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Review Article - Clinical

Unravelling the Relationship Between Obesity and Inflammatory Bowel Disease

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Mirroring the global obesity epidemic, obesity rates in inflammatory bowel disease (IBD) patients is rising. Several epidemiological studies propose that 15%-40% of adult patients with IBD are obese, and an additional 25%-40% fall into the overweight category. This article examines the pathophysiologic relationship between obesity and IBD concerning the role of visceral adipose tissue, microbiota shifts, dietary patterns, and hunger hormone changes. Additionally, increasing evidence is demonstrating the negative impact that obesity is having on disease course and quality of life in patients with IBD. Obesity has been demonstrated to be associated with an attenuated response to immunomodulators and biological agents, as well as higher rates of peri-operative surgical complications. A better understanding of the relationship between obesity and IBD can be applied to clinical decision-making in personalizing treatment plans, promoting weight loss in patients with obesity, and identifying areas of future research.

Lay Summary

Recent trends reveal increasing rates of obesity in IBD patients, affecting disease management. This article explores links between obesity and IBD, including visceral fat, microbiota shifts, diet, and hormones. Understanding this relationship is crucial for personalising treatment and improving outcomes.

Key Words: inflammatory bowel disease, Crohn's disease, ulcerative colitis, obesity, body mass index

Introduction

Inflammatory bowel disease (IBD) is a chronic inflammatory disorder of the gastrointestinal tract with major subtypes including Crohn's disease (CD) and ulcerative colitis (UC). Clinicians have often linked IBD patients with having a low or normal BMI because of the disease's complications, including malabsorption, reduced food intake, and nutritional deficiencies. In recent years, there has been a notable increase in obesity within the IBD population.[1]

Obesity is a condition characterized by an abnormal or excessive buildup of body fat, typically caused by an imbalance between calorie intake and energy expenditure. In Western populations, individuals with a body mass index (BMI) between 25.0 and 29.9 kg/m² are considered overweight, while a BMI of 30 kg/m² or higher is classified as obese.[2]

According to the World Health Organisation, in 2022, 2.5 billion adults were overweight, which included over 890 million adults who were living with obesity.[2] Based on current projections, it has been estimated that by 2050, 60% of males and 50% of females will be obese.[2] A similar increase in the prevalence of obesity has been seen in the IBD population.[1,3–9] In 2019, higher-than-optimal BMI contributed to an estimated 5 million deaths from noncommunicable diseases such as cardiovascular diseases, diabetes, cancers, neurological disorders, chronic respiratory diseases, and digestive disorders.[10]

This review explores the growing link between obesity and IBD, examining the prevalence of obesity in patients with IBD, inflammatory mechanisms, impact on disease progression, treatment response, surgical outcomes, and quality of life (QoL). This article adds to existing research by incorporating recent studies on additional obesity measures outside of BMI alone, such as visceral adipose tissue (VAT). It reviews the bidirectional relationship between IBD and obesity, highlighting the need to address both conditions equally in treatment plans.

Prevalence of Obesity in Patients With IBD

The reported BMI of individuals with IBD has undergone a significant upward shift, with 15%-40% of adult IBD patients found to be obese, and an additional 25%-40% falling into the overweight category[1,3–9] (Table 1). This trend is consistent with the rising prevalence of obesity globally which has nearly tripled between 1975 and 2016.[2] In 2013, a hypothesis-generating study that analysed the changes in

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Key Messages

1. What is already known?

The prevalence of obesity in IBD patients is rising, with obesity adversely affecting both surgical and treatment outcomes for these individuals, complicating disease management and worsening overall health.

2. **What is new here?**

This article advances the literature by incorporating recent research on obesity metrics beyond BMI, such as visceral adipose tissue, exploring the bidirectional impact of IBD and obesity, and emphasizing the need for integrated treatment that considers how each condition influences the other, including the roles of dietary changes, hormonal effects, medication impacts, and related psychological factors.

3. **How can this study help patient care?**

By exploring the complex interplay between obesity and IBD, this article offers insights to guide personalized treatment strategies, enhance patient care, and improve outcomes for individuals with both conditions.

body weight and disease activity over time in patients with CD, utilizing data from 40 randomised control trials, was undertaken.[16] The findings revealed a significant increase mean BMI of patients with CD over time, increasing from 20.8 kg/m^2 in 1992 to 27 kg/m^2 in 2001.[16]

However, there exists a notable gap within the current literature whereby studies on obesity and IBD have relied solely on BMI as the measure of obesity. Relying solely on BMI can misclassify individuals and alternate measures of obesity should be measured including waist circumference and body fat percentage. Furthermore, as discussed in later sections of this review covering pathophysiology of obesity in IBD, one factor supporting the link between obesity and IBD is the distinct metabolic and biochemical characteristics of VAT. It has been suggested that VAT carries prognostic value in predicting disease recurrence in patients with CD after surgery, whereas BMI does not.[15] VAT can be directly measured by methods such as dual energy X-ray absorptiometry and abdominal computed tomography.

Premorbid Obesity and Risk of IBD

There is currently limited information regarding the causality or directionality effect between obesity and IBD. Premorbid obesity is associated with increased risk of CD development, but not UC, although this is not consistent.[17–19] A large prospective study in 2015 involving women in the United States from the age of 18 enrolled in the Nurses' Health Study II found that participants with obesity (BMI > 30) had a 2.3-fold higher risk of developing CD compared with women with a normal BMI at the same age (hazard ratio [HR] = 2.33 [95% CI, 1.15-4.69]).[17] Greater weight gain correlated with increased CD risk; however, no discernible association was found between obesity during young adulthood and the risk of developing UC (HR = 1.17 [95% CI, 0.54-2.52]).[17] Similarly, findings from participants enrolled in the Danish National Birth Cohort study indicated women who were obese had a 1.9-fold higher risk of developing CD (HR = 1.88 [95% CI, 1.02-3.47]); there was no observed link between prepregnancy obesity and the risk of developing UC (HR = 0.77 [95% CI, 0.48-1.25]).[18] It is interesting to note that women with a BMI < 18.5 were also at increased risk of developing CD by 2.6-fold compared with women with a normal BMI. In contrast, the European Prospective Cohort Study (EPIC), which involved 300 724 participants, suggested no association between pre-morbid obesity and the risk of developing either CD or UC.[19] Furthermore, amongst those with IBD, BMI was neither associated with phenotypic disease expression (CD vs UC), nor disease location and extent.[19]

The disparity in findings between the Nurses' Health II study, the Danish National Birth Cohort, and the EPIC study could be attributed to differences in cohort population characteristics. Notably, the EPIC cohort had an older cohort (median age of 52), compared with the American and Danish cohorts (median age of 35 and 30, respectively). The American and Danish cohorts were exclusively female, while the EPIC cohort had a nearly equal distribution of sexes, indicating that factors such as age and sex may influence the relationship between obesity and IBD risk. The Danish cohort did not include multivariate analysis to control for age as a potential confounder, while the use of matched controls in the EPIC cohort adds complexity to this interpretation. Additionally, a common limitation across these studies is the lack of analysis of the duration of premorbid obesity on the development of IBD. Furthermore, these studies use BMI as the only measure of obesity. This may not accurately reflect VAT, and consequently, this limitation should be considered when interpreting the data.

Pathophysiology of Obesity in IBD

Role of Adipose Tissue

Obesity leads to a persistent, low-level inflammatory state, driven by the release of multiple pro-inflammatory signaling molecules from enlarged fat cells (hypertrophic adipocytes). Adipose tissue secretes both pro- and anti-inflammatory cytokines, including a group of signaling proteins unique to fat tissue known as adipokines.[20] In obesity, mesenteric VAT accumulates and becomes further infiltrated by immune cells. Notably, mesenteric VAT is rich in pro-inflammatory M1 macrophages, which release inflammatory cytokines including tumour necrosis factor (TNF) and interleukin (IL)-1.[20] It is the imbalance in cytokines that also lead to the development, recurrence, and exacerbation of the inflammatory process in IBD.[21] Additionally, adipocytes contribute to the inflammatory environment by generating other pro-inflammatory elements such as IL-6, chemokines, and adipokines including leptin and resistin.[22] These inflammatory mediators promote the recruitment of more M1 macrophages and activation of CD4 + T cells, leading to the differentiation of T helper (Th)1, Th2, and Th17 cells, which produce major cytokines that play key roles in the pathogenesis of IBD.[22]

Both preclinical models and humans with obesity exhibit elevated circulating cytokine levels, stimulating various

Table 1. Key findings on obesity epidemiology in adult patients with IBD.

Study	Study characteristics	Patient characteristics	Prevalence of obese and overweight patients[a]	Key findings
Greuter et al. (2020)[4]	Retrospective analysis of nation-wide cohort study conducted in Switzerland between July 2006 and September 2018	• *N* = 2050 IBD patients (54% female) • 1171 CD patients • 879 UC patients	• 325 (10.6%) of patients with IBD were obese • 194 (16.5%) patients with CD were obese • 131 (14.9%) patients with UC were obese	• Disease activity scores were higher among patients with obesity with CD, whereas there was no significant difference observed in patients with UC • Obesity showed a negative correlation with disease remission in CD (OR: 0.610, 95% CI, 0.402-0.926, *P* = .020), whereas no such association was found in UC • There was no observed link between obesity and disease progression or treatment failure in either CD or UC
Jain et al. (2019)[11]	Cross-sectional and longitudinal cohort study conducted on internet-based Crohn's and Colitis Foundation's IBD Partners cohort from 2011	• *N* = 7296 patients with IBD (>70% female) • 4748 patients with CD • 2548 patients with UC	• 19.5% of patients with CD were obese and 28% were overweight • 20.3% of patients with UC were obese and 29.5% were overweight	• Obesity was independently and, in a dose-dependent fashion, associated with a higher likelihood of persistent disease activity or relapse in both patients with CD and UC • Obesity was also independently associated with increased levels of anxiety, depression, fatigue, pain and reduced social function scores amongst patients with CD and UC
Flores et al. (2015)[3]	Two-centre retrospective cohort study conducted in Dallas, Texas, USA, between 2000 and 2012	• *N* = 581 patients with IBD (28% female) • 297 patients with CD (31% female) • 284 patients with UC (24% female)	• In CD: 30.3% obese, 33.3% overweight • In UC: 35.2% obese, 36.3% overweight	• Patients with obesity were considerably less likely to undergo anti-TNF therapy, have surgery, or be hospitalized for their IBD compared to those who were not obese • No differences between CD phenotype (age at onset, location, behaviour) in patients who were obese vs overweight vs normal or underweight • There were lower rates of CD-related surgery or hospitalization and/or initiation of anti-TNF therapy in patients who were obese and overweight compared with patients who were normal weight or underweight • No differences in disease extent (age at onset, location, behavior) in patients with UC who were obese vs overweight vs normal or underweight • There were lower rates of UC-related surgery, hospitalization and/or initiation of anti-TNF therapy in patients who were obese and overweight compared with patients who were normal weight or underweight
Pringle et al. (2015)[6]	Single-centre cross-sectional study conducted in Boston, Massachusetts, USA, 2004–?	• *N* = 846 patients with CD (55% female) • Mean disease duration 12 years • Penetrating disease in 29% • Biologic use in 56%	• 16% of patients were obese • 30% of patients were overweight at diagnosis	• Obesity was not associated with risk of stricturing disease, perianal disease, or need for surgery in patients with CD • Obesity may be associated with a lower risk of penetrating disease in patients with CD • Genetic predisposition did not seem to modify the effect of obesity on risk of penetrating disease, stricturing disease, perianal disease, or the need for surgery
Hass et al. (2006)[5]	Single-centre, retrospective cohort study conducted in in Philadelphia, Pennsylvania, USA, 1997-2002	• *N* = 138 patients with CD (59% female) • Mean disease duration 13 years • Perianal disease in 10% • Biologic use in 45%	• 32% overweight or obese (at diagnosis)	• No difference in the number of CD-related surgeries, escalation of medical therapy, and disease distribution in patients with BMI ≥ 25 kg/m^2 vs BMI < 25 kg/m^2 • Patients with a BMI of less than 18.5 kg/m^2 had a shorter time to first surgery than patients with a BMI of 25 kg/m^2 or higher
Stabroth-Akil et al. (2015)[8]	Single-centre retrospective cohort study conducted in Cologne, Germany, 2000-2006	• *N* = 202 patients with UC (49% female)	• 54 patients (26.7%) were overweight • 27 patients (13.4%) were obese	• BMI was inversely correlated to disease severity, with a significantly smaller proportion of years with chronic active disease among overweight subjects vs normal weight subjects (17.6 vs 23.9%, *P* = .05) • Pancolitis was inversely related to weight. • Disease activity was higher for underweight vs normal-weight patients

Table 1. Continued

Study	Study characteristics	Patient characteristics	Prevalence of obese and overweight patients[a]	Key findings
Seminerio et al. (2015)[7]	Single-centre, retrospective cohort study conducted in Pittsburgh, Pennsylvania, USA, between 2009-2011	• *N* = 1494 patients with IBD (51% female) • 860 patients with CD • 634 patients with UC • Mean disease duration = 16 years	• 36.4% patients with IBD were overweight • 31.5% were obese of which 4.4% were severely obese (BMI ≥ 40 kg/m^2)	• There was no difference in the risk of IBD-related surgery, hospitalization, or emergency department utilization among patients categorized as obese, overweight, or with a normal BMI • Obesity was associated with poorer IBD-related quality of life and higher frequency of elevated CRP compared with normal BMI patients • The prescribed medication doses for weight-based therapies were lower than expected based on body weight • Higher BMI correlated with higher prevalence of diabetes mellitus, hypertension, and hyperlipidaemia
Steed et al. (2009)[9]	Retrospective population-based study conducted in Tayside, Scotland	• *N* = 489 patients with IBD • 295 patients with CD • 94 patients with UC	• 18% of Tayside patients with IBD were obese (compared with 23% of the general population of Scotland) • 38% of Tayside patients with IBD were overweight (the same percentage as the general population of Scotland) • The proportion of obesity was comparable between patients with CD (18% obese) and UC (17.5% obese)	• In UC patients who were overweight or obese, there were increased levels of surgery • Conversely, in the CD group, the normal-weight individuals had the highest rates of surgery • The rise in obesity within the general population of Scotland is reflected in the subgroup of individuals with IBD
Bryant et al. (2018)[12]	Prospective cohort study conducted between April 2012 and September 2013	• *N* = 97 patients with CD • Median age 31	• 5 patients (5%) classified as underweight • 24 patients (25%) were overweight • 25 patients (26%) were obese	• The ratio of visceral to subcutaneous fat (VAT:SAT) was linked to stricturing CD behavior, elevated faecal calprotectin, and reduced quality of life • There were no correlations between BMI and disease behavior, disease activity, or quality of life.
Van Der Sloot et al. (2017)[13]	Prospective cohort study conducted in Massachusetts, USA in 2004	• *N* = 482 patients with CD • 174 developed penetrating disease, 132 developed stricturing disease, 147 developed perianal disease	• 269 (55.8%) patients had a BMI < 25 • 130 (27%) patients were overweight • 71 (14.7%) patients were obese	• Patients in the highest quartile VAT volume had increased rates of requiring surgery compared with patients in the lowest quartile of VAT volume • The risk of penetrating disease increases with with greater VAT volume, but this is not seen in not stricturing or perianal disease
Sehgal et al. (2024)[14]	Retrospective cohort study conducted in NewYork-Presbyterian/Columbia University Irving Medical Center between 2010 and 2022	• N = 200 patients with IBD • 100 patients with CD • 100 patients with UC • 14% had severe disease activity on endoscopy	• 100 (50%) patients were overweight • Median VAT 4727 (IQR 1845-14 238) • Median SAT 13 241 (IQR 8615-24 611)	• Higher VAT:SAT was associated with shorter time to IBD flare (hazard ratio of 4.8 for VAT:SAT ≥ 1.0 vs VAT:SAT ratio < 1.0) • Higher BMI was not associated with shorter time to flare • The relationship between increased VAT:SAT and shorter time to flare appeared stronger for CD than for UC
Holt et al. (2017)[15]	Prospective study conducted in Australia and New Zealand	• N = 44 patients with CD (54% female)	• 29.5% had a BMI in the overweight or obese range (compared with 63.4% in the general Australian population)	• All patients with a VAT/height^2 >1.5 times the gender-specific mean experienced endoscopic reoccurrence at 18 months (compared with 47% in patients with a VAT/height ≤ 1.5 the gender-specific mean) • Low levels of skeletal muscle did not predict endoscopic recurrence. • Appendicular skeletal muscle indices were inversely correlated with faecal calprotectin levels.

Abbreviations: BMI, body mass index; CD, Crohn's disease; CDAI, Crohn's Disease Activity Index; CI, confidence interval; CRP, C-reactive protein; FC, faecal calprotectin; IBD, inflammatory bowel disease; OR, odds ratio; TNF, tumour necrosis factor; UC, ulcerative colitis; VAT, visceral adipose tissue; VAT:SAT, visceral adipose tissue: subcutaneous adipose tissue.
[a]Obesity is defined as a BMI of ≥30 kg/m^2 and overweight is defined as a BMI of 25.0-29.9 kg/m^2.

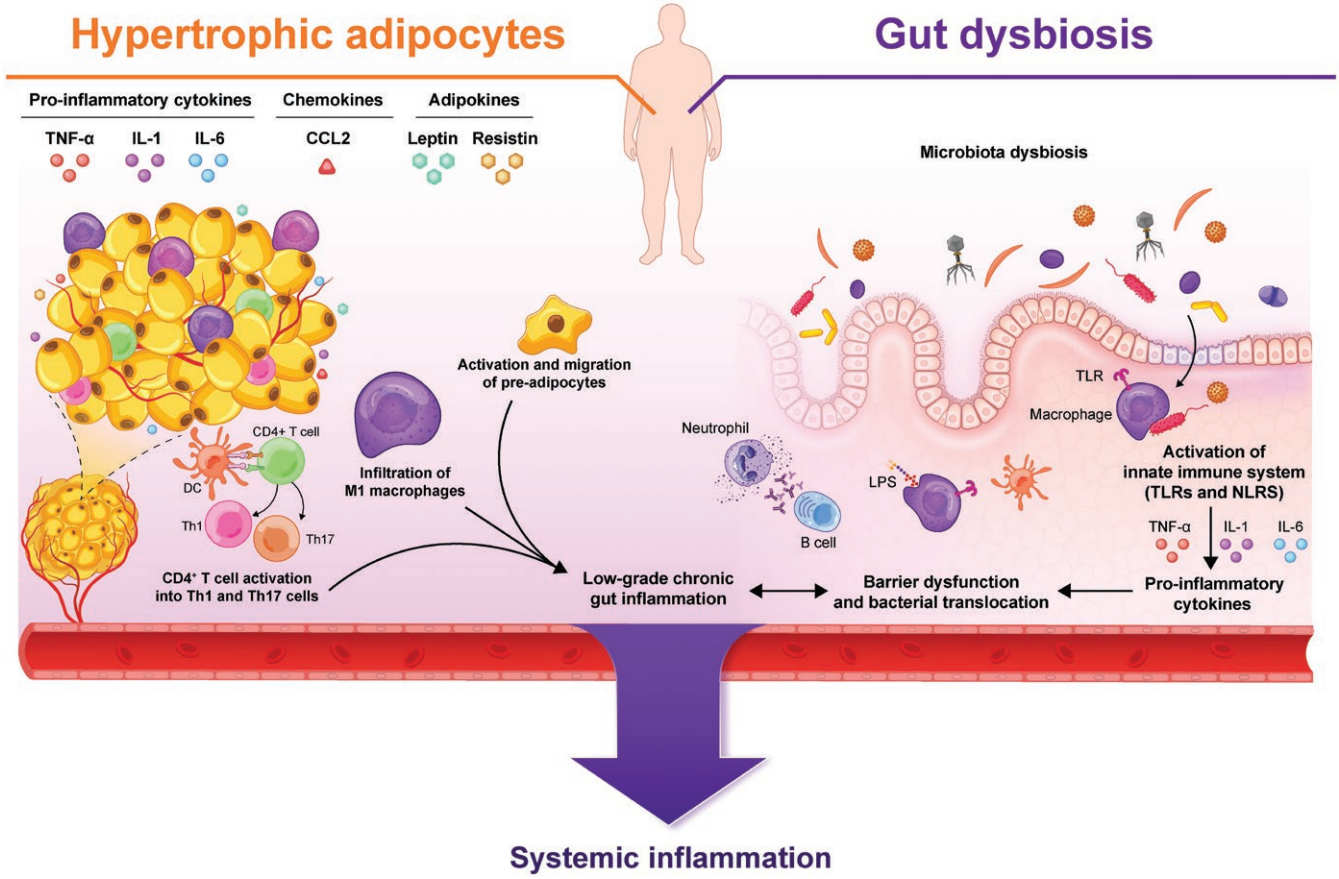


Figure 1. Postulated pathophysiology of obesity and IBD. CCL2, chemokine ligand 2; DC, dendritic cells; IL, interleukin; LPS, lipopolysaccharides; NLRS, Nod-like receptors; TLR, toll-like receptors; TNF, tumour necrosis factor. Hypertrophic adipocytes in mesenteric visceral adipose tissue generate pro-inflammatory cytokines (TNF-a, IL-1, IL-6), chemokines, and adipokines (including leptin and resistin), which induce inflammatory cell activation leading to a state of chronic low-grade inflammation.[20,27] Intestinal inflammation in turn contributes to impaired mucosal barrier function and bacterial translocation.[28,29] Microbiome dysbiosis, bacterial dysfunction, and bacterial translocation occur with an increase in the expression of pro-inflammatory cytokines and increasing local and systemic inflammation.[28]

inflammatory mediators.[23] In patients with obesity, there is a direct correlation between visceral adiposity and IL-6 levels.[24] VAT has also been associated with increased C-reactive protein (CRP) levels.[25,26]

Thus, the increased activity of adipokine and cytokine interactions in obesity triggers chronic low-grade inflammation. In particular, mesenteric VAT serves as a reservoir for various immune cells which also act as key factors in the pathophysiology of IBD (Figure 1).

Creeping Fat

Patients with CD exhibit a distinct localised form of VAT known as creeping fat associated with intestinal inflammation, which is distinct from adipose tissue in obesity. While adipose tissue in obese individuals grows in hypertrophy, CD-associated mesenteric fat accumulation in CD occurs due to hyperplasia.[30,31] Additionally, creeping fat is considered more immunologically active, exhibiting increased pro- and anti-inflammatory gene expression with elevated levels of leptin, adiponectin, resistin, and various cytokines and chemokines.[30,31] Creeping fat formation may arise from the migration of preadipocytes originating in mesenteric VAT, driven by elevated fibronectin signals released from the inflamed gut. In CD, creeping fat has been associated with several pathological changes, including hyperplasia of the muscularis propria, transmural inflammation, and intestinal fibrosis—all of which may contribute to the development of strictures.[32] However, it remains debated on whether creeping fat is pathogenic or protective in IBD. Although creeping fat is associated with more severe or complicated CD, it also potentially acts as a protection barrier to limit systemic bacterial dissemination and prevent systemic inflammatory response.[33]

A key limitation in current research on VAT in IBD is the challenge in distinguishing creeping fat from VAT, highlighting an area for future exploration. The effectiveness of imaging techniques to separate creeping fat is debated, as peri-enteric and creeping fat have similar radiodensity and signal on computed tomography and magnetic resonance imaging, though fat stranding and oedema may offer some insight.[34] Therefore, imaging studies of VAT area are related to, but not identical to, creeping fat.

Microbiome Effects

A key aspect of IBD pathogenesis is the disruption of intestinal immune homeostasis, mucosal barrier dysfunction, and bacterial translocation. Intestinal inflammation impairs mucosal barrier function through alterations in tight-junction proteins which promotes bacterial translocation.[28,29] Bacterial translocation has been linked to the activation of adipocytes and preadipocytes, leading to an increase in the expression of

pro-inflammatory cytokines and alterations in immune homeostasis.[28,29] Subsequently, a feedback loop involving the colonic mucosa, bacteria, and adipose tissue is established (Figure 1).

There has been increasing attention toward exploring the potential links between the microbiome and obesity. Gut bacteria play a crucial role in extracting calories from undigested foods, impacting the overall health of their human hosts, in addition to regulating the integrity and function of the intestinal barrier. Obesity and high-fat diets lead to changes in the intestinal microbiota with a significant reduction in bacterial diversity and impairment in intestinal barrier function.[35] Microbiome changes include a lower proportion of Bacteroidetes microbiomes, which are linked to higher functional diversity, and a higher proportion of Actinobacteria microbiomes, which are associated with lower functional diversity.[35] Studies examining pairs of monozygotic and dizygotic twins, who were either concordant or discordant for obesity, showed that individuals with obesity differ from their lean counterparts in terms of gut bacterial diversity.[35] Another study involving sets of twins similarly demonstrated that host genetics influence the composition of the human gut microbiome, leading to the selection of a more obese-associated microbiome.[36] This suggests that obesity may be related to gut microbiome shifts deviating from a "healthy core microbiome," reflected by a decreased bacterial diversity and enrichment of bacterial gene products associated with carbohydrate metabolism. Gut microbiome transfer studies from obese individuals into germ-free mice induced significant weight gain, which was not seen in the mice receiving transfers from lean individuals.[37] Individuals with diminished colonic bacterial diversity also appear to be predisposed to obesity.[38]

Current epidemiological data are unable to accurately assess the directionality of the association between obesity and IBD. Preclinical models have associated a high-fat diet, both directly and through its contribution to obesity, with an increased risk of CD.[37] These effects are believed to be mediated by microbiome changes and alterations in gut permeability as discussed above.[37] Microbiome changes may contribute to the development of obesity through the influence of hormones such as ghrelin, glucagon-like peptide (GLP), peptide YY, gastric inhibitory polypeptide and bile acids which regulate appetite, insulin secretion, and lipid metabolism.[39,40] Enteroendocrine cells can directly sense their microbial environment.[39] For instance, probiotics have been shown to promote GLP-1 secretion and improve metabolic state in mice.[41] Microbial derived short-chain fatty acids can both directly and indirectly regulate ghrelin secretion from enteroendocrine cells.[42] Bile acid metabolism is strongly affected by intestinal microorganisms which in turn inhibit the expression of gluconeogenic genes.[43]

Dietary Patterns in Obesity and IBD

A poor-quality diet low in nutritional value and chronically exceeding energy expenditure are well-established core contributors to obesity. A meta-analysis by Lane et al. confirmed that consuming ultra-processed foods significantly increases the risk of becoming overweight or obese.[44] Narula et al. then found a link between a high intake of ultra-processed foods, including sugary drinks, refined sweets, salty snacks, and processed meats with a higher incidence of IBD.[45] Ultra-processed foods commonly include emulsifiers (eg, carboxymethylcellulose and polysorbate-80) that cause mucosal thinning, microbial changes, and promote development of inflammation and inflammation-associated colon cancer in preclinical models.[45] Emulsifiers and noncaloric artificial sweeteners can disrupt the gut microbiota, promote inflammation, and are linked to cardiometabolic issues and metabolic disturbances, including insulin resistance.[44] Carcinogenic compounds, such as acrylamide and acrolein, are found in ultra-processed foods, which are created by the heat processing of comprehensive food processing; these can increase cancer risk via DNA damage, inflammatory promotion, and induction of oxidative stress.[44] Consumption of foods with these additives can disrupt the gut microbiota, causing immune activation and potentially exacerbating diseases such as obesity and IBD.[44] Additionally, processed foods often have a high salt content which can induce inflammatory activity, such as the IL-23/IL-17 pathway.[46] A high salt diet also has been shown to negatively affect the gut microbiota by decreasing *Lactobacillus* levels and metabolite levels including short-chain fatty acids.[46]

It has been long up for debate whether diet influences disease activity in patients with IBD. Although there is no universal diet for patients with IBD, ~82% of patients believed that they should eliminate some specific foods from their diets, with the most common strategy being to remove "triggering" foods.[47,48] The most common dietary components excluded or minimized include: high-fat foods, high-fibre, dairy products, spicy foods, alcohol, processed foods, additives and preservatives, sugary foods, and red meat.[47,49] Patients with IBD are more likely to modify their diets during active disease flare-ups; however, most patients continue a restricted diet even in remission.[47,48] Despite their intended benefits, recent research highlights a strong negative impact of these restrictive diets on patients' daily lives, encompassing their psychosocial well-being, psychological state, social interactions, and family dynamics.[47,50] A survey-based study demonstrated that impaired food-related QoL was associated with recurrent disease flares, a reduced IBD-specific QoL, greater IBD-related distress, as well as a lower intake of key nutrients vital for gut health and bone mineralisation.[51] Moreover, exclusion diets may lead to various nutritional deficiencies; for example, a gluten-free diet is associated with decreased microbiota diversity, and a lactose-free or paleo diet has been shown to increase the risk of osteoporosis in patients with IBD.[46]

While the link between specific foods and IBD remains unclear, patients with IBD often find reducing their intake of "triggering" foods such as fatty foods, processed foods, additives, preservatives, and sugary foods can be helpful.[47,49] These findings raise the question of whether the poor diets seen in patients with obesity may contribute to the development of IBD or perpetuate the inflammation associated with IBD, and further research is needed to explore these areas.

Ghrelin and Leptin Signalling in IBD

Ghrelin and leptin are responsible for mediating appetite and are thought to be involved in the loss of appetite often seen in patients with IBD.[52] Ghrelin, an anabolic hormone produced in the stomach, is responsible for stimulating hunger, acid secretion, gut motility, growth hormone release, and has effects on body composition.[52] Ghrelin also plays a role in modulating immune responses and inflammatory processes and is associated with higher levels of CRP and fibrinogen.[53] In a study of 31 patients with IBD, ghrelin levels were significantly lower

compared with controls and even lower in those with disease,[52] which supports the theory that ghrelin plays a role in loss of appetite in IBD. In contrast, higher levels of ghrelin have also been found in patients with IBD when compared with healthy controls.[53] Higher levels of circulating ghrelin have been associated with increased severity of disease and activity of disease markers (sedimentation, CRP, and fibrinogen).[53]

Leptin is a peptide hormone released from adipose tissue which plays a role in the regulation of appetite, energy homeostasis, neuroendocrine function, and metabolism.[54] Leptin reduces hunger by signalling the hypothalamus, to suppress appetite and regulate energy balance. If adipose tissue is sufficient within the body, circulating leptin levels will increase, subsequently decreasing hunger and increasing energy expenditure from adipose tissues.[54] Leptin abnormalities have associations with various metabolic syndromes including obesity.[54] Due to the increased adipose tissue in obesity, leptin levels are high but often fail to suppress appetite and regulate energy balance effectively, a condition known as leptin resistance, which leads to continued overeating and weight gain.[54] Leptin resistance is believed to be the result of impaired leptin signaling, inflammation, and metabolic disruptors.[54] However, the relationship between leptin and IBD remains inconclusive and increased levels of leptin have not been consistently found in patients with IBD.[55] Karmiris et al. and Ghomraoui et al. found decreased levels of serum leptin in patients with IBD.[40,52] Whereas a study by Trejo-Vazquez et al. correlated higher levels of serum leptin with an increased risk of IBD and disease activity.[56] Patients with inactive IBD were also shown to have slightly higher levels of leptin compared with patients with active IBD.[52] On the other hand, a systematic review found no significant difference between serum leptin levels of patients with IBD and healthy controls nor any association of leptin levels to disease activity.[57] It was noted that patients with CD have significantly higher levels of leptin compared with those with UC.[57]

There is a clear lack of consensus surrounding ghrelin and leptin levels in patients with IBD and how these outcomes may influence the patient with respect to appetite, energy homeostasis, and body composition. Building on prior observations, gut dysbiosis in IBD patients might influence ghrelin levels,[39,40] while increased adipocytes, as expected, would generate more leptin[54]; this could theoretically explain the dysregulated expression of ghrelin and leptin. Further research into the potential link and directionality between ghrelin and leptin levels in IBD in relation to nutritional status and body composition is needed.

IBD Treatment and Weight Gain

Weight loss is common during active IBD due to malabsorption, increased intestinal losses, reduced appetite, and the increased catabolic state of active disease. Therefore, obtaining more effective control of inflammation through IBD treatment can be expected to return the individual to their pre-relapse weight. Furthermore, reduced visceral sensitivity and fullness sensation following control of intestinal inflammation likely also play a role in improving appetite and subsequent weight gain.[58] In patients with moderate-to-severe UC, approximately one-third of patients had a significant weight gain of ≥5% after 1 year of treatment.[59] Additionally, after the initiation of treatment for UC, the proportion of patients who were overweight or obese increased by 38%-47%.[59]

Unintended weight gain is a common adverse effect of glucocorticoids, reported by up to 70% of patients on chronic glucocorticoid therapy.[60] In addition to this, studies have suggested that biological therapies themselves may also be associated with excess weight gain.[61–64] Infliximab has been shown to increase total abdominal fat in CD patients after induction therapy.[61] Similarly, Kaazan et al. demonstrated an overall net weight gain during infliximab treatment.[62] Interestingly, two-thirds ($n = 98$) of patients gained weight (6.6 ± 5.5 kg), whilst a quarter of patients ($n = 40$) experienced microbiome changes and a net weight loss (3.6 ± 2.9 kg) over 12 months.[62] However, the reduction in CDAI scores from the start of infliximab therapy to 12 months was similar regardless of net weight gain or loss.[62] In a large post-hoc analysis of ACCENT I, ACCENT II, ACT 1, and SONIC trials, patients with IBD with markers of severe disease (such as elevated CRP, low haematocrit, and low albumin) were more likely to gain more weight on infliximab treatment.[63] In a prospective study of 314 patients (including 197 CD, 117 UC) initiating biological therapy, anti-TNF, vedolizumab, and ustekinumab were all associated with a modest weight gain by 30 weeks after treatment initiation (1.06 ± 3.91 kg, 0.83 ± 4.05 kg, and 1.21 ± 3.28 kg, respectively) and continued up to 1 year.[64] There were no differences in weight gain across therapeutic classes.[64] The weight gain observed did not affect health-related quality of life across these biological treatments. Furthermore, as many patients with IBD have significant weight loss prior to diagnosis, the recorded weight gain after IBD treatment does not necessarily mean obesity. The study did not address whether the weight gain changed the proportion of patients who were overweight or obese.[64]

It remains unclear if there is a true causal relationship between IBD treatment with biologics and weight gain. Biologic therapies are typically more effective in achieving disease control than immunomodulators and are mostly used in patients with moderate to severe disease phenotypes who have more extensive symptoms.[65] This may explain the observed modest weight gain seen with biologics compared with immunomodulators as a result of good disease control in this population. Another potential consideration is that TNF-a blockers increase serum leptin production and thus increase appetite.[66] Furthermore, TNF therapy may promote adipogenesis, modulate lipid profile, and increase insulin sensitivity.[67] The finding of similar weight gain changes in patients with IBD treated with vedolizumab and ustekinumab suggests that other TNF-independent mechanisms are involved, and further research is needed.[64]

Other novel drugs used in the treatment of IBD include ozanimod, etrasimod, upadacitinib, and tofacitinib. Weight increase has been reported in upadacitinib clinical trials as a common side effect in patients treated for atopic dermatitis.[68] There have been 6 reported cases of tofacitinib-induced weight gain in patients with rheumatoid arthritis, ankylosing spondylitis, and vasculitis.[69] Ozanimod, etrasimod, and newer biologics including risankizumab and mirikizumab have not been implicated with weight gain in clinical studies thus far.

Weight gain and obesity may also have a negative impact on the efficacy of specific drugs commonly used to treat IBD, particularly immunomodulators and anti-TNF agents. The impact of obesity on clinical response to therapy is covered in more detail in section 7.0.

Effect of Obesity on IBD Disease Course

Evidence regarding the effect of BMI on outcomes in IBD is limited and inconclusive. Several studies have demonstrated an association between a obesity and higher ratio of visceral to subcutaneous fat, to disease severity and poorer outcomes[12–15,70,71] (Table 1).

Studies show that obesity may have benefit in CD.[3,6,72] A study of 846 CD patients showed a lower prevalence of penetrating disease, and comparable rates of perianal and stricturing disease, in patients who were obese compared to adults with a normal BMI.[6] Flores et al. observed lower rates of CD-related surgery, hospitalization, and initiation of anti-TNF therapy in patients who were obese and overweight compared with those who were normal weight or underweight.[3] However, Hass et al. demonstrated no difference in the number of CD-related surgeries or escalation of medical therapy in patients with obesity.[5]

In patients with UC, several studies suggest that obesity may have a worse prognosis; however, there are contrasting results.[3,9,73] A retrospective study, involving >1200 patients, found that patients with UC who were obese or overweight were more likely to undergo surgery compared with patients who had a normal weight.[9,73] Furthermore, one population-based cohort study demonstrated that each incremental increase in BMI by 1 kg/m^2 was associated with a 3.4% increase in the risk of hospitalisation (P = .052) and a 6% increase in the risk of surgery in patients with UC (P = .01).[73] Conversely, Flores et al. demonstrated lower rates of UC-related surgery or hospitalization and/or initiation of anti-TNF therapy in patients who were obese (40%) or overweight (49%) compared with patients who had a normal weight or who were underweight (67%).[3]

In a pooled meta-analysis, Hu et al. suggested that patients with obesity were significantly less likely to undergo IBD-related surgery and experience hospitalization compared with nonobese patients.[74] Furthermore, it has been demonstrated that IBD patients with obesity had a higher risk of having active disease and a higher risk of relapse compared with patients with a normal BMI.[11] The effect appeared to be stronger in patients with UC compared with CD.

When using VAT rather than BMI as a measure of body composition, further correlations between obesity and IBD outcomes are demonstrated. Amongst patients with CD, visceral adiposity has been shown to be positively associated with stricturing disease,[70] penetrating disease, and CD-related surgery.[12,13] Similarly demonstrated in a retrospective cohort study of 200 IBD patients, visceral adiposity (measured by VAT:SAT) was associated with decreased time to IBD flare, while BMI was not.[14] Visceral adiposity thought to be an independent risk factor for endoscopic reoccurrence of CD following surgery.[15] Additionally, higher intra-abdominal VAT % (VAT as a percentage of total body mass) is correlated with lower rates of corticosteroid-free deep remission and endoscopic remission.[71] An area for future research is whether interventions targeted at decreasing visceral adiposity may improve IBD disease outcomes.

Quality of Life in IBD and Obesity

Patients with IBD experience a lower QoL than individuals without the condition. During active disease, patients with IBD may face specific challenges in mental functioning, contributing to a diminished QoL.[75] Interestingly, while in remission, patients with CD have been shown to have lower mental QoL compared with patients with UC.[75] Higher levels of depression, anxiety, and stress have also been noted in patients with IBD and were associated with a lower QoL.[76] A study by Keller et al. found 87% of UC patients and 91% of CD patients demonstrated an impaired QoL; a reduced QoL was linked to active extraintestinal manifestations, smoking, a heightened fear of progression, and demand for psychotherapy.[77]

An impairment in QoL is not exclusively associated with IBD; it is also independently linked to obesity. A systematic review concluded that obesity, particularly when combined with metabolic disturbances, was associated with an increased risk of mental health problems and poor QoL.[78] Even when considering individuals with other chronic illnesses, patients who were overweight and obese have significantly lower health-related QoL across physical health measures, vitality measures, and health perceptions, compared with patients were not overweight after adjustments for demographics, medical conditions, depression, and health habits.[79] Notably, prospective studies included in a meta-analysis suggested that individuals with a higher BMI were at an increased risk of developing depression.[80]

In a study of 7296 patients with IBD, of which ~20% were classed as "obese," obesity independently associated with increased rates of anxiety, depression, fatigue, pain, and inferior social function scores.[11] Moreover, these measures were shown to gradually increase from patients with normal weight to patients with class II/III obesity. Of note, sleep quality was not affected by the different weight groups in those with IBD.[11] Obesity has been associated with an increased risk of persistent disease activity or relapse in both patients with CD and UC in a dose-dependent manner.[11] Using the Short Inflammatory Bowel Disease Questionnaire (SIBDQ) which measures disease-related QoL, patients with IBD with obesity type II (BMI: 35–39.9) and III (BMI: ≥ 40) had significantly lower QoL compared with patients with normal weight.[7] Within the prospective Swiss IBD cohort, the QoL for individuals with CD and UC who were obese was found to be diminished, with the impact being somewhat less pronounced in UC.[4] Specifically, CD patients with obesity exhibited lower Inflammatory Bowel Disease Questionnaire (IBDQ) systemic and social scores, as well as decreased 36-item Short Form Survey (SF-36) physical scores, in comparison to patients who had normal weight.[4] Patients with obesity have also been shown to have poor body appreciation,[81] and therefore, this may be a key factor in QoL outcomes.

Effect of Obesity on IBD Management

Impact on Medical Management

With the rising prevalence of obesity within the IBD population, understanding the impact that obesity has on IBD management becomes increasingly important. When considered by class, multiple studies suggest that obesity may have a negative impact on the efficacy of specific drugs commonly used to treat IBD.[7] It has been demonstrated that obesity impacts the pharmacokinetics of drugs by affecting drug absorption, distribution, and clearance, resulting in shorter half-life and lower trough concentrations.[82]

Immunomodulators

AZA and 6-MP are dosed according to weight, yet obesity, particularly morbid obesity, is a suspected risk factor for

suboptimal weight-based dosing and reduced therapeutic response.[7,83,84] Seminerio et al. found significant differences in milligrams per kilogram equivalent of immunosuppressants (ie, methotrexate, AZA, 6-MP) when stratified by BMI in patients with IBD.[7] To align with recommended weight-based dosing, patients with type III obesity would require an AZA dose of 319.5 mg/day—more than twice the average dose they were receiving (140.3 mg/day).[7] Similarly, dosing of 6-MP based on actual body weight would necessitate over double the average administered amount, with a required dose of 187.4 mg/day compared with the received average of 92.9 mg/day.[7]

A retrospective study involving 132 patients with IBD treated with thiopurines found that patients with obesity had significantly lower levels of the thiopurine metabolite (6-thioguanine [6-TGN]) when adjusted for the total dose of AZA or 6-MP they were receiving relative to total body weight.[83] Furthermore, there was an inverse relationship between 6-TGN and body fat index, suggesting that adipose tissue may play an important role in the inter-individual variability of thiopurine efficacy.[83] Adequate levels of the 6-TGN correlate with remission and improved outcomes in IBD.[85] The finding of suboptimal levels of 6-TGN in patients with obesity by Poon and colleagues suggests that obesity may adversely affect outcomes of IBD therapy with thiopurines.[83] A retrospective study of 1176 patients with IBD demonstrated that patients in the UC subgroup with a BMI of >25 kg/m^2 had poorer responses to AZA, as defined by increased disease flares requiring an increasing dosage of steroids, when compared with patients with a BMI of <25 kg/m^2 (0.3 flares/year compared with 0.0 flares/year).[84] In contrast, no correlation was shown between BMI and response to AZA in patients with CD.[84]

Anti-TNF

Pharmacokinetic studies of biologic agents approved for use in IBD, including anti-TNF agents (infliximab,[86] adalimumab,[87] certolizumab pegol[88]) have demonstrated high body weight as a risk factor for increased drug clearance, resulting in shorter half-life and lower trough concentrations. Additionally, there is a hypothesised phenomenon described as "TNF-sink." This is whereby high levels of TNF (which are more pronounced with the higher inflammatory burden in patients with obesity) serve as a sink for anti-TNF agents, increasing monoclonal antibody clearance.[89]

Overall, data suggest that obesity may be a predictor of suboptimal response to anti-TNF agents. Adalimumab and certolizumab pegol are administered subcutaneously at a fixed dose. There is evidence that increasing BMI is associated with an attenuated response in adalimumab therapy.[90] Bhalme et al. found that patients with CD and a BMI of ≥30 had a significantly shorter time to adalimumab dose escalation; this reduction in efficacy was not observed in patients with infliximab.[90] A pooled analysis of data collected from 4 clinical trials of infliximab (ACCENT-I, SONIC, ACT-1, and ACT-2) demonstrated that obesity was not associated with inferior response to infliximab in patients with IBD.[91] With regards to certolizumab pegol, it has been shown that there is a significant inverse relationship between plasma concentrations and body weight.[88] Higher concentrations of certolizumab are associated with endoscopic response and remission.[88]

Contrastingly, in a retrospective cohort study involving 124 patients with IBD commencing infliximab naive to previous biologic therapy, increased body weight was associated with a quicker time to loss of response to infliximab and requiring dose escalation.[92] This was a novel finding given infliximab is unique amongst the anti-TNF agents for being dosed according to weight. Similarly, a subsequent retrospective cohort study of biologic-treated UC patients showed that an increase in BMI was independently associated with an increased risk of treatment failure.[93] This effect on treatment failure was independent of the dosing regimen (fixed-dose and weight-based dosing).[93] In a pooled meta-analysis, it was demonstrated that obesity was associated with higher risk of treatment failure in UC patients (OR = 1.413 [95% CI, 1.008-1.980]; P = .045) but not CD (OR = 1.099 [95% CI, 0.928-1.300]).[94] The difference in results between UC and CD may be due to the role of local mesenteric fat in CD which may have a greater impact on anti-TNF failure than systemic obesity.[94] Creeping fat is richer in pro-inflammatory cytokines

Table 2. Key takeaways of the relationship between obesity and IBD.

Prevalence	Several epidemiological studies propose that 15%-40% of adult patients with IBD are obese, and an additional 25%-40% falling in the overweight category.[3–9]
Premorbid obesity	Premorbid obesity has been shown to be associated with an increased risk of developing CD, but not UC, although this relationship has not been consistently observed.[17–19]
Pathophysiology	Mesenteric VAT generate pro-inflammatory agents and cytokines which induce a state of chronic low-grade inflammation.[20,27] Intestinal inflammation and impaired mucosal barrier function in IBD leads to bacterial translocation with an increase in the expression of pro-inflammatory cytokines resulting in a continuous feedback loop.[28,29]
Disease course	Evidence regarding the effect of obesity on the disease course in IBD is limited and inconclusive with conflicting results in both patients with CD and patients with UC (Table 1). Increased VAT has been shown to be to be associated with decreased time to IBD flare, endoscopic reoccurrence, and stricturing CD disease.[14,15,70,96]
Medical management	When considered by class, obesity may have a negative impact on the efficacy of specific drugs commonly used to treat IBD, particularly immunomodulators and anti-TNF agents.[7]
Surgical management	Obesity is linked to higher rates of adverse peri-operative outcomes in patients undergoing abdominal operations including greater estimated blood loss, longer operative times, postoperative wound infections, and wound disruptions.[108]
Quality of life	Concurrent obesity has been shown to diminish QoL further in those with IBD,[4,7,11]

Abbreviations: CD, Crohn's disease; IBD, inflammatory bowel disease; QoL, quality of life; UC, ulcerative colitis; VAT, visceral adipose tissue.

including TNF, which contribute to increased antigen sink.[31] In CD patients with obesity, the amount of local mesenteric fat may not align with BMI measured. Regardless, obesity was significantly associated with increased risk of failure of both dose-fixed (OR = 1.121 [95% CI, 1.027-1.224]; $P = .011$) and weight-based anti-TNF agents (OR = 1.449 [95% CI, 1.006-2.087]; $P = .046$).[94] However, the analysis was limited by the included studies using BMI as sole measures of obesity, which does not fully reflect the amount of mesenteric fat that plays a key role in intestinal inflammation. Higher VAT area, as determined by computed tomography scan, has been negatively associated with disease remission in CD patients treated with infliximab.[95] Furthermore, a prospective study by Yarur et al. showed that higher VAT percentage was associated with increased optimal infliximab trough levels required for steroid-free and endoscopic remission (15.3 mcg/mL in patients in the highest 2 VAT percentage quartiles vs 3.9 mcg/mL in patients in the lowest 2 VAT percentage quartiles).[96]

Ustekinumab

Ustekinumab is a monoclonal antibody which targets the p40 subunit of IL-12 and IL-23. It has been demonstrated that although BMI affects ustekinumab drug levels, there is no impact of BMI on clinical efficacy.[97] However, there is sparse data regarding the effect of BMI or visceral adiposity on ustekinumab and further studies of the pharmacodynamic effects of ustekinumab in patients with obesity is needed.

Vedolizumab

There remains limited data on the association between obesity and the therapeutic efficacy of vedolizumab in patients with IBD. Lower BMI has been associated with higher vedolizumab trough levels.[98] Higher vedolizumab trough concentrations are associated with a greater probability of attaining effective endpoints such as endoscopic healing, clinical response, and biological response remission in patients with IBD.[98] However, in a single-centre, retrospective study of patients with IBD who received vedolizumab, obesity (defined by BMI) was not associated with higher rates of vedolizumab dose escalation.[99]

Impact on Surgical Management

Obesity presents unique technical challenges in commonly performed IBD-related surgeries, such as stoma formation and ileal pouch-anal anastomosis (IPAA). In patients with obesity, the mesentery is often more fatty and shortened, posing challenges in achieving the necessary bowel length for pouch construction.[100] Additionally, obesity complicates the pelvic exposure required for performing restorative proctocolectomy with IPAA.[100] Consequently, patients with obesity undergoing IPAA are less likely to undergo laparoscopic surgery and have greater estimated blood loss and longer operative times.[101,102] These patients are also at increased risk of pouch-related complications including strictures, inflammatory pouch complications, and pouch fistulas.[103] Furthermore, excessive VAT gain and BMI gain following ileal pouch construction were found to be associated with poorer long-term outcomes including new chronic pouch inflammation, new pouch sinus, and pouch failure in IBD patients.[104] Others, however, have suggested that long-term outcomes are not affected.[101] Factors such as increased abdominal wall thickness, altered abdominal contour, and a large pannus make the stoma placement and formation in a patient with obesity technically challenging.[100] Patients with obesity also have a higher risk of stoma-related complications, including parastomal hernia, stomal prolapse or retraction, and mucocutaneous separation.[105,106] A higher visceral/subcutaneous fat ratio has been shown to be an independent predictor of postoperative morbidity in CD patients undergoing ileocolectomy.[107] IBD patients with obesity have an increased risk in terms of overall complications, infectious complications (especially wound complications), as well as conversion to laparotomy.[108]

Conflicting results have also been published. A retrospective review of 391 surgeries performed for patients with IBD demonstrated no differences in intraoperative variables such as surgeries converted to open, estimated blood loss, and intraoperative complications in patients with obesity compared with patients without obesity.[109] No differences in postoperative complication rates including wound infection or anastomotic leak were found.[109] This study however may be limited by using BMI as the sole measure of obesity. A combination of various factors including visceral adiposity, immunosuppressant use (in particular corticosteroids), and comorbidities likely contribute to adverse perioperative outcomes and further study into this complex patient population is needed.

Future Directions

With obesity becoming increasingly prevalent among individuals with IBD, it is important to focus efforts on finding effective IBD-specific weight management strategies. Current literature suggests that many weight-loss methods are typically avoided or have not been thoroughly studied in this population. Weight management strategies that should be implemented into clinical practice in management of IBD patients include lifestyle changes, medications, and bariatric surgery. Lifestyle changes to aid weight loss include a personalized diet plan and an increase in physical activity. Even though some patients with IBD may be overweight, they can still be at risk for vitamin and micronutrient deficiencies, which must also be considered in a patient's diet.[110] In addition to diet modifications, moderate-intensity exercise has been shown to reduce inflammation, visceral fat, and stress-induced intestinal barrier dysfunction.[111]

Several prescription weight loss medications are available; however, utilization rates are low and few have been specifically studied in the IBD population.[112] A retrospective study, based in the United States, found that only 2.8% of eligible adults with IBD and obesity were prescribed anti-obesity drugs in the past decade.[113] The limited use of weight-loss medications including GLP-1 agonists in IBD patients is due to a lack of high-quality data on their effectiveness and the limited experience healthcare professionals have in prescribing these treatments.[113] GLP-1 agonists have been linked to a lower risk of adverse IBD outcomes, such as the need for corticosteroids, TNF inhibitors, hospitalizations, and IBD-related surgery.[114] On the other hand, Orlistat, a lipase inhibitor, is not recommended for IBD patients because it can increase malabsorption.[115]

Bariatric surgery has proven to be more effective than lifestyle changes in reducing mortality for patients with a BMI of 40 kg/m² or higher, or those with a BMI of 35-39.9 kg/m² and at least one obesity-related health condition.[116] However,

bariatric surgery remains limited among patients with IBD due to concerns about underlying luminal inflammation, irreversible anatomical changes, immunosuppression, and worsening nutritional deficiencies.[117] Recent studies have explored the safety and practicality of bariatric surgery in patients with IBD, revealing that these individuals face a higher risk of preoperative small bowel obstruction compared with those without IBD.[118] However, early (22%) and late (20%) postoperative complication rates are similar between patients with IBD and those without IBD (13%-21%).[119] Future research is required to compare how different bariatric procedures, such as Roux-en-Y gastric bypass and sleeve gastrectomy, may affect IBD outcomes. The risk of developing new-onset IBD after bariatric surgery is still unclear. A case series has suggested a link between bariatric surgery and the development of IBD, however, whether this is a true causal relationship remains uncertain.[120] Most of the current literature consists of case reports and case series, highlighting the need for further research in the development of de novo IBD following bariatric surgery.

Conclusion

Despite malnourishment being a common feature of IBD, recent trends indicate a growing prevalence of obesity within this population. The question of whether IBD directly influences obesity or vice versa requires further investigation (Table 2). Current evidence suggests that the rise in obesity among patients may be due to a confluence of factors, including VAT accumulation, gut dysbiosis, IBD treatment side effects, dietary modifications, and potential alterations in hunger hormones. Obesity in patients with IBD can negatively impact different aspects of disease management, including a reduced efficacy of medications, an increase in surgical complications, and an increase in morbidity. Interestingly, obesity has been shown to have a protective effect on CD with increased time to IBD flare, reduced endoscopic reoccurrence, and lower prevalence of stricturing disease, while poorer disease outcomes and increased hospitalizations have been seen in UC. Further research into these correlations are still needed due to conflicting results. Including a more nuanced reflection of obesity such as adipose tissue distribution, VAT and abdominal circumference may help in clarifying these links. Increased awareness and understanding of rising obesity rates in patients with IBD are crucial for clinicians to personalize treatment plans and support effective weight management, ultimately improving patient outcomes. There exists an important opportunity to promote obesity-directed treatment such as lifestyle modifications and pharmacological management in patients with IBD and obesity.

Author Contributions

J.S., E.C.B., and G.L.H. conceptualized the article. J.S. and E.C.B. contributed to the literature review and manuscript writing. All authors contributed constructive feedback and manuscript content guidance. J.S., E.C.B., and G.L.H. reviewed and edited the article. All authors have reviewed and approved the published version of the manuscript.

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