished. Only 3.8% did not experience any relief or their symptoms were not abolished. An intake of 14g of bran avoided straining in 88.6% (62/70). A very small percentage (5.7%) were unable to take the unprocessed bran as it caused the following symptoms; nausea, distention, left iliac fossa pain or ache, lower or general abdominal pain, severe colic or constipation. The study by Painter (1972), however, lacked a control group and the study was uncontrolled, lowering the strength of the evidence.

A six-month prospective, uncontrolled, intervention study by Brodribb & Humphreys (1976) assessed symptoms (dyspeptic, abdominal pain, symptoms related to defecation, constipation) in 40 patients with SUDD (Table 2.1). Patients were instructed to supplement with 24g of wheat

[2] Dyspeptic symptoms measured in Painter *et al* 1972, Brodribb & Humphreys (1976) and Ornstein *et al* (1981) were nausea, vomiting, flatulence, abdominal distention and wind.

Table 2.1: Studies investigating the use of fiber in diverticular disease.

Author Year	Type of study	Length of study	No. of pts (n)	Treatment type(s)	Results
Painter *et al* (1972)	Prospective uncontrolled intervention	22 months	70	SUDD pts received a high fiber diet with unprocessed bran (12-14g/day) plus low sugar intake.	88.6% (62/70) experienced significant reduction of symptoms and avoidance of straining.
Brodribb & Humphreys (1976)	Prospective, uncontrolled intervention	6 months	40	SUDD patients were given 24g wheat bran supplement/day in addition to normal diet.	60% (24/40) of symptoms were abolished and 28% (11/40) symptoms were reduced.
Taylor & Duthie (1976)	Randomised, cross-over intervention	2 months with cross-over in-between but no wash out period	20	SUDD pts were given a high fiber diet plus extra unprocessed bran where possible or Normacol and antispasmodic or 18g bran tablets/day.	With each treatment, all patients experienced some improvement in symptoms. Bran tablets: 60% (12/20) entirely symptom free. Normacol: 40% (8/20) entirely symptom free. High fiber diet: 20% (4/20) entirely symptom free.
Ornstein *et al* (1981)	Randomised, cross-over, double blind controlled intervention	12 months -16 weeks for each treatment period, with cross-over in-between, no wash out period.	58	SUDD pts were split into 3 treatment groups Group A: 8 bran biscuits (4.2g fiber) & placebo. Group B: Ispaghula powder (6.7g fiber) & placebo biscuits. Group C: placebo biscuits and placebo powdered drink.	Both dietary fibers reduced constipation but neither resulted in any improvement in symptoms and ispaghula increased flatulence.
Leahy *et al* (1985)	Prospective ,case-controlled intervention	54-76 months	56	SUDD pts were given a high fiber diet >25g/day or non-high roughage diet <25g/day.	High fiber diet: fewer symptoms such as pain and constipation was relieved, lower re-admission with complications and surgery compared to non-high fiber diet.
Strate *et al* (2008)	Prospective, cohort intervention	18 years	47 228	Diet, lifestyle and medical information was used to investigate the relationship between nuts, popcorn, and corn in being able to reduce diverticulitis occurrence.	No association of diverticulitis occurrence in patients consuming nuts, popcorn and corn.
Peery *et al* (2012)	Cross - sectional observational study	12 years	2104	Diet assessed to determine whether a high fiber diet and frequent bowel movements prevent diverticulosis.	A high fiber diet increased the occurrence of diverticulosis. A high fiber diet and > 7 bowel movements per week increased the risk of developing diverticula.

No.=number; pts=patients; SUDD=symptomatic uncomplicated diverticular disease; DD=diverticular disease

bran (Prewett's) per day in addition to their normal diets. The results showed that 83% (33/40) were extremely satisfied with the bran supplement, 60% of symptoms were abolished and a further 28% of symptoms were reduced. Five patients (13%) still had some form of abdominal discomfort and only a slight improvement was noticed in two of the patients (5%) at the end of the study. The bran modified the transit time to a mean of 48 hours ($p<0.006$), increased stool weight from 23g to a mean of 66g to 89g ($p<0.0002$) and reduced intraluminal pressure during ($p<0.003$) and after eating ($p<0.0001$). The authors concluded that an increased fiber intake relieved symptoms in SUDD. The study had a small sample size and it did not contain a control group, reducing the quality and evidence of the study (Brodribb & Humphreys 1976).

In a two-month randomised, crossover trial (RCT), Taylor & Duthie (1976) investigated the effect of fiber supplements in 20 patients with SUDD (Table 2.1). Three standard regimes were implemented; a HFD plus extra unprocessed bran, where possible or Normacol[3] (sterculia[4]) and an antispasmodic; or bran tablets supplying 18g bran per day. Those on the HFD were told to eat high fiber foods, were given a dietary sheet containing the information and asked to supplement their diets with unprocessed bran, where possible. The actual amount of unprocessed bran was not specified in the study. A quarter took the HFD plus unprocessed bran for one month and a quarter took Normacol plus an antispasmodic for one month. The others were given the bran tablets for a month.

Treatments were then crossed over for another month whereby those who had taken the bran tablets initially received the HFD or Normacol for a month, while the others were given the bran for a month. There was no wash out period during the study. Symptoms (degree of pain, bowel habits, distention), stool weight and transit time were measured at the start, at cross over and at the end of the study. The most effective were the bran tablets with 60% being entirely symptom free, followed by the Normacol (40%) and lastly the HFD plus unprocessed bran supplements (20%). Some improvement in symptoms was noted in all the patients within each treatment group. Stool weight had significantly increased after one month on either the bran tablets or Normacol and the transit time improved considerably in individual patients taking the bran

[3] The dosage for the Normacol was not given in the article by Taylor & Duthie (1972).

[4] Sterculia (a soluble fiber) is a vegetable gum from the karaya tree (Electronic Medicines Compendium 2016)

tablets compared to either the HFD ($p<0.001$) or Normacol ($p<0.05$). The mean transit time before treatment was 96.6 ± 7.1 hours and with bran tablets, the transit time reduced to 56.1 hours. The challenge with the Taylor and Duthie (1976) study was that it did not include a washout period therefore the impact of the various treatments was not clearly separated and could have impacted the results. Other problems with the study was that eight patients who had recently had an acute diverticulitis attack were included, the study was not double-blind and no high versus low fiber diet was assessed during the study (Taylor & Duthie 1976).

A twelve-month randomised, cross-over, double-blind controlled trial consisting of 58 patients with SUDD was conducted by Ornstein, Littlewood, Baird, Fowler, North & Cox in 1981 (Table 2.1). A self-administered questionnaire that measured patient's symptoms (abdominal pain, symptoms related to defecation, constipation, dyspepsia) was given at baseline, monthly and at the end of the study to all patients. Patients were told to follow their normal diets without including extra fiber besides that which was prescribed in the study. Two forms of dietary fiber and two placebos were used in the study. The placebos consisted of Energen wheat crispbread and a highly refined wheat powder.

Patients were divided into three treatment groups: group A took 8 bran biscuits containing 4.2g of fiber (Energen bran crispbread, an insoluble fiber) plus two sachets of placebo powder per day, group B was given eight placebo biscuits with two sachets of powdered ispaghula husk (Fybogel, a soluble fiber that consisted of 6.7g fiber) consumed daily and group C consisted of eight placebo biscuits and two sachets of placebo powder, given daily. Each treatment was taken for sixteen weeks and all patients were subsequently treated to the three treatment periods with a cross-over period that neither the patient nor the physician was aware of. No wash out period was given between treatments. The study found that neither of the dietary fiber supplements had any effect besides reducing constipation ($p<0.01$) although ispaghula resulted in increased flatulence ($p<0.05$). Although Ornstein *et al* (1981) believed that the use of fiber supplements in those with constipation may be helpful for the management of overall patient symptoms, fiber supplements may not be required in the long-term management of SUDD.

In comparison to Ornstein *et al* (1981) study, Painter et al (1972), Brodribb & Humphreys (1976) and Taylor & Duthie (1976), all showed a positive outcome in reducing or eradicating over 60% of symptoms (dyspeptic, abdominal pain, symptoms related to defecation, constipation) in most SUDD patients receiving a HFD and/or a bran supplement on a daily basis. The fiber intake in these three studies (Painter et al 1972; Brodribb & Humphreys 1976; Taylor & Duthie 1976) was three to six times higher than that prescribed by Ornstein *et al* (1981). Taylor & Duthie (1976) supplemented for a shorter period of time compared to Ornstein *et al* (1981) and still managed to show a significant reduction in symptoms from the higher bran supplement. Ornstein *et al* (1981) had the strongest study design however it did lack a wash out period, as did Taylor & Duthie (1976), reducing the efficacy of their results.

Leahy, Ellis, Quill & Peel (1985) prospective, case-controlled study assessed 56 SUDD patients who were allocated to a HFD (>25g/day) group (31/56) or non-HFD (<25g/day) group (25/56) (Table 2.1). An average follow-up for the HFD group was 54 months and 76 months in the non-HFD group. A medical and dietetic staff member counselled those on the HFD and each was supplied with a booklet recommending a minimum intake of 25g of fiber per day. Those on a HFD experienced fewer symptoms (19%, 6/31) such as abdominal pain and altered bowel habits (constipation) in contrast to those on the non-HFD (44%, 11/25) ($p<0.05$). There was a significantly lower rate of re-admission with complications and surgery (2/56 for the HFD versus 8/56 for the non-HFD group) ($p<0.05$).

Leahy *et al* (1985) concluded that a HFD favouring 20-25g/day dietary fiber reduced symptoms, constipation and those on a HFD were less likely to develop complications or require surgery. This was different to Ornstein *el al* (1981) study whereby a HFD was only seen to reduce constipation and no other symptoms although, the time frame for fiber supplementation in Ornstein *et al* (1981) study (16 weeks per treatment group) was much shorter than Leahy *et al* (1985) study (54-76 months). The problem with Leahy *et al* (1985) study is that it measured the HFD (54 month) 24 months earlier to the non-HFD (76 months), which may have resulted in discrepancies when assessing the data and the study size was small.

In 2008, Strate *et al* conducted a cohort prospective observational study investigating the consumption of nuts, popcorn and corn in 47 228 United States male health professionals aged 40 to 75 years (Table 2.1). Excluded from the study were men that had irritable bowel disease (IBD), cancer other than non-melanoma cancer and those with already existing diverticulosis or DD. A self-administered semi quantitative, validated food frequency questionnaire as well as a lifestyle and medical history questionnaire was sent out to the men at baseline and then every four years. Within the eighteen-year follow-up study, 801 incidences of diverticulitis (1.7%) and 383 incidents (0.8%) of diverticular bleeding were recorded. The study found no association with diverticulitis and diverticular bleeding in patients with diverticulosis who consumed nut, popcorn and corn during that time. The consumption of a higher amount of nuts, popcorn and corn lowered the risk of diverticulitis occurrence ($p=0.034$) and according to Strate *et al* (2008), these foods do not invoke diverticular complications and should not be avoided in DD. It has been assumed in the past that these foods may provoke symptoms in DD patients and lead to diverticulitis (Painter 1982) although Strate *et al* (2008) prospective study appears to demonstrate otherwise. The short fall of Strate *et al* (2008) study is that it looked at men with a mean age of between 40-75, it did not assess woman and symptoms such as abdominal pain, abdominal discomfort and constipation were not measured.

Peery *et al* (2012) conducted a cross-sectional, observational study over a twelve-year period on 2104 asymptomatic diverticulosis participants between the ages of 30-80 years whereby the diet was assessed using the Block Diet History food frequency questionnaire which looked at 100 food items (Table 2.1). The results showed that a mixed HFD including high grain fiber, insoluble fiber and soluble fiber had an increased rather than a decreased prevalence of diverticula occurrence ($p=0.004$) and more frequent bowel movements (greater than 7 per week) increased the risk of diverticulosis ($p<0.001$). Constipation is thought to increase the risk of developing diverticulosis but a reduction in stool movement in Peery *et al* (2012) study showed the opposite response. Tursi (2010) and Peery *et al* (2012) both mentioned that diverticulosis could lead to complications and increase morbidity. Most of the studies mentioned in Table 1 (Painter *et al* 1972; Brodribb & Humphreys 1976; Taylor & Duthie 1976; Ornstein *et al* 1981; Leahy *et al* 1985;) provided evidence that a HFD reduces abdominal symptoms and/or constipation in SUDD patients whereas Peery *et al* (2012) study presented otherwise.

In a systematic review by Ünlü *et al* (2012), the treatment of SUDD with the inclusion of a HFD was reviewed. Studies that did not have a control group were excluded. Out of the thirteen studies, only four met the inclusion criteria (Ünlü *et al* 2012), two of which have been previously discussed (Ornstein *et al* 1981; Leahy *et al* 1985). A mix of fiber supplements was used including bran crisp bread (6.7g/day; Brodribb[5] 1977), bran (4.2g/day) and ispaghula (6.7g/day) (Ornstein *et al* 1981), methylcellulose (1 g/day; Hodgson[6] 1977) and a HFD (25g fiber/day) (Leahy *et al* 1985). The conclusion stated that inconsistent results were obtained in the studies by Brodribb (1977), Ornstein *et al (*1981) and Hodgson's (1977) and that the studies had small sample sizes. Most of the evidence was inconsistent level two and level three evidence, therefore high quality evidence was lacking when recommending a HFD diet in the treatment of SUDD (Ünlü *et al* 2012)[7].

A more recent review which assessed fiber intake in diverticulosis and SUDD by Elisei & Tursi (2016) included the three RCT studies found in the Ünlü *et al* (2012) review as well as the three prospective cohort studies by Leahy *et al* (1985); Strate *et al* (2008), Crowe *et al* (2014*)* and the cross-sectional study conducted by Peery *et al* (2012). In contrast to Ünlü *et al* (2012), Elisei & Tursi (2016) concluded that there was adequate quality controlled studies to advise using a HFD in SUDD. However, Crowe *et al* (2014) and Strate *et al* (2008) prospective studies did not measure a range of symptoms in patients (dyspeptic, abdominal pain, symptoms related to defecations) and yet they had been compared with other research on the use of SUDD. The two reviews came to two different conclusions, one using more rigorous and controlled studies with a control group (Ünlü *et al* 2012), while the other included prospective studies (Elisei & Tursi 2016). Ünlü *et al* (2012) did point out that epidemiological and observational studies are confounding as they lack recent evidence on the prevalence of DD in different populations. Strate *et al* (2008) relied heavily on association which was different to causation when analysing research and should be viewed with caution in epidemiological studies (Geneva Foundation for Medical Education and Research 2016). Depending on the interpretation of the available

[5] The following journal article was unobtainable: Brodribb, A.J. (1977). Treatment of diverticular disease with a high fiber diet. Lancet 1:664-666.

[6] The following journal article was unobtainable: Hodgson, W.J. (1977). The placebo effect. Is it important in diverticular disease. American Journal of Gastroenterology 67(2): 157-162.

[7] Level 1 evidence is based on high quality evidence such as randomised controlled trials (RCT) (Practicing Chiropractors' Committee on Radiology Protocols 2006; Song & Chung 2010, Andersen *et al* 2011).

evidence, there seems to be controversy as to whether a HFD and/or fiber supplements are the best form of treatment in SUDD.

The evidence supporting the prescription of insoluble fiber from nuts, popcorn and corn appears to be mostly based on the study by Strate *et al* (2008). Tursi (2013) expressed concern as to how one study could have had such an impact on most of the research presented in the current literature and how based on this one study, many reviews and ICCG have advocated the use of these types of insoluble fiber foods.

The anecdotal evidence and experience of both patients and medical community cannot be overlooked. Strate *et al* (2008) citing Schechter, Mulvey & Eisenstat (1999) [8] found that approximately 47% of colorectal surgeons believed that avoiding nuts, corn and popcorn were of importance as these foods might incite diverticulosis complications.

Anecdotal evidence from dietitians in practice and from patients support groups have suggested that some are sensitive to certain insoluble fiber rich foods, such as whole meal bread, nuts, fruit, shredded coconut and generally following a HFD (National Health Service 2015; Thompson 2016). Patient's comments posted on the NHS site strongly stated that their symptoms were much worse since including certain trigger foods such as insoluble fiber, nuts, popcorn and that they were returning to the old approach (National Health Service 2015).

The idea that one approach fits all seems to be lacking in scientific evidence and requires further investigation. This is why the current study is important as it may provide a more accurate idea of what dietitians are currently prescribing compared to the ICCG. It also helps to clarify based on practical experience, whether certain trigger foods and/or fiber supplements and/or a HFD are beneficial in reducing SUDD in clinical practice.

Insoluble and soluble fiber may play an additional role as a prebiotic stimulating the growth of probiotics and positively manipulating the gut microbiota.

[8] The following article was unobtainable: Schechter, S., Mulvey, J. & Eisenstat, T.E. (1999). Management of uncomplicated acute diverticulitis: Results of a survey. Dis Colon Rectum 42:470-475.

2.6 GUT MICROBIOTA

2.6.1 Microbiota in the healthy individual

Microbiota are compounds that are able to produce vital nutrients (Silva, Carneiro, dos Anjos Pultz, Pereira Silva, Lopes & dos Santos 2015) in the gut. These microbiotas have a symbiotic relationship in the gut, providing homeostasis between the residing host and the microbes (Silva *et al* 2015). The colon is home to a large complex community of bacteria and greater than 95% of the two most prominent bacterial phyla are *Bacteroides* and *Firmicutes* (Silva *et al* 2015; Daniels, Budding, de Korte, Eck, Bogaards, Stockmann, Consten, Savelkoul & Boermeester 2014). Other common bacteria phyla include *Actinobacteria, Fusobacteria, Verrucomicrobia* and *Proteobacteria* (Silva *et al* 2015).

2.6.2 Microbiota in diverticular disease

Increased bacterial populations of certain phyla, such as *Escherichia (Proteobacteria), Clostridium (Firmicutes),* and *Bacteroides* have been identified in patients with uncomplicated DD (Pietrzak *et al* 2013*)*. A dysbiosis of these bacteria and other *Proteobacteria* may cause a negative shift in the microbiota composition in DD which may in turn, stimulate inflammation of the diverticulum causing diverticulitis (Pietrzak *et al* 2013*;* Daniels *et al* 2014).

In a multi-center RCT, faecal microbiota had been analysed using deoxyribonucleic acid (DNA) extraction obtained from rectal swabs, taken from 31 patients with uncomplicated acute diverticulitis (mean age of 58 years) and 25 controls (mean age of 53 years) (Daniels *et al* 2014). The results showed that the *Firmicutes/Bacteroidetes* ratio were similar in the patient and the control group. This indicates that there was no dysbiosis between these two phyla as the *Firmicutes/Bacteroidetes* ratio is used as an indicator of gut microbiota dysbiosis (Daniels *et al* 2014). A higher diversity of faecal microbiota, however, was noted in the DD versus the control group. *Proteobacteria,* gram-negative bacteria that are more prevalent in disease conditions (Kelly & Mulder 2012) and able to increase intestinal mucosal inflammation, were found to be

more prevalent in DD compared to the control group (Daniels *et al* 2014; Goel, Gupta & Aggarwal 2014).

Inflammation is thought to be implicated in DD as microbial changes may cause disturbances on the tissue and mucous membranes surrounding the diverticuli, causing proliferation of inflammatory cytokines, which in turn can create a chronic inflammatory effect (Sheth & Floch 2009; Tursi 2010; Pietrzak *et al* 2013). The increased release of inflammatory cytokines, colonic bacterial overgrowth, mucous secretion and impaired mucosal barrier function may result from the diverticula being exposed to faecal stasis (Sheth & Floch 2009). Faecal stasis may cause distention and erosion in the colon, enabling bacterial translocation and eventual perforation (Figure 2.2) (Janes *et al* 2006; Sheth & Floch 2009; Pietrzak *et al* 2013).

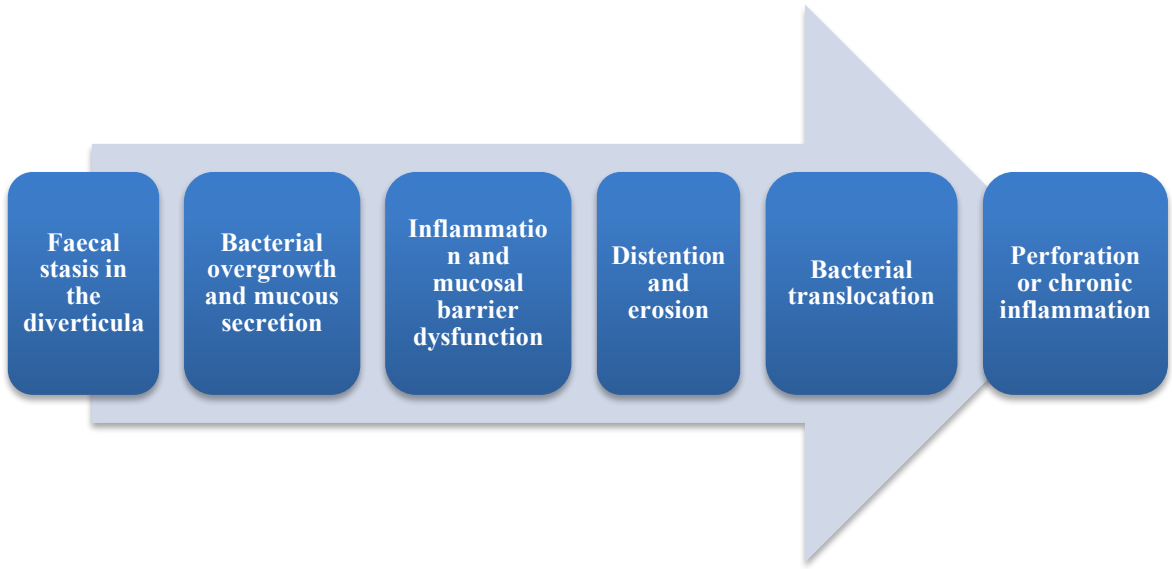

Figure 2.2: Faecal obstruction leading to inflammation, bacterial translocation and perforation

Altered microbiota, low levels of inflammation and altered mucosal defences in diverticulosis may predispose patients to acute diverticulitis (Sheth & Floch 2009). Manipulation of the gut flora with viable probiotic bacteria has been proposed as a therapeutic option in the treatment of SUDD (Lamiki *et al* 2010).

2.7 PROBIOTICS

Probiotics are live organisms that have a positive impact on the health of the host (Sheth & Floch 2009) by successfully competing with other microbes, thus preventing their growth or that of other pro-inflammatory organisms (Lamiki *et al* 2010) (Figure 2.3). Probiotics help to provide a mucosal defence on the epithelial lining thereby limiting or inhibiting translocation and adherence of pathogens (Lamiki *et al* 2010). Probiotics also improve immune function and reduce concentrations of pro-inflammatory cytokines such as interleukin 1 (IL-1), tumour necrosis factor-alpha and interferon gamma (Tursi *et al* 2007; Lamiki *et al* 2010; Quigley 2010; Verna & Lucak 2010). Some probiotics produce certain agents that are able to kill or inhibit the growth of certain microorganisms which may be as effective as antibiotics (Lamiki *et al* 2010). Antibiotics, frequently used in the treatment of SUDD, do not offer the additional benefits of gut homeostasis, pH alteration and suppression of pro-inflammatory cytokines (Figure 2.3) (Lamiki *et al* 2010; Narula & Marshall 2010).

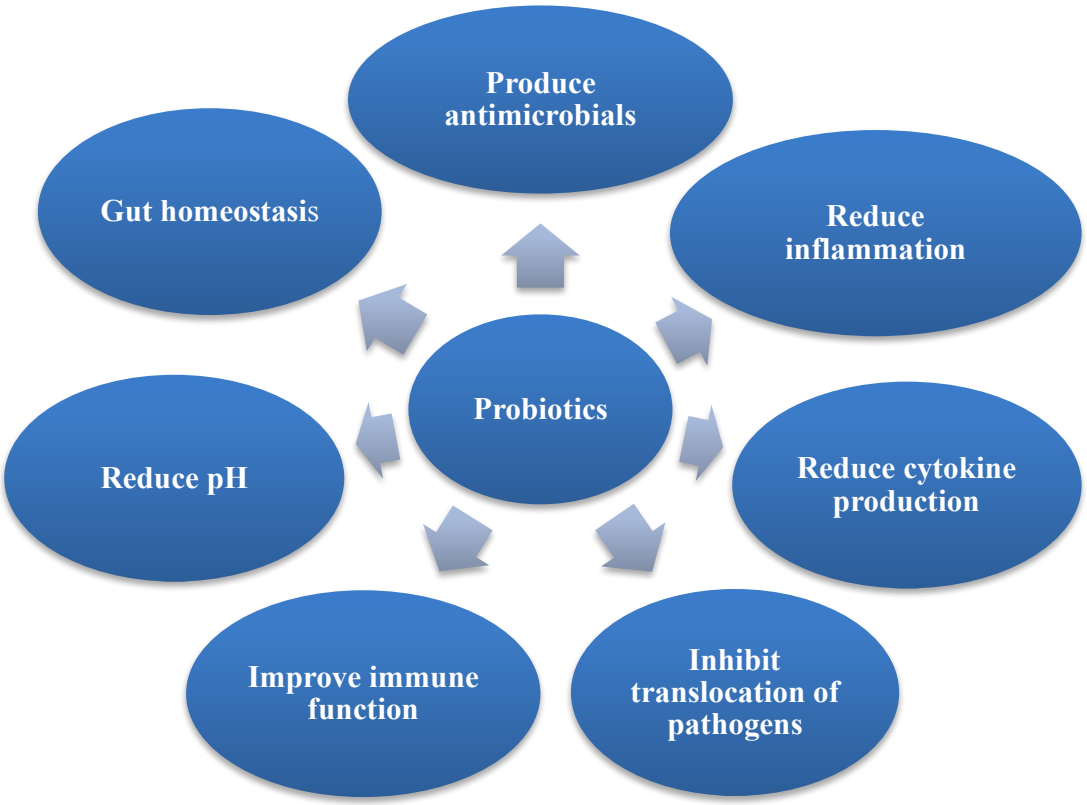

Figure 2.3: The beneficial effects of probiotics

Certain probiotic strains such as *Lactobacillus* and *Bifidobacteria* stimulate the immune system and decrease intestinal pH by releasing SCFA (acetate, butyrate and propionate) which in turn inhibits the growth of certain pathogens (Anderson *et al* 2009; Slavin 2013; Goel *et al* 2014; Silva *et al* 2015). Short chain fatty acids are found in the distal colon, a common site affected by DD and are able to enhance epithelial barrier function, enable epithelial restoration and are an important fuel source for the colon (Aldoori *et al* 1998; Goel *et al* 2014).

2.7.1 Use of probiotics in the treatment of diverticular disease

Probiotics have been investigated for microbial interface treatment as an alternative or adjunct for antibiotic use in SUDD. Gram negative flora are usually treated by antibiotic use in DD patients but probiotic bacteria are able to regulate certain enteric pathogens (Bengmark 1998). Current research in SUDD has investigated antibiotics, probiotics or a mixture of both (Lamiki *et al* 2010; Narula & Marshall 2010).

Frič & Zavoral (2003) presented the first prospective, nonrandomized, open-labelled pilot study which investigated antimicrobial and probiotic use in fifteen SUDD patients who experienced abdominal discomfort (Table 2.2). The pilot study used dichlorchinolinol (an antimicrobial) and an absorbent (active coal tablet) for a week in treatment group one (T1). When the T1 group experienced a relapse in symptoms, the same antimicrobial and absorbent were administered again to the same T1 group. In addition, a probiotic called *Escherichia coli* Nissle 1917 ($2.5x10^{10}$ viable bacteria in capsule form) was administered for a further five weeks and two days, creating treatment group two (T2). One probiotic capsule was given daily on days one to four and two capsules daily from day five. Eight out of fifteen patients (T2) were symptom free at the end of the study and a significant decrease of all symptoms was observed with probiotic use ($p<0.001$). The remission rate was much longer in those administered probiotics (14.1 months) versus patients who received the antimicrobial and an absorbent (2.4 months) ($p<0.001$). The study did not include a probiotic only treatment group, the sample size was small and the study was not blinded, lowering the efficacy of the results (Frič & Zavoral 2003).

A multi-center, prospective, randomised, open-label study by Tursi *et al* (2006) evaluated the use of *Lactobacillus casei* subsp. *DG* with or without the use of mesalazine (an amino salicylate anti-inflammatory drug) in SUDD patients (Table 2.2). *Lactobacillus casei* subsp. *DG* was chosen for its high antimicrobial effect, especially against gram negative bacteria such as *Helicobacter pylori* and its ability to improve and maintain human intestinal colonization (Tursi *et al* 2006). Eighty five patients took part in the twelve month study and were divided into three groups; the M group was given 1.6 g mesalazine per day, the L group was given two capsules daily each containing *Lactobacillus casei* subsp. *DG* (8 by 10^9 viable lyophilized bacteria) plus a vitamin cocktail (Vitamin B1, B2, B6) for fifteen days per month and the LM group were given mesalazine 1.6 grams per day plus 16 by 10^9 *Lactobacillus casei* subsp. *DG* for fifteen days per month. There was no reason given for the fifteen-day implementation of mesalazine, probiotic and the cocktail vitamin mix; dietary intervention was also not provided. Symptoms such as constipation, diarrhoea, abdominal pain, rectal bleeding and mucus with the stools were evaluated on enrolment and at the end of the first, second, ninth and twelfth month. The results showed that 76.7% in both group M and Group L ($p<0.001$) were symptom free, hence, the probiotic with the vitamin cocktail was as effective as the medication. In the LM group, 96% were symptom free therefore the probiotic in combination with the medication as well as the probiotic with the vitamin cocktail appeared to have had a synergistic effect. There was a statistical significance obtained from group LM versus group L and group M ($p<0.05$). The Tursi *et al* (2006) study concluded that both mesalazine and probiotics seemed to have a beneficial effect in preventing the recurrence of SUDD. The results, however, were not directly comparable as the study did not contain solely a probiotic group, making it difficult to distinguish which factor (vitamin cocktail, mesalazine, probiotic) played a significant role in reducing symptoms. In addition, the study was not blinded, weakening the outcome (Tursi *et al* 2006).

An open label, randomised study by Tursi *et al.* (2007) compared the efficacy of probiotics versus balsalazide[9] and rifaximin (antibiotic) versus probiotics in 30 SUDD patients with a mean age of 60.1 years, over a twelve-month period (Table 2.2). Group A was given 2.25 g balsalazide and 800 mg rifaximin initially for ten days, followed by 2.25 g balsalazide for ten days plus VSL#3 (*Lactobacillus plantarum DSM 24730, Lactobacillus acidophilus DSM 24735, Lactobaci-*

[9] An anti-inflammatory drug converted to mesalazine in the body

Table 2.2: Studies using probiotics in symptomatic uncomplicated diverticular disease

Author Year	Type of study	No. of pts	Probiotics strain	Interventions & follow up	Measured outcomes	Efficacy of intervention
Frič & Zavoral (2003)	Prospective, non-randomised, open-label pilot study	15	*Escherichia coli* Nissle 1917	T1: dichlorchinolinol and active coal tablet for 1 week. T2: dichlorchinolinol for 1 week and active coal tablet and probiotic daily. 5.2 weeks treatment	Remission rate in SUDD patients	T2: 8/15 symptom free. T2: 14.1 months remission rate compared to 2.4 months in T1 group.
Tursi *et al* (2006)	Multicentre, prospective, randomised, open-label study	85	*Lactobacillus casei* subsp. *DG*	M group: mesalazine 1.6 g/day. L group: probiotic 15 days/month plus vitamin cocktail. LM group: mesalazine 1.6 g/day and probiotic for 15 days/month. 12-month treatment	Remission of abdominal symptoms in SUDD patients	M group: 76.7% (23/29) symptom free. L-group: 76.6% (23/29) symptom free. LM group: 100% symptom free (29/29).
Tursi *et al* (2007)	Open label, randomised study	30	VSL #3	A Group: balsalazide 2.25g and 800 mg rifaximin for 10 days/month then followed by balsalazide 2.25g for 10 day/month plus probiotics for 15 days/month for 12 months. B Group: balsalazide 2.25g & 800 mg rifaximin for first 10 days then for 15 days/month probiotics for 12 months. 12-month treatment	Remission of abdominal symptoms in SUDD patients	Group A:73.3% symptom free (11/15). Group B: 60% (8/15) symptom free.
Lamiki *et al* (2010)	Prospective, randomised, open-label study	46	*Lactobacillus acidophilus* 145 *Lactobacillus helveticus* ATC 15009, *Bifidobacterium* spp. 420	Probiotics, prebiotic and phytoextract three times daily. 6-month treatment	Reduction of abdominal symptoms	68% (31/46) symptom free.

Lahner *et al* (2012)	Randomized, controlled, parallel-group study	44	*Lactobacillus paracasei B21060*	Group A: High fiber diet (>30g/day) and 1 sachet Flortec© /day Group B: High fiber diet (>30g/day). 6-month treatment	Abdominal symptoms reduced	Group A: 30 % reduction in abdominal bloating. Group A & B: significant reduction in abdominal pain.
Tursi et al (2013)	Multi-center, randomised, double-blind, double-dummy, parallel group, placebo - controlled study	210	*Lactobacillus casei* subsp. *DG*	M group: active mesalazine 1.6 g/day and a probiotic placebo for 10 days/month. L group: mesalazine placebo and active probiotic for 10 days/month. LM group: active mesalazine 1.6 g/day and active probiotic for 10 days/month. P group: mesalazine placebo & probiotic placebo for 10 days/month. 12-month treatment	Recurrence of SUDD Acute diverticuli-tis	M group: 13.7% (7/51) L group: 14.5% (8/55) LM group: 0% (54/54) P group: 46% (23/50) P group: 12 % (6/50) L group: 1.8% (1/55)

No.=Number; pts=patients; SUDD= symptomatic uncomplicated diverticular disease

llus paracasei DSM 24733, Lactobacillus delbrueckii subsp. *bulgaricus DSM 24734, Bifidobacterium longum DSM 24736, Bifidobacterium breve DSM 24732, Bifidobacterium infantis DSM 24737, Streptococcus thermophiles DSM* 24731) 450 by 10^9 per day for fifteen days, every month for twelve months. Group B was primarily prescribed 2.25 g balsalazide and 800 mg rifaximin for ten days, followed by VSL#3 probiotic, 450 by 10^9 per day for fifteen days every month over a twelve-month period. Intensity of symptoms was assessed during the study. Rifaximin was used as it is effective against Gram-negative and Gram-positive bacteria, both aerobic and anaerobic as well as being an appropriate and effective antibiotic that is used in the treatment of SUDD (Tursi 2010; Elisei & Tursi 2016). Symptoms included bloating, upper and/or lower abdominal pain, constipation, diarrhoea, rectal bleeding, mucous in the stools, abdominal tenderness and tenesmus. In group A, 73.3% (11/15) (95% CI per-protocol: 55-92%; on intention-to-treat: 47%-87%) were symptom free, which was statistically significant compared to 60% (8/15) (95% CI per-protocol: 44-81%; on intention-to-treat: 39-76%) in group B. This showed that the combination therapy (monthly treatment of anti-inflammatory and probiotics) was more effective than monthly probiotics given alone. Although there was no control group

(probiotics intervention only) in the study, monthly probiotic use after the initial intake of balsalazide and rifaximin, was effective and did show a significant reduction in symptoms without the use of a monthly anti-inflammatory. Tursi *et al* (2007) concluded that mucosal inflammation is suppressed in SUDD patients when using either probiotics and/or balsalazide/rifaximin. A limitation of Tursi *et al* (2007) study was that it did not contain a control group and it was not blinded, weakening the study results.

Lamiki *et al* (2010) conducted a prospective, randomised, open-labelled study in 46 patients suffering from SUDD (Table 2.2). The symptoms assessed were constipation, diarrhoea and abdominal pain. All patients were asymptomatic at the start and no dietary advice was given. The patients were advised to take 10 ml of a symbiotic mixture three times a day. A 30 ml symbiotic mixture contained: *Lactobacillus acidophilus* 145 (3.75 by 10^5) *Lactobacillus helveticus* ATC 15009 (3.9 by 10^8), *Bifidobacterium* spp. 420 (1.485 by 10^9) mixed with enriched phytoextracts[10] (27.3g) over a six-month period. The study showed that the symbiotic mixture was effective in preventing the recurrence of SUDD in 68.0% (31/46 patients), reducing constipation and having a positive effect on the gut flora (Lamiki *et al* 2009). There was no control group in the study design, making it difficult to determine whether the probiotic or the phytoextract created the positive effect. The difference in the reduction of symptoms between the balsalazide and probiotic study (Tursi *et al* 2007), versus the probiotic and phytoextract study (Lamiki *et al* 2010) was marginal, 73.3% (11/15) and 68% (31/46) respectively.

Sheth and Floch (2009) reviewed 4 studies (Frič & Zavoral 2003; Tursi *et al* 2006; Tursi *et al* 2007; Giaccarci, Tronci, Falconieri & Ferrieri 1993[11]), to determine the efficacy of probiotic use in the treatment of DD. They concluded that as the studies were small, and combined with other therapies, the impact of probiotics in the treatment of SUDD was unclear, however, probiotics may be an effective management tool to help reduce diverticular inflammation. Sheth & Floch (2009) recommended that RCT were needed before probiotics could be recommended in the treatment of SUDD.

[10] Consisted of a prebiotic phytoextract mix of vaccinium myrtillus, ribes nigrum, urtica dioica, taraxacum officinalis leaves and roots, equinacea purpurea leaves and roots, daucus carota in the amounts of 82g/100 ml.

[11] The original study by Giaccarci *et al* (1993) could not be obtained and has been cited (Sheth & Floch 2009). The other three studies in the review have been discussed.

A more comprehensive and sophisticated study design was presented by Lahner, Esposito, Zullo, Hassan, Cannaviello, Paolo, Pallotta, Garbagna, Grossi & Annibale in 2012. In a randomised, controlled, parallel-group study, the effects of a HFD and a symbiotic containing *Lactobacillus paracasei B21060* were assessed in 44 SUDD patients over a six-month period (Table 2.2). Group A (24/44) received the HFD (>30 g per day) and 1 sachet of Flortec©**.** This symbiotic preparation consisted of 5 by 10^9 *Lactobacillus paracasei B21060,* 500mg glutamine, 700 mg xylooligosaccharides[12] (XOS) and 1243 mg arabinogalactone[13]. Group B (21/44) was only treated with the HFD (>30 g per day). Dietary counselling and an information sheet were issued regarding the dietary fiber contents of foods including vegetables, fruits and cereals. During the seven days before the study took place, patients had to record their daily fiber intake. A maximum of four points was given: one point for the intake of vegetables, a point for the intake of whole grain cereals at lunch, another point for whole grain cereals at dinner and a point for an intake of fruit. To verify compliance to the HFD a clinical interview was done at entry and at three months and six months. Abdominal pain lasting less than 24 hours, abdominal pain lasting greater than 24 hours and abdominal bloating were also measured at baseline and at three months and at six months.

Statistically, there was no difference between dietary fiber intake score in both of the groups (group A: 13.3 ± 7.3 *vs* group B: 16.0 ± 9.1) at the end of the six-month study. A significant reduction (30%) in abdominal bloating was noted in the symbiotic treatment group A ($p=0.005$) and no significant changes were observed in group B ($p=0.11$). Group A (75%) showed a significant reduction in abdominal pain lasting less than 24 hours ($p<0.001$) as well as group B who presented with a 52.4% reduction ($p=0.001$). Group A (55%) had a higher reduction in abdominal pain lasting greater than 24 hours ($p<0.001$) compared to group B (23.8%) ($p=0.03$), giving an indication that a HFD in addition to a symbiotic preparation is more beneficial in reducing symptoms in SUDD patients. In group B (HFD), the onset of new abdominal symptoms had developed in three patients, one had prolonged abdominal pain and the other two suffered from abdominal bloating compared to the Flortec© group, who had not developed any new symptoms. Lahner *et al* (2012) concluded that a HFD was effective in relieving abdominal pain

[12] Xylo-oligosaccharides is a mixture of oligosaccharides and xylose residues which acts as a prebiotic in the colon (Aachary & Prapulla 2010).

[13] Arabinogalactan is a polysaccharide which acts as a prebiotic in the GIT (Kelly 1999).

in most patients and combining a HFD with a symbiotic preparation such as Flortec©, showed a significant reduction in abdominal bloating and abdominal pain in SUDD patients. Once again, the use of a synergist complex versus the use of probiotics alone had not been assessed in the Lahner *et al* (2012) study, raising the question as to which component in the study (probiotic, glutamine, XOS or arabinogalactone) actually made the overall difference.

Tursi, Brandimarte, Elisei, Picchio, Forti, Pianese, Rodino, D'Amico, Sacca, Portincasa, Capezzuto, Lattanzio, Spadaccini, Fiorella, Polimeni, Polimeni, Stoppino, V., Stoppino, G., Giorgetti, Aiello & Danese (2013) conducted a multi-center, randomised, parallel-group, double-dummy, double-blind, placebo-controlled study based on the pilot study by Tursi *et al* (2006) (Table 2.2). Tursi *et al* (2013) replicated the previous study using the same dosage of mesalazine with or without the same amount of *Lactobacillus casei* subsp. *DG*, given over ten days per month rather than fifteen days per month. The study also included a placebo arm (Tursi *et al* 2013). A total of 210 SUDD patients were randomised to four groups (Table 2.2). Group M was prescribed 1.6 g of active mesalazine per day and a probiotic placebo. Group L was given mesalazine placebo and active probiotic i.e. *Lactobacillus casei* subsp. *DG* (24 by 10^9 lyophilized bacteria). Group LM was prescribed 1.6 g of active mesalazine per day and the active probiotic (24 by 10^9 lyophilized bacteria) and lastly, the P group was asked to take mesalazine placebo and probiotic placebo. Each group took their allocated treatment for ten days per month over the twelve-month period. No dietary interventions were implemented during the study. Remission of previous SUDD episodes[14] was the primary endpoint of the study.

None of LM group experienced recurrence of SUDD symptoms although recurrence occurred in 7 patients in the M group (13.7%; 7/51), 8 patients in the L group (14.5%; 8/55), and lastly 23 patients in the P group (46.0%; 23/50) (LM group versus M group, P=0.015; LM group versus L group, P=0.011; LM group versus P group, P=0.000). Recurrence of diverticulitis occurred in 12.0% (6/50) of the P group and in only 1.8% (1/55) of the L Group (P=0.003). The other two groups (LM and M) did not experience a recurrence of diverticulitis. Tursi *et al* (2013) concluded that taking a probiotic or mesalazine alone, or in combination is significantly better

[14] Defined by Tursi *et al.* 2013 as "the absence of recurring abdominal pain scored ≥ 5 for at least 24 consecutive hours and recorded at any time of the follow up".

than a placebo in preventing the occurrence of diverticulitis in SUDD patients. The results from Tursi *et al* (2013) were very similar to Tursi *et al* (2006) though a placebo group was added to Tursi *et al* (2013) to strengthen the results and allowed for better comparison between the groups. The use of the probiotic and vitamin cocktail mix in Tursi *et al* (2006) study and the use of the probiotic alone in Tursi *et al* (2013) study, seemed to provide evidence that the probiotics was in fact, the main driver for reducing the recurrence of SUDD symptoms and not the vitamin cocktail.

The review by Guslandi (2013)[15] emphasized that not all probiotics are alike and that the type of probiotic needs to be tested separately to understand the suitability of probiotic use in SUDD patients. Although, the conclusion of the 2016[16] systematic review by Lahner, Bellisario, Hassan, Zullo, Esposito & Annibale stated that the paucity of high-quality data for the use of probiotics in the treatment of SUDD do not allow firm recommendations to be made, single controlled studies seemed to show an improvement in the reduction of symptoms (Lahner *et al* 2016).

As probiotics may potentially be beneficial in the treatment of SUDD and prebiotics enhance the growth and survival of probiotics, prebiotics may play a role in treatment of SUDD (Anderson *et al* 2009; Lahner *et al* 2016).

2.8 PREBIOTIC EFFECT ON GUT MICROBIOTA

Prebiotics are non-digestible, fermentable food ingredients or substances that are able to stimulate the growth and/or activity of beneficial microbiota in the colon, thereby providing a healthy environment for the host (Slavin 2013). Slavin (2013) stated that "although all prebiotics are fiber, not all fiber is prebiotic". Prebiotics and probiotics are also known as "functional foods"

[15] Which included most of the studies discussed in this literature review (Frič & Zavoral 2003; Tursi *et al.* 2006; Tursi *et al.* 2007; Lamiki *et al.* 2009; Lahner *et al.* 2012; Tursi *et al.* 2013) except for Stollman, Mogowan, Shanahan & Quigley's (2013) study.

[16] Which included most of the studies discussed in this literature review (Frič & Zavoral 2003; Tursi *et al.* 2006; Tursi *et al.* 2007; Lamiki *et al.* 2010; Lahner *et al.* 2012; Tursi *et al.* 2013) except for the following that were unobtainable: Giaccarci, Tronci, Falconieri & Ferrieri (1993); Tursi, Brandimarte, Giorgetti & Elisei (2005); Tursi, Brandimarte, Giorgetti & Elisei (2008); Annibale, Maconi, Lahner, De Giorgi & Cuomo (2011); Stollman, Mogowan, Shanahan & Quigley's (2013).

that when administered, create a specific result, exert a metabolic effect or have an ability to change the host's metabolism (Floch & Hong-Curtiss 2002).

Common prebiotics used to initiate microbiota growth, mainly of *Bifidobacteria* and less often *Lactobacillus* (Slavin 2013), include soluble fibers such as inulin, GOS, FOS, wheat dextrin, acacia gum and psyllium (ispaghula) (Slavin 2013; Elisei & Tursi 2016). Prebiotics, such as inulin and FOS, naturally occur in certain foods such as soybeans, leeks, chicory, oats, onion, artichokes, wheat, bananas, asparagus and garlic (Ten Bruggencate, Bovee-Oudenhoven, Lettink-Wissink, Katan & van der Meer 2006; Slavin 2013). Some insoluble fibers (wheat bran, whole grain corn) are also fermented to a small degree in the colon and therefore may have an effect on SCFA production, thereby acting as a prebiotic (Aldoori *et al* 1998). Dietary fiber and prebiotics are able to both preserve the natural microflora and may enhance probiotic use (Floch & Hong-Curtiss 2002).

Crowe *et al* (2014) and Lamiki *et al* (2010) discussed the ability to manipulate prebiotics gut flora in a way that may play an important role in reducing or improving SUDD, and overall DD. The review by Park & Floch (2007) stated that there were no significant studies investigating the use of prebiotics in DD, although they mentioned that certain studies (Painter 1972, Findlay[17] *et al* 1974 and Taylor & Duthie 1976), supported the use of dietary fiber (bran tablets, unprocessed bran, high fiber diet) in reducing symptoms in symptomatic DD. The role of dietary fiber in SUDD has been reviewed earlier. In summary, Brodribb and Humphreys (1976) found that a high wheat bran intake showed a reduction in symptoms in DD patients (Table 2.1). Ünlü *et al* (2012) and Elisei & Tursi (2016) reviews arrived at a conflicting conclusion regarding the use of a HFD. Ünlü *et al* (2012) stated that the evidence for a HFD was weak whereas Elisei & Tursi (2016) concluded that even though there was inconsistent evidence, a HFD was still recommended. Lahner *et al (*2012) found that a symbiotic preparation of prebiotics and probiotics (Flortec©) resulted in a good therapeutic response in SUDD patients. The effects, however, could be credited to either the prebiotic, the probiotic or the HFD (Lahner *et al* 2012).

[17] The following journal article was unobtainable: Findlay, J.M., Mitchell, W.D., Smith, A.N., Anderson, A.J & Eastwood, M.A. (1974). Effects of unprocessed bran on colon function in normal subjects and in diverticular disease. **Lancet** 1 (7849): 146 - 149.

2.9 CONCLUSION

Over two-thirds of the Westernized elderly population have DD (Guslandi 2013) and approximately 20% develop symptomatic DD (Elisei & Tursi 2016). The ICCG has recommended a HFD even though the level of good quality evidence presented in the literature was lacking and none provided the actual amount of fiber that constituted a HFD. Supplementing with fiber was also controversial as only two Consensus Guidelines promoted their use while the others either found them to be controversial, or did not promote their use at all. Some of the studies showed a reduction of symptoms when SUDD patients were fed bran fiber supplements and/or a HFD, however, most of the studies had a small sample size, many did not have a control group and most lacked level one evidence. A few studies had noted that a small percentage of patients were unable to supplement with unprocessed bran as the bran caused more abdominal discomfort (Painter *et al* 1972; Brodribb & Humphreys 1976).

Probiotics are important for gut homeostasis, reducing inflammation and preventing bacterial translocation. The use of certain probiotic strains in SUDD such as *Escherichia coli* Nissle, *L. acidophilus* 145, *L. helveticus* ATC 15009, *Bifidobacterium* spp. 420, *L. casei subsp. DG*, VSL #3 (*Lactobacillus plantarum DSM 24730, Lactobacillus acidophilus DSM 24735, Lactobacillus paracasei DSM 24733, Lactobacillus delbrueckii* subsp. *bulgaricus DSM 24734, Bifidobacterium longum DSM 24736, Bifidobacterium breve DSM 24732, Bifidobacterium infantis DSM 24737, Streptococcus thermophiles DSM 24731)* and *Lactobacillus paracasei B21060*, have shown promise in lowering abdominal symptoms with or without the help of other intervention strategies. Most of the studies reviewed did however, use different probiotic strains, different intervention methods were used, small sample sizes had been implemented and high quality data was lacking.

Prebiotics provide fuel for the microbiota yet there are no studies to recommend their use in SUDD. Certain fibers may act as a prebiotic requiring further investigation into their use in SUDD. The current confusion that resides around the use of a HFD in SUDD as well as prebiotic, probiotic and fiber supplementation requires further investigation in order to determine current methods that may benefit SUDD patients.

CHAPTER 3: METHODOLOGY

3.1 TYPE OF STUDY

The study was a quantitative, descriptive study. All RDs who were currently treating or who had treated DD in SA at the time of the study were invited to complete a self- administered questionnaire.

3.2 STUDY DESIGN

Quantitative research is well suited to online questionnaire data collection, problem quantification, determining the effectiveness of treatment methods and allowing for statistical inferences (Sandelowski 2000; Neergaard, Olesen, Andersen, & Sondergaard 2009). A self-administered open and closed ended questionnaire was considered to be the best method to use as it was cost effective and enabled distribution to a larger sample size (Walonick 1993; Sandelowski 2000; Grimes & Schulz 2002). Respondents are also familiar with questionnaires and are less likely to feel apprehensive when filling them out (Walonick 1993). The limitations of using an open-ended questionnaire is that more time is required to interpret the questions and the researcher may subjectively interpret the results (Munn & Drever 1990). Closed-ended questions, however, limit the response to the question outlined and can be suggestive, rather than allowing for a spontaneous response (Reja, Manfreda, Hlebec & Vehovar 2003).

The advantage of the descriptive approach was that it allowed participants to state their beliefs and practices regarding nutritional intervention in DD. The disadvantage, however, is that the data could be subjectively interpreted (Grimes & Schultz 2002).

3.3 SAMPLE SELECETION AND STUDY POPULATION

Non-probability snowball sampling was used in order to reach as many dietitians as possible. Technically there was no sample selection as the goal was to invite all RDs in SA who treated DD to participate (Heckathorn 2011). The challenge was how to contact them. Although the

Health Professional Council of South Africa (HPCSA) has the largest data base of RDs in SA (3139 were registered at the time of the study), confidentiality laws prevented access to the database. As the next largest data base was that of ADSA (1500), sampling was initiated with ADSA members. As approximately 52% did not belong to ADSA, internet searches were conducted using the term "dietitian". Details were downloaded from internet sites such as the Discovery Vitality Wellness Nutrition dietitian list (Discovery Vitality Wellness Network 2016) and Medline pages. Questionnaires were handed out at ADSA meetings. The sample size was then "snowballed" by encouraging each respondent to forward the study information and web link onto all dietitians on their contact lists.

The study population included RDs practicing in SA who had treated DD or who were currently treating DD.

3.4 DATA COLLECTION, INSTRUMENTS AND TECHNIQUES

3.4.1 Research instrument and validation

An open and closed-ended, self-administered questionnaire (*Appendix A*) was initially designed and tested in a pilot study and then modified based on the detailed input of the RDs treating DD. The questionnaire was designed to determine the treatment methods prescribed by RDs for patients with SUDD. The questionnaire was not validated by an expert as there were no SA experts in the field of SUDD and no previous studies were available to base the questionnaire on. Each respondent on submission of the questionnaire was contacted by the candidate to clarify the answer.

3.4.2 Pilot study

A "Diverticular Letter" (*Appendix B*) was made available to all respondents and the letter contained a brief outline of the study, the researcher and supervisor details, a link to the questionnaire and an informed consent note. An email containing the "Diverticular Letter" (*Appendix B*) and web link (http://diveticulitis.weebly.com/) was sent out to 10 RDs in KwaZulu-

Natal (KZN) on the 23rd January 2014. Participants were asked to fill in the questionnaire and then comment on the questions that had been presented to them and to highlight any problems, such as a lack of ambiguity. Changes were made to the questionnaire according to the feedback given by the respondents and certain questions were expanded on to prevent misunderstanding, when interpreting the questions. Registered dietitians who responded to the pilot study were known by name and were asked not to be part of the study. Registered dietitians names were checked by the candidate to prevent the pilot study dietitians from being part of the study.

3.4.3 Data collection

Ethical clearance (HSS/0179/012) was obtained from the Humanities and Social Sciences Research Ethics Committee of the University of KwaZulu-Natal (UKZN) (*Appendix C).*

Roberta Govender, the secretary for ADSA (Roberta@vdw.co.za), was contacted and asked if the ADSA newsletter could be used to invite participation in the study. On the 8th April 2014, the ADSA newsletter contained the "Diverticular Letter" (*Appendix B*) with the link to the questionnaire (http://diveticulitis.weebly.com/). The "Diverticular Letter" contained an informed consent statement. The questionnaire, hosted by Weebly, was password protected (DIET) to ensure that only ADSA members filled this in. Registered dieticians downloaded the questionnaire, completed it and then emailed the response either to the research supervisor, Dr Chara Biggs (biggsc@ukzn.ac.za) or the researcher (tanyamarch@telkomsa.net). The researcher or supervisor reviewed the questionnaire immediately and any queries were immediately followed up via email, with the registered dietitian. Once clarity was obtained, the questionnaire was allocated a study identity number and the original email deleted to ensure confidentiality. Respondents were then asked to forward the email onto all other dietitians that they knew, creating a sampling snowball effect.

The initial DD letter that was sent out by ADSA in April 2014 had a poor response rate. Other websites then had to be considered (Discovery, Medline Pages) in order to obtain RDs details which allowed for the DD letter and questionnaire to be sent out. In an effort to further increase the response, a decision was made to resend the DD letter in August 2015. Catherine Day

(cath.day.rd@gmail.com), the ADSA communication representative was contacted on the 30th August 2015 in order to resend the newsletter to encourage participation. On the 1st September 2015, the "Diverticular letter" and a link to the questionnaire was resent.

In addition, the Discovery Vitality Wellness Nutrition dietitian list was obtained from the internet and each applicant was directly emailed the "Diverticular letter" (*Appendix B*) and the study questionnaire (*Appendix* A). This was followed by two reminder emails. The researcher phoned and sent emails to RDs who were listed on the Medline pages and ADSA website. The researcher attended the ADSA KZN branch meeting in September 2015 and handed out questionnaires that were completed and collected at the end of the meeting. For the ADSA Johannesburg branch meeting, questionnaires were couriered in August 2015, handed out to members and the completed questionnaires were couriered back to the researcher. Again, all dietitians who responded were encouraged to email the link onto other dietetic colleagues to increase the sample size. Although a few dietitians employed at Government hospitals completed the questionnaire, some declined as the questionnaire had not been approved by the Nutrition Directorate from the KZN Health Department.

To further increase the sample size, a R1000 Yuppie Chef voucher (*Appendix B*) was offered as an incentive and was awarded at the end of the study. Registered dietitians who were part of the study were allocated a number and a winner was randomly selected. The winner was contacted and the prize was given to them.

The period of data collection was from April 2014 to December 2015.

3.5 VARIABLES INCLUDED IN THE STUDY, DATA CAPTURING AND ANALYSIS

3.5.1 Data analysis

All the data from the questionnaires were captured on two separate occasions into an excel program that was specifically designed by the statistician (Gill Hendry, hendryfam@telkomsa.net). The researcher then compared the data bases for inconsistencies

which were then rectified. The data was then analysed by the statistician using Statistical Package for the Social Sciences (SPSS), version 21.0 dissertation.

Descriptive statistics including means and standard deviations were used to analyse the data and frequencies were represented in tables or graphs (Table 3.1). A chi-square goodness-of-fit-test, a univariate test was used on a categorical variable to test whether any of the response options were selected significantly more or less often that the others. Under the null hypothesis, it was assumed that all responses are equally selected when the data was analysed. Chi-square test of independence was used on cross - tabulations to determine whether a significant relationship existed between the two variables represented in the cross-tabulation. When conditions were not met, a Fisher's exact test was used. Trigger foods that were listed had been recoded so that 10 were listed as most important and 1was listed as least important (out of 10 listings). Therefore, the sum of the listing code gave a measure of importance of a specific item. A table of these measures, ordered from most important to least important follows the individual frequency table outlined in chapter 4. A p value of <0.05 was taken as statistically significant.

Table 3.1: Data analysis of objectives

Objectives	**Variables used for the analyses**	**Method of analysis**
To determine whether RDs practicing in SA agreed with the Current Consensus Guidelines.	Questionnaire OR Current dietary approach	Descriptive statistics and Chi-square goodness- of- fit- test.
To determine whether RDs practicing in SA supplemented with fiber in the treatment of SUDD.	Trigger foods	Descriptive statistics, significance $p<0.05$ and a Fisher's Exact Test.
To determine whether RDs practicing in SA identified specific	Fiber supplementation	Descriptive statistics and Chi-square goodness- of- fit- test.

foods believed to trigger attacks in SUDD.		
To determine whether RDs practicing in SA supplemented with prebiotics and/or probiotics and other nutritional supplements.	Prebiotic supplementation Probiotic supplementation Nutritional supplementation	Descriptive statistics and Chi-square goodness-of- fit- test.
To determine whether RDs practicing in SA believed that their dietary approach was successful.	Beliefs around dietary approach	Descriptive statistics and Chi-Square goodness-of-fit-test.

3.6 DATA QUALITY CONTROL

3.6.1 Field tested

Rigour in the research is required in quantitative research to obtain an accurate measurement of the reliability and validity (Heale & Twycross 2015). The validity refers to the extent to which a quantitative study is accurately measured (Heale & Twycross 2015). The quantitative descriptive questionnaire was found to be the best approach to validate the study as the questionnaire was designed to achieve the objectives and to accurately measure the response (Heale & Twycross 2015). The quantitative descriptive questionnaire was also used to determine the current performance of SA dietitians in the treatment of SUDD and correlates performance with the concurrent behaviour practices of dietitians (Heale & Twycross 2015). The use of open-ended questions allowed the respondents to express themselves more freely compared to close-ended questions (Heale & Twycross 2015).

The reliability of a study depicts the coherence of a measure in order to yield the same results, when the research has been repeated (Heale & Twycross 2015). Initially, a pilot study was

performed in 2014 to determine the efficacy of the questionnaire and was used to increase the reliability of the study. During the study, dietitians were contacted to determine if there were any ambiguous questions that required further clarity, improving the outcome and reliability of the study. The consistent measure used in the study was a questionnaire that included multiple choice questions, closed and open ended questions. The questionnaire was written in English (one of the official languages in SA) as most dietitians are taught dietetics at English speaking Universities in SA. The data was captured twice in order to improve reliability of the study.

3.6.2 Reduction of bias

Using a self-administered questionnaire allowed the RDs to answer the questions without being swayed by an interviewer and neutral, open ended questions allowed the respondents to express their own thoughts and ideas, thereby reducing bias. Contacting RDs to clarify their response in order to enable correct interpretation of the questionnaire also minimized a biased response. Simple and precise closed-ended questions were used in the questionnaire to decrease ambiguity and reduced biased feedback by RDs (Choi & Pak 2005).

There was a selection bias as the questionnaire mainly reached those that had access to the internet and email although, there is a high probability that RDs would have had access to the internet and emails. Another bias in the study is that it mainly focused on addressing RDs who were ADSA members attending ADSA meetings or who received the ADSA newsletter (Pannucci & Wilkins 2010). Registered dietitians that did not have much interest in the field, may have answered the questionnaire briefly in order to obtain the prize, which could have introduced another bias towards the results of the study.

3.7 ETHICAL CONSIDERATIONS

The Humanities and Social Sciences Research Ethics committee of UKZN gave ethical clearance (*Appendix C)* for the study (HSS/0179/012).

A covering letter (*Appendix B)* was sent to each respondent explaining the confidentiality of each completed questionnaire and that by completing the questionnaire, the respondents were giving the researcher consent to use it. Registered dietitians were informed that the study was voluntary and they were able to withdraw at any time throughout the study period. Registered dietitians were given the researchers and supervisors email address in case they had any queries or questions throughout the study period.

In order to maintain confidentiality during the data management stage, the participants were allocated a study number. The questionnaire was then destroyed by shredder machine and the emails were deleted from the in-box.

CHAPTER 4: RESULTS

The results obtained from 155 RDs were analysed in order to determine the relevance of each question. An overview of each question outlined in the study has been discussed in the following chapter.

4.1 RESPONSE RATE

A total of 155 RDs responded to the questionnaire. At the time of the study, there were 3139 RDs with the HPCSA, 47% (1500) of whom belonged to ADSA. As the total number of RDs in SA who treated DD was unknown, it was not possible to estimate what proportion of the total treating DD was sampled. Likewise, a response rate could not be calculated as the number who were invited to participate was unknown due to snowball sampling.

4.2 PLACE OF EMPLOYEMENT

Seventy five percent (116/155) worked in the private sector and 25.0% (39/155) in the government sector

4.3 FREQUENCY OF TREATMENT

A significant number (36.9%, 52/155) treated less than five patients per year (χ^2 (3) = 19.369, $p<0.0005$). A significant proportion (31.2%, 44/155) treated approximately two or more patients a month. There was no significant difference for all treatment parameters between these two groups (Figure 4.1).

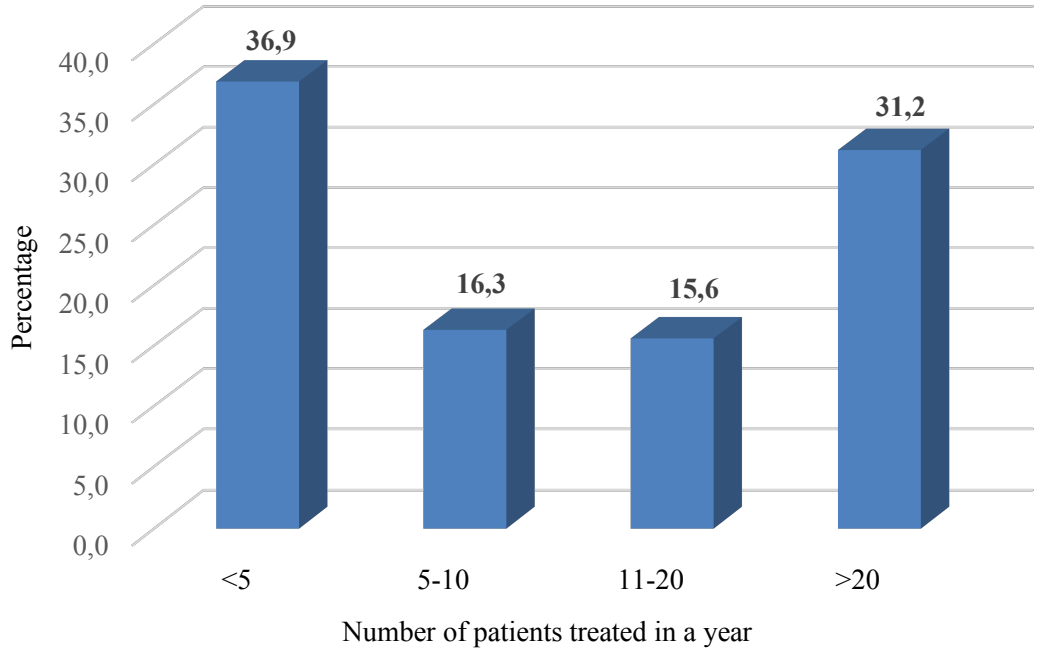

Figure 4.1: Number of patients seen by dietitians per year

4.4 RESPONSE TO THE CURRENT DIETARY GUIDELINES

A significant majority (77,1%, 101/131) disagreed with the ICCG that promote an unrestricted HFD, compared to those (19.4%, 30/131) who agreed (χ^2 (2) = 38.481, p<0.0005).

4.5 DIETARY APPROACHES

A significant difference (χ^2 (2) = 166.805, p<0.0005) was found between the dietary approaches. The majority (57.7%, 86/149) believed that high soluble fiber plus insoluble fiber (wheat bran, bran flakes) with the avoidance of skins, pips, whole grains and nuts was the best approach used in-between acute attacks. An additional 28.9% (43/149) supported this approach but supported the removal of insoluble fiber. Only 7.3% (11/149) recommended a high insoluble fiber diet with greater than 25g of fiber per day (Figure 4.2).

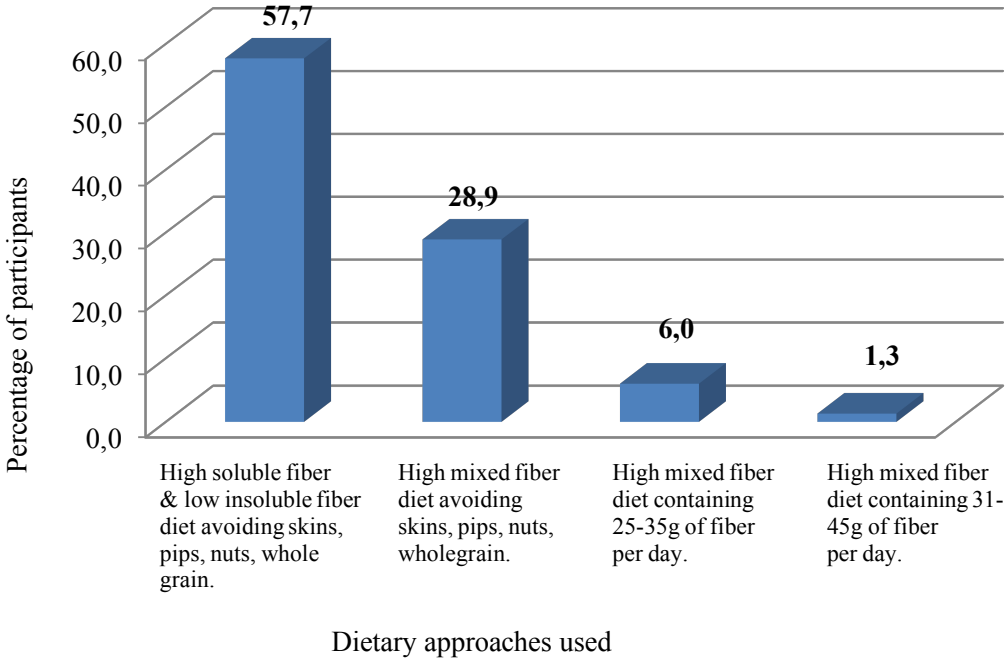

Figure 4.2: The dietary approaches used by registered dietitians

4.6 FIBER SUPPLEMENTS

A significant number either prescribed soluble fiber (35.4%, 51/144) or did not prescribe fiber supplements (53.5%, 77/144) (χ^2 (3) = 97.889, p<0.0005). A blend of fiber was recommended by 9.0% (13/144) and 2.1% (3/144) prescribed insoluble fiber. The fiber that was prescribed the most was psyllium husk (19.4%, 28/144), oat bran (16.7%, 24/144), Benefiber (wheat dextrin) (11.8%, 17/144) and Movicol[18] (polyethylene glycol) (3.5%, 5/144) (*Appendix D*) (Figure 4.3).

[18] Movicol is not a fiber supplement, it is an iso-osmotic laxative which is used to soften the stools.

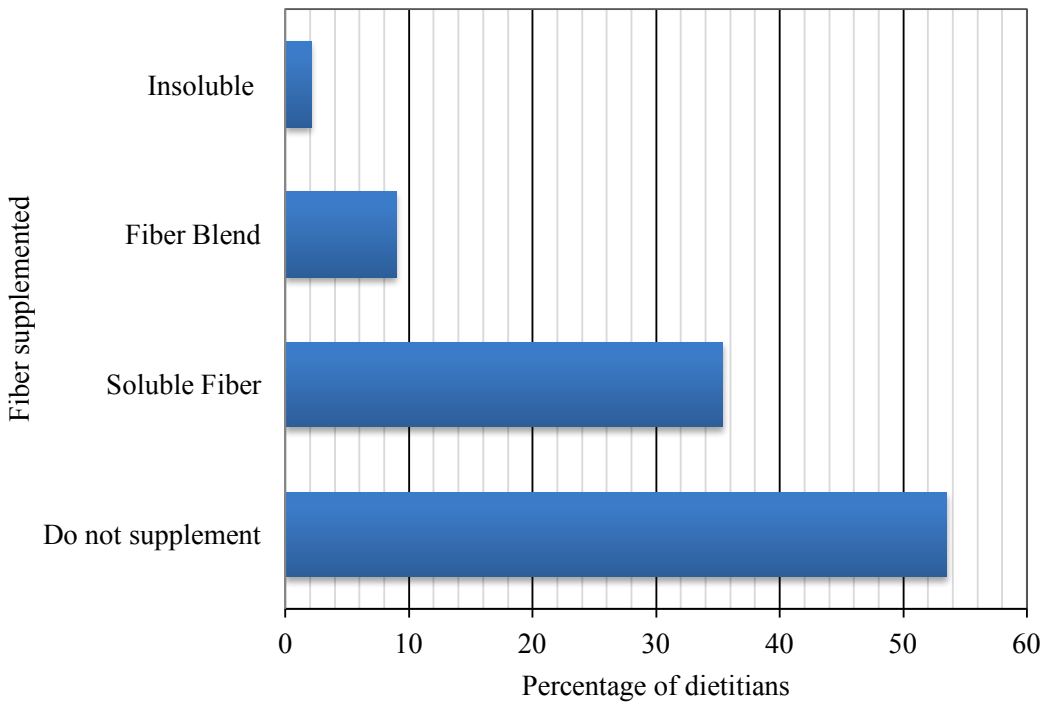

Figure 4.3: Prescription of fiber supplementation

4.7 TRIGGER FOODS

A significant proportion of RDs (79.3%, 119/150) identified foods they believed provoked attacks of diverticulitis ($p<0.0005$), compared to 20.7% (31/150) who did not support the concept of trigger foods. The foods most frequently identified as provoking attacks and having a high level of importance included seeds, nuts, pips, wheat, gas forming vegetables, fried/fatty foods, popcorn and fruit (Figure 4.4). Legumes are classified as a seed and include beans, lentils, peas and peanuts. The seed (legumes) heading in Figure 4.4 was required to differentiate legume based seeds from other seeds such as sesame seeds, pumpkin seeds, flax seeds, sunflower seeds and poppy seeds.

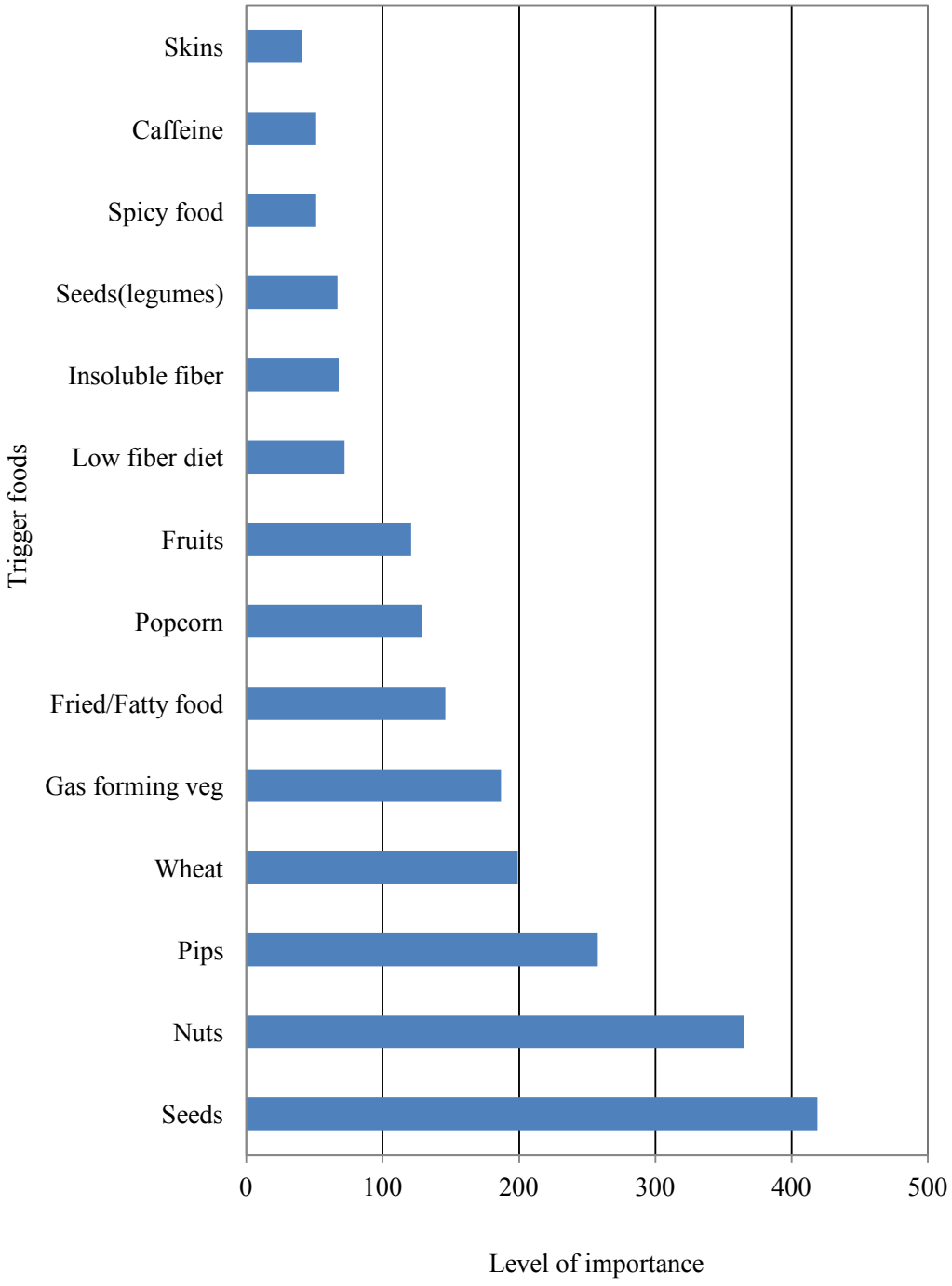

Figure 4.4: Commonly identified trigger foods and the level of importance

4.8 USE OF PREBIOTICS AND PROBIOTICS

The results obtained from 155 RDs were analysed in order to determine the relevance of each question. An overview of each question outlined in the study has been discussed in the following chapter.

4.8.1 Beliefs

Approximately half (51.3%, 79/154) believed that prebiotics were beneficial in the treatment of DD (χ^2 (2) = 40.377, p<0.0005), in contrast to 38.3% (59/154) who were unsure of their role (Figure 4.5).

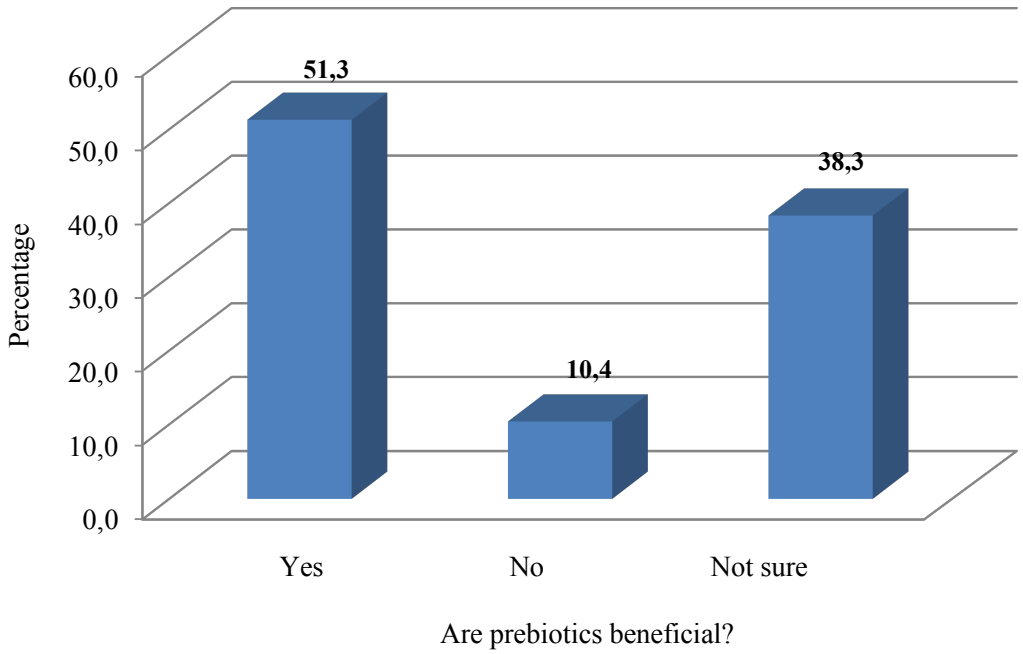

Figure 4.5: The percentage who found prebiotics beneficial

Although the majority (70.6%, 108/153) believed that probiotics were beneficial in the treatment of DD (χ^2 (2) = 103.804, p<0.0005), a quarter (24.2%, 37/153) were unsure of their potential role (Figure 4.6).

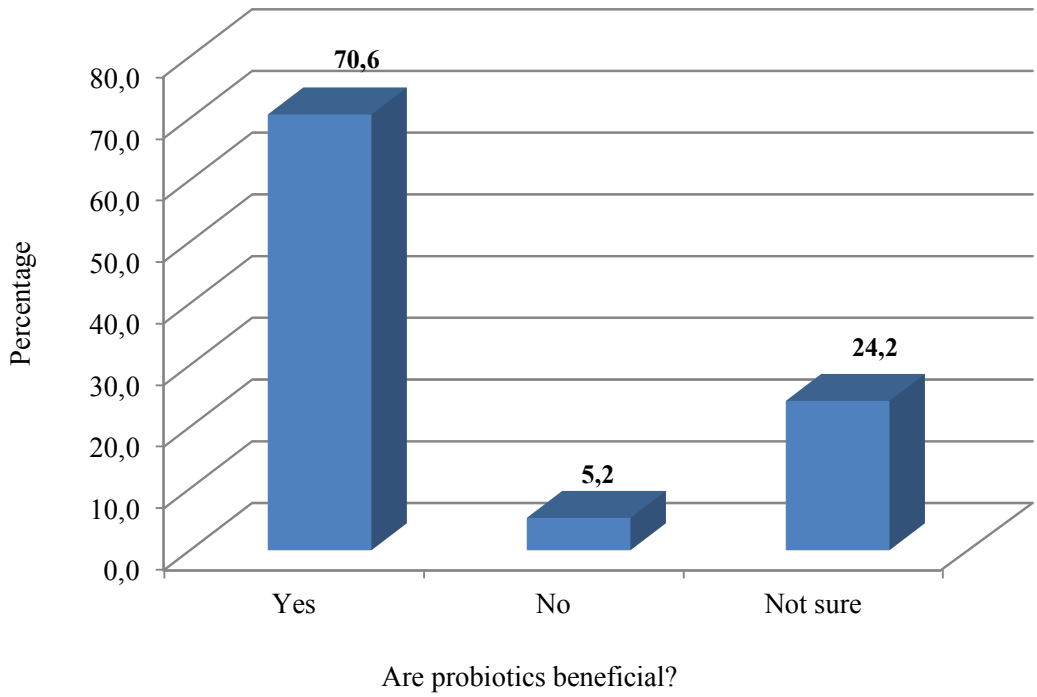

Figure 4.6: The percentage who found probiotics beneficial

4.8.2 Prescription

Over half routinely prescribed probiotic supplements (55.3%, 84/152) and 18.4% (28/152) recommended using a combination of both prebiotic and probiotics (symbiotics), giving a total of 73.7% (112/152) of RDS using probiotics or both (Figure 4.7). Only 1.3% (2/152) prescribed prebiotics and 25.0% (38/152) prescribed neither (Figure 4.7). A few respondents stated they did not prescribe prebiotics when in fact, it was in the supplement they prescribed and one other was not a prebiotic or probiotic supplement.

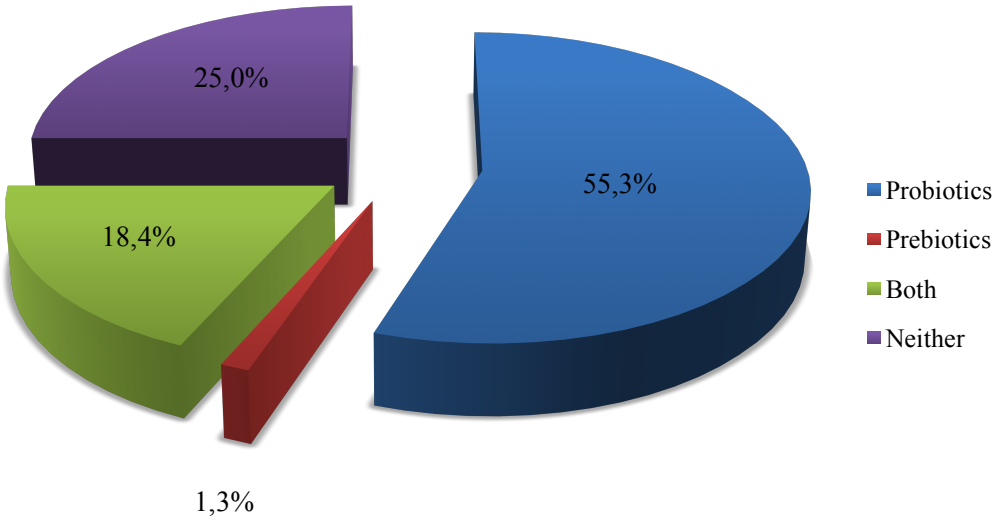

Figure 4.7: Prescription of probiotics and prebiotics

There was a significant relationship between opinions on the beliefs of probiotic use and the prescription of probiotic supplements (Fisher's = 35.998, $p<0.0005$). A significant number of those who saw the benefit of probiotics prescribed them; a significant number who did not see their benefit prescribed neither pre- nor probiotics. For those who were not sure of their benefit, a significant number prescribed neither.

There was a significant relationship between opinions on the benefit of prebiotics and the prescription of prebiotic supplements (Fisher's = 26.800, $p<0.0005$). A number of RDs (26.9%, 41/152) who claimed they only promoted probiotics and not prebiotics, did promote fiber supplements that were actually prebiotics. Out of 25.0% (38/152) that claimed to prescribe neither, 5.3% (8/152) of those recommended a fiber supplement.

4.8.3 Supplements

The two RDs who routinely prescribed prebiotics (Figure 4.7) recommended FOS. Those that prescribed both, recommended prebiotics such as oat bran (2.6%, 4/152), inulin (2.0%, 3/152), FOS (2.0%, 3/152) and psyllium husks (1.3%, 2/152) while others prescribed a symbiotic preparation that was found in Probiflora Intensive Care 9, Ultra Flora Synergy and the Real Thing Pro-Probiotics (*Appendix E*).

The most commonly prescribed bacteria found in the probiotic supplements were *Lactobacillus acidophilus* (22%, 34/155), *Bifidobacterium lactis* (21%, 32/155) and *Lactobacillus plantarum* (14%, 22/155) (Figure 4.8).

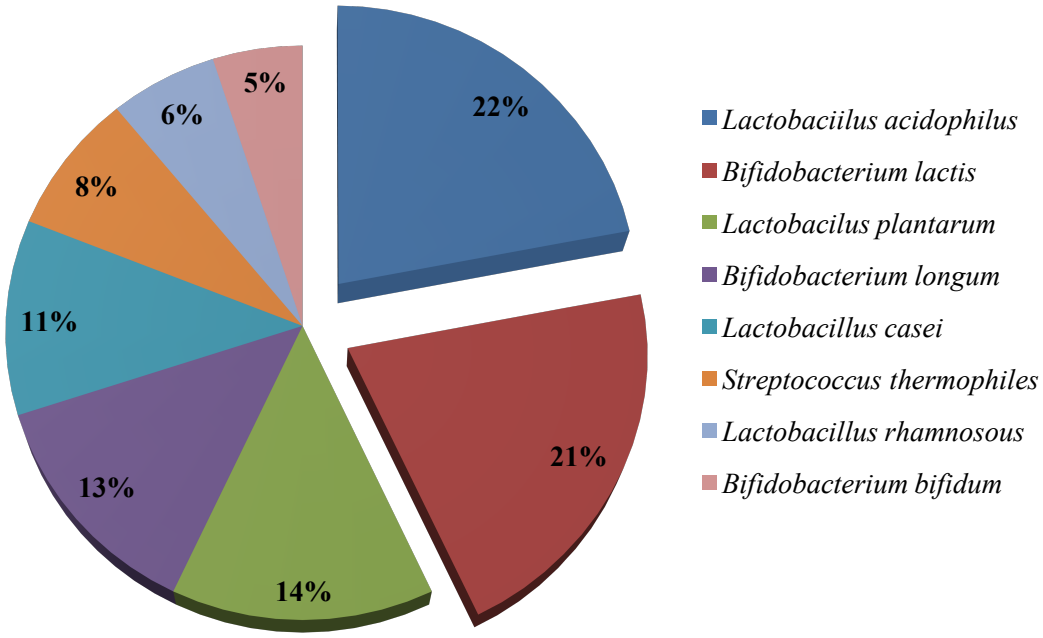

Figure 4.8: The main probiotic species prescribed

The most common probiotics prescribed were, the Probiflora range (22.3%, 34/152), Metagenics (21.1%, 32/152), LP299V (11.1%, 17/152), Reuterina (8.6%, 13/152), Gastrochoice (7.2%, 11/152) and VSL#3 (6.7%, 10/152) (*Appendix E*). Some RDs supplemented with two or three supplements in combination. The probiotic strains of the main probiotic species prescribed are found in Table 4.1. The probiotic strains that were mentioned by the manufacturers were included.

Table 4.1: The amount and type of probiotics prescribed

Probiotic: Genus and Specie	**Probiotic Strains**
Lactobacillus acidophilus	*Lactobacillus acidophilus NCFM®* *Lactobacillus acidophilus HA-122* *Lactobacillus acidophilus DSM 24735*
Bifidobacterium lactis	*Bifidobacterium lactis HN019* *Bifidobacterium lactis Bi-0* *Bifidobacterium lactis Bl-04*
Lactobacillus plantarum	*Lactobacillus plantarum 299v* *Lactobacillus plantarum Lp-155* *Lactobacillus plantarum HA-119* *Lactobacillus plantarum DSM 24730*
Bifidobacterium longum	*Bifidobacterium longum Bl-05,* *Bifidobacterium longum HA-135* *Bifidobacterium longum DSM 24736*
Lactobacillus casei	*Lactobacillus casei Lc-11*
Bifidobacterium bifidum	
Streptococcus thermophiles	*Streptococcus thermophiles St-21* *Streptococcus thermophiles HA-132* *Streptococcus thermophiles DSM 24731*
Lactobacillus rhamnosous	*Lactobacillus rhamnosous HNO19* *Lactobacillus rhamnosous HNOO1* *Lactobacillus rhamnosous GG* *Lactobacillus rhamnosous BHA-114* *Lactobacillus rhamnosous HA-111*

Symbiotics were prescribed by 29.7% (46/155) and a quarter (25.2%, (39/155) recommended a symbiotic that contained the prebiotic FOS. These included Solal Probiotic Maximum, Probiflora 4, Probiflora 9, Probiflora Colonease, Biogen Probimax 4 Strain, Foodstate 11 Strain and Green Vibrance Health. Two symbiotics, the Real Thing-Pro-probiotic and Nativa digestive (1.9%, 3/155), contained inulin and oligofructose which was also found in the Real Thing Pro-probiotic (1.3%, 2/155). A symbiotic preparation that consisted of ispaghula husks was Probiflora Colonease (1.3%, 2/155).

4.9 ADDITIONAL SUPPLEMENTS

Omega 3 fish oils (14.8%, 23/155), L- glutamine (10.0%, 15/155) and multi–vitamin and mineral (7.1%, 11/155) containing products were the three additional supplements mainly prescribed. Digestive enzymes (2.6%, 4/155) and herbal extracts such as Iberogast[19] (1.9%, 3/155) were prescribed by the minority. Gastrochoice probiotics and Gastrochoice IBS were two of the probiotic supplements containing L-glutamine and digestive enzymes.

4.10 LIFESTYLE RECOMMENDATIONS

Nearly one third of participants (29.0%, 45/155) believed that the fluid intake should be increased. Lifestyle changes included avoiding alcohol (17.7%, 12/155), encouraging healthy eating and exercise (9.0%, 14/155), regular and balanced meals (6.5%, 10/155), an individualised approach (5.8%, 9/155), keeping a food diary (3.9%, 6/155%), using the FODMAP diet (2.6%, 4/155) and chewing properly (1.3%, 2/155).

An individualised approach was mentioned throughout the study. In the restriction of insoluble fiber, a few (11.0%, 17/155) believed a treatment approach should be individualised for each patient. An individualised approach was advised by 17% (26/155) of the RDs when treating patients and treatment outcome also specified an individual approach.

[19] Plant-derived extract supplement composed of Iberis amara, Angelica, Chamomile, Caraway Fruit, St. Mary's Thistle, Lemon Balm Leaves, Peppermint Leaves, Celandin, Liquorice Root and alcohol

4.11 TREATMENT OUTCOME

The majority (73.6%, 109/148) felt that patients responded well with significant improvement in symptoms and had a decreased relapse rate (χ^2 (2) = 192.054, p<0.0005) while 1.4% (2/148) believed that the diet did not work (Figure 4.9).

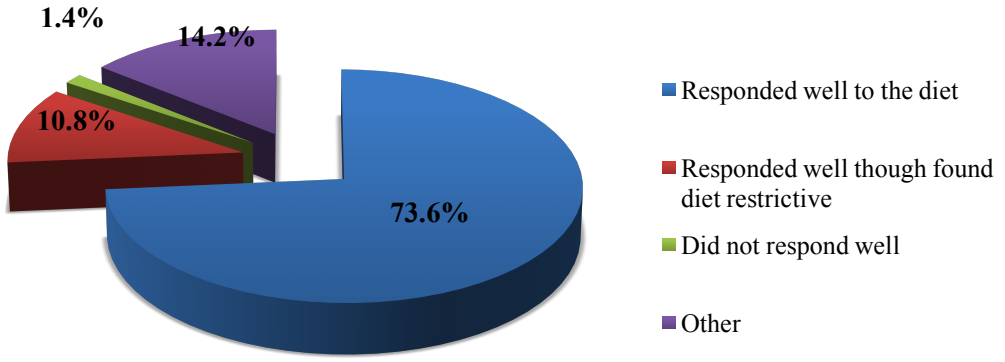

Figure 4.9: Response of patients to the dietary approach

Many respondents who chose "other" stated that patients did not come back for follow-up, leaving them unable to determine the success of the dietary approach they recommended. Others stressed the importance of the response being individualised.

4.12 SUMMARY

A significant proportion (77.1%) of RDs disagreed with the ICCG and over half (53.5%) did not supplement with fiber supplements, whereas 35.4% prescribed soluble fiber supplements. Over two thirds (79.3%) of RDs identified trigger foods that were believed to provoke DD attacks. The common trigger foods mentioned were seeds, nuts, pips, wheat, gas forming vegetables, fried/fatty foods, popcorn and fruits. Prebiotics and probiotics were both found to be beneficial, although only 25.0% of RDs prescribed prebiotic and 55.3% recommended probiotics. Different probiotic strains and species were noted in the study, the two most commonly prescribed probiotics were *Lactobacillus* and *Bifidobacteria*. Additional supplements such as omega-3 fish oil, L-glutamine, multi-vitamin and mineral, digestive enzymes and Iberogast were advised by RDs. Many (73.6%) RDs believed that their approach was successful in improving patient's symptoms and decreased relapsed rate.

CHAPTER 5: DISCUSSION

The ICCG have recommended the inclusion of a HFD in all patients with SUDD. Reviewing the literature, assessing the current study's findings and looking at anecdotal evidence, may help provide a clearer understanding of how to manage and treat SUDD.

5.1 SECTOR OF EMPLOYMENT

Out of the 155 RDs that responded to the questionnaire, a significant proportion (75%) worked in the private sector. Petruzziello *et al* (2006) mentioned that urbanization and a Westernized diet have been linked to an increased prevalence of DD, which may explain why a greater number of the private sector dietitians responded as they may have been more likely to treat DD. An additional consideration is that those that work for the government sector are less likely to treat DD as the Millennium Criteria Goals (MCG) outlined by the South African Department of Health (SA DoH) do not address DD (Department of Health, Republic of South Africa 2014). The SA DoH focuses on the treatment of human immunodeficiency disease (HIV) and acquired immunodeficiency syndrome (AIDS), tuberculosis (TB) as well as child and maternal mortality (Department of Health, Republic of South Africa 2014).

5.1.1 Frequency of treatment

Although there was a vast difference in their exposure to DD[20], those with the greater experience did not treat significantly differently to those with the least experience, regardless of the treatment parameter.

5.2 DIETARY APPROACHES IMPLEMENTED VERSUS CONSENSUS GUIDELINES

The term "high fiber diet" has been used very loosely in most of the ICCG, as it does not dictate the amount of soluble versus insoluble fiber that should be prescribed in SUDD. A systematic review by Ünlü *et al* (2012) showed that there is inconsistent evidence to state whether a HFD

[20] A third (31.2%) treated two or more patients a month compared to the third (36.9%) who treated less than five patients per year.

should be used in the treatment of SUDD. Yet the ICCG still recommend a high HFD in DD and in SUDD patients.

The ICCG for DD state that patients should be encouraged to eat a HFD including insoluble fibers such as nuts, seeds and popcorn. Most RDs (85.6%) recommended varying degrees of insoluble fiber restriction. Over half (57.7%) promoted the avoidance of skins, pips, whole grains and nuts, although the inclusion of both soluble and insoluble fiber (including wheat bran and bran flakes) was promoted. An additional third of the RDs (28.9%) supported this approach but recommended the removal of insoluble fiber. Very few RDs (7.3%) recommended greater than 18 to >25 g of insoluble fiber per day as recommended by the consensus statements (Leahy *et al* 1985; Crow *et al* 2014; Cuomo *et al* 2014; Boynton & Floch 2013; National Health Service 2015; United States Department of Health and Human Services and United States Department of Agriculture 2015; Stellenbosch University 2016). Contrary to the ICCG, most RDs therefore believed that insoluble fiber in a variety of forms was responsible for provoking attacks. Dietitians in SA did not support the ICCG (WGO, AGA, Italian Consensus, Great Britain's Royal College of Surgeons, National Health Services, Polish Consensus; Danish National Guidelines), advocating a HFD with no limitations on the type (insoluble versus soluble) of fiber (Murphy *et* al 2007; Andersen *et al* 2012; Royal College of Surgeons Advancing Surgical Standards 2014; Peery *et al* 2012; Pietrzak *et al* 2013; National Health Service 2015; Stollman *et al* 2015).

Just under half prescribed fiber supplements (44.4%), with a very small percentage recommending the use of insoluble fiber (2.1%). In the literature, the use of bran supplements (insoluble fiber) was shown to reduce symptoms in SUDD and yet none prescribed them. Approximately 57.5% believed that an insoluble fiber diet such as wheat bran and bran flakes would be the best dietary approach, contradicting their beliefs to their action. The ICCG for fiber supplementation are confusing, as two promoted (Andersen *et al* 2012; Pietrzak *et al* 2013) the use of fiber supplements without mentioning the type of fiber to supplement with, few stated that fiber supplementation is controversial (Cuomo *et al* 2014; Stollman *et al* 2015) and two others (Murphy *et al* 2007; Royal College of Surgeons Advancing Surgical Standards 2014) did not mention fiber supplementation at all.

Only four RCT studies were reviewed by Ünlü *et al* (2012), as they met the criteria for obtaining a control group and each used different treatment methods i.e.: different doses and different types of fiber supplements (bran, ispaghula, methylcellulose). All the studies had a small sample size which makes it difficult to demonstrate a significant effect in SUDD patients consuming high fiber supplements. A recent review by Elisei and Tursi (2016) commented on the lack of data to support the role of fiber in the use of SUDD patients. However, it was mentioned that a HFD is still recommended in SUDD. Although Leahy *et al* (1985), Strate *et al* (2008) and Crowe *et al* (2011) prospective studies had been reviewed, Crow *et al* (2011) & Strate *et al* (2008) study did not look at abdominal symptoms and is questionable when assessing their results in SUDD (Elisei & Tursi 2016).

Over a third prescribed soluble fiber (35.4%) primarily psyllium husk followed by oat bran and wheat dextrin. The dietitians did not mention the amount they prescribed. Most of these fibers have a prebiotic effect in the gut. There seems to be a lack of general knowledge surrounding prebiotics as some dietitians prescribed soluble fiber supplements that act as prebiotics, while denying that they supplemented with prebiotics.

Three of the studies showed that between 12g to 24g of bran supplementation may have a beneficial effect on reducing abdominal symptoms (Painter *et al* 1972; Brodribb & Humphreys 1976; Taylor & Duthie 1976). In the Painter *et al* (1972) and Brodribb & Humphreys (1976) studies, it was found that a small percentage of patients could not tolerate the supplemented unprocessed bran as it caused symptoms such as constipation, abdominal discomfort or nausea. In the Taylor & Duthie (1976) study, the authors found that a HFD plus supplementing the diet with unprocessed bran where possible (the amount of fiber consumed per day was not noted in the study), had a much lower reduction in eliminating symptoms (20.0%) compared to patients supplementing with their normal diet and bran tablets (60.0%). This implies that a HFD may be more likely to contain certain trigger foods and high roughage food, reducing symptom improvement, whereas increasing fiber by using simple bran tablets that have been refined into smaller particles, may play a beneficial role in eliminating symptoms in SUDD.

Trigger foods were not supported by any of the ICCG (Andersen *et al* 2012; Pietrzak *et al* 2013; Royal College of Surgeons Advancing Surgical Standards 2014; Cuomo *et al* 2014; Stollman *et al* 2015). Despite the limited evidence to support the inclusion or exclusion of trigger foods (Strate *et al* 2008; Tarleton & DiBaise 2011), the majority (79.3%) believed that specific foods triggered attacks and identified seeds, nuts, pips, wheat, gas forming vegetables, fried/fatty foods, popcorn and fruits as being common problematic foods which is in accordance with the historical approach (Tarleton & DiBaise 2011; Peery & Sandler 2013).

Two dietitians from the current study stated that "from my experience and from working with three gastroenterologists, we have found the above items (insoluble fiber, pips, gas forming fruits and vegetables) significantly worsens symptoms and episodes of relapse" and that "surgeon says pips get stuck in diverticula". Interestingly, this has been supported by comments posted on the internet. A number of patient reviews posted on the NHS website criticized the high fiber recommendations and stated that abdominal symptoms worsened (National Health Service 2015). Some seemed to be sensitive to foods such as whole meal bread, nuts, fruit and by generally following a high fiber diet (National Health Service 2015).

Thompson (2016), a medical doctor posted a remark by a diverticular patient: *" I have had diverticula this condition for twenty-five years. On several occasions the ingestion of nuts and seeds and even shredded coconuts has caused the most acute repeated attacks of diverticulitis, marked with acute pain on the left side, bowel movement distress, and a fever. When nuts, seeds, and offending foods were eliminated from my diet I no longer suffered the diverticulitis symptoms described above – except on one or two occasions when due to careless lapses in such dietary precautions, (such as eating an unidentified mixed dish in a darkly-lit restaurant) the attack recurred. Moreover, a sibling with the same condition experienced precisely the same symptoms after eating seeds and nuts. Only a diet that scrupulously avoids these foods in her case and in mine has prevented subsequent attacks of this kind. I would appreciate some clarification regarding the role of diet in this syndrome with special reference to the question of seeds, nuts, and any other possible offending foods"*.

Other patient responses to dietary intervention for SUDD were obtained from patient support website groups:

"*Avoiding any root vegetables (these cause wind and irritate the pockets) keeps me mainly flare free, also be careful with beef, pork and lamb*" (Anonymous 2016).

"*I cannot eat seeds or any kind, I have a flare up right now caused I believe by fresh figs. Strawberries, blackberries and raspberries are also out*" (MedicineNet.com 2016a).

"*I cannot eat nuts*" (MedicineNet.com 2016b).

"*My surgeon had mentioned that it was ok to eat a wide variety of things, including those with seeds, but I found out the hard way that was NOT the case for me. I had something with sesame seeds, for example, and I had one of the worst attacks I ever had*" (Topix 2016).

"*There's a definite connection for him between it (developing diverticulitis) and small seeds. Like poppy or sesame seeds on bread, or certain ones in fruit. Can't have them*" (HealingWell.com 2008).

Many of the ICCG rely heavily on the prospective cohort study by Strate *et al* (2008), which concluded that the consumption of nuts, corn, popcorn and seeds does not provoke diverticular complications, are not associated with SUDD and may be protective rather than harmful. The study by Strate *et al* (2008) did not focus on men greater than 60 years of age and current studies show that DD increases considerably in people over the age of 60 years. Likewise, symptoms such as abdominal pain, abdominal discomfort and constipation were not monitored, providing limited evidence on the effects that nuts, popcorn and corn may have on the gut.

It is possible that dietitians treat those SUDD patients intolerant to bran or a HFD. This would explain the overwhelming belief in trigger foods and the need to restrict specific types of fiber by dietitians. Salzman & Lillie (2005) mentioned that patients with SUDD usually find that eating food precipitates an attack. An individualised approach as suggested by about 17% of the

participants in the study, may be more beneficial than a "generic approach' as it is possible that a sub section of SUDD sufferers are intolerant to the HFD and react to specific trigger foods, a possibility that the guidelines should not ignore. Two approaches could be offered – a HFD could be the first line of treatment followed by the removal of insoluble fiber including nuts, seeds and popcorn as the second line of treatment, if the HFD worsens the symptoms. The exclusion diet could then be slowly liberated so as to identify the trigger foods. Bran supplementation may be included in insensitive individuals although an individualised approach is required.

5.3 USE OF PREBIOTICS AND PROBIOTICS

More confidence was placed in supplementation with probiotics rather than prebiotics as a greater number of DD studies have investigated the use of probiotics in SUDD.

5.3.1 Prebiotic use

Although there are no studies showing the efficacy of prebiotic use in DD (Park & Floch 2007; Cabré 2011), over half of the participants believed that prebiotics were beneficial. The minority (1.3%), however, prescribed prebiotics (FOS) which showed that their prescription did not match up to their beliefs. There were dietitians who claimed that they did not supplement, yet prescribed probiotic supplements (Probiflora and Gastrochoice) which contained FOS. The beliefs of some did not match up to their prescription such as those who only recommended probiotic use (24.0%), even though they also prescribed fiber supplements which are known to be a prebiotic. The lack of general knowledge surrounding prebiotic use may be a result of limited research to support its use in SUDD and that probiotics tend to be more widely investigated, allowing more emphasis on probiotic use.

The main reason for prescribing FOS was to increase the *Bifidobacteria* population and to a lesser extent, *Lactobacilli*. Both assist in lowering the colonic pH thereby creating an environment in which pathogenic bacteria e.g. *Clostridia* find difficult to survive (Floch & Hong-Curtiss 2002). *Bifidobacteria* are able to produce vitamins, balance intestinal microflora,

increases phagocytosis and help restore the gut flora after antibiotic use (Floch & Hong-Curtiss 2002). The use of FOS may then be beneficial and could potentially be an appropriate choice, even though there was no current research to support its use in SUDD.

5.3.2 Probiotic use

Lactobacillus, Bifidobacterium, Escherichia and *Streptococcus* have been assessed in the treatment of DD (Frič & Zavoral 2003; Tursi *et al* 2006; Tursi *et al* 2007; Lamiki *et al* 2010; Lahner *et al* 2012). Over half of the probiotics prescribed in the current study contained a variety of species and strains of *Lactobacillus* (53.0%), *Bifidobacterium* (39.0%) and *Streptococcus* (8%). Most of the species and strains promoted by the dietitians were not the probiotics which had been investigated in the literature.

Probiotic species have different properties and may be strain-specific in their action (Boyle, Robins-Browne & Tang 2006). It is important not to generalize the effect one probiotic strain may have compared to another, even when the species are the same (Boyle *et al* 2006). It is important therefore to consider the strain-specific probiotic and whether the use was appropriate in SUDD (Boyle *et al* 2006; Tursi 2010). It cannot be assumed that the same probiotic genus or specie will have the same effect in the gut and using strain-specific probiotics requires a thorough evaluation of safety before marketing the probiotic (Boyle *et al* 2006).

Strain specific probiotics used in the treatment of SUDD resulted in a positive reduction in symptom response such as abdominal discomfort, abdominal pain, constipation and abdominal bloating (Frič & Zavoral 2003; Tursi *et al* 2006; Tursi *et al* 2007; Lamiki *et al* 2010; Lahner *et al* 2012). These included *Escherichia coli* Nissle, *L. acidophilus* 145, *L. helveticus* ATC 15009, *Bifidobacterium* spp. 420, *L. casei subsp. DG*, VSL #3 (*Lactobacillus plantarum DSM 24730, Lactobacillus acidophilus DSM 24735, Lactobacillus paracasei DSM 24733, Lactobacillus delbrueckii* subsp. *bulgaricus DSM 24734, Bifidobacterium longum DSM 24736, Bifidobacterium breve DSM 24732, Bifidobacterium infantis DSM 24737, Streptococcus thermophiles DSM 24731) and Lactobacillus paracasei B21060*. These probiotic strains were shown to be effective either by themselves or in combination with either a HFD, phytoextracts, prebiotics, balsalazide,

mesalazine or an antimicrobial. Tursi *et al* (2007) demonstrated that VSL#3 was seen to cause a remission in abdominal symptoms by up to 60.0% over a twelve-month period (Tursi *et al* 2007). Lamiki *et al* (2010) also showed that 68.0% of SUDD patients were symptom-free within a six-month period when a probiotic mix, prebiotics and phytoextracts were used.

Of those (73.8%) who prescribed probiotics, only a small minority (7.0%) recommended VSL#3 (6%) and Vivomixx (1%), which contained the actual probiotic species and strains investigated in the treatment of SUDD (Tursi *et al* 2007; Lahner *et al* 2016). *Escherichia coli* Nissle 1917 was also not prescribed by any of the dietitians. Other probiotics prescribed contained the same probiotic genus but different species and strains that had not been researched. For example *Lactobacillus acidophilus* was contained in probiotic supplements such as Gastrochoice, Probiflora Colon Ease, Real Thing Pro-Probiotic, Biogen Probimax 4 and Food State 11 Strain, although the strain was not mentioned. The prescription of probiotics by most of the dietitians in the current study does not coincide with those strains researched in the treatment of SUDD (Sheth & Floch 2009; Limiki *et al* 2010). The intention of the dietitians to supplement with a probiotic in SUDD patients was appropriate although their practice was not evidence-based.

5.4 ADDITIONAL SUPPLEMENTATION

There is no direct evidence to support the use of omega-3 fish oil (15%) and L-glutamine (10%) in SUDD, yet these supplements were recommended. A review by Seamen (2002) mentioned that diverticulitis is an inflammatory disease and to reduce the chances of developing an inflammatory response in the body, omega-3 fish oil may help to reduce inflammation which in turn, may provide pain relief (Barbalho, Goulart, Quesada, Bechara, & de Carvalho 2016). Many patients with DD suffer with low-level mucosal inflammation (Sheth, Longo & Floch 2008) and may benefit from omega-3 fish oil supplementation. Diets deficient in omega-3, antioxidants, phytochemicals, vegetables and fruit may induce a pro-inflammatory state and DD is inflammatory in nature (Seaman 2002). Bouteloup-Demange, Claeyssens, Maillot, Lavoinne, Lerebours & Dechelotte (2000) discussed the benefits of glutamine supplementation on the gut barrier as glutamine is the major fuel for enterocytes in the intestinal mucosa. Glutamine improves the function, metabolism and structure of the intestinal mucosa and may prevent

increased permeability of the gut, reduce disease activity and lower intestinal damage (Bouteloup-Demange *et al* 2000; Akobeng, Miller, Stanton, Elbadri & Thomas 2000). However, there seems to be no research to support glutamine use in DD. Glutamine has been shown to have certain prebiotic activities in the faecal flora of the human gut (Lahner *et al.* 2012). Lahner *et al* (2012) investigated Flortec© which contained 500 mg of glutamine and demonstrated a significant reduction in symptoms but this may be attributed to a HFD as well as the inclusion of a prebiotic and probiotic.

5.5 LIFESTYLE RECOMMENDATIONS

At present, there is no supporting evidence to suggest lifestyle modifications for SUDD. Approximately a third (29%) recommended an increase in fluid intake. Siegel & Di Palma (2005) did mention that constipation was a factor in SUDD and recommended a high fluid intake, in conjunction with an increased intake of fiber, was thought to help reduce constipation. The RCS commissioning guide also promoted a higher fluid intake if fiber increased in DD (Royal College of Surgeons Advancing Surgical Standards 2014).

Some participants (18%) recommended the avoidance of alcohol while others (9%) advocated increased exercise. Interventions such as reducing alcohol consumption and regular exercise have been recommended in preventing the reoccurrence of diverticulitis (Wilkins *et al* 2013; Pisanu *et al* 2013). However there seems to be conflicting opinions in the literature regarding the exclusion of alcohol (Aldoori, Giovannucci, Rimm, Wing, Trichopoulos & Willett 1995b; Wilkins *et al* 2013). Wilkins *et al* (2013) advocated a reduction in the intake of alcohol whereas Aldoori *et al* (1995b) found no benefit in excluding it. Regular exercise was found to be beneficial in the reducing the reoccurrence of SUDD according to Wilkins *et al* (2013) and Aldoori, Giovannucci, Rimm, Ascherio, Stampfer, Colditz, Wing, Trichopoulos, & Willett (1995a). The prospective men's study by Aldoori *et al* (1995a) showed an increased risk of SUDD in men with low activity levels and low fiber intake. There is limited evidence to support the reduction or exclusion of alcohol in SUDD patients and regular exercise may be beneficial in reducing the reoccurrence of SUDD.

5.6 TREATMENT OUTCOMES

The dietitians who participated in the study strongly believed in the approach they were using as the majority (74%) felt their patient's symptoms improved as there was a decreased relapse rate which is not in accordance with the ICCG. However, dietitians may have been referred those patient's in which the HFD had failed and therefore required further individualised assistance to improve their SUDD.

5.7 SUMMARY

The dietitians who participated in this study did not prescribe the HFD recommended by the ICCG. Many prescribed different degrees of insoluble fiber restriction including skins, pips, whole grains and nuts, while wheat bran and bran flakes were promoted. The participants believed that certain trigger foods impacted SUDD and identified nuts, seeds, pips, gas forming vegetables, fried/fatty foods, popcorn and fruit as being the main trigger foods. Soluble fiber was the most prescribed fiber supplement and a very small percentage advised insoluble fiber. The use of bran supplements had been shown in the literature to be useful in SUDD, yet not one dietitian prescribed their use. Despite the lack of evidence, the minority prescribed prebiotics. The knowledge surrounding prebiotics was poor as those who supplemented with soluble fiber were unaware of its prebiotic role and some supplemented unknowingly. The majority prescribed strains of probiotics that had not been researched in SUDD and very few prescribed the probiotics that the literature had identified as having positive results in reducing abdominal symptoms in SUDD. Few supplemented with either omega-3 fish oils or glutamine, neither of which has been investigated in SUDD. A HFD with the inclusion of a high fluid intake, may reduce constipation in SUDD. The recommendations surrounding a decrease in alcohol is conflicting although the increased exercise recommended by some may be beneficial. An individualised approach was promoted and the majority believed that their treatment approach showed a significant improvement in symptoms and relapse rate. At the time of the write up, Universities were unable to provide an indication of the study material they used to teach DD. This does warrant further investigation to increase the strength of the study.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The purpose of this research was to examine dietary treatment methods used by SA dietitians when treating SUDD and to determine their beliefs regarding the international current dietary guidelines for SUDD, trigger foods, the use of a HFD, fiber supplements, prebiotics and probiotics. Although the ICCG advocates a liberal unrestricted HFD for patients with SUDD and that nuts, seeds and popcorn do not appear to exacerbate DD symptoms. There was conflicting anecdotal evidence that their inclusion may worsen symptoms and provoke attacks in some patients suffering with DD. The results of the questionnaire distributed to SA dietitians indicated that the dietitians who participated in the study who were treating or who had treated DD, were not in agreement with the ICCG.

Most dietitians recommended a high soluble fiber diet (86.6%) although 57.7% additionally prescribed a high insoluble fiber diet (wheat bran and bran flakes) with the exclusion of whole grains, skins, pips and nuts. Under half (46.0%) promoted fiber supplementation, mainly soluble fiber (35.0%) which included oat bran, inulin, FOS, wheat dextrin and psyllium husks. There was a significant reduction in abdominal symptoms noted in SUDD patients consuming 12g to 24g of bran fiber as a supplement, although bran supplementation was not advised by dietitians. It was noted that a small percentage of patients did not benefit from bran supplementation and over half of the ICCG do not promote their use in SUDD. Despite not being in accordance with the ICCG, dietitians strongly believed that their approach improved patient symptoms and resulted in a reduced relapse rate.

Approximately 80.0% identified trigger foods and the most popular were nuts, seeds, popcorn, pips, fruits, gas forming foods and fried/fatty foods. There is limiting and conflicting evidence to support the use of a HFD and/or fiber supplementation in SUDD. Anecdotal evidence from reputable websites and the dietitian's beliefs regarding trigger foods were in opposition to the ICCG.

Although the majority believed that prebiotics were beneficial, only two prescribed them. There was a general lack of knowledge regarding fiber supplements having a prebiotic effect, which may be partially attributed to the fact that available research on the use of prebiotics was poor. Many of the dietitians in the questionnaire prescribed probiotics. A small minority recommended the actual probiotic strains found in VSL#3 and Vivomixx, that had been successfully researched and shown to reduce abdominal symptoms. The others prescribed probiotic species and/or strains whose value in the treatment of SUDD had not been determined. There was no direct evidence to support the use of omega-3 fish oil and glutamine supplements which a small minority of dietitians advised.

The dietitians who participated in the study, believed that their approach improved patient's symptoms and reduced the relapse rate in SUDD patients when they did not follow a liberal unrestricted high fiber approach in between acute attacks. This appears to refute the conflicting ICCG which advocates a liberal unrestricted HFD. Evidence indicates that there may be a sub-section of SUDD sufferers that are intolerant to the high fiber approach and/or fiber supplements and who require an individualised approach to their dietary needs and required food restrictions. These individuals are often referred to dietitians for treatment only after the failure of the high fiber approach. This would support the dietitian's current perception that fiber restriction and reducing certain trigger foods may be necessary despite the ICCG. Research on the use of prebiotics in SUDD has lacked focus and requires further investigation before promoting their use. The inclusion of probiotics is showing promise, though better quality controlled trials are needed to support the use in SUDD.

6.2 CRITIQUE OF THE STUDY

6.2.1 Study constraints/limitations

- Registered dietitians who did not have access to the internet and email were not invited to participate in this study.
- The number of RDs treating DD at the time of the study could not be accurately determined.

- There was a lack of participation by RDs employed in the government sector as they required special permission by the Nutrition Directorate to complete the study.

6.2.2 Recommendations for improvement of the study

- To include a larger number of RDs in the study to help increase the sample size.
- Registered dietitians in specilaised gastrointestinal units could be interviewed to determine their treatment methods.
- Attend certain functions i.e.: ADSA workshops, where government and private practicing dietitians may attend and hand out questionnaires as well as collect them at the end of the function.
- Investigating the current DD dietary practices that are taught by Universities to strengthen the results.

6.3 RECOMMENDATIONS FOR NUTRITIONAL PRACTICE

- An individualised assessment and approach is required for each SUDD patient in order to prescribe the best treatment method for that patient. For some, the avoidance of certain insoluble fiber foods such as seeds, nuts, pips, popcorn, fruits, gas forming foods and fatty/fried foods may trigger an attack. These foods should be avoided initially and then introduced gradually to isolate the individual trigger foods.

- Specific probiotics strains, such as *Lactobacillus acidophilus* 145, *Lactobacillus casei* subsp. DG, Lactobacillus helveticus ATC 15009, *Lactobacillus paracasei B21060, Bifidobacterium* spp. 420 and *Escherichia coli* Nissle 1917 and a probiotic mix (VSL#3, Vivomixx) may be supplemented.

- Bran fiber supplements or soluble fiber supplements including oat bran, wheat dextrin, FOS and ispaghula/psyllium husk, were promoted by the dietitians and may be prescribed on an individual basis. In the literature, a bran supplement of 12g-24g may reduce abdominal symptoms in some SUDD patients.

- Prebiotics such as FOS and inulin have not been extensively studied in SUDD and should not be prescribed until further studies prove their benefit in SUDD.

- Omega-3 and glutamine are important for gut health, however, there are no studies to support their use in SUDD and should not be advised until further research supports their role in SUDD.

6.4 IMPLICATIONS FOR FURTHER RESEARCH

- The prevalence of DD in SA should be investigated.
- To compare the efficacy of the two opposing approaches using a randomised trial.
- To determine whether gastroenterologists believe that insoluble fiber affects the diverticula in DD.
- To determine whether SUDD sufferers support the ICCG or whether they have identified trigger foods and which approach works best for them.
- To determine the effectiveness of probiotics and prebiotics in SUDD.

Further research is required to understand the prevalence of DD in SA and the best treatment method in SUDD patients.

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APPENDICES

APPENDIX A: DIVERTICULAR QUESTIONNAIRE

Please complete the mini questionnaire. The mini questionnaire is to establish the dietary treatment of diverticular disease.

To ensure confidentiality your questionnaire responses will be allocated a study number and saved and your email correspondence deleted after that. Permission for this study has been given by the UKZN Humanities & Social Sciences Research Ethics Committee HSS/0179/012. The results of the survey will be released via the ADSA newsletter.

1. Do you currently treat or have you previously treated diverticular disease? Please underline the correct answer.

1. Yes
2. No

If yes, please indicate approximately how many patients you treat/treated per month or per year

_____

2. Where were you employed when you treated diverticular disease? You may select multiple options. Please underline the correct answer.

- Government hospital
- Private hospital
- Private practice (self-employed)
- Community service
- University department
- Clinical dietitian
- Foodservice dietitian
- Community dietitian
- Clinic dietitian
- Specialised Gastrointestinal unit

Other (please specify)

_____
_____

3. Have you found in your experience that there are foods that provoke attacks of diverticulitis? Please underline the correct answer.

1. Yes
2. No

If yes, please list the foods in order of importance (from the most to the least important)

_____
_____
_____

4. In your opinion are probiotics beneficial in the treatment of diverticular disease? Please underline the correct answer.

1. Yes
2. No
3. Not sure

_____

5. In your opinion are prebiotics beneficial in the treatment of diverticular disease? Please underline the correct answer.

1. Yes
2. No
3. Maybe

_____

6. Do you routinely prescribe any of the following supplements? Please underline the correct answer.

1. Probiotics
2. Prebiotics
3. Both probiotics and prebiotics
4. Neither

If you prescribe probiotics, please specify the product name and dose that you prescribe (if it differs from that recommended by the manufacturer) and briefly the reason for the choice of that particular product

_____
_____
_____

If you prescribe prebiotics, please specify the product name and dose that you prescribe (if it differs from that recommended by the manufacturer) and briefly the reason for the choice of that particular product

_____
_____
_____
_____
_____

7. When your patients are in between acute attacks, which of the following approaches do you use? Please underline the correct answer

1. A high mainly insoluble fiber diet (wheat bran, fruit skins, nuts, seeds, pips) with 25 - 35g of fiber per day
2. A high mainly insoluble fiber diet (wheat bran, fruit skins, nuts, seeds, pips) with 31 - 45g of fiber per day
3. A low insoluble fiber (avoid skins, nuts, seeds and pips) and high soluble fiber diet
4. A high soluble fiber plus insoluble fiber (wheat bran, bran flakes) but with the avoidance of skins, pips, whole grains and nuts
5. Other

If other, please specify

_____
_____

8. Do you routinely prescribe a supplement of any of the following? Please underline the correct answer

1. Insoluble fiber
2. Soluble fiber
3. Insoluble/soluble fiber blend
4. Don't supplement fiber

If you prescribe fiber supplements, please specify the product name and dose that you prescribe (if it differs from that recommended by the manufacturer) and briefly the reason for the choice of that particular product.

_____
_____
_____
_____

9. If you prescribe supplements <u>other</u> than pre/probiotics and fiber please specify the product name and dose that you prescribe (if it differs from that recommended by the manufacturer) and briefly the reason for the choice of that particular product.

_____
_____

_____
_____

10. Are there any further dietary modifications/restrictions that you would implement? Please comment below.

_____
_____
_____
_____

11. Do you find that your patients:

1. Respond well with significant improvement in symptoms and have a decreased relapse rate?
2. Respond well with significant improvement in symptoms and have a decreased relapse rate but that they feel that the diet is restrictive and impacts negatively on quality of life?
3. Do not respond well and there are no significant improvement in symptoms and no decreased relapse rate?
4. Other

If other, please specify

_____
_____
_____

12. From your experience in treating diverticular patients, would you agree with the approach of not restricting insoluble fiber and/or allowing skins, pips, nuts and seeds with the use of high fiber supplements? Please explain why. Your opinion is very important.

_____
_____
_____
_____

13. The current guidelines for diverticular disease state that no changes in the diet are necessary and a patient can eat any fiber he/she wants. In your professional opinion, do you agree with this statement?

1. Yes
2. No

If you disagreed, please specify which diet you would prescribe for a diverticular patient and why you have chosen that diet.

Thank you very much for completing this questionnaire.
Your time and effort is highly appreciated.
Please save your questionnaire
and then attach the questionnaire to an email and send to
tanyamarch@telkomsa.net

School of Agricultural, Earth and Environmental Sciences
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Telephone: **+27 (0) 33 260 5515** Facsimile: **+27 (0) 33 260 6094** Email: saees@ukzn.ac.za Website: www.ukzn.ac.za

APPENDIX B: DIVERTICULAR LETTER AND INFORMED CONSENT

Dear Dietician

MASTERS STUDENT -DIVERTICULITIS SURVEY

WIN a R1000 Gift Voucher from Yuppy Chef.

If you are interested in your name being put into a draw for winning a **R1000 Yuppy Chef Voucher**, please complete the Diverticulitis Survey. If you have already completed the questionnaire, your response has automatically been entered into the R1000 draw.

The Diverticulitis Survey intends to establish whether practicing dietitians are implementing a high insoluble fiber diet or a low insoluble fiber diet (no nuts, skins, pips, seed) in the treatment of diverticular disease, whether supplements of fiber, prebiotics and probiotics are being prescribed and whether there are any particular foods that are thought to provoke attacks. The questionnaire takes less than 10 minutes to answer. If you do not treat diverticular disease, please send an email to tanyamarch@telkomsa.net and state that "you do not treat", your response counts.

Please follow this link, http://diveticulitis.weebly.com/ to enable you to complete the survey. The file will download into Word. The password is **DIET**. Please note that by sending the email you are providing informed consent. Please return the questionnaire to tanyamarch@telkomsa.net. The results will be forwarded to you once the masters has been completed.

Chara Biggs (biggsc@ukzn.ac.za, 0814877950) is the supervisor for this masters. Permission for this study has been given by the UKZN Humanities & Social Sciences Research Ethics Committee HSS/0179/012. If you have any questions, please contact Tanya March at tanyamarch@telkomsa.net or on her cell, 0845999021.

Thank you so much for your time and support.

Warm regards,

Tanya March,RD (SA)

Masters Student

School of Agricultural, Earth and Environmental Sciences
iSikole seSayensi yeZolimo, eZomhlaba kanye Nemvelo
Postal Address: **University of KwaZulu-Natal, Pietermaritzburg Campus, Private Bag X01, Scottsville, 3209**
Telephone: **+27 (0) 33 260 5515** Facsimile: **+27 (0) 33 260 6094** Email: saees@ukzn.ac.za Website: www.ukzn.ac.za

APPENDIX C: ETHICAL APPROVAL OF THE STUDY

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

Research Office (Govan Mbeki Centre)
Private Bag x54001
DURBAN, 4000
Tel No: +27 31 260 3587
Fax No: +27 31 260 4609
Ximbap@ukzn.ac.za

23 May 2012

Ms Chara Biggs 13
SAEES

Dear Ms Biggs

Protocol reference number: HSS/0179/012
Project title: Current practices of private practising dieticians in South Africa regarding the treatment of diverticulosis/diverticulitis.

EXPEDITED APPROVAL

I wish to inform you that your application has been granted Full Approval through an expedited review process:

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....

Professor Steven Collings (Chair)
Humanities & Social Sciences Research Ethics Committee

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APPENDIX D: FIBER SUPPLEMENTS PRESCRIBED BY DIETITIANS

	FIBER SUPPLEMENTS								
Product Name	**Agiobulk**	**Benefiber**	**Duphalac**	**Fiber Clear (Dischem)**	**Fybogel (ispaghula)**	**Glucachol 22**	**Psyllium Husk**	**Nativa Spasmopep**	**Futurelfe**
Total number	**1**	**17**	**1**	**3**	**15**	**3**	**12**	**3**	**1**
Plantago ovata	*								
Ispaghula husks	*								
Wheat dextrin		*							
Ispaghula					*				
Lactulose			*						
Oar Bran powder						*			
Psyllium Husk							*		
Probiotic									
Enzymes								*	
Cascara Sagrada								*	
Pectin								*	
FOS								*	
Inulin									*
Bromelain								*	
Vitamins									*
Minerals									*
SmartMaize									*
FutureSoy									*
Sucrose									*
Vegetable oil									*
Soya Isolate									*
Fructose									*
Lecithiin									*
Cocoa Powder									*
Beetroot red									*
Moducare									*

Product Name	Aim Herbal Life Fiber Blend	Clicks Fiber Supplement	Dischem Fiber Supplement	Fresubin Energy Fiber Drink	GNLD Fiber	Lactulose	Oats	Oatbran	Encourage food
Total Number	**1**	**3**	**2**	**1**	**2**	**1**	**2**	**24**	**5**
Plantago ovata									
Oats *(Avena sativa)*							*		
Bran of the oats *Avena sativa)*								*	
Ispaghula husks									
Wheat dextrin		*		*					
Ispaghula									
Lactulose						*			
Oar Bran powder									
Psyllium Husk	*				*				
Inulin from Chicory				*					
Neo-Polyfiber (soy fiber, whole oat fiber, acerola)					*				
Pea Fiber					*				
Soy Fiber					*				
Apple Fiber					*				
Banana Powder					*				
Guar Gum					*				
Prune Powder					*				
Almond Powder					*				
Apricot Powder					*				
Cellulose				*					
Fructose					*				
Vitamins				*					
Minerals				*					
Maltodextrin				*	*				
Vegetable oil				*	*				
Milk Proteins				*					
Whey Proteins					*				
Emulsiifiers (soya lecithin)				*	*				
BlackAlfalfa walnut	*								

Licorice	*								
Shavegrass	*								
Rose hip	*								
Oatstraw	*								
Pumpkin	*								
Irish Moss	*								
Yucca	*								
Passionflower	*								
Marshmallow	*								
Capsiucum	*								
Violet	*								
Mullein	*								
Witch Hazel	*								
Slippery Elm	*								
Product Name	**Metamucil**	**Movicol**	**Nestle Nutren Fiber**	**NRF**	**Normicol**	**Solal Invisible Fiber**	**Tony Ferguson dietary powder**	**Wheat Bran**	
Total Number	**2**	**5**	**1**	**1**	**1**	**2**	**1**	**1**	
Plantago ovata									
Wheat Bran								*	
Guar Bean Fiber						*			
Sterculia					*				
Macrogol (polyethylene glycol)		*							
Psyllium Husk	*								
Pea fiber			*						
Oligofructose			*						
Sucrose			*						
Vitamins			*						
Minerals			*						
Emulsifier			*						
Electrolytes		*							
Maltodextrin			*						
Milk proteins (whey/caseinate)			*						

Vegetable oils			*						
Sucrose			*		*				
Sodium hydrogen carbonate					*				
Talc					*				
Titanium dioxide					*				
Hard paraffin					*				
Vegetable oils			*						
Sucrose			*		*				
Sodium hydrogen carbonate					*				
Talc					*				
Titanium dioxide					*				
Hard paraffin					*				

APPENDIX E: PROBIOTIC SUPPLEMENTS PRESCRIBED BY DIETITIANS

	Probiotic							
Product name (n)	**Entiro Capsules**	**Vivomixx**	**LP299 v-Adcock Ingram**	**VSL3#**	**Reuterina Daily**	**Bioflora Combiforte**	**Interflora**	**Intestiflora – Bioflora**
Total Number	4	1	17	10	13	2	2	17
Bifidobacterium bifidum						*		*
Bifidobacterium breve		*		*				
Bifidobacterium longum		*		*		*		*
Bifidobacterium infantis		*		*				
Enterococcus mundtii	*							
Lactobaciillus acidophilus		*		*		*		*
Lactobacillus bulgaricus		*						
Lactobacillus delbrueckii subsp. bulgaricus		*		*				
Lactobacillus paracasei		*		*				
Lactobacillus plantarum	*	*		*				
Lactobacillus plantarum 299v			*					
Lactobacillus reuteri **Protectis ™**					*			
Lactobacillus rhamnosus GG						*		
Saccharomyces boulardii 17							*	

Streptococcus thermophiles		*		*				
	Probiotic					**Probiotic, Enzyme & Glutamine/FOS**		
Product Name	**Ultraflora Spectrum Metagenics**	**Ultra flora intensive care-Metagenics**	**Ultraflora Balance-Metagenics & Amipro Daily flora**	**Ultraflora Acute Care – Metagenics**	**Enteron LP299v**	**Gastrochoice Probiotic**	**Gastrochoice IBS**	**Solal Probiotic Maximum**
Total Number	2	4	22	4	1	7	4	1
Bifidobacterium lactis						*	*	*
***Bifidobacterium lactis* Bl-04**	*							
***Bifidobacterium lactis* Bi-07**	*		*					
***Bifidobacterium lactis* HNO19**				*				
Lactobaciillus acidophilus						*	*	*
***Lactobaciillus acidophilus* NCFM®**	*		*					
Lactobacillus Casei						*		
Lactobacillus plantarum							*	
***Lactobacillus plantarum* Lp-155**	*							
Lactobacillus plantarum 299 v		*			*			
Lactobacillus rhamnosus						*	*	
***Lactobacillus rhamnosus* HN001**				*				
***Lactobacillus salivarius* Ls-33**	*							
Lactobacillus sporogenes								*

Saccharomyces boulardii	*			*				
Saccharomyces cerevisiae								*
Streptococcus thermophiles **St-21**	*							
FOS								*
Enzymes						*	*	*
Glutamine						*	*	
	Pre & Probiotics						**Pre & Probiotic, Vitamins/ Enzymes**	
Product Name	**Probiflora 4-Adult classic Bowel Support**	**Probiflora 9- Adult Intensive Rescue**	**Probiflora Colonease**	**Real Thing Pro-probiotic**	**Biogen Probimax 4 Strain**	**Foodstate 11 Strain**	**Nativa Digestive Complex Capsules**	**Green Vibrance Health**
Total Number	10	22	2	2	2	1	1	1
Bifidobacterium bifidum				*		*	*	
Bifidobacterium breve						*		
Bifidobacterium breve HA-129								*
Bifidobacterium lactis					*	*		
Bifidobacterium lactis Bi-07	*							
Bifidobacterium lactis Bl-04		*						
Bifidobacterium lactis HNO19		*						
Bifidobacterium longum				*		*	*	
Bifidobacterium longum Bl-05		*						
Bifidobacterium longum HA -135								*
Bifidobacterium infantis						*	*	

Lactobaciillus acidophilus				*	*		*	
Lactobaciillus acidophilus HA-122								*
Lactobaciillus acidophilus NCFM ®	*	*				*		
Lactobacillus bulgaricus						*		
Lactobacillus Casei			*	*	*	*		
Lactobacillus Casei Lc-11	*	*						
Lactobacillus helveticus			*					
Lactobacillus helveticus HA-132								*
Lactobacillus lactis			*					
Lactobacillus lactis HA-136								*
Lactobacillus Lactis Ll-23	*	*						
Lactobacillus longum			*					
Lactobacillus paracasei				*				
Lactobacillus plantarum						*		
Lactobacillus plantarum Lp-115		*						
Lactobacillus rhamnosus				*		*		
Lactobacillus rhamnosus B HA -114								*
Lactobacillus rhamnosus HA-111								*
Lactobacillus rhamnosus HNOO1		*						

Lactobacillus paracasei HA-108								*
Lactobacillus Plantarum HA-119								*
Lactobacillus sporogenes				*				
Lactococcus lactis					*			
Propionibacterium bifidum HA-132								*
Saccharomyces boulardii				*				
Saccharomyces boulardii 17								
Streptococcus thermophillus				*		*		
Streptococcus thermophillus HA-132								*
Streptococcus thermophilles St-21		*						
Pectin							*	
FOS	*	*			*	*		*
FOS Raftilose ™			*					
Inulin				*			*	
Oligofructose				*				
Ispaghula Husk			*					
Digestive Enzymes							*	*
Vitamin Blend								*