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The Effect of Exercise on the Signs and Symptoms of Inflammatory Bowel Disease

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ABSTRACT

Introduction: Inflammatory Bowel Disease (IBD) generally describes several autoimmune disorders that involve inflammation of the gastrointestinal tract, including Ulcerative Colitis (UC) and Crohn's disease (CD). An estimated 3.1 million Americans are affected by IBD. Although the inflammation caused by IBD mainly affects the gastrointestinal tract, when IBD is exacerbated, the inflammation can become systemic. Consistent exercise is theorized to reduce chronic inflammation and reduce signs and symptoms of IBD.

Objective: This meta-analysis aims to examine the effects of exercise on the signs and symptoms of IBD. Methods: A literary search was conducted using Cochrane Library, PubMed, and Cinahl databases. Of the 1031 records identified, twelve articles met the inclusion criteria, with seven articles presenting data that could be meta-analyzed. The reported data from the seven included articles were standardized to compare dependent variables using the Stata17 statistical package. Pooled effect sizes and 95% confidence intervals were obtained through the random-effects model. The results were used to examine the effects of exercise on C-reactive protein (CRP), fecal calprotectin (FC), and IBD signs and symptoms related questionnaires.

Results: Signs and symptoms questionnaires were standardized and compared, resulting in a low risk of heterogeneity of 0.00% (I2), an effect size of 0.02, 95% CI [–0.66 to 0.70], p=0.96. Biomarkers were pooled, standardized, and compared, resulting in heterogeneity of 0.00% (I2) and an effect size of -0.48, 95% CI [–1.60 to 1.42], p=0.40.

Conclusions: These results suggest that exercise does not decrease signs and symptoms in IBD patients.

Keywords

C-Reactive Protein, Exercise, Fecal Calprotectin, Inflammatory Bowel Disease, Physical Activity.

Abbreviations

IBD: Inflammatory Bowel Disease; CRP: C-Reactive Protein; FC: Fecal Calprotectin; HBI: Harvey Bradshaw Index; UCAI: Ulcerative Colitis Activity Index; IBDQ: Inflammatory Bowel Disease Questionnaire; IPAQ: International Physical Activity Questionnaire; PMayo: Partial Mayo Index; CDAI: Crohn's Disease Index; P-SCCAI: Patient Simple Clinical Colitis Activity Index.

Introduction

According to the Mayo Clinic, Inflammatory Bowel Disease (IBD) is a disorder that involves chronic inflammation of the gastrointestinal tract [1]. The most common types of IBD are Ulcerative Colitis (UC) and Crohn's Disease (CD). Both conditions can lead to a myriad of intolerable signs and symptoms such as malnutrition, abdominal pain, fatigue, and ulcers. The Centers for Disease Control and Prevention estimate that over 3 million U.S. adults have been diagnosed with Inflammatory Bowel Disease [2].

Although the exact etiology of IBD is still unknown, it has been well established that patients diagnosed with IBD have elevated inflammatory biomarkers such as Fecal Calprotectin (FC) and C Reactive Protein (CRP) [3-5]. Due to the unknown cause of IBD, symptoms are typically treated with varying interventions, including diet restrictions, anti-inflammatory medications, and invasive surgery [1,6]. These interventions along with the side effects from IBD often elicit malnutrition as diets can be low in vitamin D and calcium, anti-inflammatory medications have been shown to alter metabolic turnover of some nutrients within the body, intestinal inflammation decreases absorption, and associated diarrhea excretes nutrients. Good nutrition is often key in bodily health, making it difficult for IBD patients to see remission [7]. With the needs of IBD sufferers in mind, there may be potential benefits from exercise training as it can increase nutrient availability and is less invasive than current interventions. Another benefit of exercise training is the known decrease in chronic inflammation. Therefore, exercise training as a potential intervention may reduce inflammatory biomarkers of IBD as exercise has been shown to reduced chronic inflammation. Determining if exercise will reduce IBD biomarkers and signs & symptoms of IBD thereby minimizing need of more invasive procedures is of importance for improved health of IBD patients.

The specific aim of this meta-analysis is to determine if exercise is a feasible intervention to alleviate inflammation, as well as signs and symptoms of IBD.

Literature Review

A systematic review is a research method utilized for analyzing data from numerous studies conducted on similar research topics. Rather than depending on results from isolated studies, a meta-analysis combines results from multiple independent studies with similar dependent variables to statistically determine the practical response a particular intervention elicits. This calculated effect from a meta-analysis is deemed more reliable than isolated studies. Gene V Glass, an American statistician, described how the need for meta-analysis is evident due to the rapid growth of the literature on a myriad of topics with dichotomous findings [8].

Integrating and analyzing findings from different sources gives the meta-analysis a paramount role in providing appropriate recommendations on a particular intervention. This method of investigation is a systematic approach offering reliable, objective, and, most importantly, reproducible results. Multiple independent studies investigating the effects of exercise on the signs and symptoms of IBD were integrated to form the current meta-analysis. The extant literature demonstrates that exercise is associated with an improvement in the quality of life for IBD patients; however, little is known about the effects of exercise on both systemic inflammation, and signs & symptoms in IBD patients.

Inflammatory Bowel Disease is a chronic inflammatory disease of the gastrointestinal (GI) tract. The two primary forms of this disease are Ulcerative Colitis and Crohn's Disease. Ulcerative Colitis is characterized by inflammation and ulcerations along the superficial lining of the descending large intestine, sigmoid colon, and rectum. Crohn's Disease, in turn, is defined by inflammation of the superficial and deeper layers of the entire digestive tract, specifically the colon and ileum of the small intestine. The inflammation involved in IBD damages the intestines resulting in malnutrition, abdominal pain, fatigue, and ulcers which often lead to other symptoms such as diarrhea, cramping, blood in the stool, reduced appetite, and decreased weight [1].

Although IBD initially causes local inflammation of the GI tract, it can lead to extraintestinal or systemic inflammation [9].

The main inflammatory marker molecules in IBD are Fecal Calprotectin (FC) and C - reactive protein (CRP). In response to continuous damage within the bowel, white blood cells (WBC) invade the impaired area. First, neutrophils release calprotectin which will translocate to the gastrointestinal tract and can be measured in feces as a local biomarker, Fecal Calprotectin [1,6]. Subsequently, macrophage's present themselves after the initial stages of inflammation as a more chronic systemic response. Macrophage's release interleukin signaling molecules, which travel to the liver and stimulate synthesis of CRP [6]. Both CRP & Calprotectin can be used to quantify IBD inflammatory activity objectively. Systemic inflammation results from the release of pro-inflammatory cytokines and the chronic activation of the innate immune system. Inflammation is a response to injury or any foreign pathogen within the body and is stimulated to attack non-self-pathogens. Evidence suggests that food particulate, viruses, or other bacteria translocating across the GI lumen may irritate the lower parts of the digestive system initiating the acute non-specific immune response. The response is a set of vascular, molecular, and cellular events that are designed to clean out cellular debris or pathogens to initiate repair. Acute inflammation is seen as a normal response following an injury resulting in increased blood creatine kinase (CK) and CRP. Whereas the effects of chronic gastrointestinal inflammation can be observed with an increase in these inflammatory molecules as well as fecal calprotectin due to ongoing GI injury. While additional chronic immune system activation may complete the response to the speculated foreign invader, there still exists no known specific causes of IBD. However, there are risk factors for developing this disease, including tobacco use, obesity, appendectomy, oral contraceptives, diet, antibiotic use, genetics, and ethnicity. These risk factors are associated with chronic injury to the gastrointestinal tract, which are associated with the inflammatory response.

Inflammatory Bowel Disease is most commonly treated through anti-inflammatory medical interventions, which consist of corticosteroids and aminosalicylates, but these medications have many side effects [1]. An intervention with fewer side effects consists of exercise as it has routinely been utilized as a countermeasure for inflammatory-related damage in IBD patients. Interestingly, isolated bouts of exercise appear to initiate an acute inflammatory response [10,11]. As an example, in the Brown et al. 2015 review IL-6 increased (pre 1.1 ± 0.6 vs post-ex 2.7 ± 1.0 g/ml, $p \leq 0.05$). Though an isolated bout of exercise is known to cause inflammation, an investigation by Beavers et al., suggests that chronic exercise training leads to physiologic adaptation evidenced by lower levels of inflammatory biomarkers [12]. The reviewed data suggests that an inverse relationship exists between markers of chronic systemic inflammation and exercise training, supported by a 37 percent decreased likelihood for elevated resting levels of C-Reactive Protein (CRP) after exercise training an average of three days a week for nine months. Consistent physical activity has been suggested to reduce adipose tissue, decrease white blood cells, increase antioxidant activity, and increase the body's capability to resist damage which are additional factors that may lead to the reduction in systemic inflammation [13]. Another recent systematic review of twenty-seven studies by G.L Rose et al. investigated the effects of aerobic and resistance exercise on chronic inflammation in a healthy adult population. It was determined that a significant pooled ES was observed for higher- versus lower-intensity exercise on diminishing CRP concentrations, in studies of middle-aged adults (ES=-0.412, 95% CI=-0.821– -0.004, p = 0.048) or interventions >9 weeks in duration (ES=-0.520, 95%CI=-0.882–-0.159, p = 0.005). Conclusions found that exercise duration greater than 9 weeks in middle-aged adults improved inflammatory levels [14].

The anti-inflammatory adaptation to consistent exercise training has been cited within the literature for both healthy populations and individuals with chronic disease. An additional systematic review by Hammonds et al, determined that exercise reduced CRP, a systemic marker of inflammation in healthy adults and those with cardiovascular disease [15] (standardized mean difference −0.53 mg/L; 95% CI, −0.74 to −0.33). In summary, a single bout of exercise elicits an acute inflammatory response. Consistent repeated bouts of exercise offer physiologic adaptation, which reduces markers of chronic inflammation [16-18]. This adaptation offers potential as an inflammatory countermeasure to reduce both inflammation and signs & symptoms of IBD.

Along with the objective blood markers of inflammation (CRP, FC) for IBD, many subjective questionnaires quantify IBD signs & symptoms. The frequently utilized Irritable Bowel Disease Questionnaire (IBDQ) assesses health-related quality of life in IBD patients. The questionnaire is broken down into four subcategories: emotional, social, bowel, and systemic. The emotional subcategory evaluates the psychological conditions that may worsen in patients with IBD, particularly in flare-ups. The social subcategory measures IBD effects on a patient's societal functioning. The bowel subcategory assesses the intestinal symptoms of patients, and the systemic subcategory measures total body symptoms associated with IBD, such as fever and weight loss. Other subjective questionnaires that are included in the current study are: Pediatric Ulcerative Colitis Activity Index (PUCAI), International Physical Activity Questionnaire (IPAQ), partial MAYO index (PMAYO), Pediatric Crohn's Disease Activity Index (PCDAI), Patient Simple Clinical Colitis Activity Index (P-SCCAI), Harvey Bradshaw Index (HBI), and Crohn's Disease Activity Index (CDAI). These subjective measurements are significant in better understanding disease states in patients with IBD. Increases in patient reported IBDQ scores and are favorable, while decreases in reported HBI and CDAI scores are deemed a positive outcome.

Review of the literature suggests that there may be positive effects from exercise training on inflammation, and signs & symptoms of IBD that suggest exercise training is a beneficial intervention. The benefits include lower pro-inflammatory biomarkers (CRP & FCP) and improved signs & symptom questionnaire scores. The specific aim of this review is to determine if exercise training is an effective countermeasure for both the inflammation and the signs & symptoms experienced in IBD patients.

Methods

Literature search

The research team conducted a solely electronic literature review using Cochrane Library, PubMed, and Cinahl databases. Searches were conducted on March 19th, 2021, using the search terms Inflammatory Bowel Disease AND Exercise, Inflammatory Bowel Disease AND Motor Activity, Inflammatory Bowel Disease AND Exercise Therapy, Inflammatory Bowel Disease AND Physical Activity. Articles included in this analysis were published between January 1st, 2000, and March 19th, 2021.

The literature search results were compiled into one master list of 1,031 articles. The research team reviewed each article on the list in groups of 2-3 to determine acceptance based on primary and secondary inclusion criteria. Inclusion criteria were established before the articles were thoroughly reviewed. The designs of included studies were randomized controlled trials, cross-sectional, correlational, and quasi-experimental designs. Through this process, a total of twelve articles met all the inclusion criteria, however, five studies that met all inclusion criteria were excluded because data was not reported in means and standard deviations. Attempts were made to contact the authors to obtain data in this form; however, attempts were unsuccessful. This process resulted in seven articles remaining for the final review (Figure 1).

Inclusion criteria

Primary inclusion criteria: human study, exercise or physical activity as an independent variable, study participants diagnosed with IBD, Ulcerative Colitis, or Crohn's Disease. The following objective dependent variables were selected as secondary inclusion criteria to assess IBD signs, C-Reactive Protein (CRP) or Fecal Calprotectin (FC). Additional secondary inclusion criteria included assessment tools for subjective signs & symptoms of IBD: Harvey Bradshaw Index (HBI), Ulcerative Colitis Activity Index

(UCAI), Inflammatory Bowel Disease Questionnaire (IBDQ), International Physical Activity Questionnaire (IPAQ), Partial Mayo Index (PMayo), Crohn's Disease Activity Index (CDAI), or Patient Simple Clinical Colitis Activity Index (P-SCCAI). The study participants were individuals diagnosed with IBD. The primary investigated exercises included walking, running, and resistance training. The intensity of each exercise intervention was classified as low, moderate, or vigorous, defined by each study.

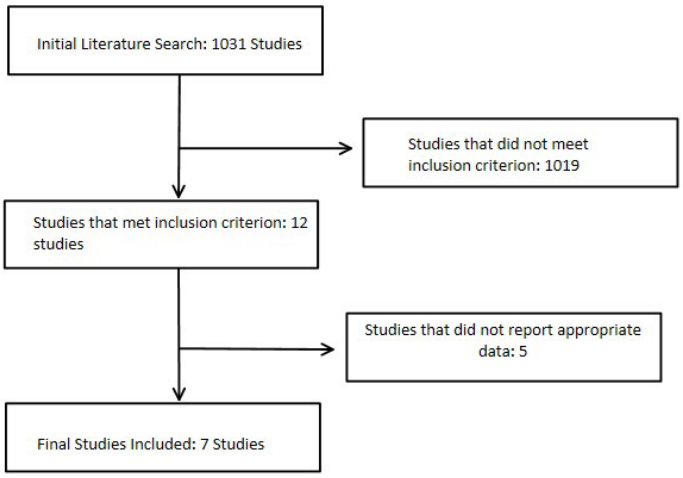

Figure 1: Starting with 1031 studies, this figure shows how the research team systematically excluded studies based on established criteria presented in figure 2. Of the 1031 articles, 12 met inclusion criteria, but 5 did not present data in a usable format.

Statistical Analysis

To analyze the diverse data reported, dependent variables were standardized & pooled to combine the results of individual studies into an overall effect on a standardized scale.

For studies that included a comparison of more than two groups, the IBD diagnosed groups (remission and active disease) were pooled to compare diseased vs. non-diseased subjects. Weighted average and Standard Deviation were calculated by adjusting the means and SD with the group population then dividing by the population sample size (Equation 1.1). This process was repeated for both pre-and post-data. Cohens D was converted to Hedges G estimate to accurately obtain the pooled standard deviation and effect size in studies with varied sample sizes. Hedges G accounts for small sample size when calculating the overall gain (equation 1.2). The process was then repeated to compare the control and intervention groups and determine the overall effect of the intervention per study. To allow for varied questionnaire signs and symptoms scale direction, health improvement was uniformly adjusted to a positive gain and detriment in health a negative gain. The IBDQ was the only questionnaire included that has a higher score interpreted as an improvement in health. All other questionnaires interpreted lower scores as an improvement in health and a higher score as a detriment in health. Therefore, the IBDQ was the only survey tool that did not require scale direction adjustment allowing for gain score comparison on a standardized scale. The same standardization was used to compare biomarker data. As FC and CRP are in different units, µg/g and mg/L respectively, the research team converted to gain ± standard deviation so a comparison could be made.

The pooled gain score, standard deviation, and inverse variance weight was entered into STATA-17. STATA-17 determined the effect size (95% CI) and weight (%) of each study as well as the heterogeneity (I^2) of the combined study variable variance.

Equation 1.1

Weighted Average = $\frac{\sum(x_i * n_i)}{\sum n}$

n = sample size

X = Intervention mean, dependent variable

Equation 1.2, Hedges G with Pooled Standard Deviation

$$g = \frac{\bar{X}_1 - \bar{X}_2}{S^*}$$

$$S^* = \sqrt{\left\{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_2 + n_2 - 2}\right\}}$$

Coding

Articles used in the meta-analysis were uploaded into a shared excel file and coded based on; dependent variables, subject traits, and exercise characteristics. The coding table is shown below (Figure 2).

- **Study Characteristics**
  - Type of Study
    - Randomized Clinical Trial
    - Cross Sectional Study
    - Correlational Designs
    - Quasi Experimental Design
  - Number of Participants
    - 0 - 20
    - 21 - 50
    - 51 - 200
    - 201 - 500
    - 501 +
  - Disease State of Participants
    - Inactive
    - Active
    - Both
- **Subject Characteristics**
  - Subjects
    - Male
    - Female
- **Exercise Characteristics**
  - Intensity
    - Low
    - Moderate
    - High
  - Type
    - Yoga/ Range of Motion
    - Endurance
    - Resistance
- **Dependent Variables**
  - Disease Activity/Quality of Life
    - CDAI
    - HBI
    - PUCAI
    - IBDQ
    - IPAQ
    - pMayo
    - PCDAI
    - P-SCCAI
  - Inflammatory Biomarkers
    - FC
    - CRP
- **Analysis of Study**
  - Means Pre and Post
  - Correlation
  - Odds Ratio

Figure 2: CDAI- Crohn's Disease Activity Index, HBI- Harvey Bradshaw Index, PUCAI- Pediatric Ulcerative Colitis Activity Index, IBDQ- Inflammatory Bowel Disease Questionnaire, IPAQ- International Physical Activity Questionnaire, PCDAI- Pediatric Crohn's Disease Activity Index, P-SCCAI- Patient Simple Clinical Colitis Activity Index, FC- Fecal Calprotectin, CRP- C-Reactive Protein. Primary and secondary criteria for the inclusion of journals for review.

Bias prevention

The researchers conducted searches using three databases: Cochrane Library, PubMed, and Cinahl. Cochrane Library was included as this database includes unpublished research and dissertations to

prevent publication bias. These specific databases were used to provide peer-reviewed, trustworthy, and high-quality articles. Confirmation bias is the tendency for researchers to interpret results that adhere to pre-existing beliefs. Attempts to minimize confirmation bias included a mitigated focus on the statistical significance of individual studies and including articles in which the hypothesized outcome was not achieved.

Results

Six of the seven studies utilized sign & symptom assessment questionnaires. The overall effect size of the exercise intervention on signs & symptoms of IBD (questionnaire) results are: 0.02 CI [–0.66, 0.70], p=0.96. The heterogeneity T^2 was 0.00, indicating full homogeneity across all study results (Figure 3).

Of the seven studies, three reported inflammatory biomarkers results. The overall effect size and 95% confidence interval of the combined CRP and FC results is –0.48 CI [-1.60, 0.64], p=0.40. The heterogeneity T2 was 0.00%, as presented in (Figure 4).

Discussion

The meta-analyzed questionnaire data (Figure 3) is not statistically significant suggesting that exercise does not alter signs & symptoms of IBD. With full homogeneity across our studies and the effect size of 0.02 CI [-0.66, 0.70] for questionnaire results and -0.48 CI [-1.60, 0.64] for biomarker results, this contradicts our hypothesis that physiologic adaptation to exercise will diminish signs and symptoms of IBD.

Three of the seven reviewed articles analyzed systemic inflammatory biomarker concentrations and yielded dichotomous results. Both Tew et al. & Jones et al. analyzed FC in Crohn's disease patients resulting in no significant change following exercise intervention lasting 6 months. Conversely, Legeret et al. found a decrease in CRP following two months of moderate exercise in pediatric patients diagnosed with IBD. In that study baseline CRP concentrations of the pooled remission & active disease group significantly decreased from 3.64 ± 5.08 g/dl to 0.75 ± 0.856 g/dl p-value = 0.02. The current analysis yielded one study

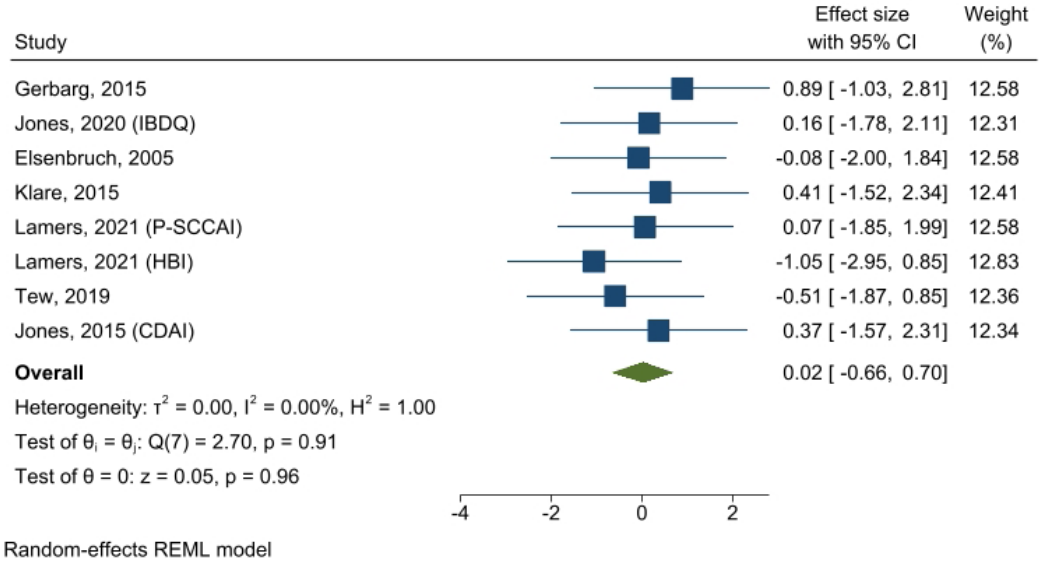

Figure 3: CI- confidence interval, IBDQ- Inflammatory Bowel Disease Questionnaire, P-SCCAI- Pediatric Simple Clinical Colitis Activity Index, HBI- Harvey Bradshaw Index, CDAI- Crohn's Disease Activity Index. Results reported in effect size [95% confidence interval] and weight between studies. Statistics were calculated using the data analysis software STATA17.

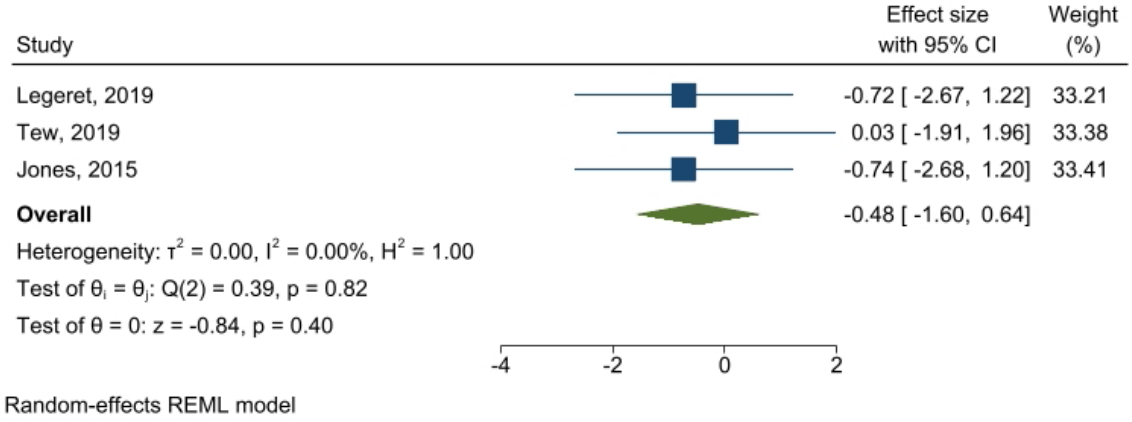

Figure 4: CI- confidence interval. Results reported in effect size [95% confidence interval] and weight between studies. Statistics were calculated using the data analysis software STATA17.

demonstrating a significant reduction in systemic inflammation measuring blood CRP (Legeret, 2019). Potential mechanisms for reduced CRP concentrations could be due to the decrease in tissue cytokine activity [19]. The remaining two studies, Tew et al. (2019) & Jones et al. (2015), determined that no significant change occurred in the inflammatory marker FC response.

Literature on the effects exercise has on FC in IBD patients is limited because of the small number of studies performed utilizing exercise intervention and measuring the specific parameters utilized in the current meta-analysis. However, a recent cohort study investigated the effects of intense exercise on twelve IBD patients. Results suggest that exercise training did not alter FC in IBD patients [20]. FC is not a commonly measured exercise induced biomarker because healthy individuals should have little to none in fecal samples. Nevertheless, FC is a good indicator of change in those with IBD as concentration rises and falls with disease severity. The absence of consistent change in FC observed in the literature may be due to the high specificity of FC, the rarity of measurement in healthy individuals within CN groups, the inability to reach a theorized exercise threshold for optimal benefit, and its localization in the GI tract [21]. These factors may limit the patient's ability to reach the most beneficial physiologic adaptations that may improve both inflammatory markers and signs and symptoms of IBD.

Exercise training has many beneficial effects, including a reduction in markers of systemic inflammation. This trend is seen for both healthy and unhealthy individuals as a reduction in risk of mortality, chronic disease, and premature death [22]. However, the overall effect on individuals diagnosed with IBD remains unclear. The current meta-analysis demonstrates that exercise does not decrease the signs and symptoms of inflammatory bowel disease.

With 95% confident intervals of the questionnaire data [–0.66, 0.70], and biomarker data [-1.60, 0.64], the hypothesis that exercise reduces inflammation and signs & symptoms of IBD is not supported. The null hypothesis that exercise does not affect inflammation or signs and symptoms of IBD is accepted with no change in IBD activity between control and intervention groups within the meta-analysis.

Given the literature suggests that acute bouts exercise increases inflammatory markers. The thought that exercise exacerbates inflammation, or signs and symptoms of IBD is also not supported. An exacerbation or flare-up could be due to various factors such as stress and diet. IBD patients that report "feeling better" following exercise training could be contributed to psychosocial or quality of life improvements, independent of potential physiological improvements that were not characterized in this review. Both increases and decreases in disease state may be due to other factors not analyzed by the studies reviewed. Therefore, since current results suggest that there is no improvement of signs and symptoms of IBD and that exercise does not exacerbate IBD demonstrated by acceptance of the null hypothesis, providers working with IBD patients should encourage exercise in conjunction with the traditional medical interventions for IBD to observe the best possible health benefits as literature suggests quality of life and overall wellbeing improve with exercise [23].

Limitations

The limitations of this study were inevitable. IBD is a highly variable disease, with many uncontrollable factors affecting this study. Twelve articles met the inclusion criteria; however, five of the articles could not be used in Stata17 due to the presentation of data as medians. Attempts were made to get the appropriate data, but we were unable to obtain the needed data for this subset of studies. Meta-analyses require data in means and standard deviations, odds ratios, or correlations. Therefore, the limited number of quality studies is a limitation.

Other study limitations included differing modes and durations of exercise intervention, adherence to the program, intensity of exercise performed, and study sizes. A wide variety of exercise modes is expected but using one or two modes would be more effective for comparison to decrease statistical variance. For further research, choosing more cohesive interventions using similar exercise programs between studies could improve statistical power of analysis. The search criteria allowed for many different modes of exercise but limited the research to what was encompassed in the specific wording of the search. Specific types of exercise that did not use the general terms of exercise or physical activity in the title were not included. For instance, yoga and other excluded exercises could provide a larger number of articles included in the study, which would result in a more inclusive meta-analysis. Future studies could use more descriptive search terms and inclusion criteria to obtain more data such as specific types of exercise which could include yoga or high intensity interval training (HIIT). Along with descriptive search terms affecting types of exercise and intensity, the wide variance of intensities from walking to HIIT made it difficult to compare studies. Not only does exercise intervention and intensity have possible effects on IBD, but diet and stress influence symptoms of IBD. Patients are often referred to different diets such as a low FODMAP diet to improve symptoms along with traditional medical intervention [24]. Another limitation in the studies reviewed was the lack of control in participants' diets during exercise intervention, thereby confounding interpretation of any independent exercise effect. Similar to diet, stress also has a profound impact on disease activity. The reviewed studies did not control for stress levels which could further confound any possible exercise effect on IBD.-

The analyzed studies grouped participants into disease state levels based on biomarker activity, these groupings include remission, active state, mild state IBD, or no history of IBD. The grouping of patients differed between studies as some had less specific, wider range categories such as grouping all diseased subjects and non-diseased subjects whereas some studies had specific and narrow categories with defined parameters. The most common disease states in the analyzed 7 articles are remission or mildly active IBD. Future studies could investigate exercise effects across similar IBD grouping/categories. Exercise effects may exist in only certain

disease states however this cannot be determined given the lack of consistency across the extant literature.

Various intervention lengths for each study were also used, which may have influenced biomarker and questionnaire results. Out of the 7 studies analyzed the interventions ranged from 4 days to 6 months. The biomarker and questionnaire results may have had a significant change due to the varied intervention lengths. Adherence to exercise is another limitation as at-home programs relied on self-reporting of adherence which is notoriously unreliable. With methodological differences between studies there were varied participant sizes and subsequently, effect sizes from each study. Six out of the 7 studies analyzed had under 40 participants whereas 1 of the studies had close to 2,000 participants. Another significant limitation that cannot be excluded is participant withdrawals due to an IBD flare up. It is unethical to make a subject complete a study. With these withdrawals, data on exercise and IBD flareups is lost. This may eliminate exercise data with poor outcomes. No animal studies were included in this study. Animal studies are generally very well controlled and could offer further insight into exercise effects on IBD. Many mice and rat studies were reviewed in the initial search but had to be excluded as they did not meet the inclusion criteria.

Conclusion

This meta-analysis examined the effects of exercise training on inflammatory markers, and signs & symptoms of patients with Inflammatory Bowel Disease. The included studies demonstrated that exercise training does not improve inflammation or the signs & symptoms of IBD. Exercise is a safe engagement for IBD patients without risk of exacerbation of symptoms.

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