Connection to Perinatal Care for the Management of Maternal Inflammatory Bowel Disease in Pregnancy

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ABSTRACT

Background: Inflammatory bowel disease (IBD) poses a public health concern, particularly in pregnant individuals, where it has been linked to adverse maternal and fetal outcomes. Routine and specialist consultation is recommended pre-conception, during pregnancy, and postpartum, yet many pregnant Canadians do not receive adequate prenatal care. Addressing these gaps requires a focus on clinical and social determinants of health, but limited data exists on prenatal care utilization, pregnancy outcomes, and inequities affecting access to care for this population.

Methods: We performed a population-level retrospective cohort study of pregnant Ontario residents who delivered a live or stillborn infant (>20 weeks gestation) at an Ontario hospital between April 1, 2012 and September 15, 2019. Our three study groups of interest included an IBD, multimorbidity, and healthy control group. Frequencies and proportions were used to report adequacy of prenatal care levels derived from the Revised-Graduated Prenatal Care Utilization Index as well as obstetrical and newborn outcomes in our study groups. Specialty visits for the IBD groups were identified 6 months pre-conception, during pregnancy, and 6 months postpartum. Adequacy of prenatal care among the study groups and social inequities affecting adequacy of care were investigated using multivariable logistic regression to compute unadjusted and adjusted odds ratios (aOR). Social inequities were derived from the Ontario Marginalization Index (ON-Marg).

Results: We identified 373,101 pregnancies that met our study criteria, with 3,451 pregnancies in the IBD group, 6,280 in the multimorbidity group, and 363,370 in the healthy control group. Compared to the healthy control group, the IBD (aOR: 1.55; 95% CI, 1.53-1.57) and

multimorbidity (aOR: 2.10; 95% CI, 2.08-2.12) groups were at higher odds of receiving adequate prenatal care. For IBD patients, the prevalence of visits with a general practitioner was high in all three trimesters of pregnancy, with a range of 75-93%, while visits with gastroenterology ranged from 44-57%. Obstetrical and neonatal outcomes such as caesarean sections, preterm birth, and low birth weight were higher in the IBD and multimorbidity groups, compared to the healthy control group. For the IBD group, those living in neighborhoods with the highest racialized populations (0.78 [0.72-0.85]), least access to material needs (0.67 [0.62-0.73]), and least residential stability (0.93 [0.87-0.99]) were associated with having lower odds of adequate prenatal care compared to individuals living in the least marginalized neighborhoods.

Conclusion: The findings of this study suggest that despite higher odds of receiving adequate care, those with IBD and multimorbidity may have higher rates of adverse obstetrical and newborn outcomes. Social inequities at the neighborhood level had mixed effects on adequacy of care, with some study groups more likely to receive inadequate care, depending on the social inequity dimension. These results highlight the need to address both clinical and social factors to improve prenatal care access and outcomes for individuals with IBD and other chronic conditions in Ontario.

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PREFACE

Maisha Islam was responsible for collecting all approvals to conduct the research for this thesis. Under the supervision of Dr. Darine El-Chaâr, Dr. Steven Hawken, and thesis advisory committee member, Dr. Katherine Muldoon, Maisha Islam designed the study, performed the data analysis, interpreted study findings, and drafted the final thesis. The study cohort was cut by Michael Pugliese at ICES uOttawa. All supervisors and thesis committee members provided feedback and revisions on the final paper.

LIST OF ABBREVIATIONS

ACOG: American College of Obstetrician and Gynecologists

AGA- American Gastroenterological Association

ART- Assistive reproductive technology

BORN- Better Outcomes Registry & Network

CCI- Canadian Classification of Health Interventions

CD- Crohn's disease

CI- Confidence interval

CIHI- Canadian Institute for Health Information

DAD- Discharge Abstract Database

HCPs- Health care providers

IBD- Inflammatory bowel disease

ICD- International Statistical Classification of Diseases

ICES- Institute of Clinical Evaluative Sciences

IKN- ICES key number

IQR- Interquartile range

LBW- Low birth weight

LGA- Large for gestational age

MES- Maternal Experiences Survey

NACRS- National Ambulatory Care Reporting System

OBGYN- Obstetrician / gynecologist

ON-Marg- Ontario Marginalization Index

OR- Odds ratio

R-GINDEX- Revised-Graduated Prenatal Care Utilization Index

SGA- Small for gestational age

UC- Ulcerative colitis

VC-Voluntary childlessness

CHAPTER 1: INTRODUCTION

1.1 Background

The rising trend in inflammatory bowel disease (IBD) is a public health concern that is increasingly impacting individuals of reproductive age, including those during pregnancy. In 2023, it was estimated over 320,000 Canadians (0.8%) would be living with IBD, with a forecasted prevalence of over 1.0% by 2035 (1). IBD has been associated with adverse maternal and fetal outcomes including preeclampsia, preterm birth, and increased risk of neonatal morbidity (2–6). Hence, individuals with IBD are recommended to consult a specialist pre-conception, during pregnancy, and postpartum (7). Unfortunately, many individuals across the world, including Canada, do not receive the recommended minimum number of clinical visits throughout pregnancy (8,9). Improving prenatal and specialist care requires consideration of both clinical and social determinants to ensure equitable access. However, there is limited information on access to prenatal care amongst individuals with IBD in Canada, obstetrical and neonatal outcomes in this population, and associated social inequities that may influence adequacy of care.

1.2 Thesis rationale & objectives

A comprehensive evaluation of access to routine prenatal care, specialist care, and the coordination of multidisciplinary care is needed to understand how individuals with IBD navigate pregnancy and how best to improve care pathways for this Canadian population. Along with the IBD group, we will compare outcomes to a high-risk group of pregnant individuals with pre-existing multimorbidity (not including IBD) and a healthy control group with no pre-existing chronic conditions.

The first objective of this thesis was to investigate the adequacy of prenatal care amongst pregnant individuals within our three study groups in Ontario. Adequacy of care will be measured using the Revised-Graduated Prenatal Care Utilization Index (R-GINDEX) and will be further stratified by parity to characterize differences in care between nulliparous and multiparous women. A multivariable logistic regression analysis will be conducted to investigate the association between each of the study groups and their odds of receiving adequate care. This objective will also provide information on the primary prenatal care providers that our study groups were visiting along with specialty specific visits for our IBD cohort in the pre-pregnancy period, during pregnancy, and postpartum. Objective 2 will explore the prevalence of obstetrical and neonatal outcomes amongst our study groups. Lastly, Objective 3 will investigate the association between social inequities from the Ontario Marginalization Index (ON-Marg) and adequacy of prenatal care characterized by a dichotomized version of the R-GINDEX categories.

1.3 Thesis organization

This thesis is presented in a monograph format and is separated from Chapters 1 to 6. Chapter 1 is an overview of the topic, including the rationale for the thesis as well as the main research objectives. Chapter 2 presents a review of the current literature on IBD, including its epidemiology worldwide and in Canada. The effect of IBD on the pregnant population is further explored, including its effect on fertility, risk of adverse obstetrical and neonatal outcomes, and perceptions of pregnancy management in this population. Lastly, the literature review covers care pathways for pregnant patients with IBD including social determinants of care, prenatal care utilization, international and national guidelines in IBD management, and the role of health care providers in providing care to this population. Chapter 3 discusses study methodology, including how our study population was derived, data access and privacy, data sources, exposure and

outcome measurement, and statistical analysis methods. Chapter 4 summarizes the main study results including our final study sample and the outcomes for our three study objectives. Chapter 5 will be a discussion of our results and their ties to the current literature, strengths and limitations of this study, as well as implications for future research. Lastly, Chapter 6 is the conclusion of this thesis and provides a summary of our study's findings.

CHAPTER 2: LITERATURE REVIEW

2.1 Inflammatory Bowel Disease

2.1.1 What is Inflammatory Bowel Disease?

Inflammatory bowel disease (IBD) is a group of autoimmune diseases characterized by relapsing inflammation of the gastrointestinal tract and comprises of two main conditions- Crohn's disease (CD) and ulcerative colitis (UC) (10). CD may affect any part of the digestive tract starting from the mouth to the anus, but most commonly affects the small intestine and the beginning of the large intestine (11). In patients with CD, inflammation is discontinuous and affects all layers of the intestine. Comparatively, UC tends to be localized to the colon with patients having continuous inflammation limited to the mucosal layer (12). The exact etiology of IBD has not been established. However, it is presumed IBD may be attributed to a range of environmental, lifestyle, and genetic factors and their interactions with the intestinal microbiome (13). Such factors may contribute to an overactive inflammatory response in the gut, resulting in increased microbial dysbiosis and a compromised intestinal barrier.

Although there are common symptoms between CD and UC, their clinical presentations may vary. Classic presentation of UC includes bloody diarrhea with or without mucous as well as pain in the lower left part of the abdomen (14,15). In contrast, patients with CD more commonly experience pain in the lower right abdomen as well as blockage of the intestine because of

swelling and inflammation (15). Due to the nonspecific symptoms of IBD which are similar to other gastrointestinal conditions, diagnosing IBD remains a clinical challenge. Healthcare providers implement a combination of procedures to distinguish between these conditions to make a differential diagnosis. These procedures may include blood tests, stool tests, endoscopic procedures, and imaging techniques (16). As there are currently no permanent cures for IBD, the focus of IBD treatment is to manage symptoms and to maintain remission. First step treatments include pharmacotherapies to reduce inflammation of the gut such as sulfasalazine and 5-aminosalicylic acids, immunomodulators, corticosteroids, and biologics (17). Despite the number of treatments available, up to 20% of patients with UC and up to 80% with CD will eventually require surgery (17). Reasons for surgical interventions may include failed medical therapy, recurrent disease, bowel obstruction, infections, malignancies, etc. (18).

2.1.2 Epidemiology of IBD

IBD is on the rise globally with up to 5 million cases reported worldwide and an age-standardized prevalence rate of 59.25 per 100,000 in 2019 (19). The epidemiology of IBD exhibits substantial variation across time and different geographical areas. Industrialized countries, such as those in North America, Europe, and Eastern Asia have some of the highest rates of IBD internationally (19). Among these nations, Canada has one of the highest burdens of IBD in the world. The prevalence of IBD in Canada in 2023 was estimated at 825 per 100,000 and it is forecasted that by 2035, approximately 470,000 Canadians will be living with IBD (10). Additionally, the incidence of IBD in 2023 was 30 per 100,000 person-years which indicates that there were over 11,000 new IBD diagnoses in Canada (10). The incidence of IBD was similar between men and women in 2023 in Canada, with an incidence of 30.0 per 100,000 for men and

28.9 per 100,000 for women (10). Previous studies have demonstrated a longer diagnostic delay of IBD amongst women compared to men (20).

A theoretical framework has been developed that stratifies the global evolution of IBD into four epidemiological stages (21). The first stage, *Emergence,* proposes that IBD occurs as sporadic, incident cases in developing countries. As these countries continue to industrialize and adopt a more Western lifestyle, incidence of IBD rises rapidly which propels these countries to the second stage, *Acceleration in Incidence.* The third stage, *Compounding Prevalence,* demonstrates that the sharp incline in incidence begins to decelerate over time. However, prevalence still increases steadily as IBD is commonly diagnosed in younger individuals and consequently has low mortality. As there is currently no cure for IBD, prevalence continues to increase with an increasing number of cases over a given time. The final stage, *Prevalence Equilibrium*, remains a theoretical stage where prevalence begins to plateau as mortality increases in the aging IBD population (21). Currently, Canada and most Western countries are in the third stage of the IBD epidemiologic transition, *Compounding Prevalence* (21).

2.1.3 Economic burden of IBD in Canada

IBD poses a significant economic burden to the individual, society, and the overall healthcare system. The rising prevalence of IBD inevitably contributes to increased healthcare utilization as well as individual direct and indirect cost. In Canada, the cost of IBD has risen from an estimated $2.57 billion in 2018 to $5.38 billion in 2023, which is potentially an underestimate of the true burden of the disease (10). Direct out-of-pocket costs associated with IBD management may include medical supplies often not covered by insurance (i.e., ostomy supplies, bowel preparation medications for colonoscopies, etc.) and additional costs associated with diet and supplements. Out-of-pocket costs are approximated to reach $536 million annually

for Canadians (10). Furthermore, IBD imparts direct costs on the healthcare system as measured by resource utilization and cost of medications. Costs associated with healthcare utilization include emergency department visits, surgeries, hospitalizations, diagnostic tests, and specialist consultations (10). With the introduction of biologics for the treatment of IBD, the distribution of directs costs associated with the disease have shifted from surgeries and hospitalizations to the cost of medications (22,23), Cost of biologics make up approximately 50% of total IBD medication costs in Canada (10). Overall, the direct cost of health resource utilization and medications on the healthcare system is estimated to reach up to $4.47 billion dollars (10).

Furthermore, the indirect costs of IBD on individuals and society is substantial with an estimated indirect cost of $1.51 billion in Canada (10). Indirect costs affecting the individual may be employment-related such as delayed entry into the workforce and early retirement, or impact on quality of life. Lastly, indirect costs may be faced by employers when hiring employees with IBD as there is the potential for reduced productivity through absenteeism (i.e., sick leave or reduced work hours) and presenteeism (i.e., being present at work but having minimal productivity (10,24).

2.1.4 Risk Factors of Inflammatory Bowel Disease

Understanding the risk factors contributing to IBD etiology is a critical area of research in both Canada and worldwide. The cause of IBD is suspected to be due to the interaction between a host and their genetic susceptibility, lifestyle, and environmental exposures, which may ultimately disturb their intestinal immune system. It is well documented that family history of IBD remains one of the most significant risk factors for developing the disease (25,26). In a meta-analysis of 71 studies, the prevalence of family history of IBD in UC patients was 12% (95% confidence interval [CI]: 11– 13%, I2 = 0.002) (27). Additionally, a large Danish cohort

study found that having two or more relatives (aOR: 6.26, 95% CI 1.34, 29.29) or a sibling with IBD (aOR: 1.36, 95% CI 1.18, 1.57) substantially increased the risk of having the disease (28). Likewise, the relation between diet and IBD has been extensively studied. Western diets, which are highly processed, high in refined sugar and saturated fats, as well as lower in fiber may contribute to increased IBD incidence (29). Diets rich in whole foods such as fruits and vegetables, whole grains, and omega-3 oils from fish are associated with a lower risk of IBD and maintaining remission in those with IBD (30,31). A systematic review investigating early life exposures and the risk of IBD found prenatal exposure to antibiotics and tobacco smoke were positively associated with IBD, while breastfeeding was protective against IBD (32).

2.2 IBD and pregnancy

2.2.1 Fertility and IBD

Although IBD affects people of all ages, peak onset tends to be between 15-35 years for CD and 15-45 years for UC, which overlaps with a women's reproductive years (11). Thus, for women of childbearing age with IBD, there are often many factors to consider when making reproductive decisions. When the disease is in remission, women with IBD who never had any surgical procedures had similar fertility rates to those of the general population (33). A Canadian cohort study comparing pregnancy rates in women with IBD to non-IBD controls from 1992-2018, found that women with IBD have lower pregnancy rates, although these differences weren't evident after 2010, which may be attributed to increased use of biologics and improved disease control (34). Additionally, a study conducted in the UK found that women with CD have marginally lower fertility rates compared to those without IBD, and these rates further decreased following flares and surgical interventions (35). Previous research suggests that women who had undergone surgery to manage IBD may have an increased infertility rate ranging from 26 – 50%,

depending on the type of surgical intervention (36–38). This is often due to the development of adhesions or blockage of the fallopian tubes resulting from surgical procedures. However, recent systematic reviews concluded that the effect of surgery for IBD on female fertility remains uncertain due to the poor quality of evidence of existing studies (39,40).

As there are a range of factors that may increase the risk of infertility in women with IBD, consideration of assisted reproductive technologies (ART) may be beneficial to this population. The use of ART for women with IBD has been shown to have safe and effective clinical outcomes, where pregnancy rates were comparable between IBD patients and those from the general population (41–43). However, pregnancy outcomes in those who used ART were less successful in those who had undergone prior surgical interventions to manage their symptoms (42,44,45).

2.2.2 Adverse obstetrical and neonatal outcomes associated with IBD

Women with IBD are presented with a variety of challenges when navigating pregnancy and childbirth. Appropriate management of IBD in the prenatal period and throughout pregnancy is critical as active disease has been shown to be associated with adverse pregnancy-related and neonatal outcomes in observational and cohort studies. Such outcomes include gestational diabetes (2), hypertensive complications (2,46), caesarean delivery (3,47–49), preterm birth (2,48–51), low birth weight (LBW) (51,52), small for gestational age (SGA) infants (48–50), spontaneous abortion (3), and fetal death (2,50,51). Such findings are further supported by recent systematic reviews and meta-analyses (4–6). Firstly, a systematic review conducted by Tandon et al. on the risk of adverse pregnancy-related outcomes in IBD patients found that these patients were more likely to experience caesarian deliveries, gestational diabetes, and preterm pre-labor rupture of membrane (PPROM) (5). Secondly, Leung et al. investigated the risk of adverse

neonatal outcomes and maternal IBD and found that compared to healthy controls, infants delivered by patients with IBD were more likely to have LBW and had increased admission to the neonatal intensive care unit (NICU) (6). Additionally, active disease was associated with an increased incidence of preterm birth, LBW, and SGA (6). Lastly, Kim et al. found that women with active IBD during the periconception period and pregnancy had an increased risk of spontaneous abortion, LBW, SGA, and stillbirth compared to women with inactive IBD (4). In the subgroup analysis by disease type, both women with active CD and UC had a higher risk of spontaneous abortion and preterm birth, while those with UC and CD were independently at higher risk for LBW and SGA, respectively (4).

2.2.3 The effect of pregnancy on IBD disease course

Along with the impact of IBD on pregnancy outcomes, pregnancy may also affect the overall disease course of IBD. Pregnancy induces a variety of physiological changes including hormonal, gastrointestinal, and immunological changes that may interact with the pathophysiology of IBD (53). Elevated estrogen and progesterone levels in pregnancy can induce gastrointestinal symptoms like bloating, nausea, and constipation, which may mimic or complicate IBD symptoms (53,54). A meta-analysis revealed that active disease at the time of conception is associated with active disease during the pregnancy period, for those with UC (RR 2.0, 95% CI: 1.5-3, $P < 0.001$) and CD (RR 2.0, 95% CI: 1.2-3.4, $P = 0.006$), when compared to those who conceived in remission (55). Furthermore, pregnant individuals with UC are more likely to relapse both during pregnancy (RR: 2.19; 95% CI 1.25-3.97) and the postpartum period (RR: 6.22; 95% CI 2.05-79.3), when compared to non-pregnant individuals with UC in a European prospective cohort study (56). The same study found that relapses occurred more frequently in the first and second trimesters (56). Other studies have found that pregnancy has

rather a protective effect on IBD relapse, where it was associated with increased quality of life (57) and there were reduced number of relapses in the years following pregnancy (58).

2.2.4 Perceptions of fertility and pregnancy in patients with IBD

Previous studies have shown that women with IBD face increased anxiety and concerns about their reproductive health and that many are misinformed about managing pregnancy with their condition. Inadequate knowledge/education regarding family-planning with IBD may consequentially result in negative views on fertility and pregnancy (59). A systematic review assessing the factors influencing IBD patients' family-planning decisions on reproductive health found that approximately 50% of all IBD patients have poor knowledge of pregnancy-related issues in IBD and that 17-38% of IBD patients choose voluntary childlessness (VC) (20), which is significantly higher than the rate of 6% in the general population (60). Likewise, another review found that women with CD were suggested to have up to 44% reduction in fertility compared to controls (61). However, this reduction in fertility was mainly ascribed to VC as there was no evidence supporting physiological causes of infertility (61). Overall, higher IBD-specific reproductive knowledge is associated with lower odds of VC and higher odds of trying to become pregnant (62,63).

Along with a lack of general reproductive health knowledge in those with IBD, additional factors have been identified to explain reasons of VC amongst this population. Sociodemographic predictors of VC include racial background, educational level, lower household income, unemployment, and age of diagnosis (60,64,65). Furthermore, individuals with IBD are often concerned about the heredity of the disease (59,60,66,67). A study by Selinger et al. found that up to 75% of participants expressed concern about passing IBD to their offspring (59). Medication teratogenicity is another commonly cited concern across this

population (65–67), which may explain why up to 20% of patients stop their medication during the pre-conception period and throughout pregnancy (68). A misconception amongst these patients is that their IBD medications may harm their fetus and result in adverse pregnancy outcomes (69). Likewise, patients often stop breastfeeding due to concerns of medication exposure to their infant (62,68,70). A study found that almost 70% of participants believed that women on any IBD medication should not breastfeed (59). Most IBD medications have been established as safe and well-tolerated during pregnancy and breastfeeding, with international organizations having acknowledged that the benefits of adhering to IBD medications during pregnancy outweighed any associated risks (71,72).

2.3 IBD care pathways in pregnancy

2.3.1 Social determinants of care in the general IBD population

Understanding health care utilization patterns and the determinants affecting access to care amongst individuals with IBD is imperative in the development of tailored interventions to maximize care to this population. However, there is limited information on access to routine prenatal care and specialist care among women with IBD. Likewise, there is limited information on the social determinants of prenatal care amongst the IBD population in Canada.

A systematic review and meta-analysis investigating the racial and ethnic disparities in health care utilization for those with IBD found that Black patients were more likely to undergo surgery, more likely to be hospitalized due to IBD, and more likely to visit the emergency department (73). Similarly, while all Canadians have access to universal health coverage, social determinants may impact access to care amongst the IBD population. A study conducted in Manitoba found that low socioeconomic status was associated with increased rates of annual outpatient physician visits (RR: 1.10; 95% CI 1.06-1.13), hospitalizations, (RR: 1.38; 95% CI

1.31-1.44), intensive care unit admission (RR: 1.94; 95% CI 1.65-2.27), and death (hazard ratio: 1.53; 95% CI 1.36-1.73) (74). These results reflect the downstream result of poor access to health care and resources for proper disease management. Differences in rural and urban health care utilization amongst IBD patients were also observed among several provinces (75,76). In Saskatchewan, rural residents had lower gastroenterology visits, less likely to have a gastroenterologist as a primary IBD care provider, and higher risks and rates of IBD-specific and IBD-related hospitalizations compared to those living in urban settings (75). Similar trends were observed in Alberta, Manitoba, and Ontario, where IBD-specific and IBD-related hospitalization rates were higher in rural patients (76). The same study found that rural patients had fewer IBD-specific gastroenterologist visits, and a smaller proportion of their IBD-specific care was provided by gastroenterologists (76). Other Canadian studies found that First Nation patients and immigrants had higher rates of IBD-specific hospital admissions and emergency department visits (77,78).

2.3.2 Prenatal care utilization and access to care

Prenatal care is routine healthcare provided during pregnancy until birth to ensure the best possible outcomes for both mother and baby. In Canada, prenatal care is provided by a diverse group of health care providers (HCPs) including obstetricians/gynecologists (OBGYN), family physicians, midwives, nurses and nurse practitioners. According to the Canadian Maternity Experiences Survey (MES), most women receive their prenatal care from obstetricians (58%), family physicians (34%), and midwives (6%) (8). It is estimated that early perinatal screening interventions could reduce nearly two-thirds of the global maternal and neonatal disease burden (79). The World Health Organization recommends at least eight prenatal care visits including one contact in the first trimester (8-12 weeks), two contacts in the second

trimester (20 weeks and 26 weeks) and 5 contacts in the third trimester (30, 34, 36, 38, and 40 weeks) (80). Currently, there are no Canadian guidelines about the optimal number of prenatal visits (81). However, there may be provincial or institution-specific recommendations, such as the British Columbia Maternity Care Pathway that HCPs may use to guide their patient care (82).

Although the importance of prenatal care is emphasized internationally, many women across the world, including Canada, do not receive the minimum number of healthcare visits throughout pregnancy (80). Measurement of prenatal care utilization is imperative in evaluating trends between prenatal service use and pregnancy outcomes. Several indices have been developed to measure utilization of prenatal care, such as the Adequacy of Prenatal Care Utilization index (83) and the R-GINDEX (84). These indices use measures such as timing of prenatal care initiation, total number of prenatal visits, and the gestational age of the infant to characterize level of care into categories: inadequate, intermediate, adequate, intensive, and no prenatal care. A systematic review exploring the determinants of inadequate use of prenatal care in high income countries found several factors influencing use of care including low educational status, low maternal age, ethnic minority, high parity, uninsured status, and living in deprived neighborhoods (85). Furthermore, a study using data from the Canadian MES mothers found those who were immigrants, primiparous, smoked or consumed alcohol were more likely to receive inadequate care (9). The same study found that mothers with a family doctor as a prenatal care provider were more likely to receive inadequate care compared to those with an obstetrician (OR: 1.26; 95% CI 1.08-1.48) (9). Studies conducted in Manitoba, Canada report similar socioeconomic determinants of inadequate prenatal care use and highlight the impact of rural/northern residence and Indigenous status on prenatal care utilization (86–88). Aboriginal

women (15.7%) were significantly more likely to receive inadequate prenatal care compared to non-Aboriginal women (86).

Furthermore, inadequate prenatal care is known to increase the risk of adverse pregnancy outcomes. A large retrospective study of 28 million births conducted in United States found that inadequate care was associated with a higher risk of prematurity, stillbirth, and infant death (89). Inadequate prenatal care was associated with increased odds of stillbirth, preterm birth, low birth weight, SGA, admission to the NICU, postpartum depressive/anxiety disorders, and short interpregnancy interval to next birth in Manitoba, Canada (90). Overall, there are very few studies in the Canadian setting investigating the impact of inadequate prenatal care on pregnancy outcomes, with most of these studies having been conducted in the province of Manitoba. This is partly due to lack of data on prenatal care utilization at a national level. With a growing population that is increasingly becoming culturally diverse, further population-level studies are warranted both in the province of Ontario and in Canada.

A few Canadian studies have also explored access to care in the pregnant IBD population and associated outcomes. An Ontario population-based cohort study found that women with IBD are more likely to have increased healthcare utilization, including ER visits and hospitalizations, during pregnancy and postpartum compared to those without IBD (91). Despite these outcomes, the same study found that women with IBD had higher prenatal care utilization where they were more likely to have a first-trimester prenatal care visit, more likely to have had more than four prenatal visits and were more likely to have adequate care as determined by the R-GINDEX (91). Another Ontario-based study found that compared to non-immigrants, immigrants had higher rates of IBD-specific ambulatory visits during preconception, pregnancy, and postpartum, as well as greater rates of endoscopy visits during all three stages. Furthermore, immigrants with IBD

were also less likely to have had a prenatal care visit (92). Similar results were found in the general IBD population in Ontario, where immigrants had greater ED visits and hospitalizations compared to non-immigrants. Likewise, immigrants were more likely to see gastroenterologists and had greater IBD-specific outpatient service use (77). Further studies found geographical variations in adverse pregnancy outcomes in women with IBD, where those located in more remote regions were more likely to experience outcomes such as SGA, preterm delivery and Cesarean deliveries (93).

2.3.3 International and Canadian guidelines on IBD management

Ensuring that maternal IBD is stable and well managed prior to conception is critical for establishing a healthy pregnancy trajectory, coupled by clinical monitoring during the prenatal and postpartum periods. Several guidelines have been published on the management of IBD throughout pregnancy, although there have yet to be any international guidelines. Such recommendations include the *European Crohn's and Colitis Guidelines on Sexuality, Fertility, Pregnancy, and Lactation* published by the European Crohn's and Colitis Organization, which is the third version of the European Consensus on reproduction in IBD (94). Consensus statements have also been published for both the Australian (95) and Asian (96) settings.

Currently, there are no general guidelines for managing IBD in pregnancy in North America that are consistent among different jurisdictions. However, the American Gastroenterological Association (AGA) published the *Inflammatory Bowel Disease in Pregnancy Clinical Care Pathway* in 2019 to provide guidance to clinicians and health systems on best practices when providing care to this population (7). Likewise, *The Toronto Consensus Statements for the Management of Inflammatory Bowel Disease in Pregnancy* are the most recent guidelines published in the Canadian setting which also aims to deliver evidence-based

recommendations to those with IBD intending to become pregnant or currently pregnant (97). This statement consists of 29 recommendations which span over the preconception, pregnancy, and postpartum periods. The working group consists of gastroenterologists specializing in IBD, obstetricians, maternal-fetal medicine specialists, pharmacologists, and female IBD patients. Consensus recommendations focused on a variety of topics such as: preconception counseling, medication management throughout pregnancy, specialist care consultations, use of diagnostic and surgical interventions, delivery preferences, and breastfeeding and vaccination of newborns born to women with IBD. The working group used the Grading of Recommendation Assessment Development and Evaluation approach to assess the strength of recommendations and established that 21 of the 29 recommendations were deemed as strong despite the very low quality of evidence presented.

2.3.4 Role of health care providers in IBD management

Managing the complex interactions between pregnancy and IBD presents a challenge for both patients and HCPs. Optimal management of disease in this population warrants care across a multidisciplinary team of HCPs to ensure a healthy pregnancy. Women may interact with a variety of providers throughout their pregnancy journey including general practitioners, specialists, dieticians, nurses, and midwives. These HCPs play a critical role in educating patients and informing decisions from pre-conception to the postpartum period. Traditionally, pregnancy care may be provided by practitioners such as family physicians, nurse practitioners, obstetricians, and midwives (81). However, IBD-specific knowledge may vary amongst different HCPs (98), with general and obstetric practitioners often having inadequate knowledge to support women with IBD who intend to become or are pregnant (99–101). A Canadian cross-sectional study found that knowledge on IBD medication use during pregnancy varies

considerably amongst gastroenterologists and non-gastroenterologists (general practitioners and other specialties) (101). Responses from gastroenterologists more frequently reflected best practices in medication management during pregnancy and when breastfeeding, compared to other physicians (101). A similar study conducted in Australia found that general practitioners and obstetrician/gynecologists had significantly lower knowledge than gastroenterologists on IBD-specific pregnancy related issues (99). The results of these studies suggest that there are currently gaps in knowledge among practitioners regarding the management of IBD across this population and highlights the importance of a multidisciplinary approach to manage the disease from pre-conception to postpartum.

Based on the evidence, the Toronto Consensus recommends IBD patients who intend to become or are already pregnant be monitored by both an obstetric provider and gastroenterologist (97). *Statement 5* of the Consensus suggests that pregnant individuals with active or complicated IBD should consult with an obstetrician, preferably one affiliated with a high-risk program. Although there is currently a lack of evidence demonstrating improved outcomes amongst IBD patients managed by an obstetrician or non-obstetrician provider, the working group determined that the increased risk of adverse outcomes amongst this population suggests the importance of obstetric consultation. An obstetrician affiliated with a high-risk program may be preferable in circumstances where the patient has had prior surgical procedures, may require cesarean delivery, are on treatment with biologics or combination therapy, are currently experiencing active disease, or have a history of adverse perinatal outcomes. Similarly, the AGA guidelines recommend consultations with a maternal-fetal medicine specialist and assistance from other health care providers (i.e., nutritionist, lactation consultant, etc.), as applicable (7).

Furthermore, *Statement 6* of the Toronto Consensus suggests that a gastroenterologist also be included in IBD management of pregnant individuals (97). As with obstetric providers, there is limited to no data available on improvement of clinical outcomes amongst women with IBD who have visits with gastroenterologists during pregnancy. However, the working group agreed that consultations with a gastroenterologist will allow for active monitoring of the disease as well as further management and adjustments of IBD therapies. Additionally, the group determined that patients should be evaluated by the gastroenterologist at least once, and that frequency of follow up should be dictated based on severity of disease and other patient factors. Other healthcare providers with training in gastroenterology, such as nurse practitioners, may also play an important role in counseling and monitoring throughout pregnancy. The AGA suggests the gastroenterologist coordinates care with the patient's obstetric provider who will lead the pregnancy-related care. In addition, they recommend the patient should be seen at least once in the first or second semester and thereafter during her pregnancy, as per the patient's disease severity (7).

CHAPTER 3: METHODOLOGY

3.1 Study design and population

This study was a retrospective cohort study that used population-level health administrative data housed at the Institute of Clinical Evaluative Sciences (ICES), a non-profit research institute funded by the Ontario Ministry of Health and Long-term Care. The study cohort was drawn from the source population of all residents of Ontario who delivered a live or stillborn infant (>20 weeks gestation) at an Ontario hospital between April 1, 2012 and September 15, 2019. This start date was chosen to align with the creation of the Better Outcomes Registry & Network (BORN) database which was launched in April 2012. The end date was

chosen to avoid overlap with the start of the COVID-19 pandemic due to changes in health care delivery which may have impacted our findings. The index event was conception, or start of pregnancy, as calculated from the estimated date of a woman's last menstrual period, measured as a combination of best obstetric estimate, self-reported first day of last menstrual period and ultrasound dating, as available. The following criteria were used to exclude records from our final study population.

1) Invalid IKN (ICES key number)
2) Invalid or missing birth date or invalid death date (e.g. before index date)
3) Implausible (i.e. <20 weeks gestation) or missing gestational age
4) Non-Ontario residents at index
5) Not having continuous Ontario Health Insurance Plan (OHIP) eligibility for the 10 years prior to pregnancy start date or throughout pregnancy. This lookback period allows us to capture pre-pregnancy IBD diagnoses.
6) Not between ages 19 to 55

3.2 Data linkage, privacy, and ethics

Linked administrative healthcare databases from ICES were used to investigate perinatal healthcare patterns and to create the cohorts used to answer the study objectives. The ICES data repository holds record-level health datasets that are coded and linked and currently has health service records for as many as 13 million people. ICES assigns each individual with a unique 10-digit code known as the IKN which is used to link individual information across different databases, as all patient identifiers are removed before data access by researchers. This allows a comprehensive understanding of an individual's health service utilization and related demographic factors. ICES has several policies, procedures, and practices in place to ensure

personal health information collected from individuals is protected and complies with Ontario's Personal Health Information Protection Act and the Coroner's Act. ICES protects information by only collecting data that is necessary, relevant, and lawful; restricts institutional access by role; provides access to information on a project-by-project basis; and requires all scientists and employees to be trained in privacy and security practices. Since use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, separate research ethics board approval was not required.

3.3 Data sources

3.3.1 MOMBABY database

The MOMBABY database is an ICES-derived database which includes all Ontario inpatient birth admission records from the Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD) from 2002/03 onwards. Between 2003-2017, linkage rates ranged from 98.2%-99.2%. It links records between mothers and their newborns using a unique identifier and provides both administrative and clinical information on in-hospital births. The database was used to create our cohort as well as provide information on variables such as infant sex, gestational age, maternal age, birthweight, birth outcome (liveborn vs stillbirth) and parity.

3.3.2 *Better Outcomes Registry & Network (BORN) Database*

The BORN database contains pregnancy, birth, and newborn information and associated outcomes data for nearly all births in Ontario. Data captured by BORN includes information on the use of ART, general and specialty prenatal care, pregnancy complications, labor and birth information, postpartum information, midwifery practice data, and NICU encounters (102).

3.3.3 Canadian Institute for Health Information National Ambulatory Care Reporting System (CIHI-NACRS)

The CIHI National Ambulatory Care Reporting System (NACRS) is a national-level database containing information on hospital-based and community-based ambulatory care visits. NACRS collects demographic, administrative, clinical and service-related data for emergency departments, day surgery, and other ambulatory care visits. In Ontario, a total of 532 facilities submitted data to the NACRS (103).

3.3.4 Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD)

The CIHI-DAD captures administrative, clinical, and demographic information on hospital discharges and day surgeries from acute care institutions across Canada (104). Data classification is based on the Canadian adaptation of the International Statistical Classification of Diseases, 10th revision (ICD-10-CA) and the Canadian Classification of Health Interventions (CCI).

3.3.5 Registered Persons Database (RPDB)

The ICES Registered Persons Database (RPDB) contains basic demographic (age, sex, location of residence, date of birth, and date of death for deceased individuals) and geographic information for any individual who is eligible for OHIP. It also contains the 6-digit postal code of individuals based on reported residence on July 1st of every year. Postal codes can be used to determine information such as neighborhood income quintiles and region of residence (105).

3.3.6 Ontario Health Insurance Plan (OHIP)

The OHIP database contains claims information made by health care providers on inpatient and outpatient services provided to Ontario residents. Data elements include encrypted patient and physician identifiers, date of service, associated diagnoses, reason for visit, and fee codes which can be used to track prenatal care and other specialist visits (106).

3.3.7 ICES Physician Database (IPDB)

ICES Physician Database (IPDB) comprises information from the OHIP Corporate Provider Database, the Ontario Physician Human Resource Data Centre database and the OHIP database of physician billings. The IPDB includes information on physician demographics, practice location, specialty and services provided, as well as information on training. IPDB was used for the identification of routine and specialist visits.

3.3.8 Ontario Marginalization Index (ON-Marg)

The ON-Marg is a data tool that combines a variety of demographic indicators collected from the Statistics Canada Census into four dimensions used to measure the degree of marginalization across Ontario (107). It is multifaceted in the aspect that it measures economic, ethno-racial, age-based and social marginalization and can be used to monitor intraprovince inequities. The four dimensions include: households and dwellings, material resources, age and labor force, and racialized and newcomer populations. *Households and dwellings* considers family and neighborhood stability and is based on measures of the types and density of residential accommodations as well as family structure characteristics such as the percentage of individuals living alone. *Material resources* measures accessibility to basic material needs such as housing, food, clothing, and education. *Age and labor force* refers to area-level concentrations of people who are not participating in the labor force, including older adults, children, and/or

those unable to work due to disability. *Racialized and newcomer populations* include indicators to measure the proportion of newcomers and/or non-white, non-Indigenous populations. Scores for each of the dimensions are divided into quintiles where quintiles indicate varying levels of marginalization within a specific Census track, ranging from one (least marginalized) to five (most marginalized). For example, quintile 1 in the *Racialized and newcomer populations* dimensions indicate there is a low-density of racialized persons in a given census track. Appendix A contains the full list of indicators that were included in the creation of each dimension.

3.3.9 Ontario Crohn's and Colitis Cohort

The Ontario Crohn's and Colitis Cohort (OCCC) database is an ICES-derived cohort that consists of all incident and prevalent cases of inflammatory bowel disease in Ontario. Validation studies have been conducted for both pediatric and adult populations within the province (108,109). The databases used to develop these algorithms included CIHI-DAD for hospital discharge abstract data, OHIP for physician billing information, and RPDB for demographic data. IBD cases were identified using the following ICD codes: CD (ICD-9: 555.x; ICD-10: K50.x) and UC (ICD-9: 556.x; ICD-10: K51.x). For patients aged 18 to 64, the sensitivity of the validation algorithm was 92.3% and the specificity was 99.1%.

3.3.10 CENSUS Database

The CENSUS database holds Canadian census data from Statistics Canada and contains socio-demographic information linked to postal codes. Linking Census data will provide information on income quintile, urban-rural status, education, and geographic location.

3.4 Exposure measurement

Our final study population consisted of three main groups: the IBD group, healthy control group and multimorbidity group. Pre-existing IBD cases, which is our main exposure of interest, were identified through a 10-year look-back window prior to the start of the pregnancy and were ascertained using the OCCC database. The IBD group consists of a "clean" cohort, where no additional comorbidities were included in this group. The healthy control group consists of a cohort of pregnant individuals with no prior disease diagnoses (excluding mental health conditions). The multimorbidity group was defined as individuals having 2 or more confirmed pre-pregnancy diagnoses of the following 14 high-impact chronic conditions including: acute myocardial infarction, asthma, cancers, cardiac arrhythmia, chronic coronary disease, chronic obstructive pulmonary disorder, congestive heart failure, diabetes, hypertension, osteoporosis, kidney disease, rheumatoid arthritis and stroke. These conditions were chosen based on their impact on the health system, including population and economic burden, as suggested by previous multimorbidity research conducted in Ontario (110–114). The purpose of the multimorbidity group is to compare adequacy of care in the IBD population to a known high-risk group (multimorbidity) along with the lower risk group (healthy controls).

3.5 Outcome measurement

3.5.1 Objective 1

The first objective of this study was to investigate access to care and the adequacy of prenatal care amongst our three study groups. Adequacy of prenatal care was assessed using the R-GINDEX (84). The R-GINDEX was calculated using a published coding algorithm (115) that has been adapted for the Ontario setting using OHIP billing codes. The R-GINDEX has 6

categories of prenatal care that were created based on the American College of Obstetricians and Gynecologists (ACOG) recommendations: inadequate, intermediate, adequate, intensive, no care, and missing care (84). The index calculation is based on three criteria: gestational age of the infant, the trimester during which prenatal care was initiated, and the total number of prenatal care visits during pregnancy. For example, a woman who began prenatal care in the first 3 months of pregnancy and received between 13 to 16 visits until 40 weeks gestation would be categorized as having adequate care. Whereas a woman who began care between 1 to 6 months of pregnancy and had less than 8 visits would be categorized as having inadequate care. The intensive care category includes women who have an unexpectedly large number of prenatal care visits, which may indicate potential morbidity or complications. Prenatal visits were defined using OHIP fee codes that were billed during pregnancy (between last menstrual period and date of delivery) by a family doctor or OBGYN and was limited to one record per person per type of doctor per day (refer to Appendix B).

Access to specialist care for the IBD population was explored using physician codes from IPDB. Timing of access to specialist care at 3 time points was evaluated at: pre-conception (6 months prior to estimated time of conception), pregnancy, and post-partum (from after birth until 6 months post-partum). Specialties that are of interest include family medicine, obstetrics and gynecology, maternal fetal medicine, gastroenterology/internal medicine, and emergency medicine/critical care due to their potential involvement with the care trajectory of pregnant individuals with IBD. In addition, we investigated the primary maternal antenatal care providers for our three study groups to understand who patients were seeing during this period using the *Maternal Antenatal HCP* variable from the BORN database.

3.5.2 Objective 2

Objective 2 compared obstetrical and neonatal outcomes between those with IBD to the multimorbidity and healthy control group. Outcomes of interest included preeclampsia, postpartum hemorrhage, chorioamnionitis, caesarean delivery, preterm birth, SGA infant, large for gestational age (LGA) infant, NICU admission lasting greater than 24 hours, and infant APGAR score. SGA infants in the 10^{th} percentile identifies infants that are smaller than 90% of others of the same gestational age while LGA infants have birth weights that are greater than 90% of other infants of the same gestational age. Infant APGAR score is a widely accepted method for determining the health status of an infant after birth and considers elements such as skin color, heart rate, reflexes, muscle tone, and respiration (116,117). The APGAR score is taken 1 minute and 5 minutes after birth where each element is graded out of 0, 1, or 2, and a cumulative score of 7 and over is accepted in the literature (116,117). The risk of adverse outcomes in pregnant individuals with IBD and in newborns born to mothers with IBD were extensively explored in Chapter 2.2.2.

3.5.3 Objective 3

Objective 3 investigated the association between social inequities and their impact on adequacy of care amongst our three study groups. Adequacy of care was determined by a dichotomized version of the R-GINDEX which is further elaborated in Chapter 3.6, and the social inequities included the four dimensions of the ON-Marg which were elaborated in Chapter 3.2.8.

3.6 Statistical Analysis

All statistical analyses were conducted using SAS Version 8.3 (118). For baseline variables, continuous variables were reported as a median with interquartile range (IQR) or mean with standard deviation (SD). Categorical variables were reported as frequencies with percentages. Standardized differences were calculated for these variables, where for continuous variables the standardized difference was calculated as the difference in the mean of the variable between each of the three study groups (i.e. IBD vs multimorbidity, IBD vs healthy control, multimorbidity vs healthy control). For categorical variables, the standardized difference was calculated as the difference in the proportions of the variable for each of the three study groups. Standardized differences greater than 10% were interpreted as evidence of an important difference.

For Objective 1, a multivariable logistic regression analysis was conducted where unadjusted and adjusted odds ratios (aOR) were computed to investigate if those with IBD or multimorbidity were at higher odds of receiving adequate care compared to the healthy control group. The outcome, adequacy of care, was simplified and measured using a dichotomized version of the R-GINDEX where *adequate prenatal care* included the adequate/intensive care categories *and inadequate care* included the intermediate/ inadequate /no care categories. The models were adjusted for maternal age, parity, income quintile, rurality, and the ON-Marg dimensions. These covariates were chosen based on a review of the literature indicating potential associations with our outcomes of interest, prenatal care utilization and adequacy of care, as well as the availability of demographic variables within the included study databases. Additionally, frequencies of the R-GINDEX categories were reported for each of the study groups, with additional tables stratifying the frequencies by parity to report proportions for nulliparous and

multiparous women. Objective 2 reported obstetrical and newborn outcomes in the three study groups. Similar to Objective 1, continuous variables were reported as median with IQR or mean with SD and categorical variables as frequencies with percentages. Standardized differences were calculated across all three study groups.

Objective 3 aimed to identify the strength of association between the exposure of interest, social inequities (as measured by ON-Marg dimensions), and the outcome of interest, adequate access to care amongst our three study groups. For this analysis, a multivariable logistic regression analysis was conducted using the same dichotomized outcome for the analysis in Objective 1. The same covariates were applied to this model, however, for each ON-Marg dimension being assessed as the main exposure, only the other three dimensions were included in the model for that part of the analysis. Within each social inequity dimension, we will investigate if those living in more marginalized areas (with Q5 being the areas with the highest marginalization) are at higher or lower odds of receiving adequate care compared to Q1 (least marginalized).

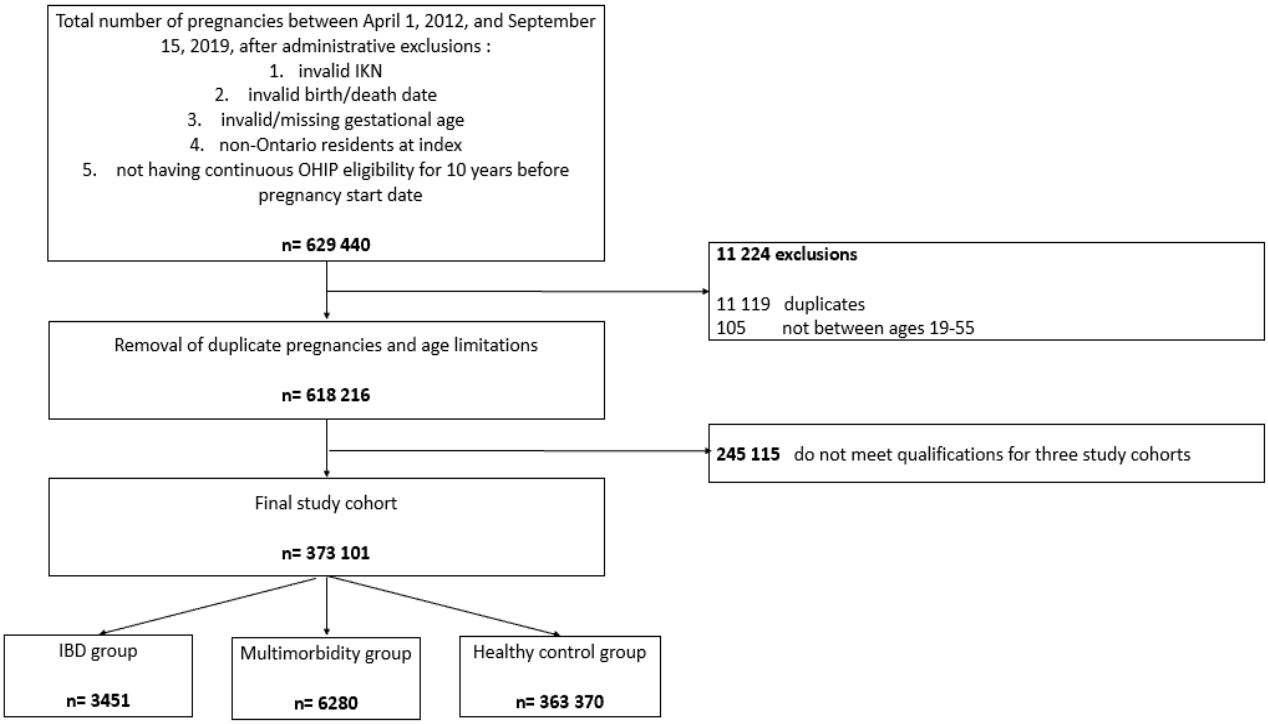
CHAPTER 4: RESULTS

4.1 Characteristics of study population

After applying our five main administrative exclusion criteria as described in Chapter 3.1, a total of 629,440 pregnancies were identified for our study period of April 1, 2012 to September 15, 2019. After excluding 11,119 duplicate pregnancy records, which includes repeat pregnancy encounter records for a single pregnancy in the same person, and 105 pregnancies where mothers who weren't between our maternal age criteria (19 to 55), 618,216 pregnancies remained. 245,115 pregnancies were excluded as the mothers of these pregnancies didn't qualify for our 3 main study cohorts which included an IBD group, multimorbidity group (2 or more diagnoses of 14 listed conditions), or healthy control group (no pre-existing conditions). These individuals are

likely to have a single chronic condition which was not being looked at in this study. This thesis is a smaller project within a larger grant that will look at additional chronic diseases, other than IBD. There was a total of 3,451 pregnancies in the IBD group, 6,280 in the multimorbidity group, and 363,370 in the control group, making the total sample size of the analytical cohort 373,101 pregnancies **(Figure 4-1).** Overall, the prevalence of IBD was 0.9% in the IBD group, 1.7% for the multimorbidity group, and 97.4% in the healthy control group.

Figure 4-1: Study cohort flow diagram



The full demographic and pregnancy characteristics are presented in **Table 4-1**. The mean maternal age at delivery was higher in both the IBD (31.96 [4.55]) and multimorbidity groups (33.54 [5.06]), compared to the control group (29.90 [5.34]), with all groups presenting standardized differences greater than 10%. The age group with the highest proportion of deliveries was 30-34 for both the IBD (43.2%) and control group (35.6%), whereas in the

multimorbidity group the most deliveries occurred in the highest age group of 35+ (43.6%). Compared to the healthy control group, those with IBD and multimorbidity were more likely to be 35+ at the time of delivery. For the neighborhood income quintile scores, the proportion of those with IBD increased from low to highest income areas. Contrarily, in the multimorbidity group, the quintile with the highest income had the lowest proportion of multimorbidity (15.5%).

The ON-Marg categories capture information pertaining to social inequities across Ontario as described in Chapter 3.2.8. The ON-Marg assigns scores to geographical areas (e.g., neighborhoods or dissemination areas) for each of the four dimensions of marginalization which are then divided into quintiles where Quintile 1 (Q1) represents areas with the least marginalization, while Q5 represents areas with the most marginalization. The first category, *Age and Labor Force,* looks at the area-level impact of concentrations of people who do not have income from employment. This may include older adults, children, adults whose work is not compensated, or those unable to work due to disabilities. For all three study groups, the highest proportion of individuals were found in Q1 for this dimension. Within this dimension, there is a decreasing gradient for all groups from Q1 to Q5. There were no evident differences between the three disease groups in all quintiles, as indicated by standardized differences less than 10%. The *Racialized and Newcomer Populations* category measures the proportion of immigrants/visible minorities at the area-level. For this dimension, the highest proportion of individuals with IBD (23.3%) were found in Q4, and in Q5 for the multimorbidity (29.6%) and healthy control groups (23.7%). There were higher rates of multimorbidity in the most marginalized quintile compared to IBD group and healthy control group. There is an increasing gradient for the multimorbidity group from Q1 to Q5. The *Household and Dwellings* category encompasses factors related to family and residential instability. There was a higher proportion of women with IBD living in

areas of lower residential instability where the proportion was the same for Q1 and Q2 (20.7%) and the highest proportion was in Q3 (21.8%). The highest proportion of women with multimorbidity was found in Q1, while in the healthy control group it was Q5. There were no evident differences between the study groups, with all standardized differences being under 10%. Lastly, the *Material Resources* dimension refers to the inability for individuals and communities to access and attain material needs such as housing, food, clothing, and education. There is a decreasing gradient from Q1 to Q5 within the IBD group, indicating the proportion of women with IBD decreased with increased material deprivation amongst the neighborhoods. The highest proportions of women were living in Q5, the more materially deprived areas, with rates of 23.3% and 21.0%, respectively for the multimorbidity and healthy control groups. Those with IBD were less likely to live in materially deprived neighborhoods compared to those with multimorbidity and no disease, with standardized differences over 10%.

Compared to the multimorbidity group, there was a higher percentage of mothers in the IBD group and healthy control group who lived in rural residences and who were nulliparous. Compared to the healthy control group (2.4%), those with IBD (4.6%) and multimorbidity (5.1%) had higher usage of ART. The highest median (IQR) of outpatient visits in the 5 years before conception was found in the multimorbidity group (64.0 [43.0]) compared to the IBD (54.0 [32.0]) and healthy control group (33.0 [23.0]). The median number of acute care (emergency department/inpatient) visits in the 5 years before conception were similar amongst the three groups.

Table 4-1: Baseline characteristics of study population

	IBD n= 3451	**Multimorbidity n= 6280**	**Healthy control n = 363 370**	**Standardized difference (IBD vs Multimorbidity)**	**Standardized difference (IBD vs Control)**	**Standardized difference (Multimorbidity vs Control)**
Maternal age at delivery, years, mean (SD)	31.96 (4.55)	33.54 (5.06)	29.90 (5.34)	**-0.33**	**0.42**	**0.70**
Maternal age at delivery, by age group, n (%)						
<20	13 (0.4%)	20 (0.3%)	11 468 (3.2%)	0.01	**-0.21**	**-0.22**
20-24	171 (5.0%)	232 (3.7%)	48 159 (13.3%)	0.06	**-0.28**	**-0.34**
25-29	793 (22.0%)	1102 (17.6%)	104 296 (28.7%)	**0.11**	**-0.15**	**-0.27**
30-34	1490 (43.2%)	2188 (34.8%)	129 220 (35.6%)	**0.17**	**0.16**	-0.02
35+	984 (28.5%)	2738 (43.6%)	70 227 (19.3%)	**-0.32**	**0.22**	**0.54**
Maternal neighborhood income, n (%)						
Quintile 1	442 (12.8%)	1349 (21.5%)	72 998 (20.1%)	**-0.23**	**-0.29**	0.03
Quintile 2	604 (17.5%)	1273 (20.3%)	71 682 (19.7%)	-0.07	-0.06	0.02
Quintile 3	788 (22.8%)	1305 (20.8%)	76 770 (21.1%)	0.05	0.04	-0.01

Quintile 4	849(24.6%)	1371 (21.9%)	78 297 (21.5%)	0.06	0.07	0.01
Quintile 5	766 (22.2%)	970 (15.5%)	62 569 (17.2%)	**0.17**	**0.13**	-0.05
Missing	*S	12 (0.2%)	1054 (0.3%)	N/A	N/A	N/A
Age and Labour Force quintile (ONMARG), n (%)						
Quintile 1	1150 (33.3%)	2041 (32.5%)	106 668 (29.4%)	0.02	0.08	0.07
Quintile 2	652 (18.9%)	1309 (20.8%)	73 999 (20.4%)	-0.05	-0.04	0.01
Quintile 3	579 (16.8%)	1053 (16.8%)	64 126 (17.6%)	0.00	-0.02	-0.02
Quintile 4	574 (16.6%)	975 (15.5%)	58 579 (16.1%)	0.03	0.01	-0.02
Quintile 5	484 (14.0%)	839 (13.4%)	53 464 (14.7%)	0.02	-0.02	-0.04
Missing	12 (0.3%)	63 (1.0%)	6534 (1.8%)	N/A	N/A	N/A
Racialized & Newcomer Populations (ONMARG), n (%)						
Quintile 1	557 (16.1%)	816 (13.0%)	63 421 (17.5%)	0.09	-0.04	**-0.13**
Quintile 2	666 (19.3%)	943 (15.0%)	66 431 (18.3%)	**0.11**	0.03	-0.09
Quintile 3	714 (20.7%)	1120 (17.8%)	67 560 (18.6%)	0.07	0.05	-0.02

Quintile 4	803 (23.3%)	1476 (23.5%)	73 437 (20.2%)	0.00	0.08	0.08
Quintile 5	699 (20.3%)	1862 (29.6%)	85 987 (23.7%)	**-0.22**	-0.08	**0.13**
Missing	12 (0.3%)	63 (1.0%)	6534 (1.8%)			
Households & Dwellings (ONMARG), n (%)						
Quintile 1	715 (20.7%)	1322 (21.1%)	70 869 (19.5%)	-0.01	0.03	0.04
Quintile 2	713 (20.7%)	1132 (18.0%)	70 009 (19.3%)	0.07	0.04	-0.03
Quintile 3	751 (21.8%)	1177(18.7%)	69 996 (19.3%)	0.08	0.06	-0.02
Quintile 4	665 (19.3%)	1293 (20.6%)	71 196 (19.6%)	-0.03	-0.01	0.02
Quintile 5	595 (17.2%)	1293 (20.6%)	74 766 (20.6%)	-0.09	-0.09	0.00
Missing	12 (0.3%)	63 (1.0%)	6534 (1.8%)	N/A	N/A	N/A
Material Resources (ONMARG), n (%)						
Quintile 1	857 (24.8%)	1134 (18.1%)	71 539 (19.7%)	**0.16**	**0.12**	-0.04
Quintile 2	800 (23.2%)	1207 (19.2%)	71 753 (19.7%)	**0.10**	0.09	-0.01
Quintile 3	714 (20.7%)	1187 (18.9%)	69 753 (19.2%)	0.05	0.04	-0.01
Quintile 4	609 (17.6%)	1225 (19.5%)	67 367 (18.5%)	-0.05	-0.02	0.03
Quintile 5	459 (13.3%)	1464 (23.3%)	76 424 (21.0%)	-0.26	**-0.21**	0.06

Missing	12 (0.3%)	63 (1.0%)	6534 (1.8%)	N/A	N/A	N/A
Maternal rural residence, n (%)	411 (11.9%)	537 (8.6%)	51 464 (14.2%)	**0.11**	-0.07	**-0.18**
Missing	*S	6 (0.1%)	484 (0.1%)	N/A	N/A	N/A
Health care encounters in the 5 years before conception						
Outpatient visits in the 5 years before conception median (IQR)	54.0 (32.0)	64.0 (43.0)	33.0 (23.0)	**-0.38**	**0.87**	**1.07**
Acute care (ED/inpatient) visits in the 5 years before conception median (IQR)	3.0 (5.0)	4.0 (6.0)	2.0 (4.0)	**-0.19**	**0.27**	**0.36**
Nulliparous pregnancies, n (%)	1515 (43.9%)	2392 (38.1%)	163 772 (45.1%)	**0.12**	-0.02	**-0.14**
Use of assisted reproductive devices, n (%)	158 (4.6%)	317 (5.1%)	8629 (2.4%)	-0.02	**0.12**	**0.14**

*S represents suppressed cells due to counts of less than six

4.2 Objective 1

Table 4-2 presents proportions of adequacy of prenatal care across the three study groups, as evaluated by the R-GINDEX. The prevalence of intensive care was highest in the multimorbidity group (16.1%) and IBD groups (10.0%), compared to the control (5.2%). Adequate care was the most prevalent R-GINDEX category across all groups, with just over 50% of patients receiving adequate care in the IBD and multimorbidity populations and approximately 40% in the healthy control group. The healthy control group also had a higher prevalence of inadequate care (14.7%) and no care (7.1%) compared to the other two groups. In the IBD group, approximately 10% received inadequate care and 3% received no care. This is slightly higher than the prevalence of the multimorbidity group, which was 6.5% for inadequate care and 1.7% for no care. To further explore the association between receiving adequate care in those with IBD and multimorbidity compared to healthy individuals, a multivariable logistic regression analysis was conducted, and results are presented in **Table 4-3**. The outcome of interest, adequacy of care, was dichotomized into an adequate care group (includes intensive and adequate care categories) and inadequate care group (includes intermediate, inadequate, and no care categories). After dichotomizing, 60.5% of patients with IBD, 67.4% with multimorbidity, 44.9% of healthy controls received adequate care. In the logistic regression analysis, those with IBD (aOR 1.55; 95% CI [1.53-1.57]) and multimorbidity (aOR 2.10; 95% CI [2.08-2.12]) were at significantly higher odds of receiving adequate care compared to the healthy control group, after adjusting for maternal age, income quintile, rurality, parity, and ON-Marg variables.

Table 4-2: Adequacy of prenatal care categories from R-GINDEX by disease group

	Inflammatory Bowel Disease n=3451	Multimorbidity n= 6280	Healthy control n =363 370
Intensive	345 (10.0%)	1012 (16.1%)	18 907 (5.2%)
Adequate	1743 (50.5%)	3220 (51.3%)	144 259 (39.7%)
Intermediate	924 (26.8%)	1531 (24.4%)	120 710 (33.2%)
Inadequate	331 (9.6%)	409 (6.5%)	53 534 (14.7%)
No care	108 (3.1%)	108 (1.7%)	25 960 (7.1%)

Table 4-3: **Dichotomized R-GINDEX categories by disease group and association between disease group and receiving adequate care for women with IBD and multimorbidity compared to healthy controls**

	Adequate care (n= 169 486)	Inadequate care (n= 203 615)	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Healthy control group	163 166 (44.9%)	200 204 (55.1%)	1.00 (reference)	1.00 (reference)
IBD	2088 (60.5%)	1363 (39.5%)	1.70 (1.68-1.72)	1.55 (1.53-1.57)
Multimorbidity	4232 (67.4%)	2048 (32.6%)	2.32 (2.30-2.34)	2.10 (2.08-2.12)

[a] Adjusted for maternal age, income quintile, rurality, parity, and ON-Marg variables

Table 4-4 and **Table 4-5** stratifies adequacy of care by parity to better characterize differences in care among those who have previously given birth and those who have never given birth. **Table 4-4** looks at adequacy of care amongst nulliparous women. Overall, there were 1,510 women who have previously never given birth in the IBD group, 2,381 in the multimorbidity group, and 163, 618 in the control group. **Table 4-5** presents information on multiparous patients in our study groups. There were 1,941 patients in the IBD group who previously gave birth, 3,899 in the multimorbidity group and 163, 618 in the control group. Amongst both nulliparous and multiparous women, the highest proportions were found in the adequate care category for all three study groups, with proportions of approximately 50% for both the IBD and multimorbidity groups. Compared to the nulliparous group, the proportions of intensive care were higher in the multiparous group for all three study groups, with the highest in the multimorbidity group (19.9%).

Table 4-4: **Adequacy of prenatal care (R-GINDEX) in nulliparous women by disease group**

	Inflammatory Bowel Disease n=1510	**Multimorbidity n= 2381**	**Healthy control n =163 618**
Intensive	205 (13.6%)	475 (19.9%)	10 563 (6.5%)
Adequate	790 (52.3%)	1242 (52.2%)	69 047 (42.2%)
Intermediate	339 (22.4%)	458 (19.2%)	48 854 (29.9%)
Inadequate	139 (9.2%)	166 (7.0%)	25 583 (15.6%)
No care	37 (2.5%)	40 (1.7%)	9751 (5.8%)

Table 4-5: Adequacy of prenatal care (R-GINDEX) in multiparous women by disease group

	Inflammatory Bowel Disease n= 1941	**Multimorbidity n= 3899**	**Healthy control n =199 752**
Intensive	141 (7.3%)	537 (13.8%)	8344 (4.2%)
Adequate	953 (49.1%)	1978 (50.7%)	75 212 (37.7%)
Intermediate	585 (30.1)	1073 (27.5%)	71 856 (36.0%)
Inadequate	191 (9.8%)	243 (6.2%)	27 951 (14.0%)
No care	71 (3.7%)	68 (1.7%)	16 389 (8.2%)

Table 4-6 presents information on the health care providers who were providing care to the patients in the prenatal period. Obstetricians were the most common prenatal care providers for all study groups. 53% of IBD patients saw an obstetrician, compared to 63% and 50% for the multimorbidity and healthy control groups, respectively. Family physicians and midwives were the next most common providers in all groups, with the same proportion from each provider group providing care in the IBD population (7.5%). There were similar proportions of patients visiting family physicians and midwives in the multimorbidity group (4.4% vs 4.1%) and the healthy control group (12.0% vs 11.6%). Pregnancies being supervised primarily by a nurse or nurse practitioner were less than 1% in all groups. 0.3% of patients with multimorbidity and 0.4% of healthy control patients didn't have a prenatal care provider. For approximately one-third of pregnancies, the prenatal care provider remains unknown for all groups.

Table 4-6: Maternal prenatal health care provider by disease category

	Inflammatory bowel disease n=3451	**Multimorbidity n= 6280**	**Healthy control n =363 370**
Nurses / Nurse Practitioner	*S	*S	648 (0.2%)
Family Physician	259 (7.5%)	276 (4.4%)	43 474 (12.0%)
Midwife	259 (7.5%)	259 (4.1%)	41 990 (11.6%)
Obstetrician	1838 (53.3%)	3999 (63.7%)	180 078 (50.0%)
None	*S	19 (0.3%)	1418 (0.4%)
Other/unknown	1088 (31.5%)	1723 (27.4%)	95 762 (26.4%)

*S represents suppressed cells due to counts of less than six

Table 4-7 presents information on what specialties were being consulted in three critical time points: preconception, during pregnancy, and postpartum amongst the IBD cohort. Of the total 3,451 pregnancies, 75.6% of patients had at least one visit with a general practitioner or family physician preconception, 93.1% during pregnancy itself, and 83% postpartum. In the acute care group, which includes visits to emergency medicine and critical care, 20.3% of

patients had preconception visits, 31.6% during pregnancy, and 17.8% in the postpartum period. For gastroenterology specific visits, 45.5% of patients had visits pre-pregnancy, 56.8% during pregnancy itself, and 44.3% postpartum. Visits to internal medicine were also captured due to the possibility of billing misclassification of gastroenterology visits as internal medicine. However, gastroenterology-specific visits under this code could not be further identified. The proportion of visits to internal medicine were overall low with 6.7% preconception, 10.4% during pregnancy, and 7.2% postpartum. Maternal fetal medicine visits were also low in the preconception and postpartum periods, with 0.4% and 1.8%, respectively, and higher during pregnancy (13.3%). Visits to OBGYN were considerably low preconception (25.9%) compared to the pregnancy (91.2%) and postpartum periods (65.4%).

Table 4-7: Specialty visits for IBD patients at each critical time point (n= 3,451)

	Preconception	**Pregnancy**	**Postpartum**
General Practitioner / Family Physician	2610 (75.6%)	3211 (93.1%)	2863 (83.0%)
Obstetrics / Gynecology	895 (25.9%)	3147 (91.2%)	2258 (65.4%)
Maternal Fetal Medicine	14 (0.4%)	460 (13.3%)	62 (1.8%)
Gastroenterology	1570 (45.5%)	1962 (56.8%)	1529 (44.3%)
Internal Medicine	232 (6.7%)	358 (10.4%)	248 (7.2%)
Acute Care (Emergency medicine & Critical Care)	702 (20.3%)	1092 (31.6%)	613 (17.8%)

4.3 Objective 2

Table 4-8 captures obstetrical outcomes by the three study categories, with standardized differences greater than 10% indicating important differences between study groups. Overall, the prevalence of obstetrical outcomes of interest were relatively low amongst all groups, apart from

cesarean sections as a delivery outcome. The prevalence of postpartum hemorrhage and PPROM was similar amongst the three groups, with the proportion ranging from 0.9-1.1%. The prevalence of pre-eclampsia was higher in the multimorbidity group (2.6%), compared to the IBD (0.8%) and control group (0.7%), with standardized differences over 10%. Due to small cell sizes, rates of chorioamnionitis were not reported for the IBD and multimorbidity groups and there was a low prevalence in the healthy control group (0.03%). Similarly, stillbirth rates were not reported for the IBD group and prevalence was low in the multimorbidity (0.2%) and control groups (0.1%). The highest prevalence of cesarean sections was found in the multimorbidity group (35.8%) compared to 24.7% in the IBD group and 20.8% in the healthy control group.

Table 4-9 presents newborn characteristics and outcomes for this study. After linking maternal and newborn data, there were 3,519 infants born to the IBD group, 6411 to the multimorbidity group, and 369 054 to the control group. Just over 50% of all births were males for each study group. There were substantially more preterm births in the multimorbidity group (19.3%) compared to the IBD group (10.7%) and healthy control group (7.6%). The average birth weight was higher in the control group (3370.36 [586.97]) compared to the IBD (3304.02 [578.95]) and multimorbidity (3246.19 [713.55]) groups. There were also more infants with LBW, identified as less than 2500g, in the multimorbidity group (12.4%) compared to the IBD (8.3 %) and control (6.3%). Proportions of SGA infants were similar across all groups ranging from 2 – 2.4%. The highest proportion of infants with LGA was in the multimorbidity group (17.6%). Additionally, there was a higher percentage of infants born to the healthy control group who were admitted to the NICU for over 24 hours (27.9%) compared to the IBD group (12.6%) and just under double for the multimorbidity group (14.5%). For APGAR score measurements at

the 1-minute mark, there was a higher prevalence of scores less than 7 in the multimorbidity group (15.4%) compared to the IBD (10.9%) and healthy control group (9.1%).

Table 4-8: Obstetrical outcomes by disease category

	Inflammatory Bowel Disease n= 3451	Multimorbidity N= 6280	Healthy control n = 363 370	Standardized difference (IBD vs multimorbidity)	Standardized difference (IBD vs control)	Standardized Difference (Multimorbidity vs control)
Postpartum hemorrhage	31 (0.9%)	64 (1.0%)	3805 (1.1%)	-0.01	-0.02	-0.01
Preterm pre-labour rupture of membranes (PPROM)	37 (1.1%)	61 (1.0%)	3419 (0.9%)	0.01	0.02	0.01
Preeclampsia	27 (0.8%)	163 (2.6%)	2508 (0.7%)	**-0.14**	0.01	**0.15**
Chorioamnionitis	*S	*S	110 (0.03%)	N/A	N/A	N/A
Stillbirth	*S	15 (0.2%)	296 (0.1%)	N/A	N/A	0.03
Cesarean section	852 (24.7%)	2248 (35.8%)	75 488 (20.8%)	**-0.24**	0.09	**0.34**

*S represents suppressed cells due to counts of less than six

Table 4-9: **Newborn characteristics and outcomes by disease category**

	Inflammatory Bowel Disease n= 3519	**Multimorbidity N= 6411**	**Control (no NCD) n=369 054**	**Standardized Difference (IBD vs multimorbidity)**	**Standardized difference (IBD vs control)**	**Standardized Difference (Multimorbidity vs control)**
Male sex	1843 (52.4%)	3299 (51.5%)	189 081(51.2%)	0.02	0.02	0.01
Gestational age at delivery, weeks, mean (SD)	38.48 (1.98)	37.69 (2.44)	38.84 (1.89)	**0.36**	**-0.19**	**-0.53**
Preterm birth (<37 weeks gestation)	376 (10.7%)	1236 (19.3%)	27 940 (7.6%)	**-0.24**	**0.11**	**0.35**
Birthweight, g, mean (SD)	3304.02 (578.95)	3246.19 (713.55)	3370.36 (586.97)	0.09	**-0.11**	**-0.19**
Low birth weight (<2500g)	292 (8.3%)	795 (12.4%)	23 202 (6.3%)	**-0.13**	0.08	**0.21**
Small for gestational age (3rd percentile)	71 (2.0%)	148 (2.3%)	8741 (2.4%)	-0.02	-0.03	-0.01
Small for gestational age (10th percentile)	330 (9.4%)	607 (9.5%)	34 055 (9.2%)	0.00	0.01	0.01
Large for gestational age (90th percentile)	307 (8.7%)	1127 (17.6%)	37 433 (10.1%)	**-0.27**	-0.05	**0.22**
NICU admission >24 hr	46 618 (12.6%)	509 (14.5%)	1786 (27.9%)	-0.06	**-0.39**	**-0.33**
APGAR01 Score <7	384 (10.9%)	988 (15.4%)	33 720 (9.1%)	**-0.13**	0.06	**0.19**
APGAR05 Score <7	176 (5.0%)	385 (6.0%)	11 406 (3.1%)	-0.04	**0.10**	**0.14**

4.4 Objective 3

Table 4-10 describes the results from the analysis of the association between the ON-Marg social inequity dimensions and adequacy of care in mothers with IBD, multimorbidity, or no disease. For the first dimension, *Age and Labour Force,* all quintiles in the IBD group were at significantly lower odds of receiving adequate care compared to the least marginalized group (Q1) in the adjusted model, except for Q5, the most marginalized group. However, in the multimorbidity group, all quintiles were significantly at higher odds of receiving adequate care, with Q3 having the strongest association (aOR: 1.37; 95% CI, 1.33-1.41).

For the *Material Resources* dimension, there was no evident gradient in the association between this dimension and receiving adequate care within the IBD group, after adjusting for covariates. Q3 (aOR: 0.93; 95% CI, 0.89-0.97) and Q5 (aOR: 0.71; 95% CI, 0.67-0.75) were significantly less associated with receiving adequate care compared to Q1. In the multimorbidity and healthy control groups, all quintiles had significantly lower odds of receiving adequate care compared to the least marginalized group.

Within the *Racialized and Newcomer Populations* dimension, the crude results in the IBD group showed that the neighborhoods with higher ethnic concentrations were significantly at higher odds of receiving adequate care compared to the least ethnically concentrated neighborhoods. However, after adjusting for covariates, all quintiles in the IBD group had lower odds of receiving adequate care compared to Q1, with Q5 having the lowest odds of receiving adequate care (aOR: 0.87; 95% CI, 0.82-0.92). The crude ORs for the multimorbidity group showed all quintiles were significantly associated with receiving adequate care, compared to Q1. After adjustment, the more ethnically concentrated quintiles, Q4 (aOR: 1.07; 95% CI, 1.03-1.11)

and Q5 (aOR: 1.07; 95% CI, 1.03-1.11) remained significantly at higher odds of receiving adequate care compared to Q1.

Lastly, for the *Household and Dwellings* dimension there was no evident direction of association for the IBD group. Those living in Q5, the least residentially stable neighborhoods, were significantly at higher odds of receiving adequate care (aOR: 1.13; 95% CI; 1.08-1.19). In the multimorbidity and healthy control groups, all quintiles were significantly at higher odds of receiving adequate care compared to Q1 after adjusting for covariates.

Table 4-10: **Association between ON-Marg social inequity dimensions and adequacy of prenatal care by disease group**

	IBD		Multimorbidity		Control	
Social Inequity (ONMARG)	**Crude OR (95% CI)**	**Adjusted[a] OR (95% CI)**	**Crude OR (95% CI)**	**Adjusted[a] OR (95% CI)**	**Crude OR (95% CI)**	**Adjusted[a] OR (95% CI)**
Age and Labour Force						
Q1 (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Q2	0.83 (0.80-0.86)	0.85 (0.82-0.88)	1.00 (0.98-1.03)	1.05 (1.03-1.08)	0.89 (0.88-0.89)	0.97 (0.96-0.97)
Q3	0.81 (0.78-9.85)	0.85 (0.81-0.88)	1.26 (1.23-1.29)	1.37 (1.33-1.41)	0.88 (0.87-0.88)	1.00 (0.99-1.00)
Q4	0.73 (0.70-0.76)	0.79 (0.76-0.83)	1.04 (1.01-1.07)	1.13 (1.10-1.17)	0.85 (0.85-0.86)	1.00 (0.99-1.00)
Q5	0.93 (0.89-0.96)	1.03 (0.98-1.08)	0.95 (0.93-0.98)	1.08 (1.05-1.12)	0.81 (0.80-0.81)	1.00 (0.99-1.00)
Material Resources						
Q1 (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Q2	1.07 (1.03-1.11)	1.16 (1.11-1.20)	0.91 (0.88-0.94)	0.92 (0.89-0.95)	0.90 (0.89-0.90)	0.96 (0.96-0.97)
Q3	0.83 (0.80-0.86)	0.93 (0.89-0.97)	0.89 (0.87-0.92)	0.91 (0.88-0.94)	0.83 (0.82-0.83)	0.94 (0.93-0.94)
Q4	0.91 (0.87-0.95)	1.03 (0.98-1.08)	0.88 (0.85-0.90)	0.92 (0.89-0.96)	0.76 (0.76-0.77)	0.91 (0.90-0.91)
Q5	0.63 (0.61-0.66)	0.71 (0.67-0.75)	0.77 (0.75-0.79)	0.91 (0.88-0.95)	0.65 (0.4-0.64)	0.84 (0.84-0.85)

Racialized and Newcomer Populations						
Q1 (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Q2	0.99 (0.95-1.03)	0.90 (0.86-0.94)	1.07 (1.03-1.11)	1.03 (0.99-1.07)	1.12 (1.11-1.12)	1.04 (1.03-1.05)
Q3	1.16 (1.11-1.210	0.97 (0.92-1.02)	1.04 (1.01-1.08)	0.99 (0.96-1.03)	1.30 (1.29-1.31)	1.12 (1.11-1.12)
Q4	1.25 (1.20-1.20)	0.97 (0.92-1.02)	1.10 (1.07-1.14)	1.07 (1.03-1.11)	1.37 (1.36-1.37)	1.14 (1.13-1.15)
Q5	1.05 (1.00-1.09)	0.87 (0.82-0.92)	1.10 (1.06-1.13)	1.17 (1.13-1.22)	1.30 (1.29-1.20)	1.15 (1.14-1.15)
Households and Dwellings						
Q1 (reference)	1.00	1.00	1.00	1.00	1.00	1.00
Q2	1.02 (0.98-1.06)	1.10 (1.06-1.15)	1.20 (1.16-1.23)	1.23 (1.19-1.27)	0.98 (0.97-0.98)	1.05 (1.04-1.05)
Q3	0.90 (0.87-0.94)	0.99 (0.95-1.03)	1.03 (1.001.06)	1.07 (1.04-1.11)	0.93 (0.93-0.94)	1.06 (1.05-1.06)
Q4	0.91 (0.88-0.95)	1.05 (1.00-1.09)	0.97 (0.95-1.00)	1.08 (1.05-1.11)	0.85 (0.84-0.85)	1.04 (1.03-1.04)
Q5	1.01 (0.97-1.05)	1.13 (1.08-1.19)	1.01 (0.98-1.04)	1.16 (1.12-1.20)	0.85 (0.85-0.86)	1.01 (1.01-1.02)

[a] Adjusted for maternal age, income quintile, rurality, parity, and ON-Marg variables that were not considered a main exposure

CHAPTER 5: DISCUSSION

This aim of this thesis was to understand the current care pathways of pregnant individuals with IBD in Ontario including investigating if this group is receiving adequate care throughout all stages of their pregnancy journey (preconception, during pregnancy, and postpartum) and identify the routine providers and specialists these individuals have been consulting. We further aimed to estimate the prevalence of adverse obstetrical and neonatal outcomes in our cohort. Lastly, we investigated the strength of association between social inequities from the ON-Marg and adequacy of care in this population. All analyses were compared to a high-risk multimorbidity group and a healthy control group, to see if there were differences in care patterns and outcomes compared to the IBD cohort.

5.1 Objective 1

5.1.1 Adequacy of Care

Prenatal care is an invaluable health care service that aims to improve maternal and fetal health outcomes. Although use of this care is encouraged, there may be barriers that influence receipt of adequate care. The findings from this objective found that overall, approximately 50% of women with IBD were receiving adequate prenatal care, with a similar prevalence in the multimorbidity group, compared to the healthy control group which had a rate of slightly under 40%. Similarly, those with IBD and multimorbidity received higher rates of intensive perinatal care, with rates of 10.0% and 16.1%, respectively. Combined, these rates estimate that over 60% of women with IBD and multimorbidity are receiving intensive/adequate prenatal care in Ontario. An Ontario study looking at differences in healthcare utilization between women with and without IBD found similar results where women with IBD were more likely to receive adequate prenatal care (91). Higher rates of prenatal care visits in this population may be attributed to regular checkups for disease monitoring and management given their pre-existing conditions. Our results align with current expert guidelines both nationally and internationally which recommends fetal and maternal monitoring in women with IBD (7,95,97,119). Our findings also suggest a high rate of intensive/adequate care in women with multimorbidity compared to the healthy control population which is optimal as their care demands often exceed those of healthier populations. A systematic review of North American studies investigating the association between pre-pregnancy multimorbidity and adverse maternal outcomes found an increased risk of maternal morbidity and mortality and emergency department visits amongst this population, especially as the number of comorbidities increased (120). Similarly, a retrospective cohort study conducted in Manitoba in the general population found that inadequate prenatal care was associated with increased odds of several adverse pregnancy outcomes (i.e., stillbirth,

preterm birth, LBW, SGA, admission to NICU) and lower likelihood of health-related behaviors (i.e., breastfeeding initiation, infant immunization) (121). Ensuring women receive adequate prenatal care is essential to improving pregnancy outcomes, regardless of one's disease condition.

Parity has been identified as a potential factor that may influence adequacy of prenatal care (122), where nulliparous women are found to be at higher risk of adverse pregnancy outcomes (123,124). To further explore this within our own cohort, we stratified our analysis by parity to determine if there are differences in adequacy of care between nulliparous and multiparous mothers. We found that rates of intensive and adequate care were lower in multiparous women compared to nulliparous women in all three of our study groups. These findings were similar to a Canadian study conducted in Winnipeg, Manitoba that found multiparous mothers were overall more likely to receive inadequate prenatal care (125). A plausible explanation for this is that first-time mothers may require more support than mothers who have previously given birth and have had prior experience balancing pregnancy with disease management. Additionally, multiparous women may believe they don't require the same frequency of prenatal care as they have prior pregnancy experience (126,127). The Canadian MES found that about two-thirds (65.6%, 95% CI: 63.8–67.4) of primiparous women reported attending prenatal classes compared to 6.0% (95% CI: 5.2–6.8) of multiparous women (8). Some prenatal care guidelines recommend that nulliparous women receive additional prenatal visits along with routine visits (128,129). Despite these results, a secondary analysis of the Canadian MES found that primiparity remained a predictor of inadequate prenatal care use (9). In the IBD population, a Danish study found an increased association between multiparity and disease activity during pregnancy (aOR: 1.19, 95% CI 0.81–1.74) (130). An international cross-sectional

study in Iran also found an increased prevalence of multimorbidity with increasing parity number (131). These findings coupled with the results of our analysis suggests that multiparous women should continue to be encouraged to receive the minimum suggested prenatal care visits to optimize pregnancy outcomes.

5.1.2 Maternal prenatal care providers

In Canada, pregnant individuals can access a variety of HCPs for prenatal care depending on their health needs, preferences, and location. These providers may include their existing family physician, obstetricians, nurse practitioners / community health nurses, or midwives (81). Women at low obstetrical risk are often cared for by primary care providers such as family physicians or midwives, while moderate or high-risk pregnancies may require additional specialist attention from an obstetrician or maternal-fetal medicine specialist. In this study, the most prevalent primary prenatal care provider for all groups were obstetricians with proportions of 53.3%, 63.7%, and 50.0% for the IBD, multimorbidity, and healthy control groups, respectively. Our findings were similar to the results of the MES which found over half (58%) of women were receiving their prenatal care from an obstetrician (8). The proportion of family physicians and midwives as the maternal prenatal care provider were similar amongst all groups. For over 25% of the pregnancies for each of the three study groups the prenatal care provider was recorded as being “other” or “unknown”. This may be due to incorrect documentation or misclassification of the data assigned to this ICES study variable.

5.1.3 Routine and specialist consultations for IBD patients

Canadian and international working groups specializing in IBD in pregnancy suggest that effective care for pregnant women with IBD requires a multidisciplinary approach during pre-

conception, pregnancy, and postpartum to optimize maternal and fetal health outcomes (7,95,97,119). This team typically includes family physicians, gastroenterologists, obstetricians, and maternal-fetal medicine specialists who collaborate to manage disease activity, optimize medication safety, and monitor potential pregnancy complications. Despite these recommendations, there is currently limited information characterizing who women with IBD are seeing for their care throughout pregnancy, both in Canada and internationally. Through this study, we found that visits with a general practitioner are high with approximately 75% of IBD patients having at least one visit pre-conception, 93% during pregnancy itself, and 83% of patients having at least one visit postpartum. Comparatively, only a quarter of IBD patients had at least one pre-pregnancy visit with an obstetrician, 91% during pregnancy, which then dropped to 65.4% postpartum. Statement 5 of the *Toronto Consensus Statements for the Management of IBD in Pregnancy* states that pregnant women with active or complicated IBD should consult with an obstetrician due to increased risk of adverse pregnancy outcomes (97). Misinformation about fertility and pregnancy management is highly prevalent in women with IBD, which may consequently lead to negative views and voluntary childlessness (59,63,65). Thus, preconception counselling is vital to addressing concerns and misconceptions in this population. For example, preconception counselling in women with IBD was associated with healthy behaviors such as adherence to IBD medication, adequate folic acid intake, and smoking cessation as well as lower risk of disease relapse (132). The Toronto Consensus advises that if a non-obstetrician provider is managing a pregnancy due to patient choice or barriers to care, then at least an initial consultation with an obstetrician is recommended. This contact would help ensure timely access to an obstetrician should complications arise during the pregnancy (97). In addition, the AGA suggests consultations with maternal-fetal medicine specialists since they specialize in high-risk

pregnancies and can determine the type of monitoring and frequency visits based on a patient's unique needs (7). Our findings suggest that visits with maternal-fetal medicine are relatively low with rates of less than 2.0% preconception and postpartum, and 13.3% during pregnancy. Rates presented may not be completely accurate and underestimated due to potential data entry errors where visits with maternal-fetal medicine may be recorded as OBGYN. There are standard billing codes in Ontario used for prenatal care and they are used by both maternal-fetal medicine and OBGYN. There are specific high risk prenatal care billing codes, but they may only be used when it meets requirements for specific time spent with a patient and if there is a clear diagnosis. Most providers prefer to avoid using them to avoid audits and billing reviews.

Furthermore, expert guidelines also highlight the role of gastroenterologists in IBD management during pregnancy (7,97). The Toronto Consensus recommends that patients consult a gastroenterologist at least once during pregnancy to ensure monitoring of disease activity, optimize treatment plans, and reinforce the importance of adherence to therapy and disease management strategies (97). Our study found that only 45.5% of patients had a preconception visit, 56.7% had at least one visit during pregnancy, which decreased to 44.3% postpartum. Although rates are around the 50% mark, these rates should be improved to optimize maternal and fetal care in this population. An Australian study found that general practitioners and OBGYNs had significantly lower IBD-specific pregnancy knowledge than gastroenterologists, with over 70% of general practitioners and OBGYNs expressing discomfort with the use of IBD medications around conception/pregnancy (99). Similarly, a Canadian study found that knowledge on IBD medication use during pregnancy varies considerably amongst gastroenterologists and non-gastroenterologists (101). Gastroenterologists were more likely to provide responses aligned with best practices in medication management during pregnancy and

when breastfeeding, compared to other physicians (101). Thus, coordination in care between a patient's primary care provider and gastroenterologists is key to ensuring a healthy pregnancy trajectory.

Previous studies have shown that women with IBD were more likely to have increase visits to the emergency department compared to males (133,134) and that close to 40% of pregnancies in the Canadian setting has at least one emergency department visit (135,136). We further explored emergency medicine and critical care visits within our IBD cohort. We found that approximately 20% of women had a preconception visit within 6 months prior to pregnancy. This increased to 31.6% during pregnancy and decreased back to 17.8% during the postpartum period. An Ontario cohort study found that women with IBD were more likely to have at least one all-cause and non-IBD specific emergency department visits, compared to women without IBD (91). The same study found that ED visits during pregnancy for women with IBD were more likely to be due to digestive-related concerns [11.9% vs 4.5%, $p < 0.0001$] compared to women without IBD and that postpartum visits were more likely to be due to venous thromboembolic events [0.6% vs 0.3%, $p = 0.001$] and digestive-related concerns [18.5% vs 8.5%, $p < 0.0001$] (91).

5.2 Objective 2

5.2.1 Obstetrical outcomes

It has been well established that IBD is associated with several adverse obstetrical outcomes in many cohort studies such as hypertensive complications(2,46), caesarean delivery (3,47–49), postpartum hemorrhage (137), stillbirth(138,139), and postpartum infections (140), which are further supported by recent systematic reviews and meta-analyses (4–6). Overall, the prevalence of adverse obstetrical outcomes was low in our IBD cohort with numbers around 1%

for PPROM, and less than 1% for preeclampsia and postpartum hemorrhage. Due to small sample sizes, we suppressed the cells for chorioamnionitis and stillbirth. Low rates of these outcomes can possibly be due to approximately 60% of the IBD pregnancies receiving adequate/intensive care, combined, indicating appropriate prenatal care utilization and possibly better pregnancy and disease management. Furthermore, there were high rates of consultations with family physicians, obstetricians, and gastroenterologists throughout the pregnancy period. Although direct evidence is lacking in the association between consultations with IBD specialists and pregnancy outcomes, a multidisciplinary team approach ensures that patients receive tailored care to effectively manage their condition and address their unique needs. Furthermore, our results found that rates of Caesarean sections were slightly higher in the IBD group (24.7%) compared to the control group (20.8%). A cohort study conducted in Ontario found that compared to non-IBD patients, women with IBD were significantly more likely to receive Caesarean sections (aOR 1.34, 95% CI, 1.22–1.49) especially those living in northern rural areas (aOR 2.48, 95% CI, 1.11–5.55) (93). Currently, the Toronto Consensus suggests that vaginal delivery is safe for most patients and that mode of delivery should be decided based on obstetric considerations, previous surgical history, and patient preferences (97). Patients who have active perianal disease and those who have undergone ileal pouch anal anastomosis are usually recommended to consider Caesarean sections (97). Despite these recommendations, a preliminary study conducted in Toronto, Ontario found that only 30% of caesarean sections in women with IBD were due to IBD-related reasons, and 70% were for non-IBD related reasons (141).

5.2.2 Neonatal outcomes

There is considerable evidence suggesting higher risk of adverse neonatal outcomes in infants born to mothers with IBD. Studies have found an increased risk in preterm birth (2,48–51), low birth weight (LBW) (51,52), small for gestational age (SGA) (48–50), spontaneous abortion (3), and neonatal death (2,50,51) in this population. Similarly, a systematic review and meta-analysis investigating the association between multimorbidity in pregnant women and adverse birth outcomes found that pregnancy multimorbidity was associated with preterm birth (4.28 [2.23-6.34]), LGA (3.33[1.50-5.17]), macrosomia (2.16 [0.34-3.98], and SGA (<10th percentile) (3.52[1.54-5.51]) (142). Our findings show there is a higher proportion of preterm births in the IBD (10.7%) and multimorbidity population (19.3%) compared to the healthy control population (7.6%), which is consistent with recent evidence. Similar results are seen for LBW where multimorbidity had the highest rate (12.4%), followed by IBD (8.3%), and the healthy controls (6.3%). The proportion of LGA infants was lowest in the IBD population compared to the other two study groups. Although, there are limited studies that investigated LGA as an outcome in this population, a French cohort study found lower rates of LGA in women with IBD compared to their non-IBD counterparts (143). Rates of SGA at the 10^{th} percentile were relatively similar in the 3 study groups. Surprisingly, there were higher rates of NICU admissions greater than 24 hours in infants in the healthy control group, compared to the other two groups. There was a higher proportion of women in the IBD and multimorbidity groups who had infants with low APGAR scored compared to infants born to healthy mothers. A Canadian study found that women with IBD who attended a dedicated IBD-pregnancy clinic had infants with better APGAR scores compared to those who did not attend, highlighting further the value of such clinics in enhancing prenatal care in this population (144).

5.3 Objective 3

5.3.1 Social inequities and adequacy of care

Despite Canada's universal healthcare system which ensures that prenatal care is provided at no cost to patients, it is possible inequities in the utilization of prenatal services may arise from other barriers, such as socioeconomic, cultural, or other systemic factors. The final objective of this thesis was to explore the association between social inequities, as described by the ON-Marg dimensions, and adequacy of care amongst our three study groups. This analysis was adjusted for maternal age, income quintile, rurality, parity, and the remaining ON-Marg variables that weren't the main exposure for that particular part of the analysis.

The first dimension, *Age and Labor Force*, is a measure of dependency and looks at a neighborhood's workforce eligibility to support those who do not have income from employment (i.e., children, seniors, and the unemployed). Our findings suggest women living in areas of higher dependency for the IBD group were less likely to receive adequate care. Comparatively, the multimorbidity group seemed to be positively associated with receiving adequate care. For the IBD group, individuals living in more marginalized areas may face increased socioeconomic barriers compared to other affluent areas, such as unemployment. Individuals with IBD may find keeping stable employment difficult due to their medical needs. A study conducted in Manitoba found that patients with IBD were more likely to be unemployed compared to the general population (145) and that unemployment is also a predictor of inadequate prenatal care use in the general pregnant population (87). Consequently, unemployment is directly correlated with financial security where the lack of stable income can limit the ability to afford resources such as transportation to specialized care facilities or to pay for prescribed medications essential for IBD management. Furthermore, these neighborhoods may lack access to specialists such as gastroenterologists or maternal-fetal medicine specialists who often support complex

pregnancies, resulting in suboptimal disease management. These individuals may receive their prenatal care from their family physician or obstetrician and it has been previously described in the literature that general practitioners may not have sufficient expertise in providing care to this specific population themselves (99).

The next inequity described by ON-Marg is *Material Resources* which looks at the ability for individuals and communities to access basic material needs and considers factors such as income, education, family structure, and unemployment. We found in the IBD cohort that compared to the least materially deprived group, the most materially deprived group (represented by Q5) was significantly at lower odds of receiving adequate care. The multimorbidity and healthy control groups demonstrated a similar association. A previous Canadian study found that women living in neighborhoods that had the lowest average family income, the highest proportion of the population who were unemployed, the highest rates of recent immigrants, the highest percentage of single parent families, and the highest percentage of the population with fewer than nine years of education were more likely to receive inadequate prenatal care (87). Furthermore, BORN data has shown that prenatal education participation rates were lowest in communities with lower levels of education, where residents did not hold a diploma, neighborhoods with the highest unemployment rates, and in neighborhoods with the lowest median household incomes (146) Similar results were reported in a systematic review of determinants of inadequate prenatal care use in high-income countries (147).

The *Racialized and Newcomer* dimension looks at neighborhood-level concentrations of recent immigrants and visible minorities, excluding Aboriginal populations. Our results demonstrate that compared to neighborhoods with the least number of ethnic minorities, the ones with the highest concentrations are significantly less likely to receive adequate prenatal care in

the IBD group. Contrarily, the healthy control groups demonstrated increased odds of receiving adequate care as well as Q4 and Q5 for the multimorbidity group. In the general Canadian population, existing literature suggests that immigration is an important predictor for health care utilization, with recent immigrants having decreased utilization compared to established immigrants (148,149). Previous studies found that immigrants who face barriers to accessing health resources may have worse self-reported health outcomes compared to those who do not face barriers (150). The Healthy Immigrant Effect is a phenomenon that describes how immigrants may have better health compared to the Canadian-born population at the time of their arrival, but this may diminish over time due to factors such as adjustment to a new environment, stress, or adoption of poor health behaviors (151). However, the validity of this effect is questionable as per a systematic review that characterized the Healthy Immigrant Effect in studies across Canada (152). Immigrant status and minority ethnicity/race has been positively associated with higher rates of adverse pregnancy and birth outcomes (153,154), however the evidence varies. An Ontario-based cohort study found that immigrant women who live in low-income urban areas had a slightly lower risk of severe maternal morbidity and mortality compared to their non-immigrant counterparts (155). Contrarily, a systematic review found that migrant women were more likely to receive inadequate prenatal care than native-born women, which may be further exacerbated by factors such as being less than 20 years of age, single marital status, poor language proficiency, education less than 5 years, and lack of health insurance (156). Specifically, for the IBD population, a cohort study in Ontario found that compared to non-immigrant women, immigrant women with IBD had the highest rates of IBD-specific ambulatory visits during preconception, pregnancy, and postpartum and that overall immigrants with IBD were less likely to have a first trimester prenatal visit (92). Our findings

suggest that despite some populations receiving adequate prenatal care, racial barriers may continue to exist for immigrant women who have pre-existing health conditions. Ensuring equitable access to care in areas of high marginalization, specifically for immigrants who face additional societal barriers, is integral in maintaining a healthy pregnancy from preconception to postpartum.

The final dimension, *Households and Dwellings,* encompasses factors such as the number of people living in a residence, proportion of those living alone, as well as the proportion of population owning a residence. Our results demonstrated that overall, for all three study groups, those living in the least unstable neighborhoods were associated with receiving higher odds of adequate prenatal care compared to those living in more stable neighborhoods. Despite our findings, a study investigating health-related social needs and association with moderate-to-severe IBD-related disability found that these patients have a higher proportion of housing instability and poor housing quality (157). Likewise, a study conducted in Vancouver, British Columbia found higher rates of mortality and multimorbidity in those living in marginal housing (158). A systematic review of 41 studies spanning North America, Europe, and Australasia also found that living in the most deprived neighborhoods compared to the least deprived had the highest prevalence or incidence of multimorbidity (pooled OR 1.42, 95% CI 1.41 to 1.42) (159), which differs from our observations. Furthermore, a systematic review examining the impact of housing instability during pregnancy and adverse outcomes and perinatal healthcare utilization found that housing instability was associated with inadequate prenatal care, increased hospital utilization, and outcomes such as preterm birth, LBW infants, NICU admission, and delivery complications (160).

A plausible explanation for areas of higher marginalization receiving adequate care is due to increased public health efforts by the federal and provincial governments as well as programs run by community organizations to mitigate barriers to accessing prenatal care. With the knowledge that investing in care in the prenatal and postnatal periods is crucial to minimizing health inequities and poor health outcomes in the long term, the Canadian government invested in the Canadian Prenatal Nutrition Program (CPNP) which provides funding to community-based organizations to develop and deliver intervention programs throughout pregnancy (161). To date, over 240 programs have been established, serving over 45,000 pregnant or postnatal individuals. A 2018 survey of the CPNP found that most satellite sites were primarily located in communities with socioeconomic vulnerabilities with a high proportion of participants being from a low-income household, identify as a lone parent, identify as an immigrant or of Indigenous background, and have low education (less than high school), indicating the programs' target population is being reached (161).

5.4 Strengths and Limitations

This thesis presents data on pregnant individuals with IBD and multimorbidity in Ontario and their prenatal care utilization, obstetric and neonatal outcomes, as well as social inequities that may influence adequacy of care in this population. Our study includes many strengths including the utilization of linked administrative health databases which allowed us to assemble a large cohort of women with IBD, multimorbidity, and without disease to serve as a comparison group, and provided us with information on the sociodemographic and clinical variables included in this study. Furthermore, Ontario is Canada's most populous province with a high multicultural population which allowed us to capture a diverse sample and further increase our external validity. To our knowledge, this is the first study investigating the association between social

inequities and adequacy of care in the pregnant population in Canada, not only specifically for women with IBD, but for those with multimorbidity and pregnant individuals with no chronic diseases. Additionally, the algorithms used to create the IBD database, which we used for the creation of our cohort, have been previously validated (109) which will minimize, although not completely eliminate the risk of misclassification bias.

Despite the strengths of our study, limitations persist. First, we were unable to capture births that occurred outside of the hospital setting as these are not available through ICES. This may include out of hospital midwifery visits that aren't captured through OHIP and may not be included in the hospital delivery record, potentially underestimating the extent of prenatal care being given to patients. Likewise, births from new immigrants or refugees may be missed due to lack of OHIP coverage. Second, the R-GINDEX was developed based on the ACOG's recommendations for number of visits for low-risk pregnant women. The effectiveness of this tool has not been previously validated, nor has it been adjusted to measure adequacy of care for women with high-risk pregnancies. The R-GINDEX measures adequacy of care based on three pre-defined variables: gestational age of infant, trimester prenatal care began, and total number of prenatal visits during pregnancy. Prenatal visits are defined as visits made with an HCP and don't account for other forms of prenatal health services, such as attendance of prenatal classes. Third, we used the ON-Marg in the analysis for Objective 3 to represent common social inequities and their association with adequacy of care. The ON-Marg only represents neighborhood level marginalization and may not always reflect individual level marginalization, which contributes to ecological fallacy. Furthermore, certain populations may not be appropriately accounted for in census data, which is what the ON-Marg is based off. This includes institutionalized populations as well as exclusion of Indigenous populations living on

reserves. Fourth, although higher prenatal care utilization may suggest receipt of adequate care, reverse causation must also be considered where those who received higher rates of prenatal care may also have more severe disease. This possibility complicates the interpretation of prenatal care metrics, as high utilization may not always be a positive indicator, but rather a marker of increased medical need or complications during pregnancy. Lastly, amongst our IBD cohort, we did not look at differences in CD and UC as there may be differences in outcomes between these two conditions. The care pathways for these subgroups may be different based on reported outcomes and is an area to consider for further research.

5.5 Implications for future research and public health

Our findings suggests that overall, approximately 60% of women with IBD and multimorbidity are receiving intensive/adequate prenatal care in Ontario. Furthermore, individuals with IBD visit a variety of HCPs in the preconception, pregnancy, and postpartum periods. However, visits with gastroenterologists range from 40-50% through the three stages, despite national and international guidelines emphasizing the importance of multidisciplinary care for this high-risk population. These findings highlight the need for further research to investigate the barriers women with IBD face in accessing general prenatal care as well as specialist care. Future studies can explore how differences in care pathways may affect overall pregnancy outcomes to ensure women with IBD receive comprehensive, timely, and individualized care throughout all stages of pregnancy. For example, IBD and pregnancy-focused clinics and educational interventions may offer a variety of benefits to improve patient knowledge and pregnancy outcomes. Subject to funding and availability, increasing access to gastroenterology providers in the community setting would be a facilitator for improved pregnancy outcomes. We reported descriptive statistics for several obstetrical and neonatal

outcomes in our study cohort. Future studies should assess the strength of association between adequate care and obstetrical and neonatal outcomes in these groups, to determine if certain groups are at higher risk of adverse outcomes. Additionally, further studies in this area may investigate differences in outcomes in women with UC vs CD.

Lastly, we investigated how area-level social inequities may influence adequacy of care in our study cohort and found that for most groups, more marginalized areas were less likely to receive adequate care. Addressing the social determinants of health is imperative in improving pregnancy outcomes in this population as factors such as income, housing stability, access to basic needs, and racial disparities may all influence a woman's ability to manage their IBD symptoms and adhere to prenatal care recommendations. For example, women with low socioeconomic status may face challenges in affording medications, attending frequent medical appointments, or accessing specialist care, potentially leading to suboptimal disease management. Future research should aim to identify how these social factors influence the healthcare access and quality of care for women with IBD and other conditions. Potential interventions to mitigate these barriers include developing community-based outreach programs, access to telemedicine, transportation services, and financial assistance initiatives to help reduce disparities in care. Enforcing cultural competency in these interventions is critical in reaching newcomers and visible minority groups who are navigating the Canadian healthcare system. Addressing these underlying social determinants, alongside improving coordination of medical care, is essential for optimizing obstetric and neonatal outcomes in women with IBD and other chronic diseases.

CHAPTER 6: CONCLUSION

The findings of this thesis presents information on prenatal care utilization patterns, obstetrical and newborn outcomes, and social inequities that may impact adequacy of care among pregnant individuals with IBD in Ontario. We additionally investigated these factors among pregnant individuals with multimorbidity and no disease in Ontario. Our findings demonstrate that although approximately 60% of those with IBD and multimorbidity are receiving adequate care in Ontario, they also had higher prevalence of several adverse obstetrical and newborn outcomes assessed in this study. There were varying results in our analysis of neighborhood-level social inequities and impact on adequacy of care where some groups were at higher odds of receiving adequate care, while some were at lower odds of receiving adequate care. Nonetheless, these findings underscore the importance of addressing both clinical and social factors to improve prenatal care access and outcomes for those with IBD and other chronic diseases in Ontario.

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APPENDICES

Appendix A : Indicators for the creation of 2021 Ontario Marginalization Index Dimensions

Households and Dwellings	Material Resources	Age and Labour Force	Racialized and Newcomer Populations
Proportion of the population living alone	Proportion of the population aged 25 to 64 without a high-school diploma	Proportion of the population who are aged 65 and older	Proportion of the population who are recent immigrants (arrived in the past 5 years)
Proportion of the population who are not youth (age 5-15)	Proportion of families who are lone parent families	Dependency ratio (total population 0-14 and 65+ / total population 15 to 64)	Proportion of the population who self-identify as a visible minority
Average number of persons per dwelling	Proportion of total income from government transfer payments for population aged 15+	Proportion of the population not participating in labour force (aged 15+)	
Proportion of dwellings that are apartment buildings	Proportion of the population aged 15+ who are unemployed		
Proportion of the population who are single/divorced/widowed	Proportion of the population considered low income		
Proportion of the population who moved during the past 5 years	Proportion of households living in dwellings that are in need of major repair		
Proportion of dwellings that are not owned			

Appendix B : Ontario Health Insurance Plan (OHIP) Fee Codes Associated with Prenatal Visits

OHIP fee code	Description
A920	Medical management of early pregnancy, initial visit
A921	Medical management of early pregnancy, subsequent visit
A005	Consultation
A006	Re-consultation
A665	Prenatal consult
Q606	Prenatal care - gen. Assess - major prenatal visit
Q607	Prenatal care - min. Assess - subsequent prenatal visit
P002	High risk prenatal assessment
P003	Obs.-prenatal care-general assess - major prenatal visit
P004	Obs.-prenatal care-minor prenatal assess - subsequent prenatal visit
P005	Antenatal health screen
A205	Consult
A206	Repeat consult
A204	Partial assessment

* Prenatal visits will be defined by limiting to one record per person per type of doctor per day. Only visits with an associated OHIP fee code related to prenatal care will be included in this definition.