A systematic review of adherence to restricted diets in people with functional bowel disorders

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Full title: A systematic review of adherence to restricted diets in people with functional bowel disorders

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ABSTRACT

Functional bowel disorders such as irritable bowel syndrome are commonly experienced within the population, and have an adverse impact on emotions, physical well-being, social activity, and occupational output. Adherence to a restricted diet can reduce symptoms, which in turn leads to increased quality of life and well-being. The aim of this review was to assess the extent to which predictors of dietary adherence have been considered in studies relating to functional bowel disorders and following a restricted diet. This was done firstly by examining such studies which contained a measure or indicator of adherence, and then by examining predictors of adherence within and between studies. A search of PsycINFO, Medline, CINAHL, Web of Science, and Cochrane databases was performed during July 2014, with the search criteria including relevant terms such as gastrointestinal disorder, irritable bowel syndrome, diet, and adherence. Of an initial 7927 papers, 39 were suitable for inclusion. Fourteen of the 39 studies included had a structured measure or indicator of dietary adherence, and the remaining 25 mentioned adherence without any structured levels of adherence. There was little investigation into the predictors of adherence, with symptom relief or induction being the primary goal of most of the studies. This review indicates that predictors of dietary adherence are rarely considered in research regarding functional bowel disorders. Further investigation is needed into the variables which contribute to rates of adherence to restricted diets, and more rigorous research is needed to characterise those individuals most likely to be non-adherent. Such research is necessary to ensure that people with these conditions can be provided with appropriate support and interventions.
INTRODUCTION

Functional bowel disorders (FBDs) are a group of disorders that include irritable bowel syndrome (IBS), functional bloating, functional diarrhoea, and functional constipation (Drossman, 2006). It is estimated that 10-20% of individuals worldwide experience IBS, 10-30% experience functional bloating, up to 27% experience functional constipation, and 5-10% experience functional diarrhoea (Longstreth et al., 2006). Some of the most commonly experienced symptoms among people with FBDs are bloating, abdominal pain, abdominal distension, and altered bowel habits (Longstreth et al., 2006).

Living with a FBD has a number of adverse impacts on an individual’s emotions, physical well-being, social activity, functioning in the home environment, and occupational output (Drossman, 2006). These disorders have a negative impact on an individual’s overall quality of life (QOL), with reduced QOL shown to be one of the primary indirect costs of FBDs (Lackner, Gudleski, DiMuro, Keefer, & Brenner, 2013). The symptoms experienced by people with FBDs have been found to play a key role in QOL outcomes. Severity of abdominal pain and discomfort have been shown to be independent predictors of reduced QOL in FBD populations (Wilson et al., 2004); and a review of the impact of IBS on QOL reported that the health related impact of IBS is of a similar significance to that experienced by people with diabetes, hypertension, and kidney disease (Agarwal & Spiegel, 2011).

Many of the symptoms seen in FBDs, such as bloating and bowel motility changes, stem from distension of the intestinal lumen (Gibson & Shepherd, 2010). Reducing foods which have the potential to cause luminal distension is an effective approach to reducing the onset of FBD symptoms (Shepherd, Parker, Muir, & Gibson, 2008). For example, adhering to a restricted diet by reducing consumption of one or more of fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (known collectively as FODMAPs); which are poorly absorbed in the small intestine has been shown to lead to symptom relief in up to 75%
of people with IBS (Gibson & Shepherd, 2010; Thomas, Nanda, & Shu, 2012). Gibson and Shepherd (2010) have argued that the research base for the benefits of following a low FODMAP diet is sufficient for it to be recommended as an evidence based clinical approach to treating functional gut symptoms.

The extent to which individuals adhere to restricted diets has been linked to the magnitude of reduction in FBD symptoms experienced, and to increases in QOL in a number of studies (Atkinson, Sheldon, Shaath, & Whorwell, 2004; Austin et al., 2009; Drisko, Bischoff, Hall, & McCallum, 2006). Given the considerable symptom relief associated with adherence to such a restricted diet and the relationship between extent of adherence and symptom relief, it might be expected that individuals with FBDs are typically strictly adherent to restricted diets. However, research from other gastrointestinal disorders with overlapping gastrointestinal symptom profiles (e.g. coeliac disease; Sanders, 2002) suggests that this may not be the case. Given the long term health implications of non-adherence to a gluten free diet for individuals with coeliac disease (Hall, Rubin, & Charnock, 2009), it would be expected that individuals with coeliac disease would be highly motivated to adhere to the diet. Instead, a systematic review of adherence to gluten free diets within coeliac disease reported that up to 32% of people with a confirmed diagnosis of coeliac disease do not adhere to the gluten free diet at all, while up to 60% of people are only partially adherent to the diet (Hall, Rubin, & Charnock, 2009). The low rates of dietary adherence seen in people with coeliac disease suggest that individuals with FBDs may also struggle to adhere to restricted diets that would provide symptom relief. Gaining an understanding of the adherence to restricted diet among individuals with FBDs, and the factors that place individuals at increased risk of non-adherence, is an important step in providing effective treatment and support for individuals with FBDs.
The aim of this review is to assess whether predictors of dietary adherence have been considered in studies relating to FBDs and following a restricted diet. In order to achieve this aim, the review will consider all such studies which have assessed adherence to restricted diets within FBD populations. This will be done firstly by examining such studies which contained a measure or indicator of adherence, and then by identifying those which have considered predictors of adherence.

MATERIALS AND METHODS

A systematic review was performed in accordance with the PRISMA guidelines (Figure 1; Liberati et al., 2009). Studies that had examined adherence to a restricted diet among individuals with a FBD were identified through searching the following databases: PsycINFO, Medline, CINAHL, Web of Science, and Cochrane. Dates in the search spanned from 1965 until 22nd July 2014. Search terms included gastrointestinal disorder, irritable bowel syndrome, diet, and adherence (see Appendix A for the full search strategy). Searches were restricted to English-language papers and human studies. The participants of interest were adults aged 18 years and over. Studies solely involving children and adolescents were rejected as it may be assumed that their diets would have a higher level of parental control, making adherence levels less clear. All studies comprised at least one group with a FBD.

Quantitative studies, including randomised control trials, prospective studies, and retrospective studies were eligible for inclusion. Studies needed to include a measure or indicator of dietary adherence to be considered in the study findings. In particular, studies needed to include a measure or indicator of successful adherence to a restricted diet or failure to adhere to restricted diet.

Relevant studies were identified during title screening by authors EK and TO. Of the 7927 titles identified, 10% were shared by both reviewers. Inter-relater agreement was
substantial (Landis & Koch, 1977); Cohen’s Kappa=0.693. Abstract screening was conducted by the first author (TO); and those remaining after abstract screenings were subject to full-text screening and a final decision (see Figure 1). A relevance tool was used to assess all full text articles for relevance; and a data extraction form which was adapted from a previous measure (Hedin & Källestål, 2004) outlined study design, intervention description (if relevant), theoretical basis of the study, timeframe, outcome measures, participant characteristics, results, and statistical analyses. Data were extracted from the studies included in this review by the first author (TO).

Owing to the variation in study aims and outcome measures, it was not possible to conduct a meta-analysis. Therefore, a qualitative investigation of the studies was conducted.
RESULTS

The search strategy yielded 39 articles that met criteria for inclusion. A detailed description of each study is included in Appendix B.

Study characteristics

Studies ranged in size from 12 to 1658 participants (King, Elia, & Hunter, 1998; Whitehead et al., 2004). A comprehensive range of participant ages were reported, from 14 years through to 87 years; however, two of the studies did not report these figures (Corlew-Roath & Di Palma, 2009; Parker et al., 1995), and in one study it was only reported as 18+ years (Mishkin, Sablauskas, & Mishkin, 1994). Most of the studies were mixed gender, with one of the studies comprising a female sample (King et al., 1998); and only one study had more men than women (Manning, Heaton, & Harvey, 1977). A number of restricted diets were adhered to in the identified studies including reducing specific carbohydrates, restricting personally specific trigger foods, elimination and rotation diets, gluten exclusion, and excluding foods seen to raise IgE or IgG levels (see Appendix B).

The range of sample sizes, age ranges, and diet types indicates that the studies are likely to have captured a wide range of FBD experiences. However, the studies were predominantly from industrialised countries, with nine from the United Kingdom and eight from the United States. Only one of the studies was from Asia, with the remainder being from North America, Europe, Australia, and New Zealand. None of the included studies were from Africa or South America; however, the search criterion was limited to English language studies which may have eliminated research from these areas. The limited coverage of FBD experiences outside of industrialised countries may present a threat to the generalizability of
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these findings to other contexts and should be taken into account when interpreting these results.

Studies with structured measures of dietary adherence

Each study was examined to identify whether it included a structured measure of dietary adherence. For the purposes of the review a structured measure was one which had more than two nominal categories, or measured adherence on a ratio scale. Twenty-five studies were included in the review because they investigated the level of adherence to the dietary restriction required for the study; however, they did not do so using a structured measure (see Appendix B for a summary of each of these studies). Instead, adherence was discussed using descriptors such as “all patients adhered” (Biesiekierski et al., 2011), “high degree of compliance” (Suarez, Savaiano, & Levitt, 1995) the diet was not adhered to by “some” (Fernandez-Banares et al., 2007) and “poor” (Fernández-Bañares et al., 2006) that were not explained. As such, the exact rates of adherence for many of these studies could not be determined, and the predictors of dietary adherence could not be examined within these studies.

The structure of adherence scales

Only 14 of the studies included in the review included a structured measure of adherence. These studies are outlined in Table 1. None of the studies that included a structured measure used the same scale, and none of the studies specified that their measures were taken from other sources; therefore it is assumed they were created by the authors for the studies.

A number of the 14 measures identified contained ratio scales to assess adherence levels. For example, in one Never related to no adherence, Occasionally to less than 50% of
the time, *Frequently* to more than 50% of the time, and *Always* as being followed totally (Shepherd & Gibson, 2006); while in another a 0-100 scale was employed where 0 equalled *did not do this at all*, and 100 equalled *followed the doctor’s recommendation completely* (Whitehead et al., 2004); and in yet another adherence was rated on a 0-100 visual analogue scale (Moritz et al., 2013). Participants who adhered for more than 81% of the days in one study were considered to be adherent (Halmos, Power, Shepherd, Gibson, & Muir, 2014); while another employed a mix of percentage of the time categories and additional options such as *followed at all times except when eating away from home* (de Roest et al., 2013).

Another used six ‘percentage of the time’ categories of adherence; however, it was only presented in a table comparing adherence with complaint improvement experienced, and it was not possible to work out how many participants fell into in each adherence band (Sui, Djuras, & Kostner, 2012).

While a number of studies quantified categories such as *strict* and *adequate* with an accompanying percentage of the time that participants had adhered (Choi, Kraft, Zimmerman, Jackson, & Rao, 2008; Staudacher, Whelan, Irving, & Lomer, 2011; Wilder-Smith, Materna, Wermelinger, & Schuler, 2013), there was no consensus on the frequency of adherence relating to each adherence category, which made comparisons between these studies difficult. In addition, categories such as *low*, *moderate* and *strict* were reported without quantifiable levels in a number of studies (Atkinson et al., 2004; Born, Vierling, & Paul, 1994; Caio, Volta, Tovoli, & De Giorgio, 2014; Goldstein, Braverman, & Stankiewicz, 2000), which made comparison impossible.

Four studies included a ‘strict’ adherence category (Born et al., 1994; Caio et al., 2014; Goldstein et al., 2000; Staudacher et al., 2011) yet only one of the four provided a definition of strict (not knowingly consuming gluten) (Caio et al., 2014). The lack of
common definitions of adherence categories within different measures is a major limitation of research within this area.

**Rates of dietary adherence**

Rates of adherence to the diets within the studies ranged from 34 to 93% in the six studies which categorised adherence as being either strict, high/full, or always adherent (Atkinson et al., 2004; Born et al., 1994; Caio et al., 2014; Goldstein et al., 2000; S. J. Shepherd & Gibson, 2006; Staudacher et al., 2011). Where non-adherence was defined as not adhering to a restricted diet at all, ranges were from 0 to 30% (Born et al., 1994; de Roest et al., 2013; Goldstein et al., 2000; Shepherd & Gibson, 2006). For studies which broke adherence rates into percentages of the time, 14.4 to 85% of participants reported adhering to the diet at least 50% of the time (Choi et al., 2008; de Roest et al., 2013; Shepherd & Gibson, 2006; Staudacher et al., 2011; Wilder-Smith et al., 2013). It would appear that even when common definition of adherence are used within studies, there are marked differences in rates of adherence to restricted diet between studies. Predictors of adherence within these studies, and the factors that might explain the marked differences in rates of adherence between studies will be considered in the following section.

**Formal investigation of predictors of adherence within included studies**

Despite high levels of non-adherence in some studies, there was limited consideration of the reasons why some people do not adhere to these diets. Only two studies conducted a formal investigation of predictors of adherence. One investigated just one predictor of adherence, gender, and found that adherence was better for women than men (39% vs. 26%; Goldstein et al., 2000). The long term ($M = 15.7$ months) prospective study of the low FODMAP diet (de Roest et al., 2013) considered the relationship between aspects of the diet
and adherence, and found that the taste of the diet, ease of following the diet, and ease of incorporating the diet into everyday life were significant predictors of adherence.

In addition to identifying quantitative predictors of adherence, a number of studies included qualitative questioning on the barriers to adherence. Qualitative questioning of those classed as non-adherers in the Shepherd and Gibson (2006) study indicated that an unwillingness to undertake dietary restriction, the expense of specialty foods, poor access to specialty foods, dislike of foods, and the challenges of following the diet when eating out were all barriers to adherence. Time per week spent adhering to a restricted diet and impact on lifestyle was considered in one study involving fructose exclusion or restriction for 12 months (Choi et al., 2008), with participants reporting that dietary restriction had a mild to moderate effect on lifestyle, with an average of 1-3 hours per week spent on tasks involving the restricted diet. While the authors reported that those who had adhered to the diet intended to continue doing so, no reasons for non-adherence were established and the potential link between the effect on lifestyle and adherence rates was not examined. When asked to rank the importance of five variables associated with dietary adherence and efficacy in one long term low FODMAP study by de Roest et al. (2013), participants ranked written information as the most important, followed by dietician consultation, support of family and friends, cookbooks, and online information.

**Comparison of adherence across included studies**

Given that the formal investigation of predictors of adherence within the studies was limited, the remainder of this review will compare rates of adherence across studies in an attempt to identify patterns of adherence and non-adherence that suggest potential predictors of adherence that warrant further investigation.
Symptom relief as a predictor of adherence

One factor that might distinguish between individuals who continue to adhere to the diet and those who do not is the level of symptom relief experienced by individuals following a restricted diet. It may be assumed that people who experience symptom improvement from a restricted diet would be more likely to adhere to one, as seen by the intention to keep adhering being reported by study participants (Choi et al., 2008); however this relationship was not analysed in any of the studies located. While the role of symptom improvement in predicting adherence is not well established, the role of increased levels of adherence on symptom relief has been shown in a number of studies. For example, strict adherence to a reduced fructose diet was found to be associated with symptom relief, with 100% of those who had strict dietary adherence and no other co-morbid conditions reporting no bowel complaints in one study (Born et al., 1994). A reduced fructose diet was found to benefit the symptoms of those adherent 50% of the time or more (Choi et al., 2008); and 85% of those following a reduced fructose and fructan diet more than 50% of the time had a positive symptoms response compared to 36% of those who adhered less than 50% of the time (Shepherd & Gibson, 2006). In addition, higher levels of dietary adherence and better symptom outcomes were found to be associated in the studies reducing IgG antibodies (Atkinson et al., 2004), fructose (Sui et al., 2012), fructose or lactose (Moritz et al., 2013), gluten (Caio et al., 2014) and FODMAPs (de Roest et al., 2013). These analyses indicated that increased adherence to a restricted diet does improve symptom experience. However, analyses were not conducted to explore the extent to which symptom severity at baseline explained adherence to a restricted diet and the role that symptom relief has as a predictor of ongoing adherence.

The role of presenting condition
The presenting condition did not appear to play a role in the rates of dietary adherence. Five of the samples comprised people with IBS according to the Rome II criteria, one comprised people with fructose malabsorption, one people with lactose intolerance and fructose malabsorption, one non-coeliac gluten sensitivity, and the remainder people with IBS and/or other functional complaints. No differences in adherence outcomes between these groups were evident.

The role of diet type

A number of restricted diets were adhered to in the identified studies, with those that reduced one or more carbohydrates being the most frequently studied. Other diets included elimination and rotation diets, restricting personally specific foods, gluten exclusion, and elimination of foods seen to raise IgE or IgG levels (see Appendix B). In one study the diet was poorly specified, only being described as following doctor’s advice (Whitehead et al., 2004). The ease of following the diet, the extent of dietary restriction required to follow the diet, the availability of food, and the impact on lifestyle of the diets are likely to vary between these different types of diet. Given that these factors were found to be barriers to adherence in formal investigation of dietary adherence by Choi et al. (2008) and Shepherd and Gibson (2006) we sought to compare rates of adherence by diet type.

Comparisons between diets where common definitions of adherence have been used indicate that diet type may not predict adherence. For example, studies of the low FODMAP diet report that 94% of participants adhered to the diet for more than 50% over a 9 month period (Staudacher et al., 2011), and over 75% of participants met this criteria over a 15.7 month period (de Roest et al., 2013). This is similar to the rate of adherence reported within to long term fructose reduction studies which showed 77% of participants reported adhering for more than 50% of the time over 2-40 months (Shepherd & Gibson, 2006).
A number of the included studies provided all or most food to individuals for up to 22 weeks (Austin et al., 2009; Biesiekierski et al., 2013; Halmos et al., 2014; King et al., 1998; Ong et al., 2010; Peters, Biesiekierski, Yelland, Muir, & Gibson, 2014; Shepherd et al., 2008; Vazquez-Roque et al., 2013). These studies eliminated the barrier of food availability and thus it may have been assumed that adherence within such studies would have been higher than those in which participants had to source their own foods. However, this did not appear to be the case, for example in one study where almost all food required for the low FODMAP diet was provided, only 80% of participants adhered to it for more than 81% of the time (Halmos et al., 2014), which indicates that factors other than food availability play a role in restricted diet adherence.

**Length of follow-up**

One factor that may explain the difference in adherence rates between studies may be the length of follow-up involved. For instance, a study which reported 0% non-adherence rates (Goldstein et al., 2000) was run over a one month period; whereas those with the highest rates of non-adherence at 13% (Shepherd & Gibson, 2006), 24.4% (de Roest et al., 2013) and 30% (Born et al., 1994) had longer time spans of up to 40, 15.7 and 3 to 6 months respectively.

However, in the study where 24.4% of participants were non-adherent to the low FODMAP diet at 15.7 months (de Roest et al., 2013), it was also reported that another 14.4% had followed the diet as taught for up to 3 months and stopped, and that another 5.6% had followed the diet as taught initially but were following it less than 50% of the time at follow up. This may indicate that the increased time that participants were expected to adhere to a restricted diet in these studies led to a decrease in willingness to undertake such a restriction, leading to an ongoing but less strict adherence level in the longer term. It may also be that
experiencing a lack of symptom benefit may have caused cessation of the diet. Further, these findings also indicate that studies which only measure adherence over a short-term follow-up may overestimate true rates of adherence within the community.

**Psychological and psychosocial predictors**

Psychological and psychosocial variables were considered in a number of studies. Quality of life improvements were seen in the very low-carbohydrate diet study by Austin et al. (2009); IBS QOL had improved at 1 year post intervention in the Drisko et al. (2006) elimination diet and food challenge study; and IBS QOL had increased after 3-9 months following the low FODMAP diet in the study by Mazzawi, Hausken, Gundersen, and El-Salhy (2013). No attributions were able to be made for the role of personality factors in perceptions of lactose intolerance in the study by Suarez, Savaiano, Arbisi, and Levitt (1997); depression, anxiety, and QOL were not found to differ significantly between diet and control groups in the IgG elimination diet study by Atkinson et al. (2004); and depression and anxiety were improved at follow up in the study by Zar, Mincher, Benson, & Kumar (2005). However, the role of these variables in explaining adherence rates was not investigated in any of the studies.

**DISCUSSION**

This review assessed past studies for the inclusion of predictors of adherence to restricted diets in people with functional bowel disorders. This was done firstly by examining studies which contained a significant measure or indicator of adherence, and then by examining those studies to ascertain which had considered predictors of adherence and by comparing rates of adherence between studies to identify potential predictors of adherence.
Of a total of 39 studies which had measured or indicated adherence to a restricted diet, 14 included structured or defined measures of adherence.

A consideration of predictors of dietary adherence was not well established in the reviewed studies. While psychological and psychosocial variables were included in a number of studies (Atkinson et al., 2004; Austin et al., 2009; Drisko et al., 2006; Suarez et al., 1997; Zar et al., 2005), these were not considered in relation to adherence rates. Likewise, the roles of symptom relief and diet type as predictors of adherence were not considered in the included studies. Gender was reported as a predictor of adherence (Goldstein et al., 2000), as well as taste, ease of following diet and ease of incorporation into daily life (de Roest et al., 2013). What has been well established in the included studies is that adherence to restricted diets leads to GI symptom improvement in many people, and that increased levels of dietary adherence lead to better improvement of GI symptoms in people with FBDs (Born et al., 1994; Caio et al., 2014; Choi et al., 2008; Corlew-Roath & Di Palma, 2009; de Roest et al., 2013; Moritz et al., 2013; Nanda, James, Smith, Dudley, & Jewell, 1989; Sui et al., 2012; Vernia, Ricciardi, Frandina, Bilotta, & Frieri, 1995). However, it has also been indicated that not everyone who could benefit from a restricted diet will adhere to one, with non-adherence rates of up to 30% seen in FBD samples (Born et al., 1994). This is consistent with the findings that up to 32% of people with coeliac disease are non-adherent to a gluten free diet (Hall et al., 2009). Therefore, more investigation into the predictors of dietary adherence in people with FBD is warranted so that the reasons for non-adherence are better understood.

Analysis of the included studies indicated that the length of time to be spent adhering to the diet may lower strict adherence; and that increased complexity of the diet may also be related to better adherence. However, FBD condition type appeared to play no role in adherence levels. More research is thus needed to clarify the relationships between long term adherence and diet type in conjunction with other predictors of dietary adherence.
Practical factors relating to adherence

A number of practical factors have been highlighted in the included studies as being related to adherence. For example, adherence to a reduced fructose diet was seen to have a mild to moderate impact on lifestyle, with an extra 1-3 hours per week spent on adherence tasks (Choi et al., 2008); however, all of those who had adhered to the diet for 12 months intended to continue with it despite the time and lifestyle impacts. Findings such as these indicate that for many individuals with FBDs the extra time spent is worth the benefit of symptom relief. The impact of ease of incorporating a restricted diet into lifestyle was found to be a significant predictor of adherence in the study by de Roest et al. (2013) where written information, dietitian consultation and the support of friends were ranked highest as being beneficial for efficacy and adherence by participants in this study. Such findings highlight the relevance of investigating the psychosocial predictors of dietary adherence to gain a better understanding of how psychological and social factors contribute to adherence, yet current measures may not be sufficient to measure the full range of factors which contribute to restricted diet adherence rates in people with FBDs. Other practical considerations such as the increased cost of gluten and wheat free breads and pastas, which may be twice the price of their non-speciality counterparts (Lee, Ng, Zivin, & Green, 2007) may also play a role in adherence behaviours.

The psychosocial aspects of adherence

It may be that people with FBDs have good intentions to adhere to a restricted diet that would benefit their symptoms, but for one or more reasons are unable to do so. Therefore, further investigation is warranted to clarify what makes some people adhere highly and others not adhere at all. To investigate this, it may be useful to adopt a theoretical
framework which can help explain the factors which guide adherence behaviours. The theory of planned behaviour (TPB; Ajzen, 1991) is one such framework. The TPB assumes that attitudes (on whether engaging in a behaviour has positive or negative benefits), subjective norms (what others think of engaging in a behaviour) and perceived behavioural control (of having the ability to engage in a behaviour) determine an individual’s intention to perform a behaviour, which informs a subsequent behaviour outcome (Ajzen, 1991). Although the TPB has yet to be applied to FBDs and dietary adherence, it has been successfully used to predict coeliac dietary adherence, as well as in the prediction of a number of other health behaviours (McEachan, Conner, Taylor, & Lawton, 2011). The TPB accounted for 39.4% of the variance in intention to adhere to a gluten free diet, along with depression, anxiety, and quality of life (Sainsbury & Mullan, 2011). Therefore, it is expected that such a theory may also predict intention to adhere to a restricted diet in a FBD sample.

Due to the lack of research into the predictors of adherence behaviours in people with FBDs, more in depth investigation into the psychosocial barriers to and enablers of adherence in this population appears warranted. This is important as it has been estimated that 20% of people with IBS have co-morbid depression (Lackner et al., 2013), while co-morbid anxiety is seen in 15.8% to 16.5% in people with IBS (Lee et al., 2009; Whitehead et al., 2003). This makes the role that psychological variables play in adherence in FBD populations important to consider, as these variables are implicated in adherence within other dietary areas. For example, a study which explored the role of psychological symptoms in gluten free diet adherence found that 8% of the variance in dietary adherence was accounted for by psychological symptoms; with higher reported psychological distress (depression, anxiety, and stress) leading to lower dietary adherence (Sainsbury, Mullan, & Sharpe, 2013). Co-morbid depression has also been found to impact on medical adherence in past research (DiMatteo, Lepper, & Croghan, 2000). While no causality can be assumed from such
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In studies, it may be the case that the experience of an FBD has the potential to increase existing depression, which in turn may make people less likely to adhere to a restricted diet. Further research can provide a better understanding of the interplay between the practical aspects of adhering to a restricted diet and the psychosocial predictors of adherence outcomes.

Further research in this area will also add to the wider body of work on the predictors of dietary adherence behaviours for people with other chronic health conditions which require dietary management. Psychological variables have been found to play a role in adherence behaviours in a number of health areas, with co-morbid depression negatively impacting adherence to self-care behaviours in people with Type-2 diabetes (Sumlin et al., 2014), adherence to dietary weight loss interventions in overweight adults (Somerset, Graham, & Markwell, 2011), reduced dietary and fluid adherence in people with end-stage renal disease (Khalil, Frazier, Lennie, & Sawaya, 2011), and on overall medical adherence in a meta-analysis performed by DiMatteo et al. (2000).

Anxiety has also been found to play a role in dietary adherence, with anxiety and depression associated with reduced dietary adherence in people with heart failure (Luyster, Hughes, & Gunstad, 2009), and with reduced gluten free diet adherence (Barratt, Leeds, & Sanders, 2011). Further, depression, anxiety, and stress have been associated with lower gluten free diet adherence (Sainsbury et al., 2013). The role of anxiety on its own is less clear, with worry linked to increased adherence to diet and exercise behaviours in people with cancer (Mosher et al., 2008).

Negative emotions have been seen to play a role in reduced adherence to dietary and medical advice for people with coronary heart disease (Platt, Green, Jayasinghe, & Morrissey, 2014), and increased levels of negative emotions decreased dietary adherence for people with diabetes mellitus (Travis, 1997). In addition, neural imaging has indicated that successful dietary adherence is dependent on the ability to inhibit emotional responses to
desired foods (Chechlacz et al., 2009). It may also be reasonably expected that emotional states and emotional inhibition will play a salient role in the adherence behaviours of people with FBDs. Collectively, the findings outlined above highlight the importance of further investigation into the psychosocial aspects of adherence, which will add to the knowledge base on FBDs, and more generally for health conditions where adhering to a restricted diet has been found to lead to positive outcomes for patients.

Methodological issues within this body of research

The lack of a common structured measure of dietary adherence in people with FBDs made it difficult to establish any solid predictors of dietary adherence. The difficulties in defining appropriate classifications to assess adherence has been highlighted by Yao et al. (2013) as a limitation of dietary research on functional gastrointestinal disorders; and such difficulties in measurement consistency have also been seen in insulin adherence in Type 1 diabetes (Toussi et al., 2008) and for defining adherence in clinical weight loss interventions (Somerset et al., 2011). In general medical terms, adherence to instructions on 80% of required days has been used as one benchmark for medical adherence (Somerset et al., 2011); however, no gold standard for measuring medical adherence currently exists (Lavsa, Holzworth, & Ansani, 2011).

One measure which has been used to measure adherence in a number of areas is the Morisky Medication Adherence Scale (MMAS; Morisky, Green, & Levine, 1986) which assesses adherence over the prior two weeks, as well as the factors involved in non-adherence such as forgetting and stopping due to feeling that symptoms were controlled. The MMAS has been used for measuring adherence to medical advice in a number of health related areas including Type 2 diabetes (DiBonaventura, Wintfeld, Huang, & Goren, 2013) and inflammatory bowel disease (Long, Kappelman, & Martin, 2014). A modified form of the
MMAS was used to assess the factors involved in gluten free diet adherence in people with coeliac disease, and was utilised to explore the differences between occasions of accidental and voluntary non-adherence to a gluten free diet, as well as how often non-compliance occurred (Casellas, López Vivancos, & Malagelada, 2006).

For the purposes of measuring adherence in FBDs, a tool which is able to differentiate between intentional and accidental deviations from the restricted diet and the reasons for these such as the modified MMAS would provide valuable insights. This differentiation has been established in gluten free diet adherence research, which has shown that inadvertent dietary lapses were more common than intentional lapses (Hall, Rubin, & Charnock, 2013). Within coeliac disease, adherence has been measured using the 7 item Celiac Dietary Adherence Test (CDAT; Leffler et al., 2009) which considers symptoms, self-efficacy, difficulties eating out, the consequences of and importance of non-adherence, and times not adhered to a gluten free diet during the last four weeks. The CDAT categorises scores, which range from 7 to 35, as excellent, good, fair, poor, very poor and not following. The creation and validation of such a measure for use with FBD populations would allow for a fuller understanding of the psychosocial predictors involved in adherence to a restricted diet, as studies that seek to predict variations in adherence without using a validated measure of such adherence will be of limited utility.

**Implications for future research**

As shown in the outcomes of the current review there is evidence for the role of gender in adherence, with women showing higher adherence than men (Goldstein et al., 2000); as well as the role that lifestyle impact (Choi et al., 2008) and challenges accessing food (Shepherd & Gibson, 2006) have on adherence. While these findings should be confirmed in further research, the relationship between gender and adherences indicates a
potential need for additional support for men following a diagnosis of FBD. The findings for lifestyle impact and challenges accessing food are consistent with research in other areas which have found perceived barriers and self-efficacy to be important predictors of adherence (Clark-Cutaia, Ren, Hoffman, Burke, & Sevick, 2014; Hall, Rubin, & Charnock, 2013; Platt et al., 2014). Interventions that seek to reduce perceived barriers to adherence and improve self-efficacy may be successful in improving adherence in this population.

The importance of gaining a broader understanding of what predicts adherence is that appropriate interventions can then be developed to help increase adherence within the population. In particular, given their relationship with adherence in other contexts, it is important that the roles that cognition, personality, and psychological well-being play in adherence in people with functional bowel disorders are better understood. This knowledge would help to guide the development of more effective intervention and support strategies for individuals with FBDs, and allow for the appropriate identification and referral of those people who are less likely to adhere. Indeed, identification of the factors associated with performance of a behaviour is a key component of a number of intervention design frameworks (Bartholomew, Parcel, Kok, & Gottlieb, 2001; Gielen & McDonald, 1997).

This review identified wide variations in the definition of adherence used between studies. The difficulties in defining appropriate classifications to assess adherence has been highlighted by Yao et al. (2013) as a limitation of dietary research on functional gastrointestinal disorders; and such difficulties in measurement have also been seen in insulin adherence in Type 1 diabetes (Toussi et al., 2008) and for defining adherence in clinical weight loss interventions (Somerset et al., 2011). The lack of consistent measurement has made it difficult to compare adherence rates across studies and as such, limits the ability to identify potential predictors of adherence within this context. As such, in order to improve the methodological quality of research within this domain, researchers should clearly define the
levels of adherence used within studies of individuals with FBDs; and should endeavour to use standard measures of adherence behaviour where possible.

The aim of this review was to assess whether predictors of dietary adherence had been considered in FBD studies. Through examining studies which contained a measure or indicator of adherence and then identifying those which have considered predictors of adherence, it became clear that predictors have had little consideration in research. A better understanding of the predictors will allow for the identification of those least likely to adhere, and allow for their referral to appropriate supports. Further research in this area will both add to the current understandings of dietary adherence specifically in people with FBDs, and for that of adherence more broadly in chronic health conditions where dietary restriction is medically recommended.
References


Restricted diet adherence in functional bowel disorders


Sui, Y., Djuras, G., & M. Kostner, G. (2012). Fructose Malabsorption Influences Chronic and Recurrent Infectious Diseases, Dyspepsia and Heartburn. The Open Gastroenterology Journal, 6(1), 1-7.


Table 1  *Summary of studies with structured measures of dietary adherence*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Participants assessed for adherence</th>
<th>Condition</th>
<th>Restricted diet</th>
<th>Reported adherence categories and corresponding rates of adherence</th>
</tr>
</thead>
</table>
| Atkinson et al.  | 93                                  | IBS (Rome II criteria)                         | Foods personally high in IgG antibodies                                        | High/full adherence: 62%  
Medium/moderate adherence: 37%  
Low adherence: 1%                                                    |
| Born et al.      | 46                                  | Fructose malabsorption                        | Reduced fructose                                                               | Strict adherence: 35%  
Moderate adherence: 35%   
Non-adherence: 30%                                                  |
| Caio et al.      | 44                                  | Non-coeliac gluten sensitivity                | Gluten free                                                                    | Strict (not knowingly consuming gluten): 93%  
Low (frequent dietary lapses): 7%                                     |
| Choi et al.      | 26                                  | IBS (Rome II criteria)                        | Reduced fructose                                                               | Adherent half the time or more: 54%  
Adherent less than half of the time: 46%                               |
| de Roest et al.  | 90                                  | Fructose malabsorption, and/or lactose intolerance, and/or small intestinal bacterial overgrowth (SIBO) | Low FODMAP                                                                    | At all times except some occasions: 35.6%  
Followed at all times 12.2%  
At all times except eating away from home 13.3%  
Adherent at least 50% of the time: 14.4%  
Non-adherent: 24.4%  
Followed for up to 3 months: 14.4%  
Followed initially but under 50% of the time now: 5.6%  
Never followed diet 4.4%                                          |
| Drisko et al.    | 20                                  | IBS (Rome II criteria)                        | Tailored food withdrawal                                                      | Adherence rated on a 5-point Likert scale where 1 = strongly disagreed and 5 = strongly agreed that the diet had been adhered to:  
Mean rating = 4.00 (± 1.45)                                           |
| Goldstein et al. | 73                                  | IBS, or functional complaints                 | Reduced lactose and/or fructose and/or sorbitol                                | Strict adherence: 68%  
Partial adherence: 32%   
No adherence : 0%                                                      |
| Halmos et al.    | 30                                  | IBS (Rome III criteria)                       | Low FODMAP                                                                    | Adherent for more than 81% of days: 80%  
Adherent for 81% of days or less: 20%                                  |
<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>IBS Criteria</th>
<th>Diet Focus</th>
<th>Adherence Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moritz et al. (2013)</td>
<td>221</td>
<td>IBS (Rome II criteria)</td>
<td>Fructose free or lactose free diet</td>
<td>Adherence on a 1-100 scale, $M = 87$ (Range = 31-100); 90% rated being adherent more than 70% of the time</td>
</tr>
<tr>
<td>Shepherd &amp; Gibson, (2006)</td>
<td>62</td>
<td>IBS (Rome II criteria)</td>
<td>Reduced fructose and fructans</td>
<td>Always: 38% Frequently (at least 50% of the time): 39% Occasionally (follow less than 50% of the time): 10% Never: 13%</td>
</tr>
<tr>
<td>Staudacher et al. (2011)</td>
<td>36</td>
<td>IBS</td>
<td>Low FODMAP</td>
<td>Strict adherence: 64% Adherent at least half of the time: 30% Adherent less than half of the time: 6%</td>
</tr>
<tr>
<td>Sui et al. (2012)</td>
<td>62</td>
<td>IBS, or IBS and fructose malabsorption</td>
<td>Reduced fructose</td>
<td>Adherence was measured as 90-100%, 80-89%, 70-79%, 60-69%, 40-59%, and not compliant at all (&lt;40%). It was reported that ‘most’ fell into the 80-89% category, followed by the 90-100% category. No firm adherence rates were reported.</td>
</tr>
<tr>
<td>Whitehead et al. (2004)</td>
<td>1658</td>
<td>IBS, or abdominal pain, or diarrhoea, or constipation</td>
<td>Unknown</td>
<td>Adherence rated on a 1-100 scale where 0 = did not do this at all and 100 = followed the doctors recommendations completely: $M = 69.3$</td>
</tr>
<tr>
<td>Wilder-Smith et al. (2013)</td>
<td>312</td>
<td>Lactose and fructose intolerance and malabsorption</td>
<td>Reduced saccharides, polyols, fructose inulin and lactose</td>
<td>Adequate (adhered to guidelines in at least 50% of meals): 85%</td>
</tr>
</tbody>
</table>
Appendix A

Search strategy: EBSCOhost

1. “gastrointestinal disorder*”
2. “gastrointestinal system”
3. “irritable bowel syndrome”
4. “functional bloating”
5. “functional constipation”
6. “functional diarrhoea”
7. “functional diarrhea”
8. “functional bowel disorder:
9. “fructose malabso*”
10. “lactose intol*”
11. disaccharide*
12. monosaccharide*
13. oligosaccharide*
14. polyol*
15. (1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14)
16. diet*
17. adherence
18. 16 OR 17
19. 15 AND 18
### Appendix B

<table>
<thead>
<tr>
<th>Study</th>
<th>Full sample and age in years</th>
<th>Symptom group</th>
<th>Study focus</th>
<th>Diet followed and timeframe</th>
<th>Adherence measure</th>
<th>Adherence outcomes reported</th>
<th>Food given</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atkinson et al. (2004)</td>
<td>$N = 150$; Range = 17-74</td>
<td>IBS (Rome II criteria)</td>
<td>Exclusion of IgG antibodies on IBS symptoms, QOL, anxiety, and depression</td>
<td>Excluding foods to which patient had raised IgG levels for 3 months</td>
<td>Questionnaire at end of diet period</td>
<td>93 participants assessed: high/full adherence = 62%, medium/moderate adherence = 37%, Low adherence = 1%</td>
<td>No</td>
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<tr>
<td>United Kingdom</td>
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<tr>
<td>Born et al. (1994) Germany</td>
<td>Retrospective $N = 81$, $M = 46.2$; Prospective $N = 46$, $M = 41.4$</td>
<td>Fructose malabsorption (FM) without other diagnoses, and with other diagnoses (Other)</td>
<td>The effect of diet on FM symptom relief</td>
<td>Reduced fructose diet: Retrospective for 26 months; Prospective for 3 to 6 months</td>
<td>Questionnaire at 3-6 months post hospital discharge, with adherence rated as strict (S), moderate (M), and non-adherent (N)</td>
<td>Retrospective and Other S=19, M=16, N=11; Retrospective and FM S=15, M=8, N=12; Prospective and Other S=8, M=9, N=6; Prospective and FM S=8, M=7, N=8</td>
<td>No</td>
</tr>
<tr>
<td>Caio et al. (2014) Italy</td>
<td>$N = 84$; Range = 17-63</td>
<td>Non-coeliac gluten sensitivity ($n = 44$) and coeliac disease ($n = 40$)</td>
<td>The effect of a gluten free diet on anti-gliadin antibodies</td>
<td>Gluten free diet 6 months</td>
<td>Questionnaire at 6 months: strict indicated not knowingly consuming gluten and low indicated</td>
<td>Non-coeliac gluten sensitivity group ($n = 44$) only assessed: strict = 93%; low = 7%</td>
<td>No</td>
</tr>
<tr>
<td>Study</td>
<td>Location</td>
<td>Sample Size</td>
<td>Inclusion Criteria</td>
<td>Intervention</td>
<td>Outcome Measures</td>
<td>Adherence Rates</td>
<td>Follow-up Time</td>
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<tr>
<td>Choi et al. (2008)</td>
<td>United States</td>
<td>$N = 80$</td>
<td>IBS (Rome II criteria)</td>
<td>Effect of a long term fructose restricted diet on symptoms</td>
<td>Structured interview at 12 months, with compliant being reducing fructose 50% of the time or more, and non-compliant being reducing less than 50% of the time</td>
<td>26 participants assessed: compliant = 54% ($M$ self-estimate = 71%, Range 50-90%); Non-compliant = 46%</td>
<td></td>
</tr>
<tr>
<td>De Roest et al. (2013)</td>
<td>New Zealand</td>
<td>$N = 192$</td>
<td>Follow up group $M = 47.0$; No reply to follow up group $M = 43.0$</td>
<td>The effect of the low FODMAP diet on GI symptoms in IBS patients</td>
<td>Participants ($n = 90$) were followed up on their symptoms, opinions about the diet, and adherence to the diet</td>
<td>90 participants responded: at all times except some occasions = 35.6%; at all times = 12.2%; at all times except eating away from home = 13.3%; at least 50% of the time = 14.4%; Non-adherent = 24.4%; followed for up to 3 months = 14.4% Followed initially</td>
<td>No</td>
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<tr>
<td>Study</td>
<td>Location</td>
<td>Sample Size</td>
<td>Diagnosis Criteria</td>
<td>Intervention</td>
<td>Outcome Criteria</td>
<td>Result</td>
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<tr>
<td>Drisko et al. (2006)</td>
<td>United States</td>
<td>N = 20</td>
<td>IBS (Rome II criteria)</td>
<td>Tailored food withdrawal and rotation diet based on IgE and IgG status – follow up at 1 year</td>
<td>Questionnaire at 12 months with 5 point Likert scale, 1 = strongly disagree, 5 = strongly agree</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Goldstein et al. (2000)</td>
<td>Israel</td>
<td>N = 239</td>
<td>IBS (n = 94); or Functional complaints (n = 145)</td>
<td>Exclusion of personally relevant sugars: lactose, fructose, sorbitol for 1 month</td>
<td>Self report post exclusion diet. Strict (S), partial (P), and no adherence (N)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Halmos et al. (2014)</td>
<td>Australia</td>
<td>N = 38</td>
<td>IBS (Rome III criteria; n = 30) and Healthy controls (n = 8)</td>
<td>Low FODMAPs or regular diet for 21 days, with washout period and cross-over</td>
<td>Assessment of food diaries. Adherence for 17/21 days (&gt;81%) was arbitrarily considered compliant</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Sample Size</td>
<td>Rome II Criteria</td>
<td>Intervention Duration</td>
<td>Method of Assessing Symptom Reduction and Adherence</td>
<td>Adherence Measurement</td>
<td>Adherence Outcome</td>
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<tr>
<td>Moritz et al. (2013)</td>
<td>Austria</td>
<td>N = 320</td>
<td>IBS (Rome II</td>
<td>Randomised to fructose or lactose free diet for 3 weeks</td>
<td>Those who completed the 3 weeks (n = 221) completed a visual analogue scale for symptoms and adherence</td>
<td>Adherence on a 1-100 scale, with a mean score of 87 (Range = 31-100); and 90% rated being adherent for more than 70% of the time</td>
<td>No</td>
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<td></td>
<td></td>
<td>Range = 19-78</td>
<td>criteria)</td>
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<tr>
<td>Shepherd &amp; Gibson (2006)</td>
<td>Australia</td>
<td>N = 62</td>
<td>IBS (Rome II</td>
<td>Reduced fructose and fructan diet for 2-40 months</td>
<td>Phone interview to assess symptoms and adherence</td>
<td>Always = 38%, Frequently = 39%, Occasionally = 10%, Never = 13%</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td>Range = 17-81</td>
<td>criteria)</td>
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<tr>
<td>Staudacher et al. (2011)</td>
<td>United Kingdom</td>
<td>N = 82</td>
<td>IBS</td>
<td>Symptoms at post-diet follow up</td>
<td>Following either low FODMAP (n = 43) or standard advice (n = 39) for 9 months</td>
<td>Of the low FODMAP group 36 were asked level of adherence on follow up questionnaire at the end of diet period.</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td>M = 38.1</td>
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<tr>
<td>Sui et al. (2012)</td>
<td>Austria</td>
<td>N = 62</td>
<td>IBS and FM (n = 32); IBS without FM (n = 30)</td>
<td>Effect of a long term fructose restricted diet on risk of chronic illness</td>
<td>Exclusion of fructose rich foods and wind producing vegetables for up to 3 years</td>
<td>Evaluation of compliance, with 6 categories of compliance</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range = 21-70</td>
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</table>
Restricted diet adherence in functional bowel disorders

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>N</th>
<th>M</th>
<th>Adherence Measure</th>
<th>Diet Intervention</th>
<th>Symptom Assessment</th>
<th>Compliance Measure</th>
<th>Adequate Adherence</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilder-Smith et al. (2013) Switzerland</td>
<td></td>
<td>1372</td>
<td>42</td>
<td>Adequate adherence = 85%, below adequate adherence = 15%</td>
<td>GI and non-GI symptoms following dietary intervention (n = 312)</td>
<td>Phone or direct contact after 6-8 weeks. Adequate compliance was considered to be adhering to the diet at least 50% of meals consumed.</td>
<td>40-59% compliance; 6) Not compliant at all</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Whitehead et al. (2004) United States</td>
<td></td>
<td>1658</td>
<td>52.9</td>
<td>Adequate adherence = 85%, below adequate adherence = 15%</td>
<td>Patients with IBS, abdominal pain, diarrhoea, or constipation</td>
<td>To assess what constitutes usual medical care for IBS</td>
<td>Adherence rated on a scale of 0 = did not do this at all to 100 = followed the doctor’s recommendations completely</td>
<td>X = 69.3</td>
<td>No</td>
</tr>
<tr>
<td>Study</td>
<td>Location</td>
<td>Sample Size</td>
<td>Criteria</td>
<td>Intervention</td>
<td>Outcome Measure</td>
<td>Results</td>
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<tr>
<td>Austin et al. (2009)</td>
<td>United States</td>
<td>N = 17</td>
<td>IBS-D (Diarrhoea, Rome II criteria)</td>
<td>Dietician provided VLCD for 4 weeks</td>
<td>Questionnaires</td>
<td>Yes</td>
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<td></td>
<td></td>
<td>M = 46 ±10</td>
<td></td>
<td></td>
<td>It was noted that 4 participants dropped out due to intolerance of the diet, or due to symptoms</td>
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<tr>
<td>Bentley, Pearson, and Rix (1983)</td>
<td>United Kingdom</td>
<td>N = 27</td>
<td>IBS</td>
<td>The effect of an elimination diet on IBS symptoms</td>
<td>Compliant, or non-compliant</td>
<td>No</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Range = 18-68</td>
<td></td>
<td>Stage 1 eliminating all food except for pears, lamb and rice; Stage 2 eliminating suspect foods (Time frames not reported)</td>
<td>Of the participants 70% were compliant and 30% were non-compliant</td>
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<tr>
<td>Biesiekierski et al. (2011)</td>
<td>Australia</td>
<td>N = 34</td>
<td>IBS (Rome III criteria)</td>
<td>Symptoms on ingestion of gluten versus placebo during gluten free diet period</td>
<td>Adherence judged on food diary entries and interview at time of 6 week review</td>
<td>No</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Range = 29-59</td>
<td></td>
<td>Exclusion of gluten (with gluten or placebo bread added) for up to 6 weeks</td>
<td>All adhered to the gluten free diet</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Biesiekierski et al. (2013)</td>
<td>Australia</td>
<td>N = 37</td>
<td>Non coeliac gluten sensitivity, and IBS (Rome III criteria)</td>
<td>The effects of gluten following reduction of FODMAPS.</td>
<td>Adherence assessed by tick box diaries and food eaten at the end of the study period.</td>
<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td>Range = 24-61</td>
<td></td>
<td>2 weeks low FODMAP followed by high gluten, low gluten or control arms for 1 week with washout</td>
<td>All adhered to the gluten free diet during the 1 week period, and 98% of provided meals were eaten</td>
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<tr>
<td>Study</td>
<td>Country</td>
<td>N</td>
<td>Mean Age ± SD</td>
<td>Study Details</td>
<td>Results</td>
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<tr>
<td>Corlew-Roath and Di Palma (2009) United States</td>
<td>N = 121 Age Range or M not given</td>
<td>IBS (n = 66); and those with FM and/or Lactose Malabsorption (LM) but without IBS (WIBS, n = 55)</td>
<td>The impact of diagnosis of LM and FM on IBS outcomes. Avoidance of lactose and/or fructose based on breath test. Follow up at 8 months to 4 years. Questioned on telephone about compliance at 8 months to 4 years follow up.</td>
<td>In the IBS with LM and/or FM group 77% were compliant (n = 17); in the WIBS and LM and/or FM group 72% were compliant (n = 13)</td>
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<tr>
<td>Fernández-Bañares et al. (2006) Spain</td>
<td>N = 36 M = 51 ±3.1</td>
<td>LM, and/or FM, and/or Sorbitol Malabsorption</td>
<td>Symptom reduction following elimination of diagnosis specific sugars Lactose free diet; or Fructose plus sorbitol controlled for 12 months. Clinic appointment at one month and phone interview at 12 months.</td>
<td>At one month, one participant was excluded due to 'poor' compliance with the elimination diet. No reports of adherence at 12 months were given.</td>
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<td>Fernandez-Banares et al. (2007) Spain</td>
<td>N = 62 M = 52.2 ±2</td>
<td>Chronic watery diarrhoea (meeting Rome II criteria of functional disease)</td>
<td>The presence of gluten sensitive enteropathy, bile acid malabsorption, and sugar malabsorption during diet period Gluten free diet; lactose free diet and/or fructose plus sorbitol free diet for 12 months. Clinic assessed at 1 month, and every three mths until finishing the 12 month follow up period.</td>
<td>It was noted that the diet was not adhered to by some of the study participants.</td>
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<td>Study Source</td>
<td>Country</td>
<td>Sample Size</td>
<td>IBD Type</td>
<td>Intervention Details</td>
<td>Assessment Method</td>
<td>Adherence</td>
<td>Notes</td>
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<td>King et al. (1998) United Kingdom</td>
<td>United Kingdom</td>
<td>$N = 12$, Range = 42-58</td>
<td>IBS ($n = 6$); or healthy controls ($n = 6$)</td>
<td>The amount of gas excreted following an exclusion diet: All dairy, all cereals (except rice) 2 weeks diet, 2 weeks break, and 2 weeks diet</td>
<td>Adherence assessed by daily contact and a food diary</td>
<td>One participant from each group reported single violations of the diet</td>
<td>Yes</td>
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<td>Manning et al. (1977) United Kingdom</td>
<td>United Kingdom</td>
<td>$N = 26$, Range = 21-60</td>
<td>IBS symptoms</td>
<td>High fibre and low wheat diets on symptoms and colonic motor activity: Excluding all whole grain cereals and reducing fruit and veg for 6 weeks</td>
<td>Questionnaires given at end</td>
<td>One participant per group was unable to adhere</td>
<td>No</td>
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<tr>
<td>Mazzawi et al. (2013) Norway</td>
<td>Norway</td>
<td>$N = 46$, Range = 18-69</td>
<td>IBS (Rome III criteria)</td>
<td>Impact of dietary guidance on symptoms and QOL: Reducing FODMAPS for 3-9 months</td>
<td>Questionnaire at 3-9 months post dietary advice.</td>
<td>At follow up only 17 completed the study. One was excluded due to non-compliance, one due to cooperation problems, and four after having become better for following the diet.</td>
<td>No</td>
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<td>Study</td>
<td>Country</td>
<td>Participants</td>
<td>Diet Intolerance</td>
<td>Symptoms Following Diet</td>
<td>Dietary Advice</td>
<td>Questionnaire</td>
<td>Follow-up</td>
<td>Adherence</td>
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<td>Mishkin et al. (1994) Canada</td>
<td>Canada</td>
<td>$N = 104$ Range = 18+</td>
<td>Lactose intolerance (LI)</td>
<td>Lactose, or fructose/sorbitol diet depending on diagnosis with breath test for 6-12 months</td>
<td>Questionnaire completed at follow up clinic visit between 6 and 12 months</td>
<td>Of the participants followed up at 12 months ($n = 60$) 92% had adhered to lactose exclusion, 86% to fructose exclusion and 85% to sorbitol exclusion</td>
<td>No</td>
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<tr>
<td>Monsbakken, Vandvik, and Farup (2005) Norway</td>
<td>Norway</td>
<td>$N = 65$ Range = 31-76</td>
<td>IBS-D, IBS-A (alternating) and IBS-C (constipation)</td>
<td>Symptom relief following diet for 6 months</td>
<td>Dietary advice based on symptoms and specific food triggers 6 month follow up</td>
<td>Postal questionnaire at 6 months</td>
<td>Of the participants ($n = 31$) given dietary advice 57% reduced fat, 58% reduced milk, 72% reduced cabbage, and 85% reduced cheese.</td>
<td>No</td>
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<td>Study</td>
<td>Sample Size</td>
<td>Population</td>
<td>Exclusion Criteria</td>
<td>Outcome Measures</td>
<td>Adherence</td>
<td>Compliance Measures</td>
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<td>Nanda et al. (1989) United Kingdom</td>
<td>N = 200, Range = 15-80</td>
<td>IBS who had failed to improve with conventional therapies</td>
<td>Symptom reduction following short term dietary exclusion (N = 200), and the long term effect of diet on symptoms (n = 91)</td>
<td>Excluding dairy, cereal, tea, citrus, potatoes, coffee, alcohol, preservatives, and personal trigger foods. Short term = 3 weeks; long term M = 14.7 months</td>
<td>Questionnaire at end of follow up period asked if continuing or not continuing. No specific measure of compliance was mentioned.</td>
<td>Of the initial 5% did not start due to difficulty, expense, or “could not be bothered” (N = 200); at final follow up 80.2% had continued with their exclusion diet, and 19.8% had returned to their normal diet (n = 91)</td>
<td>No</td>
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<td>Ong et al. (2010) Australia</td>
<td>N = 30, Range = 22-68</td>
<td>IBS (n = 15, Rome III criteria); and healthy controls (n = 15)</td>
<td>Breath hydrogen levels and GI symptoms</td>
<td>Low FODMAP diet versus high FODMAP diet - 2 days on each diet</td>
<td>Food diaries were assessed</td>
<td>All participants consumed diet as requested</td>
<td>Yes</td>
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<tr>
<td>Study</td>
<td>Phase</td>
<td>N</td>
<td>Age Range or M not given</td>
<td>IBS diagnosis</td>
<td>Adherence and symptom reduction</td>
<td>Phase 1: exclusion of 64 foods identified as problematic; Phase 2: a modified form of phase 1 with structured re-introduction</td>
<td>Phase 1: food diary and questionnaire; Phase 2: food diary and questionnaire</td>
<td>Phase 1: food diary and questionnaire; Phase 2: food diary and questionnaire</td>
<td>Phase 1: 79% adhered, 11% were unable to follow, and 10% were lost to follow up; Phase 2: 75% adhered, 12% were unable to follow, and 13% were lost to follow up</td>
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<td>Parker et al. (1995)</td>
<td>Phase 1: N = 253; Phase 2: N = 129</td>
<td>United Kingdom</td>
<td>Age Range or M not given</td>
<td>IBS diagnosis</td>
<td>Adherence and symptom reduction</td>
<td>Phase 1: exclusion of 64 foods identified as problematic; Phase 2: a modified form of phase 1 with structured re-introduction</td>
<td>Phase 1: food diary and questionnaire; Phase 2: food diary and questionnaire</td>
<td>Phase 1: food diary and questionnaire; Phase 2: food diary and questionnaire</td>
<td>Phase 1: 79% adhered, 11% were unable to follow, and 10% were lost to follow up; Phase 2: 75% adhered, 12% were unable to follow, and 13% were lost to follow up</td>
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<tr>
<td>(Parker et al., 2001) United Kingdom</td>
<td>N = 122 Range = 20-70 +</td>
<td>IBS with either positive or negative lactose hydrogen breath test (LHBT) results</td>
<td>Reduced symptoms after low lactose diet, exclusion diet, or low fibre diet.</td>
<td>Low lactose, or exclusion diet; or low fibre diet.</td>
<td>Judged on diary entries (which were noted by the authors as being poorly kept)</td>
<td>Positive LHBT: 67% adhered to low fibre diet (n = 33); Negative LHBT: 69% adhered to exclusion diet (n = 33) and 93% adhered to low fibre diet (n = 14)</td>
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<td>No</td>
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<td>Peters et al. (2014) Australia</td>
<td>N = 22 Range = 24-62</td>
<td>IBS (Rome III criteria)</td>
<td>Gluten and depression. Participants were recruited from the prior</td>
<td>Low FODMAPs; with gluten, whey or placebo arm</td>
<td>Adherence assessed by questioning and counting unused food</td>
<td>All adhered to the ongoing gluten free and low FODMAP diet, and between 96</td>
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<td>Study</td>
<td>N</td>
<td>Range</td>
<td>Group</td>
<td>Diet Details</td>
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<td>Adherence</td>
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<td>Shepherd et al. (2008) Australia</td>
<td>26</td>
<td>22-63</td>
<td>IBS (assorted types)</td>
<td>Low FODMAP diet followed by test products for up to 22 weeks</td>
<td>Consumption of provided foods and approved foods when eating out was considered adherence</td>
<td>Yes</td>
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<td>Stefanini et al. (1995) Italy</td>
<td>409</td>
<td>14-87</td>
<td>DIBS (diarrhoea)</td>
<td>Specific elimination diet (n = 209): or Oral Cromolyn sodium (n = 200) for 4 weeks</td>
<td>In the elimination diet group 14% did not adhere 'strictly' to the elimination diet (n = 209). No definition of <em>strict</em> was provided</td>
<td>No</td>
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<tr>
<td>Study</td>
<td>Country</td>
<td>N</td>
<td>Range</td>
<td>Diet Description</td>
<td>Symptoms After Milk or Lactose Ingestion</td>
<td>Method of Monitoring Adherence</td>
<td>Adherence Reporting</td>
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<td>Suarez et al. (1995)</td>
<td>United States</td>
<td>30</td>
<td>18-50</td>
<td>Lactose intolerance</td>
<td>All dairy and lactose except for test products for 2 x 1 week periods</td>
<td>Daily diaries</td>
<td>Yes</td>
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<tr>
<td>Suarez et al. (1997)</td>
<td>United States</td>
<td>42</td>
<td>18-69</td>
<td>Lactase non-persistent and lactase non-persistent</td>
<td>Avoidance of lactose for two 7 day periods</td>
<td>Daily diet records, and returned milk containers</td>
<td>Yes</td>
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<td>Vazquez-Roque et al. (2013)</td>
<td>United States</td>
<td>45</td>
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<td>IBS-D (Rome II criteria)</td>
<td>Gluten free diet (n = 23); or gluten containing diet (n = 22) for 4 weeks</td>
<td>Direct questioning by dieticians when the provided food was picked up</td>
<td>Yes</td>
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<td>Vernia et al. (1995)</td>
<td>Italy</td>
<td>230</td>
<td></td>
<td>Symptoms suggestive of IBS</td>
<td>Lactose free diet for 9-12 months</td>
<td>Interview and questionnaire at &gt;=3 months, and 9-12 months (no specific details given)</td>
<td>No</td>
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<td>Study</td>
<td>Sample Size</td>
<td>Methods</td>
<td>Findings</td>
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<td>Vesa, Korpela, and Sahi (1996) Finland</td>
<td>N = 54</td>
<td>Lactose maldigesters and lactose digesters</td>
<td>Tolerance to small amounts of lactose in those with LI</td>
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<td>Range = 25-70</td>
<td>Lactose, peas, beans, apple, onion, cabbage, bread, coffee, alcohol for 12 days</td>
<td>Food diaries were assessed</td>
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<td>Participants followed the recommended diet carefully, but lactose was consumed occasionally</td>
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<td>Zar, Mincher, Benson, and Kumar (2005) United Kingdom</td>
<td>N = 25</td>
<td>IBS (assorted types, Rome II criteria)</td>
<td>Symptom reduction following elimination of IgG4 antigen provoking foods</td>
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<td>M = 42.6, SD ±14</td>
<td>Elimination of personally specific foods e.g. milk, cheese, eggs, meat, wheat for 6 months</td>
<td>Dietician follow up during the study period. No specific measure of compliance was reported</td>
<td>All reported full compliance for the study duration</td>
<td>No</td>
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