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ORIGINAL ARTICLE

The Specific Carbohydrate Diet in the Treatment of Crohn's Disease: A Systematic Review

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ABSTRACT

AIM: The present systematic review aims to collect and review existing research related to the use of the Specific Carbohydrate Diet as a nutritional treatment for Crohn's disease.

MATERIALS AND METHODS: Four medical databases were examined in order to perform an exhaustive search for studies that used the Specific Carbohydrate Diet as an intervention in a population of individuals with Crohn's disease. Eight studies with a variety of observational designs met the predetermined inclusion criteria.

RESULTS: All 8 studies demonstrated clinical benefits of the Specific Carbohydrate Diet as a component of the management of Crohn's disease. Specific outcomes included symptom improvement (both objective and subjective), improvement in laboratory measures, and initiation or maintenance of remission. However, there were weaknesses in the design of some studies that were considered in the interpretation of results.

CONCLUSION: The Specific Carbohydrate Diet shows promise as a nutritional treatment for Crohn's disease, both in adults and children. However, further research may be needed, with stronger study designs, before clinicians can routinely recommend it.

Key words: Inflammatory Bowel Diseases; Crohn's Disease; diet therapy

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INTRODUCTION

Crohn's disease (CD) is a form of inflammatory bowel disease. It causes inflammation in the gastrointestinal tract, which may occur anywhere from the mouth to the anus. Typically, the small and large intestine are most affected. It is estimated that CD affects nearly half a million people in the United States. The exact etiology of the disease is unknown, yet genetic, environmental, and immune response factors likely play a role in its development[1]. Symptoms are varied, but often include abdominal pain, prolonged diarrhea, fever, weight loss, and fatigue. The diagnosis of CD is typically made using a combination of the patient's clinical presentation and history, along with imaging studies such as endoscopy. Laboratory markers are also useful in diagnosis[2].

Treatment for CD focuses on the goal of either achieving or maintaining remission from active disease. Typically, therapy involves medications such as aminosalicylates, antibiotics, glucocorticoids, immunomodulators, and biologic therapies. Although they are often effective in inducing remission or stopping disease progression, these treatments can be costly and are not without significant side effects[3]. When medication is unsuccessful, or if complications

develop, surgery may be necessary to remove affected portions of the gastrointestinal tract. Up to one-half of patients with Crohn's disease will require at least one surgery to manage their disease[4].

Overview of the Nutritional Management of Crohn's Disease

Over the past two decades, there has been an increased interest in the role that nutrition can play in the management of CD. Although historically diet has been mostly viewed as adjunct therapy to medication, treatments have emerged that focus on nutrition as the main intervention[5]. One common approach is the administration of enteral nutrition, using either an elemental or polymeric formula that is administered by mouth or by nasogastric tube. Especially in children, but also in adults, exclusive enteral nutrition is often successful in inducing and maintaining remission. However, long-term use presents challenges to patients such as palatability and social inconvenience. Total parenteral nutrition (TPN) has also been used in the treatment of CD, with the goal of resting the gut while maintaining or correcting a patient's nutritional status. Although the use of TPN has been shown to be useful in inducing remission, it is expensive and poses a significant risk for infection[6].

Increasingly, the use of modified oral diets has been investigated as a strategy to reduce symptom severity, or even induce and maintain remission in CD. Typically, these diets include the elimination of specific foods or food groups in order to avoid gut exposure to certain items[5,7]. Most frequently, the restricted or eliminated foods include carbohydrates, which are hypothesized to be poorly absorbed and to subsequently contribute to gastrointestinal symptoms[8].

The Specific Carbohydrate Diet

The current paper will focus on the Specific Carbohydrate Diet (SCD), which first appeared in the literature in 1924 when Dr. Sidney Haas proposed using certain starches in the diet as a treatment for celiac disease[9]. In the 1980s, the SCD appeared in its current form and was widely disseminated as a treatment for inflammatory bowel diseases, including both Crohn's and ulcerative colitis, by the biochemist Elaine Gottschall in her book *Breaking the Vicious Cycle*[10]. The SCD is based on the theory that both disaccharides and polysaccharides are not fully absorbed in the gastrointestinal tract, leading to bacterial overgrowth, yeast production, and excessive creation of mucus. These symptoms are thought to perpetuate mucosal damage, resulting in even poorer absorption and increased inflammation[7,8,11-15]. It has been further hypothesized that the malabsorption of these complex carbohydrates and certain sugars may lead to harmful aberrations in the gut microbiome, further contributing to the disease state[8,13-16].

The SCD restricts all carbohydrates other than the monosaccharides glucose, fructose, and galactose. Most fresh fruits and vegetables are allowed. Some beans and legumes may be consumed, but only if they have been soaked and carefully prepared. Honey and saccharin may be used as sweeteners. All grains should be avoided, as well as starches, including both white and sweet potatoes. Processed meats are also restricted. Lactose is not permitted, so dairy can only be consumed if it is lactose-free. Homemade yogurt may be eaten if it has no added sugar, and has been fermented for more than 24 hours to remove the lactose. This special homemade yogurt is actually encouraged, due to the presence of probiotics[10].

Typically, it is recommended that the SCD be strictly followed for one year while active disease is present, followed by an additional year after the patient is free of symptoms. After this initial elimination phase, one food item per week that was previously avoided can be re-introduced. However, if symptoms return, the original elimination diet should be strictly followed once again[10,11].

Although the SCD shows promise as a potentially effective treatment for CD, objective research is not currently abundant[8,12]. However, over the past few years, studies examining the diet have increased in number and design[15]. The current paper seeks to systematically review existing research regarding the efficacy of the SCD in the treatment of CD, and importantly will include studies that are newly published. Focusing on CD in particular, as opposed to IBD as a whole, allowed for a closer examination of the literature related to one specific disease state. The studies included in the review examined participants of all ages who carried a diagnosis of CD, and who followed the SCD as a means of treating their disease. The outcomes included a range of disease improvement, from subjective reduction in symptoms to maintenance of remission.

METHODS

The systematic review of the literature followed the PRISMA-P guidelines[17]. PubMed, CINAHL, Cochrane Reviews, and Web of Science databases were searched. There were no date restrictions placed on the databases that were searched. The last date searched was October 21, 2016. Search terms included the following: Specific Carbohydrate Diet, Crohn's disease, inflammatory bowel disease, and monosaccharides. The term monosaccharides was included to broaden the scope of the search, as this term encompasses the carbohydrates that are permitted on the diet. The search terms were combined using the operator "AND." Using the "Similar Articles" feature further broadened results in PubMed. Medical Subject Headings (MeSH) were also explored for all applicable search terms. In addition, reference lists of studies that met inclusion criteria were searched by hand for any additional studies that may have been missed in the electronic search. Finally, a search for grey literature was performed, using the following resources: Google Scholar, Science Direct, Proceedings First, World Cat, Dissertations and Theses, National Institute of Diabetes and Digestive Diseases, National Library of Medicine, and the Crohn's and Colitis Foundation.

The following criteria were used to evaluate study inclusion: subjects of any age diagnosed with CD, dietary manipulation that involved adherence to the SCD, and outcomes that examined clinical changes such as symptom improvement, normalization in laboratory results, and positive changes in remission status. Included studies were published in the English language. Given the nature of the present research, which is nearly entirely observational, all study designs were included. When studies included data for both CD and ulcerative colitis, only data related to CD were examined and reviewed when possible.

The data were managed using Thomas Reuters 'EndNote' citation manager. Search results were imported into the citation manager. Duplicates were removed, titles were examined for relevancy, and erroneous studies were eliminated. The remaining abstracts were reviewed using the inclusion criteria described above; studies that did not match the criteria were subsequently removed. Eight studies remained, which are included in the current review. Figure 1 depicts a flow chart that describes the search strategy in detail. One independent reviewer completed this process.

Outcome data in the studies that met criteria for inclusion included the following: symptom improvement, measured subjectively and also objectively using validated measures of disease severity; improvement in laboratory measures, achievement of remission from disease, and maintenance of remission. The main outcomes that were

examined varied between studies, but all studies that were included examined at least one of the outcomes listed above.

Risk of bias and quality of evidence was evaluated using the validated GRACE checklist for assessing the quality of observational studies (Table 1)[18]. In order to more fully assess study quality, some additional elements related to study design were also examined and considered in supplement to the GRACE checklist. An overall quality rating was given to each study; these data as well as a summary of results are presented in Table 2. Results are also summarized in the narrative. It is important to note that no included studies used a randomized, controlled design; this type of design would have received a 'high' quality rating.

Since the GRACE checklist was unable to capture all risk of bias, the authors further scrutinized this subject. There was no publication bias that was detected.

A variety of sources, including journals and grey literature, were examined even if results were potentially negative.

RESULTS

As previously mentioned, a total of 8 studies met inclusion criteria for the current review. These studies used a variety of observational designs, from case studies to prospective evaluations. Participants followed the SCD either as the exclusive form of treatment, or in combination with medications. As previously mentioned, Table 1 shows evaluation of potential bias of individual studies, while Table 2 details study design and overall quality.

Some of the initial research into the efficacy of the SCD in CD therapy is presented as case studies and case series. Fridge, Kerner, and Cox[19] described the cases of two school-age children with CD, one whom elected to follow the SCD as her main course of treatment and one who started the diet while also being treated with steroids. Both children demonstrated normalization in laboratory results and were reported to be symptom free within 3-6 months after beginning the SCD. Furthermore, the child who had previously depended on steroids to manage symptoms was tapered off of this medication. Nieves and Jackson[20] reported similar results in the case of a 24-year old female, who initiated the SCD after medications became ineffective in treating her disease. Like the previously described cases, her lab results normalized, she was able to stop pharmaceutical treatment, and she reported herself to be symptom-free at 3-year follow up. It should be mentioned that neither of these studies included information related to specific dietary choices that participants made while following the SCD.

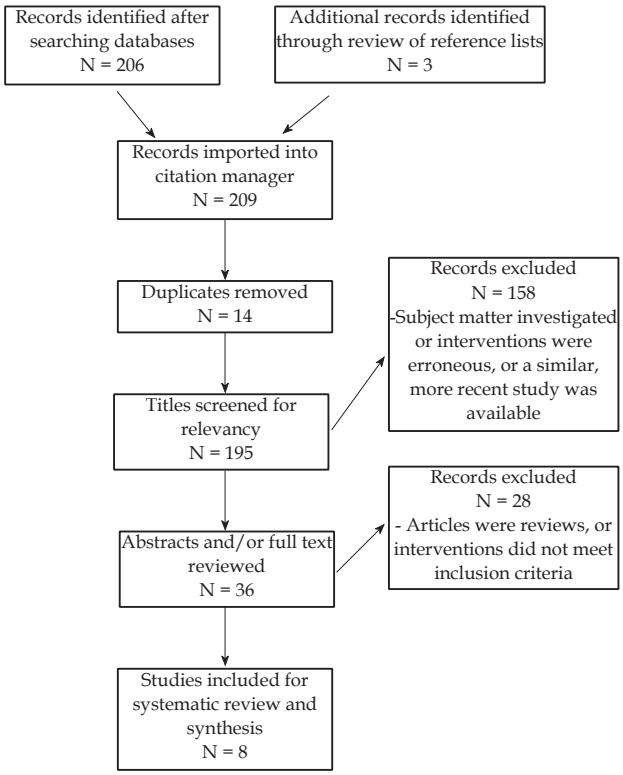

Figure 1 Process for Study Inclusion in Systematic Review.

Table 1 GRACE Checklist for Assessing Quality of Observational Studies.

GRACE Checklist Item	Burgis, *et al*[23]	Cohen, *et al*[16]	Kakodkar, *et al*[13]	Nieves & Jackson[20]	Obin, *et al*[15]	Suskind, *et al*[22]	Suskind, *et al*[21]	Fridge, Kerner, & Cox[19]
-Were treatment and/or important details of treatment exposure adequately recorded for the study purpose in the data source(s)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
-Were the primary outcomes adequately recorded for the study purpose?	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
-Was the primary clinical outcome(s) measured objectively rather than subject to clinical judgment?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
-Were primary outcomes validated, adjudicated, or otherwise known to be valid in a similar population?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
-Was the primary outcome(s) measured or identified in an equivalent manner between the treatment/intervention group and the comparison group(s)?	Yes	Yes	N/A	N/A	Yes	N/A	N/A	N/A
-Were important covariates that may be known confounders or effect modifiers available and recorded?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
-Was the study (or analysis) population restricted to new initiators of treatment or those starting a new course of treatment?	Yes	Yes	No	Yes	Yes	No	No	No
-If one or more comparison groups were used, were they concurrent comparators?	Yes	Yes	N/A	N/A	Yes	N/A	N/A	N/A
-Were important covariates, confounding and effect modifying variables taken into account in the design and/or analysis?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
-Is the classification of exposed and unexposed person-time free of "immortal time bias"?	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A
-Were any meaningful analyses conducted to test key assumptions on which primary results are based?	Unclear	Yes	Unclear	No	Unclear	Unclear	Unclear	No
Total Number of "Yes" Answers	9	10	6	6	10	6	4	5

Table 2 Study Design, Results and Overall Assessment of Quality of Included Studies

	Intervention/Study Design	Outcomes of interest	Sample Size and Follow-up Time Period	Was there a control group?	Results	Score from GRACE Quality Assessment Checklist and Overall Quality Rating†
Burgis, *et al*[23]	Retrospective chart review of children with CD‡ following the SCD§. Children followed the diet for different, specified periods of time (mean 7.7 months), and then liberalized the diet. Children were stratified into two groups: -5 patients followed the SCD either as exclusive treatment or in combination with antibiotics or aminosalicylates. -6 patients followed the SCD in combination with immunomodulator medications.	Laboratory results, including: -Hematocrit. –Albumin. -Inflammation, as measured by sedimentation rate. -Anthropometrics, as measured by weight and height percentiles	-N = 11 -Up to 18 months	No	-Hematocrit improved for all children (p = 0.006). Improvement was similar between both groups. Improvements appeared to remain stable after diet liberalization. -Improvements in albumin were seen for all but one subject (p = 0.002). There was a larger change in the immunomodulator group (p < 0.0001). -Inflammation decreased in all children (p = 0.002). Improvement was similar between both groups. -Ten children gained in weight percentiles, and 8 gained in height percentiles.	9; Moderate
Cohen, *et al*[16]	Prospective pilot study, short- and long-term, of children with CD following the SCD. -6 children followed the SCD in addition to taking medications (they were taking these medications prior to starting the diet); 3 children used the SCD as their only form of treatment. -Subjects were evaluated at week 0 and week 12; 7 patients were also evaluated at week 52.	-Mucosal inflammation, as measured by capsule endoscopy; Lewis Score was used to quantify mucosal inflammation. -Laboratory results, including hemoglobin, white blood cell count, inflammation as measured by sedimentation rate, and albumin. -Symptom improvement, as measured by PCDAI¶. -Crohn's disease activity, as measured by the HBI††.	-N = 9 -12 weeks and 52 weeks	No	-Improvements were seen in all laboratory results, although these improvements did not reach significance. -There was an improvement in symptoms as measured by PCDAI (p = 0.011). -There was a decrease in disease activity as measured by the HBI (p = 0.007). -Lewis Score for mucosal inflammation decreased (p = 0.012). -PCDAI and HBI decreased further for the patients who participated through week 52 (p = 0.027 and 0.016, respectively).	10; Moderate
Kakodkar, *et al*[13]	Case series -An internet survey was used to collect information from patients with Irritable Bowel Disease who were following the SCD. -18 subjects were using the SCD as the main form of treatment of their CD; 18 were taking medication in addition to the SCD.	-Quality of life of subjects in remission, as measured by the SIBDQ‡‡. -Presence of gastrointestinal symptoms, as measured by the GSSC§§. -Adherence to the SCD and effectiveness of the SCD, as measured by a visual analog scale.	-N = 36 (subjects with CD) No formal follow-up period. Subjects followed the SCD an average of 37.5 months.	No	-Mean GSSC score was 27.1 for subjects with CD (range 0 – 144), indicating mild symptoms. -Mean SIBDQ score was 60.9 for subjects with CD in remission (range 35 – 70), indicating a high quality of life. -Patient's mean self-reported adherence to the diet was 95.2%. -SCD was rated at a mean 91.3% effectiveness for controlling acute flare symptoms, and a mean 92.1% for maintaining remission. Authors did not separate these results for subjects with CD versus ulcerative colitis.	6; Moderate
Nieves & Jackson[20]	Internet survey and Case study -Subjects who were following the SCD completed a questionnaire. -A case study involving one woman with CD was reported.	**Internet Survey:** -Initiation or maintenance of remission, as measured by self-report . **Case study:** -Subjective symptom improvement, laboratory results (sedimentation rate and anemia), and achievement of remission.	-Survey: N = 31 -Case Study: N = 1 -Survey: N/A -Case study: 36 months	No	**Internet Survey:** -84% of subjects reported they had achieved remission using the diet, with a > 75% improvement in symptoms. Average duration of remission was 3 years. **Case Study:** -Reported symptoms improvement within one week and able to taper off medications eventually. -Anemia and sedimentation rate improved. -Remission at three year follow up.	6; Moderate

† Overall quality rating, using scores from GRACE checklist: 1 – 5 = low, 6 – 10 = moderate, 11 = high. ‡ CD = Crohn's Disease. §SCD = Specific Carbohydrate Diet. ¶ PCDAI = Pediatric Crohn's Disease Activity Index. †† HBI = Harvey Bradshaw Index. ‡‡ SIBDQ = Short Quality of Life in Inflammatory Bowel Disease Questionnaire. §§ GSSC = Gastrointestinal Symptom Severity Checklist.

Table 2 Study Design, Results and Overall Assessment of Quality of Included Studies.

	Intervention/Study Design	Outcomes of interest	Sample Size and Follow-up Time Period	Was there a control group?	Results	Score from GRACE Quality Assessment Checklist and Overall Quality Rating†
Obih, *et al*[15]	Retrospective chart review of children following the SCD. -12 patients with CD were using medication along with the SCD. -8 patients with CD used the SCD as their only treatment, -7 children with CD who were not following the SCD acted as controls.	-Symptom improvement as measured by PCDAI. -Ability to discontinue medications.-Laboratory results, including C-reactive protein, sedimentation rate, albumin, hematocrit, vitamin D, calprotectin, and BMI.	-N = 20 -Up to 14 months	Yes	-Mean PDCAI scores dropped from a mean of 14.5 before SCD to a mean of 3.1 by 6 months. -Two patients were able to discontinue medications. -Compared to controls, subjects following the SCD had a reduction in symptoms over time as measured by the PCDAI ($p = 0.03$). -Compared to controls, subjects following the SCD had an improvement in C-reactive protein ($p = 0.03$) and calprotectin ($p = 0.03$). -Subjects showed improvements in C-reactive protein, albumin, and sedimentation rate compared to baseline (before following the SCD).	10; Moderate
Suskind, *et al*[22]	Retrospective chart review of children following SCD. -4 subjects received no other treatment for CD. -2 subjects also took over-the-counter supplements. -1 subject received mesalamine therapy in addition to the SCD.	-Symptoms, as measured by PCDAI -Laboratory measures: Albumin, C-reactive protein (CRP), hematocrit, sedimentation rate, stool calprotectin	-N = 7 -6 months for all subjects; up to 18 months for 2 subjects	No	-All symptoms resolved, with PCDAI scores of zero beginning at 3 months. -Normalization in albumin, CRP, and hematocrit in all children who previously had abnormal levels; normalization or improvement of sedimentation rate in all children who had this measured; improvements in stool calprotectin in all children who had this measured.	6; Moderate
Suskind, *et al*[21]	Case series -An internet survey was used to collect information from patients with Inflammatory Bowel Disease who were following the SCD. -44% of subjects were following the SCD as sole treatment.	-Subjective improvement in symptoms. -Limitations in activity. -Perception of clinical remission.	N = 188 -No formal follow-up period. Subjects followed the SCD an average of 31.6 months.	No	-Reported symptoms decreased over time following the SCD. -Reported limitations in activity decreased over time following the SCD. -Perception of clinical remission increased over time following the SCD.	4; Low
Fridge, Kerner, & Cox[19]	Case series -Two cases of children following the SCD were reported. -One child was also taking medications; the other used the SCD as sole treatment.	-Symptoms, subjectively reported -Laboratory results, including hemoglobin, albumin, C-reactive protein, and sedimentation rate. -Ability to discontinue medications.	N = 2 -3 months for one subject; 6 months for one subject	No	-Both subjects were free of symptoms at final time of follow-up. -All lab results had normalized at final time of follow-up. -The child who was previously using medications was able to discontinue them.	5; Low

† Overall quality rating, using scores from GRACE checklist: 1 – 5 = low, 6 – 10 = moderate, 11 = high. ‡ CD = Crohn's Disease. §SCD = Specific Carbohydrate Diet. ¶ PCDAI = Pediatric Crohn's Disease Activity Index. †† HBI = Harvey Bradshaw Index. ‡‡ SIBDQ = Short Quality of Life in Inflammatory Bowel Disease Questionnaire. §§ GSSC = Gastrointestinal Symptom Severity Checklist.

Patients with CD who use the SCD as a means of treatment have also been surveyed about their experiences. In the first reported survey of this kind, results demonstrated that over half of the patients reported remission of active disease after starting the diet, as well as a reduction in medication requirements. It should be noted that the authors did not distinguish results between patients with CD versus ulcerative colitis, nor did they report on specific foods consumed or not consumed[20]. Similarly, Kakodkar *et al*[13] conducted a case series study that surveyed patients with inflammatory bowel disease who were following the SCD and were in remission. Thirty-six of the subjects had confirmed CD; about half were taking medications to help manage their disease alongside dietary strategies. Questions were included in the survey that related to specific foods consumed while following the SCD. All participants ate SCD yogurt as part of their diets, and 12 of them admitted to occasionally eating forbidden foods. Overall, the vast majority of participants reported that the SCD had significantly improved their symptoms and was effective in helping them to maintain remission from CD.

Suskind *et al*[21] recently published a larger survey of patients with inflammatory bowel disease that examined changes in reported symptoms, complications, and healthcare experiences before and after starting the SCD. The study included 188 participants with CD; the authors did not distinguish between respondents with CD and those with ulcerative colitis when they reported results. Forty three percent of participants reported strictly following the SCD, while 57% indicated that they had added non-compliant foods back into their diets at some point after initiating the SCD. Overall, the majority of subjects indicated that since starting the SCD, their symptoms had improved, limitations in their activities had lessened, and they had experienced clinical improvement in their disease.

Researchers have also conducted retrospective chart reviews in order to examine the potential benefits of the SCD in the treatment of CD. One of the first that appeared in the literature was by Suskind *et al*[22]. This study included 7 children with CD, 3 of which started the diet upon diagnosis and received no other treatment. All children reported symptom resolution at 3-month follow up, and all demonstrated significantly improved laboratory values as well. The authors did not include information regarding specific dietary components. A similar retrospective chart review stratified children with CD who had followed the SCD into 2 groups: those who used the diet as their only treatment or in combination with antibiotics, and those who used the diet in conjunction with immune-modulating medications. The authors further examined the response of the children after mild liberalization of the diet to include some foods that had previously been avoided. All children who followed the strict SCD showed improvements in anemia and inflammatory markers, as well as growth. Furthermore, all of these parameters remained essentially stable after mild diet liberalization[23].

Recently, the results of an additional retrospective chart review were published, adding depth to the body of literature through the use of a control group. Obih *et al*[15] examined the medical records of children with CD who had used the SCD as part of their treatment. Those who attempted the diet but were unable to remain on it comprised the control group; these children sought standard pharmaceutical treatment for their CD. The authors also included specific details related to whether the SCD was strictly followed, and if not, what other foods were eaten. Results demonstrated a significant improvement in indices of symptom severity as well as laboratory markers for the children following the SCD versus the controls. However, the authors did note that the diet was difficult for many of the children to follow and some experienced weight loss.

To date, there has been one prospective trial that has studied the SCD in the treatment of CD. Cohen *et al*[16] used capsule endoscopy to explore the ability of the SCD to promote mucosal healing in children with CD, in addition to other measures of clinical improvement. Outcomes were examined both 12 weeks and 52 weeks after the start of the study. Nine subjects completed the short-term trial and 7 completed the entire duration; all initiated the SCD at the beginning of the study as either adjunct or primary treatment for CD. Subjects completed 3-day food records while following the diet, but only details regarding caloric intake was reported; no specific information was provided about foods that participants chose to eat. The authors concluded that the majority of subjects showed significantly improved mucosal healing scores and clinical improvement, including increased rates of remission, when the SCD was used for 12 weeks. Overall, clinical improvement continued when the diet was extended to 52 weeks. However, it should be noted that some children's scores of mucosal healing did not continue to improve, and some worsened.

DISCUSSION

The current systematic review evaluated eight studies that were conducted to assess the potential benefits of the SCD in the treatment of CD. Outcomes of interest included measures of clinical improvement, from reduction in symptoms and normalization of lab results, to remission of disease. As previously stated, none of the studies received a quality rating of 'high,' since none were randomized, controlled clinical trials. Six studies were determined to be of moderate quality, and two were of overall low quality. The 8 studies were grouped by design, and results were examined. Overwhelmingly, outcomes of the studies point towards the value of the SCD in the treatment of CD.

Strengths and Weaknesses

Overall, each included study reported findings that indicate clinical benefits of the SCD in the management of CD. This heterogeneity of positive findings, regardless of each study's specific outcome of interest, lends strength to the body of evidence. An additional strength of the included research is the detail in which all researchers reported treatment exposures, as well as the fact that potential confounders such as concomitant medication use were acknowledged and commented upon. Additionally, many of the studies used validated methods for both collecting data and comparing outcomes[13,15,16,19-21,23]. Finally, one study utilized a control group, lending strength to the findings[15].

However, it must be emphasized that the observational nature of all included studies is an obvious weakness. Furthermore, in general, all of the studies had small samples sizes leading to limitations in generalizability. Another potential weakness that should be stated is the fact that many subjects were using medications in addition to the SCD. Although authors used tactics in their data collection and analyses to adjust for concomitant medication use, it is still an important confounding variable.

It is prudent to comment further on study design. Due to the limited research that is available regarding the efficacy of the SCD in the treatment of CD, as previously mentioned, only studies of low and moderate quality were included in the current review. Two studies utilized a case study design, which is prone to selection bias and makes results especially difficult to generalize to the population as a whole due to particularly small sample size[19,20]. Alternatively, two studies used a retrospective design in the form of chart reviews[15,23].

One of the limitations to this design includes using existing data and outcomes that were previously recorded and may not match perfectly with study goals. This type of design is also subject to selection bias.

The subjective measurement of some outcomes of interest should also be noted. One of the included studies[20] used a survey questionnaire in its design in addition to reporting on a case study; an additional two studies[13,21] also gathered information by means of surveys. Responses to these surveys were for the most part subjective in nature; although one study did use a validated questionnaire to assess symptom severity, and also verified the diagnosis of CD for all included participants[13]. Another study used an Internet survey that had not been validated, leading to potential issues surrounding the validity of the collected data[21].

Finally, limitations to the current systematic review should be pointed out. First, only one researcher conducted the systematic review process. Additionally, due to limited available research, a rather small number of studies were included. Although the current review focused specifically on the SCD in the treatment of CD, and not ulcerative colitis, it was not possible in all cases to differentiate between the two distinct forms of inflammatory bowel disease in the reported results.

Clinical Implications

Although the results of the current review demonstrate that the SCD shows great promise as a nutritional treatment for CD, further research is likely needed before clinicians can routinely recommend its use. In particular, the body of evidence needs to be augmented by more prospective studies. Research would be greatly bolstered by the use of randomized, controlled trials. However, this may prove difficult due to the challenges of controlling all aspects of a person's diet, as well as the expense that would likely be involved. Furthermore, the confounding effect of concomitant medication use is a reality that must be considered in the population of individuals with CD.

CONCLUSION

As previously stated, there is increasing interest in the use of oral diet therapy in the treatment of CD. As this review demonstrated, the SCD has been associated with significant clinical improvements for many patients, including achievement and maintenance of remission from active disease. The SCD may indeed prove to be a viable, safe, and effective treatment for CD. However, it must be emphasized that stronger study designs are needed to better investigate the true efficacy of the SCD.

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