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Investigating The Impact Of The COVID-19 Pandemic On Maternal Perceived Stress, Postpartum Depressive Symptoms, And Pregnancy Outcomes In London, Ontario: A One Health Approach

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Abstract

The 2019 novel-coronavirus (COVID-19) may have increased feelings of stress and worry in pregnant women. This study investigated the impact of the pandemic on perceived stress and postpartum depressive symptoms, with potential implications for pregnancy outcomes. Women (n=44) who recently gave birth completed questionnaires at 6 weeks postpartum that assessed stress, social support, depressive symptoms, and COVID-19 impact. In summary, 31.8% of participants had high levels of perceived stress, 36.4% had possible postpartum depression, and perceived social support was significantly negatively associated with depressive symptoms. No significant associations were observed between different biological and socio-environmental factors and perceived stress or depressive symptoms. Lastly, this cohort's prevalence of stress and depressive symptoms were higher than that observed in the 2007 Maternity Experiences Survey (MES)-Ontario cohort. In conclusion, pregnant women reported increased feelings of stress and depressive symptoms during the pandemic, and those with higher social support experienced less depressive symptoms.

Summary for Lay Audience

The 2019 novel-coronavirus (COVID-19) has affected many people physically, mentally, socially, and economically. The challenges posed by COVID-19 may have led to increased feelings of stress and worry. This may be particularly true in pregnant women, as they may be already feeling stress from their pregnancy. Evidence report that higher levels of stress may be linked with higher levels of depressive symptoms and result in adverse pregnancy outcomes.

This project investigated the relationship between stress and negative mood in women who recently gave birth, and its potential impact on pregnancy outcomes. Women who recently gave birth were recruited through posters and information sheets in the obstetrical clinics of Victoria Hospital in London, Ontario. Once enrolled, they were asked to complete a 30-minute remote questionnaire that asked about their levels of perceived stress, perceived social support, postpartum depressive symptoms, healthcare satisfaction, as well as how the COVID-19 pandemic has impacted their life and pregnancy. The collected data was analyzed with the women's medical and pregnancy history. This group of data was also compared to a "pre-pandemic" cohort from the 2007 Canadian Maternity Experiences Survey (MES) to explore if there were differences in levels of stress and negative mood in women who were pregnant during the COVID-19 pandemic.

Study results reported that the majority of women who were pregnant during the COVID-19 pandemic experienced medium to high levels of stress and 36.4% of women experienced high levels of postpartum depressive symptoms. When compared to the pre-pandemic cohort, the current COVID-19 cohort had more women that experienced increased levels of stress and depressive symptoms. However, women with high social support were observed to have lower depressive symptoms, suggesting that social support may be helpful towards reducing depression. Finally, no relationships were observed between the age, weight, medical history, and feelings of stress or postpartum depressive symptoms in this cohort of women.

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(a)PTB	(Iatrogenic) Preterm birth
ACOG	American College of Obstetricians and Gynaecologists
BDI-II	Beck Depression Inventory – II
BMI	Body mass index
BORN	Better Outcomes Registry & Networks
CDC	Center for Disease Control
CFWH	Canadian Foundation for Women's Health
CIHR	Canadian Institutes of Health Research
CMHA	Canadian Mental Health Association
COVID-19	Novel coronavirus – 2019 – (SARS-CoV-2)
DASS-21	Depression, Anxiety, and Stress Scale
EPDS	Edinburgh Postnatal Depression scale
FSA	Forward Sortation Area
HADS	Hospital Anxiety and Depression Scale
HDL	High-density lipoprotein
HPA axis	Hypothalamic-pituitary-adrenal axis
IUGR	Intrauterine growth restriction
LHSC	London Health Sciences Center
LICO-AT	Low-Income Cut-Off – After Tax
MDD	Major depressive disorder
MES	Maternity Experiences Survey
MLHU	Middlesex/ London Health Unit
MSPSS	Multidimensional Scale of Perceived Social Support
NGO	Non-governmental organization
NICU	Neonatal Intensive Care Unit
OB-GYN	Obstetrician-gynaecologist
OPR	Ontario Perinatal Record
PCCU	Paediatric Critical Care Unit
PCMCH	Provincial Council for Maternal and Child Health
PE	Pre-eclampsia
PFC	Preeclampsia Foundation Canada
PHAC	Public Health Agency of Canada
PHO	Public Health Ontario
PSI	Postpartum Support International
PSS-4/10	Perceived Stress Scale -4/10 items
PTSD	Posttraumatic stress disorder
SES	Socio-economic status
SGA	Small-for-gestational age
SOGC	Society of Obstetricians and Gynaecologists of Canada
WHO	World Health Organization

CHAPTER 1

1. Introduction

The coronavirus disease (COVID-19) first began in December 2019 as a cluster of atypical cases of pneumonia that was reported in Wuhan, China. On March 11, 2020, the World Health Organization (WHO) declared the outbreak a global pandemic [1]. This pandemic has significantly impacted multiple aspects of the global economy while drastically altering the daily lives of every citizen. As countries enacted measures to maintain control of the virus, many have lost their jobs or had reduced hours due to economic shutdowns. Those who remained employed may have had to transition to working from home and also take care of their children, who have to remain home due to school and daycare closures. The possibility and fear of being infected with the virus have also limited physical interactions with others outside of our household, access to grocery stores, non-essential services, and potentially even healthcare access. All of the aforementioned examples of COVID-19's effects on pregnant women and their social environment will be referred to as the "impact" of the pandemic within this thesis. Widespread outbreaks of infectious diseases like COVID-19 are associated with psychological distress and symptoms of mental illness.

Prior to the COVID-19 pandemic, epidemiologic data supported that there has been a steady increase in the proportion of complex pregnancies in Canada [2]. Average maternal age has steadily risen since the mid-1960s, with the average age at first pregnancy now at 30.8 years [3]. Furthermore, population-level increases in the prevalence of obesity, hypertension, and smoking meant that more women were entering pregnancy with these recognized risk factors. In Ontario between 2012 -2016, 17.8% of mothers with live singleton or twin births had pre-pregnancy BMIs greater than 30 kg/m^2, 1.1% had established chronic hypertension, 22% smoked tobacco before pregnancy [4], and 23.4% of reported living with someone who smoked tobacco [2]. These biological health factors contribute to the increased risk of iatrogenic preterm births (aPTB), intrauterine growth restriction (IUGR), and pre-eclampsia (PE) [5–7].

There is also an increasing awareness of the mental health challenges faced by many women of childbearing age. Results from the 2007 Canadian Maternity Experiences Survey (MES) estimated that 15.5% of women had a pre-pregnancy diagnosis of depression and 13% reported that they had

little or no social support available to them during pregnancy [8]. The lack of available social support during pregnancy is potentially detrimental, as social support may mitigate some of the health consequences of stress for these women [9–12]. The prevention measures put in place to combat the COVID-19 pandemic have also been reported to dramatically affect maternal mental health and social support [13–15]. Pregnant women reported feeling higher levels of stress, anxiety, and depressive symptoms, with major concerns about their decline in quality and quantity of social support due to the COVID-19 pandemic [13–15]. Additionally, social support is one aspect of the umbrella term, "socio-environmental factors", which will be defined in this thesis as the social and physical conditions in which people live and work, including socioeconomic status (SES), demographic and cultural factors, and perceived social support. It is important to note that the socio-environmental factors mentioned here has also been referred to as "Social Determinants of Health" in other studies, as both concepts encompassed similar factors within the women's environment [16,17].

Thus, it is increasingly important to understand the relationship between maternal stress, depressive symptoms, physical health factors, socio-environmental factors, and how these conditions independently and interactively affect pregnancy outcomes. Only through a better understanding of these factors and their impact on pregnant women will we be able to implement systems to support them through a healthy pregnancy. A literature review was done on the topics of interest for this thesis and was separated into three major sections below: 1) pregnancy outcomes (for this thesis, it will be limited to intrauterine growth restriction, pre-term birth, and pre-eclampsia), 2) overview of individual associations between perceived stress, depressive symptoms, and pregnancy outcomes, and 3) associations between perceived stress and depressive symptoms before and during COVID-19.

1.1   Pregnancy Outcomes

1.1.1   Intrauterine Growth Restriction (IUGR)

Intrauterine growth restriction (IUGR) is a heterogeneous disorder, typically associated with a failure of the developing fetus to achieve its pre-determined growth potential due to placental insufficiency [18]. These neonates are a subset within the group of babies termed small for gestational age (SGA), where the baby experiences growth restrictions due to a variety of different possible pathologic processes, resulting in their birth weight being less than the 10th percentile of same-gestational age counterparts [19]. Studies have observed that IUGR was associated with increased risks of other

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pregnancy complications, such as pre-eclampsia and pre-term birth, and that maternal hypertension and parity were the biggest biological health factors correlated with IUGR [20,21].

1.1.2 Iatrogenic Preterm Birth (aPTB)

Iatrogenic preterm birth (aPTB) is defined as babies born before 37 weeks of gestation due to maternal or fetal medical complications that necessitate early delivery [22] and is associated with increased risk of mortality and morbidity. However, the distinction between spontaneous and iatrogenic PTB is not often made in research and will therefore be discussed here as a cluster. In 2006 and 2007, the Canadian in-hospital PTB rates were approximately 8.1%, with the highest rates reported in mothers age 35 and older [21]. Within singletons, the average in-hospital cost associated with pre-term babies was nine times higher than full-term babies, $9,233 and $1,050 respectively. This in-hospital cost increased dramatically in babies who were born extremely preterm (less than 28 weeks of gestation), with an average cost of $84,235 [21]. SGA babies may be associated with preterm deliveries, which comprised approximately 54,000 live births in 2006 – 2007. Factors contributing to the increased risk of preterm birth included maternal hypertensive disorders, maternal age, IUGR, fetal distress, and previous history of preterm delivery [23,24]. Consequences associated with SGA and PTB babies included perinatal and infant death, and physical and cognitive disabilities such as cerebral palsy and attention disorders [25].

1.1.3 Pre-eclampsia

Pre-eclampsia (PE) is a pregnancy-specific syndrome that occurs only in humans and affects approximately 3-5% of pregnancies worldwide [26]. The diagnostic criteria for PE were changed by the International Society for the Study of Hypertension in Pregnancy in 2014, removing the necessary presence of proteinuria, and resulting in the current diagnostic definition: "de-novo hypertension occurring after 20 weeks of gestation combined with either proteinuria or other maternal organ dysfunction" [27]. The cost associated with PE was typically linked with preterm delivery and SGA, which was estimated to be several times higher when compared to full-term, normal babies. Factors associated with an increased risk of PE included a previous history of PE, chronic hypertension, pre-existing diabetes, and BMI over 30 kg/m^2 [28]. These risk factors aligned with findings from systematic reviews as women with pre-eclampsia tended to have higher levels of total cholesterol,

triglycerides, and mental stress, which may increase their lifetime risk of developing metabolic syndrome, chronic hypertension, and cerebrovascular disease.

1.2 Overview of Links between Risk Factors and Pregnancy Outcomes

1.2.1 Perceived Stress and Pregnancy Outcomes

Perceived stress is the feelings or thoughts that an individual has about how much stress they are under at a given point in time [29]. Studies have reported mixed conclusions on the relationships between perceived stress and adverse pregnancy outcomes [30–35]. From a physiological standpoint, pregnancy-specific distress and elevated levels of inflammatory markers may be associated with shortened gestational length [30]. Some studies have reported that high levels of perceived stress can increase risks of having pre-term delivery and very low birthweight babies [31,34], while other studies have not reported any statistically significant associations between levels of perceived stress, pre-term birth, and neonatal birthweight [32,36]. Interestingly, the relationship between perceived stress and pregnancy outcomes may be bidirectional as women with pre-eclampsia were observed to have significantly higher stress levels when compared to healthy pregnant women [35,37]. This presents the need to further investigate the relationship between perceived stress and adverse pregnancy outcomes.

1.2.2 Depression and Pregnancy Outcomes

In Canada, approximately 5% of women have Major Depressive Disorder (MDD) [38], 7.7% of women experienced depression during pregnancy in Ontario, and 8.6% of women experienced postpartum depressive symptoms [25,39]. Prenatal depression is defined as having depressive symptoms that occur during the pregnancy period prior to delivery, whereas postpartum depression typically occurs following the delivery of the baby and can last up to one year post-delivery [39]. Postpartum depression is the most common disability in women within childbearing age and the WHO reported it as a leading cause of disease burden for women of all income levels [40]. The strongest risk factors that predicted postpartum depression are a history of psychiatric illness, prenatal symptoms of anxiety, and the onset of depression during pregnancy [25,41]. Studies have reported that 54.2% of women who experience postpartum depression have had a previous history of depression [25,42]. In November 2018, the Healthy Human Development Table published a perinatal mental health guide for Ontario Public Health Units and stated that perinatal mental health is an important public health issue due to its

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impact on the family and society [25]. Further, untreated depression was also known as a risk factor for adverse pregnancy outcomes such as PTB, IUGR, and low birth weight [43]. Lastly, the risks and consequences of developing depression have been linked with various social factors including socioeconomic status, social support network, and educational attainment [44].

1.2.3 Socio-environmental Factors and Pregnancy Outcomes

As more people choose to move into urban settings, the space of the city itself becomes our living environment. The location of our home and living conditions are not only associated with our educational attainment, socioeconomic status, and financial stability, but also directly affect our access to resources. For example, access to health care, particularly perinatal care, has been observed to be beneficial for maternal mental and physical health, but limited access to care has also been associated with socio-environmental factors and stress [45–48]. Additionally, social support has been reported to significantly predict fetal birth weight [49], so early access to prenatal care may improve maternal and fetal outcomes as healthcare providers may be a source of support through the delivery of good care [46]. Additionally, level of educational attainment was observed to be inversely associated with smoking rates [49,50]; a risk factor that is associated with low gestation, IUGR, and low birth weight. Lastly, cultural factors also may have a strong influence on perinatal health, as studies have reported that immigrant women from minority groups have higher rates of postpartum depression compared to immigrants from majority groups and Canadian-born women [25].

1.2.4 Interconnections between Depression, Perceived Stress, COVID-19, and Pregnancy Outcomes

The previous sections discussed the individual associations between perceived stress and pregnancy outcomes, and depressive symptoms and pregnancy outcomes individually. However, perceived stress and depressive symptoms have also been reported to be associated with one another in a bidirectional relationship [51], and therefore may contribute synergistically to affect pregnancy outcomes [52]. For instance, studies have observed that women who experienced high levels of perceived stress and depressive symptoms were at an increased risk for pre-term birth and small for gestational age babies [34,53]. As the COVID-19 pandemic may have brought changes to the lives of pregnant women, its impact on perceived stress, depressive symptoms, and subsequent pregnancy

outcomes must be examined. Specific details of the impact of COVID-19 are discussed in the following section.

1.3   Depression and Perceived Stress Before and During the COVID-19 Pandemic in the Pregnant Population

Before COVID-19

The relationship between perceived stress and depression and/or depressive symptoms is a relatively new topic that has emerged in recent decades. Perceived stress is closely associated with one's cognitive appraisal of whether an event is personally stressful; if an individual deems the situation to be stressful, the brain then acts upon the received signals and manifests the perception as physiological stress [54–56]. Studies have reported a bidirectional relationship between depressive symptoms and stress, as individuals who experienced depressive symptoms reported increased levels of oxidative stress and inflammation [57], and those who experience chronic stress were at an increased risk of developing depressive symptoms and depression [58,59]. In this research project, we examined stress as levels of perceived stress, with consideration of the number of stressful life events experienced.

Prior to the COVID-19 pandemic, approximately 10% to 20% of women experienced mental health concerns during the perinatal period [60]. A meta-analysis of 102 prenatal and postnatal studies reported the pooled prevalence of anxiety among participants to be 15.2% [61] compared to 8.1% in the general population [62]. Another review reported that the pooled prevalence of depression in women during the perinatal period was 11.9% [63], compared with the 5.7% with moderate depressive symptoms within the general population [64]. Pregnant women who experienced higher levels of stress during pregnancy have been linked with increased risks of antenatal depressive symptoms as well as postpartum depression [25,65]. Multiple studies supported that perceived stress was significantly correlated with postpartum depressive symptoms within the pregnant population, suggesting that pregnant women who experienced higher levels of perceived stress may also experience increased depressive symptoms, especially in first-time mothers [33,65]. Additionally, levels of both perceived stress and depressive symptoms were reported to have gradually decreased from late pregnancy to 3 months postpartum [65].

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During COVID-19

In December 2020, both the Center for Disease Control and Prevention (CDC) and the American College of Obstetricians and Gynaecologists (ACOG) stated that although the absolute risk is low, pregnant women are identified to be at increased risk of severe outcomes with symptomatic COVID-19 infection [66]. Research data supported that those who are pregnant may be more vulnerable to infection of COVID-19 due to their naturally suppressed immune systems. Pregnant women have an increased risk of ICU admission, need for mechanical ventilation and ventilator support (ECMO), and other health complications [63,66,67]. Since mental health concerns such as depression, stress, and anxiety have been associated with increased risk of other health conditions and pregnancy complications prior to the pandemic [68–72], primary studies that investigated the impact of COVID-19 on maternal mental health were reviewed. We explored whether the pandemic led to additional stress for this group as lockdowns and preventative measures may have limited their mobility and social interactions.

Due to the infectious nature of COVID-19, most research was conducted online through web-based surveys and questionnaires. A majority of studies reported elevated prevalence of depressive symptoms in pregnant women during this time, ranging from 32% to 57%, compared to the 9% to 11% observed during non-pandemic times [73–77]. The highest prevalence of depressive symptoms was observed in Turkey, as Kahyaoglu & Kucukkaya used the Hospital Anxiety and Depression Scale and reported the prevalence of depression and anxiety to be 56.3% and 64.5% respectively [77]. Interestingly, this result was slightly higher than the findings of other studies conducted around this time (which did not exceed 40%). In addition, a positive trend was observed between the prevalence of depressive symptoms and the number of suspected and/or confirmed total cases of COVID-19 at the beginning of the pandemic, suggesting that rising numbers of cases may be associated with increased depressive symptoms in pregnant women [73]. Similar to depressive symptoms, the prevalence of anxiety was also observed to be elevated, ranging between 34% and 64%, with the result from Kahyaoglu & Kucukkaya again slightly higher compared to the other studies [74,76,77]. Lockdown measures were also reported to impact maternal mental health, as significant differences in depressive symptoms and anxiety were observed between different time points within the lockdown, along with a gradual increase in psychopathological symptoms as the number of days in lockdown increased [78].

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Interestingly, Moyer *et al*. suggested that the pandemic amplified two important contributions that may lead to greater levels of anxiety: 1) real or anticipated threat to pregnancy or its outcomes and 2) low perceived control [79]. This meant that women who perceived themselves to be at higher risk of adverse pregnancy outcomes demonstrated greater changes in levels of anxiety [79]. However, the same women would be reassured and less anxious if they had access to prenatal care such as ultrasound exams, or if they were assured by their healthcare provider [79]. The importance of prenatal care was also emphasized as studies reported that the most frequent worry and distress from patients were concerns regarding hospital visits for antenatal check-ups and ultrasounds, fear of protecting themselves from infection, social media messaging, and infant health after delivery [60,80,81]. Higher levels of COVID-19-related health worries and grief were significantly associated with clinically significant symptoms of depression, anxiety, and PTSD [60]. The findings from these studies suggested that access to prenatal care as well as healthcare provider assurance may have positively contributed to maternal mental health as a source of support and reassurance during unprecedented times. Similarly, the uncertainty and lack of research surrounding the potential for vertical transmission of COVID-19 through breastfeeding may also be associated with levels of maternal perceived stress and postpartum depressive symptoms [82–84], but the literature on this topic is currently limited.

To date, only two studies investigated the impact of the COVID-19 pandemic on the associations between mental health and pregnancy outcomes. These studies assessed postpartum depression in Israel and Turkey respectively, within 2 days after delivery using the Edinburgh Postnatal Depression Scale (EPDS) questionnaire. Pariente *et al*. reported that women who delivered from March 18 to April 29, 2020, had a lower risk of probable postpartum depression compared to women who delivered before the COVID-19 pandemic in 2016 and 2017 (16.7% vs. 31.3%, p=0.002) [85]. Conversely, Oskovi-Kaplan *et al.* reported that 14.7% of the 223 postpartum women enrolled had probable postpartum depression, compared to the 6.5% to 12.9% range reported in 2016 by Donna & Simone [86,87], suggesting that women who delivered during COVID-19 may have a higher risk of developing postpartum depression. As the pandemic started roughly a year ago in 2020, more studies focusing on the pandemic's impact on mental health and pregnancy outcomes are expected to emerge as this is currently a gap in the literature.

1.3.1 Impacts of Socio-environmental Factors on Perceived Stress and Depressive Symptoms on the Pregnant Population Before and During COVID-19

Before COVID-19

Socio-environmental factors are the conditions within the environments where we live, learn, work, and play that contribute to our health and wellbeing [88]. It includes demographic factors such as race and ethnicity, location of residence, SES, social support, and access to resources. In a Canadian study, Black and First Nations mothers have 1.67-fold and 1.6-fold higher mean depressive symptom scores, and 1.36 and 1.28-fold increase in perceived stress scores respectively, when compared to White Caucasian mothers [89]. Aside from ethnicity, factors such as household income, employment, and immigration also impacted maternal levels of perceived stress and depressive symptoms [55,90,91]. Studies reported that pregnant women in the lowest bracket of household income (CAD $0-$39 999) were more likely to experience high levels of perceived stress and depressive symptoms at various perinatal stages compared to women with an income of CAD $100 000 or greater [91]. Additionally, those who have lived in Canada for 5 to 10 years have a 3.77-fold (95% CI 1.38-5.21) and 2.69-fold (95% CI 1.54-9.24) increased risk of consistently experiencing high levels of depressive symptoms and perceived stress throughout the perinatal period when compared to those who lived in Canada for less than 5 years [91].

Other than demographic factors, social support from friends and family have been identified to have buffering effects that helped pregnant women to cope with stress and depressive symptoms [92,93]. Both Perceived Stress Scale (PSS) scores and Edinburgh Postnatal Depression Scale (EPDS) scores were observed to have significant negative correlations with social support, suggesting women who felt well-supported tended to experience lower levels of stress and depressive symptoms [33]. Similarly, a lack of social support was strongly associated with an increased risk of antenatal depression [88].

During COVID-19

Similar to its effect on perceived stress and maternal mental health, the COVID-19 pandemic also contributed to amplifying the effects of socio-environmental factors on pregnant individuals' mental health. Education was examined in most of the studies that assessed the impact of the pandemic on maternal mental health and reported that having less education was associated with an increased risk

of developing depression during the perinatal period [14,73,76,77,90,94]. Education is also closely associated with employment status, which has been heavily impacted by the pandemic restrictions as many were laid off due to business closures [95]. Changes in employment status may impact household finances as income decreased due to reduced or lack of work. Several studies have reported that unemployment and low household income were risk factors that increased the risk of stress and depressive symptoms as part-time or unemployed women reported increased levels of stress, anxiety, and increased risk of developing depression [14,33,63,73,77]. The associations reported between these SES factors and mental health aligned with the established correlation that as one's SES increases, their health also improves due to the additional resources available [96–98].

One of the biggest social changes brought on by the COVID-19 pandemic is social isolation and its connection to social support. Pregnant women may be already in higher need of social care and support given the current pandemic situation, highlighting the need to investigate how maternal levels of social support have been affected by the pandemic [99]. Social isolation was suggested to have the largest effect on depression as the odds for clinically-elevated depressive symptoms increased by 5% per unit increase in feelings of isolation [100]. Similar positive associations were reported in other studies that assessed social isolation due to lockdown [75,78], while obstetricians also reported social isolation as one of the most commonly mentioned concerns by their patients that induced feelings of anxiety and distress [80].

Contrary to social isolation, social support and perceived levels of social support have previously been reported to reduce depressive symptoms, anxiety, and stress [88,97]. In one study, social support was the only factor that had a significant negative correlation with depressive symptoms as women who reported low levels of social support also reported higher numbers of depressive symptoms [75]. Additionally, lower odds of clinically elevated levels of depression and anxiety were associated with higher levels of perceived social support. Accordingly, the lack of social support was suggested to be a source of stress that directly and indirectly impacted maternal health during the pandemic [101]. It was suggested that social support may directly affect maternal mental health by encouraging positive health behaviours and enhancing emotional regulation, which in turn could indirectly reduce physiological stress responses [102]. Lastly, marital life satisfaction and relationship strain were also contributors to one's perceived level of social support. Several studies reported that marital life satisfaction was significantly negatively associated with depression, anxiety, and stress, while the

odds of clinically-elevated depressive symptoms increased 2% per unit increase in relationship strain [14,100].

The current literature suggests that the COVID-19 pandemic has altered our environment and led to changes in various areas of life within the pregnant population. Province-wide lockdowns may have increased feelings of social isolation, stress, anxiety, and decreased levels of social support. These factors need to be considered to have a holistic understanding of the impact of the pandemic on maternal mental health.

1.4 Summary and Existing Knowledge Gaps

Based on the literature reviewed, early studies suggested that the COVID-19 pandemic may have affected levels of perceived stress, depressive symptoms, and pregnancy outcomes through changes in employment, income, healthcare access, and social support. However, there is only limited knowledge on how these factors interact with each other in addition to the limited comparisons between pre-pandemic and pandemic conditions. We need to investigate whether the various biological and socio-environmental factors exacerbate the relationships between perceived stress, postpartum depressive symptoms, and pregnancy outcomes so they can be integrated into the development and execution of maternal care. The purpose of this project is to assess the biological and socio-environmental health factors associated with pregnancy outcomes, particularly perceived stress and postpartum depressive symptoms, and determine if the COVID-19 pandemic has impacted these factors to reduce maternal mental health.

CHAPTER 2

2. Rationale and Hypotheses

The COVID-19 pandemic has changed the way we live, work, and learn, to keep our families and ourselves safe. Working couples with children may have to juggle working from home and childcare. Times of uncertainty are usually accompanied by added stress, and the pregnant population may be a group especially in need of additional support [95]. Prior to the pandemic, the prevalence of complex pregnancies was increasing, meaning more women were entering into pregnancy with physical and mental health factors such as obesity, hypertension, and depression [103,104]. In addition, elevated levels of perceived stress have been associated with an increased risk of depression [105]. Importantly, depression and/or depressive symptoms before and during pregnancy are one of the most predictive indicators of postpartum depression and adverse pregnancy outcomes such as pre-eclampsia, preterm birth, and intrauterine growth restriction [72,106–108].

Along with the socio-environmental changes from the COVID-19 pandemic, there is a clear need to better understand how changes from the pandemic are impacting the prevalence and severity of perceived stress and postpartum depressive symptoms, with implications in pregnancy outcomes. Therefore, the overall research question is: "What are the impacts of the COVID-19 pandemic on levels of perceived stress, postpartum depressive symptoms, and pregnancy outcomes in women within London, Ontario and are there any socio-environmental factors that may help mitigate the impact of the COVID-19 pandemic?"

2.1 The One Health Approach to Addressing the Research Question in this Thesis

2.1.1 What is One Health?

One Health is defined by the One Health Commission as "a collaborative, multisectoral, and trans-disciplinary approach - working at local, regional, national, and global levels - to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants, and their shared environment." [109] Although the approach stemmed from infectious diseases [110], non-infectious and non-communicable diseases (NCDs) now account for more than one-half of the global burden of disease [111]. The increased burden suggests a need to broaden the application of One Health

to NCDs and mental health as the interactions between humans, animals, and the environment are also relevant to NCDs [112]. The Public Health Agency of Canada described One Health as a "multi-sectoral concept that incorporates human, animal, and environmental health, through the key activities of surveillance, response, and prevention" [113]. Importantly, the agency's diagram of One Health nests the interactions between humans, animals, and the environment within socio-environmental factors, which is further encompassed by the impact of culture, the economy, and the global context [113]. This emphasized that One Health is more than the interaction between humans, animals, and the environment, but rather, One Health explores these interactions within the context of socio-environmental factors, the economy, and other events that are happening globally. As the COVID-19 pandemic has affected everyone and everything on a global scale, the interactions between the pandemic, the women's biological and socio-environmental factors, and its impact on perceived stress and postpartum depressive symptoms further suggest the need to use a One Health approach to explore the overall research question. The approach will allow for a clearer understanding of these interactions, allowing for the development of more holistic and strategies and action plans to improve maternal mental health.

The second advantage of the One Health approach is the extension beyond single-disciplined research into transdisciplinary research by bringing together stakeholders from different sectors in society (beyond academia, medicine, and the health sectors) to account for and integrate their knowledge and ideas in a solution-oriented way. Stakeholders are defined as "individuals, organizations, or communities that have a direct interest in the process and outcomes of a project, research, or policy endeavour" [114], and they are engaged to broaden the range of ideas and opinions that are presented. The collaboration and engagement of stakeholders are important because it allows for knowledge translation between different disciplines and sectors, which aid to improve the implementation of programs and events.

2.1.2   The Application of One Health in this Thesis

This thesis utilizes the One Health approach in two main ways: 1) exploration of the research question is done with consideration for the interactions between human health and the environment, and 2) relevant stakeholders within various disciplines and sectors that can affect or are affected by

health are identified as a part of this thesis to encourage collaborations and implementation of solutions to support and improve maternal mental health.

The overall research question for this project is how maternal mental health, particularly perceived stress and postpartum depressive symptoms, have been impacted by the COVID-19 pandemic. First, to holistically understand the impact of the pandemic on perceived stress and postpartum depressive symptoms, we must acknowledge the contribution of humans and our environment, along with their interactions to maternal mental health. As not all health issues are explored equally between the three pillars of One Health, this research study mainly explored the interactions between humans (biological factors) and our environment. For this thesis, the environment will be focused specifically on the participants' social environment. This includes their demographic characteristics, socio-economic status, age, and support networks. Further, these interactions are explored within the global context of the COVID-19 pandemic as its impact on women's income, access to health care, and social support were measured. The access to both biological health information and socio-demographic information allowed us to understand the participant's health within the context of their social environment and the pandemic.

While this research study mainly focused on human health and our surrounding environment, animal models have significantly contributed to the understanding of underlying mechanisms of stress, depression, and adverse pregnancy outcomes [115–119]. Firstly, animal models have been used to investigate how various representations of stress (e.g. maternal separation [120,121], chronic unpredictable/mild stress [122], and social isolation [121,123]) affect depression-like symptoms observed in rodents that are analogous to human depression [120]. Early life separation can affect the development of one's ability to react and cope with subsequent stressful events [120], whereas offspring who received high levels of licking and grooming from their mothers were less fearful and have lower HPA responses to stress [124]. Secondly, recent literature also explored the effects of pet companionship on maternal health, but it was limited as one study reported that pet ownership was negatively correlated with prenatal anxiety [125], while another reported that pet ownership was associated with increased likelihood of postpartum depressive symptoms if the women perceived maternity as a burdensome role [126]. In addition, animal models have been critical for studying pregnancy outcomes such as pre-eclampsia. Since pre-eclampsia is a pathology that occurs uniquely in humans, the disease has been difficult to mimic in animal models [127–129]. The main problems that arose from various rodent and

non-rodent experiments were either the inability to replicate all relevant criteria for the diagnosis of PE [130] or that the symptoms could not be replicated only in the experimental group [129,131]. Although there were challenges, these models contributed valuable information on the biophysiological mechanisms that underlie parts of the disease etiology such as the identification of soluble Fms-like tyrosine kinase-1's (sFlt-1) role, and the interactions of various systems with vasodilators [128–131].

Lastly, stakeholders are a crucial aspect of the One Health approach as engagement and collaboration of stakeholders from different disciplines and sectors drive knowledge translation and implementation of strategies and programs to improve maternal mental health. However, before transdisciplinary action plans can be developed, relevant stakeholders that are involved in maternal mental health need to be identified and compiled so we have an understanding of how each of them contributes to reducing the levels of perceived stress and postpartum depressive symptoms in women who recently gave birth.

Therefore, the One Health approach allows for an opportunity to assess and understand issues of maternal perceived stress, depressive symptoms, and pregnancy outcomes within the broader context of socio-environmental factors and the COVID-19 pandemic. The approach identifies and brings together relevant stakeholders to extend research beyond academia and collaborate with government institutions, private and public organizations, and the media to create and implement actionable plans at local, regional, national, and global levels. Ultimately, the goal is to reduce and mitigate the effects of perceived stress and postpartum depressive symptoms in pregnant women, which will help optimize their overall health.

2.2   Overall Study Objectives and Hypotheses

The overall study objectives of this project were to assess the impact of COVID-19 on levels of perceived stress, postpartum depressive symptoms, and pregnancy outcomes in women in London, Ontario and to identify any socio-environmental factors that have been beneficial to reducing these outcomes. The primary outcomes were perceived stress and postpartum depressive symptoms and the secondary outcomes were adverse pregnancy outcomes, such as pre-eclampsia (PE), intrauterine growth restriction (IUGR), unplanned operative deliveries, and iatrogenic preterm birth (aPTB). This study also observed how COVID-19 has affected biological and socio-environmental health factors and whether the impact subsequently affected the primary outcomes. Schematically, these objectives

are illustrated in **Figure 1**. The overall hypothesis was that levels of perceived stress and postpartum depressive symptoms within this "pandemic cohort" will be elevated compared to mothers from the pre-pandemic period.

Figure 1 Visual concept map of the complex relationship between COVID-19 pandemic, various health factors, and perceived stress, postpartum depressive symptoms, and pregnancy outcomes
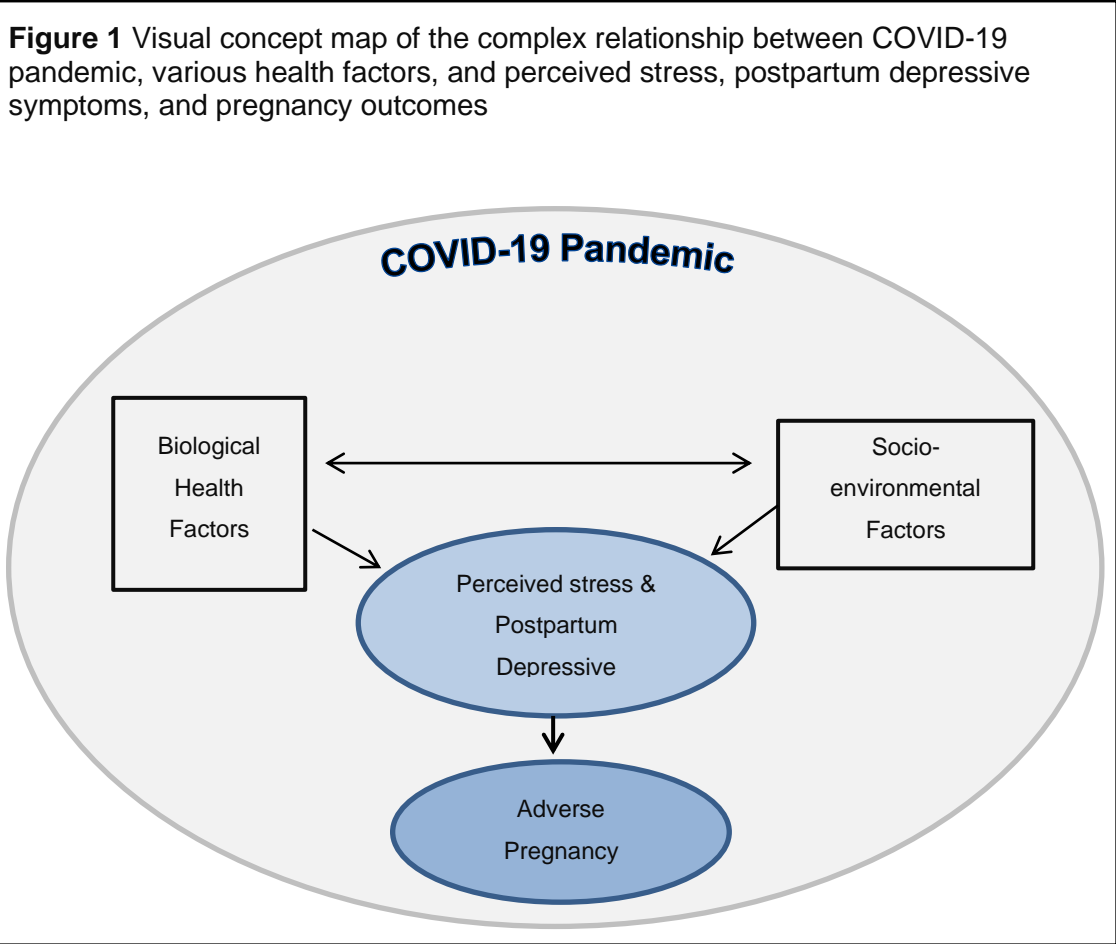
2.2.1 Specific Objectives and Hypotheses

Prior to the data collection process, a set of specific objectives and hypotheses were formulated for this project. However, restrictions from the pandemic have led to revisions of the objectives. Additional details on the impact of the pandemic and the original set of specific objectives are presented in **Appendix A**. Below are this project's current specific objectives and hypotheses.

Specific Objective 1: To measure the prevalence and severity of perceived stress and postpartum depressive symptoms in women who recently delivered during the COVID-19 pandemic and compare the results to a pre-COVID-19 pandemic cohort from the Maternity Experiences Survey in 2007.

>   **Hypothesis 1:** The prevalence and severity of perceived stress and postpartum depressive symptoms in the current COVID-19 cohort of postpartum women will be increased compared to a pre-COVID-19 cohort from the Maternity Experiences Survey in 2007.

Specific Objective 2: To explore the associations between individual biological and socio-environmental health factors, and the prevalence and severity of perceived stress, postpartum depressive symptoms, and pregnancy outcomes in postpartum women during the COVID-19 pandemic.

>   **Hypothesis 2:** Increased burden of individual biological and socio-environmental health factors will be positively associated with prevalence and severity of postpartum depressive symptoms, levels of perceived stress, and adverse pregnancy outcomes in postpartum women during the COVID-19 pandemic.

Specific Objective 3: To identify relevant stakeholders within different disciplines involved in investigating, preventing, and managing maternal perceived stress, and postpartum depressive symptoms.

Specific Objective 4: To develop a schematic classification of the identified stakeholders to encourage collaborations in the development and implementation of strategies to optimize the health of pregnant women through the reduction of perceived stress and postpartum depressive symptoms.

CHAPTER 3

3. Materials and Methods

3.1 Study Population

This study was an observational, prospective cohort study based in London, Ontario that investigated the impact of the COVID-19 pandemic on the prevalence and severity of perceived stress and postpartum depressive symptoms among women who have recently given birth. Participants were made aware of the study through a one-page information sheet (presented in **Appendix B)** within their Mother/Baby admission package or during their postpartum visit at Victoria Hospital. Interested participants filled out the contact portion of the sheet and the document was collected and sent to the Pregnancy Research Group within Victoria Hospital. Those who were interested were contacted at around 3-4 weeks postpartum by a member of the research team via telephone or email to screen for eligibility, to explain the study details as described within the Letter of Information (presented in **Appendix B)**, and to obtain verbal consent to participate in the study. The inclusion criteria were women who are 18 years or older and delivered a singleton baby at Victoria Hospital. Women were excluded from the study if their baby was admitted to the neonatal intensive care unit (NICU) or the pediatric critical care unit (PCCU), if the mother and baby were not discharged from the hospital to go home together, or if the woman was unable to comprehend and comply with study requirements (e.g. did not have sufficient English proficiency to complete the questionnaire). Due to pandemic restrictions, informed consent was obtained remotely through the participant's preferred method of contact (email or phone) and the consent letter (attached in **Appendix B**) was filled out by the contacting member of the research team and stored on Microsoft Teams. At the time of enrollment, participants also consented to give the research team access to their medical records to retrieve demographic information and previous medical history. Enrolled participants were contacted via email to complete the questionnaire electronically via Qualtrics at approximately 6-12 weeks postpartum. The methodology of this project is schematically presented in **Appendix C** and details of the included measures are discussed in the following sections.

The Review Ethics Board at Western University and The Lawson Health Research Institute of London, Ontario, Canada approved the study protocols and the use of secondary data listed within this study. The official letter of approval is presented in **Appendix B.**

3.2   Operationalization of Factors

This section describes the information retrieved from the participant's medical record, mainly from London Health Sciences Centre's Perinatal Database.

Biological Health Factors

The biological health factors mentioned and assessed in this project were operationalized as obesity, hypertension, smoking, diabetes, and other pre-existing diseases. Obesity was classified based on the participant's BMI, which is calculated from their recorded height and weight. Hypertension diagnosis was based on the participant's recorded blood pressure or any pre-existing diagnosis of hypertension pre-pregnancy. Smoking, alcohol consumption, and cannabis use were categorized based on the information extracted from the participant's medical chart, and diabetes was categorized based on diagnosis from the participant's medical chart. Other pre-exiting morbidities were also extracted from the medical records.

Socio-environmental Factors

Socio-environmental factors assessed in this project were socioeconomic status (SES) and social support. SES was obtained from the participant's postal code retrieved from their medical chart. Each participant's SES was not obtained at the individual level, but rather their forward sortation area (FSA; the first 3 digits of the postal code) was linked to the 2016 Census information from Statistics Canada and was therefore represented by the neighbourhood or geographic area they reside in. The following variables were linked: Median Household Income After-Tax and Low-Income Cut-Off – After-Tax (LICO-AT). LICO-AT is established based on an income threshold at which a household spends 20% or more of the annual after-tax income on food, clothing, and shelter, and this threshold is adjusted for household size and structure and geographic region, among several other factors. LICO-AT reported at the FSA represents the proportion of households within that FSA that are below this income threshold; that is, LICO-AT is interpreted as the prevalence of low-income within the FSA. In 2016, the LICO-AT-based prevalence of low-income households in Canada was 9.2% and 9.8% in Ontario [132]. This Canada-wide prevalence (9.2%) was used as a cut-off value to categorize whether the FSA of the women in our sample was considered as "high poverty" (above the Canadian prevalence), or "low poverty" (below the Canadian prevalence). Social support was categorized based

on the participant's score on the Multidimensional Scale of Perceived Social Support (MSPSS) questionnaire [133].

COVID-19 Pandemic Factors, Healthcare Access, and Breastfeeding Behaviours

The impacts of the COVID-19 pandemic were assessed with questions adjusted from the Coronavirus Perinatal Experiences –Impact survey [134], assessing whether the pandemic has affected the women's employment, lifestyle changes, and family conditions. Questions about healthcare access and breastfeeding behaviours were adapted from the 2007 Canadian Maternity Experiences Survey [135].

3.3   Measurement Instruments

The following measures were included within the questionnaire to help address specific objectives 1 and 2, which investigated the prevalence and severity of perceived stress and postpartum depressive symptoms, and the associations between different biological and socio-environmental health factors on maternal perceived stress, postpartum depressive symptoms, and pregnancy outcomes. The questionnaire provided to the participants via Qualtrics is included in **Appendix C**.

Perceived Stress: Perceived Stress Scale – 4 items (PSS-4)

The PSS-4 is a widely used psychological instrument used to measure the perception of stress one feels. Specifically, the scale is meant to explore how unpredictable and uncontrollable respondents feel about their lives by asking about the feelings and thoughts they had over the last month [136,137]. This 4-item scale has been validated with the more widely used PSS-10 item questionnaire and contains 4 questions asking about the women's feeling of control and stress. Each question is scored from 0 (never) to 4 (very often), with a total score ranging from 0 to 16. A score of 5 and above is considered as high levels of perceived stress [137]. In addition, since the MES does not use the PSS, an extra question from the MES was added to allow for direct comparison with the survey. The question asks the women to recall their overall level of stress during the 12 months before the birth of their baby: "Thinking about the amount of stress in your life during the 12 months before your baby was born, would you say most days were?" The available responses were "Not stressful", "Somewhat stressful", and "Very stressful" [138].

Postpartum Depressive Symptoms: Edinburgh Postnatal Depression Scale (EPDS)

The EPDS is a 10-item standardized self-report questionnaire that measures whether an individual had symptoms commonly observed in women with depression and anxiety during pregnancy within the past week [139]. It was designed in 1987 in Edinburgh to serve as a simple to administer screening tool that was fully acceptable to women who may not regard themselves as unwell [139]. Currently, it is considered as one of the "gold standard" screening tools for perinatal depressive symptoms [140]. Each question is scored from 0 (not at all) to 3 (most of the time), and a total score greater than 9 indicated a possible risk of depression, while a score of 13 and greater was suggestive of a high risk of clinical depression [141].

Perceived Social Support: Multidimensional Scale of Perceived Social Support (MSPSS)

This study defines perceived social support as the quality and quantity of support that the participant feels they have received. The Multidimensional Scale of Perceived Social Support (MSPSS) is a self-report measure of perceived social support that addressed the subjective assessment of social support adequacy from three sources: friends, family, and significant other or special person [12]. This questionnaire is brief, simple to administer, and has been tested for reliability and validity in the pregnant population [133]. The questionnaire consists of 12 questions, each ranging from the choices 1 to 7, 1 being "very strongly disagree" and 7 being "very strongly agree". A higher cumulative score suggests higher levels of perceived social support [142].

Stressful Life Events

Examining the number of stressful life events experienced by the women is one way to measure prenatal maternal stress. The 13 questions from this questionnaire were used in the Maternity Experiences Survey (MES) to ask women about stressful life events they experienced in the 12 months before their baby was born and the MES adapted these questions from the Life Events Inventory [138].

Healthcare Access and Breastfeeding Intention and Behaviours

The COVID-19 pandemic may have affected access to health care and attitudes towards breastfeeding. These changes may have affected maternal mental health as the mothers-to-be may be

stressed and worried about whether to access perinatal care due to fear of infection. Therefore, it is important to see how the pandemic has affected women's breastfeeding intentions and behaviours. The questions about the women's healthcare access and breastfeeding behaviours were adapted from the 2007 MES to allow for a context to interpret our findings [138].

Pregnancy outcomes

The participants' pregnancy outcomes were extracted from their medical charts or the Perinatal Database – a prospectively-entered clinical database with information on the pregnancy, the delivery, and infant information. The database is housed at the Women's Care Program at LHSC Victoria Hospital in London, Ontario. Information such as pregnancy information (e.g., pre-pregnancy weight, age, estimated date of birth, etc) and pregnancy history/outcome/complications (e.g., diabetes treatment/results, preeclampsia, gestational diabetes, preterm birth, etc.) were extracted from the perinatal database. Information on the newborn baby such as their sex and birthweight were extracted directly from the participant's medical charts.

Stakeholder Identification and Connection Concept Map

To accomplish specific objectives 3 and 4, relevant stakeholders were identified following the methodology by Leventon *et al.* [143]. The first step of the methodology consisted of a questionnaire distributed to the involved research groups that first characterized the stakeholders based on their basic information (location), level of function (municipal, provincial, and national), and the stakeholder's interest (field of activity, form of role, and their sector). The latter half of the questionnaire was called the "snowball sample", where information on other stakeholders that may be known to the initially-identified stakeholders was collected. Leventon's method built on the researcher's existing networks and extended it through a snowball effect as the researcher collected information on broader levels beyond their known networks. In line with the overall research question of this project, stakeholders were considered if they were affected by, or could reduce maternal perceived stress, depressive symptoms, and pregnancy outcomes, regardless of the discipline. For this project, the initial group of stakeholders was identified by my known network of stakeholders involved in maternal mental health and pregnancy outcomes. Further, the snowball sample exercise was done twice, using the Google search engine to find the official websites of the initial stakeholders. Additional stakeholders were subsequently identified through affiliated links,

resulting in a total of three identification processes. The results from the processes were compiled and classified within Microsoft Excel and then transformed into a schematic network that displays existing relationships between the identified stakeholders.

3.4   Data Analysis

The data collected from this study were analyzed using the SPSS statistical software from IBM Corp. [144]. Descriptive statistics such as means, standard deviations, and proportions were calculated for demographic information, EPDS, PSS-4, and MSPSS data. Normality of variables, such as scores from the EPDS, PSS-4, MSPSS, maternal age, and BMI were tested using the Shapiro-Wilk test of normality to identify whether the variables were normally distributed. Parametric tests were performed on normally distributed variables and non-parametric tests were performed on variables that were not normally distributed. Spearman's correlation, Kruskal-Wallis, and chi-square test were used to analyze the associations between EPDS, PSS-4, and MSPSS. Demographic information and medical history variables were analyzed for associations with EPDS and PSS-4 scores using the chi-square test. Comparisons to the MES-Ontario cohort were performed by accessing the publicly available summary data from the 2007 MES within the Public Health Agency of Canada [8]. The specific data from the MES included: the distribution of the postpartum EPDS scores by province, the distribution of women's reported level of stress in the 12 months before birth, the number of stressful life events experienced, prenatal routine care, postnatal routine care, postnatal non-routine care, and breastfeeding behaviours. The collected data from this study was compared directly to the Ontario subset of the aforementioned MES data. Statistical testing between our cohort and MES Ontario-subset could not be completed due to the complex sampling plan used within the MES survey, as the survey data was weighted and we did not know the sample weights needed to conduct any testing. Comparisons were based on visual comparisons only.

The initial sample size for this study was calculated based on the Edinburgh Postnatal Depression Scale and the comparisons of our study to the MES. A total of 6421 women completed the MES and the MES data tables stated that an overall proportion of 16% of women had an EPDS score greater than 9. Assuming that the proportion has increased to 25% from the 16%, we will need a minimum of 500 women to have 80% power to estimate a difference of 9% between the two populations after

accounting for dropouts and missing data. However, it is important to note that this calculated sample size was not achieved within the time frame of this project due to COVID-19 disruptions.

CHAPTER 4

4. Results

In this section, I will present the results obtained from the investigation of the impact of the COVID-19 pandemic on perceived stress, postpartum depressive symptoms, and pregnancy outcomes. This chapter is divided according to the previously-stated specific objectives in Chapter 2.

4.1 Study Population Demographic and Medical Characteristics

Out of the 243 women that indicated an interest in the study, 79 were successfully contacted and enrolled in the study. Of the 79 participants enrolled, 50 completed the questionnaire by June 19, 2021. However, completed questionnaires and medical chart data were only available for 44 participants, which was the sample size for the analyses reported below.

Demographic and medical characteristics collected from the perinatal database are presented in **Table 1**. Half of the participants were first-time mothers with the mean age at 32.6 ± 3.24 years old, and the mean gestational age at delivery around 39 weeks. From the 44 participants, BMI was calculated with a sample size of 40, as four of the participants did not have either their height or weight recorded in the database. The median BMI was 23.0 kg/m^2, and 14 out of the 40 women experienced obesity (BMI ≥ 30 kg/m2). From the sample population, 63.6% of the women were married or had a common-law status. In terms of SES, 34.9% of the women resided within neighbourhoods that had median household incomes below the Canadian median of $61,348, and 39.5% resided in neighbourhoods that were characterized as having a LICO-AT above the Canadian LICO-AT prevalence (9.2%). None of the women reported consuming alcohol or smoking tobacco during their pregnancy. With regards to pregnancy complications and method of delivery, 18.2% of participants had either gestational diabetes or gestational hypertension, and 70.5% of deliveries were vaginal (spontaneous or induced).

Table 1 Demographic and Medical Information of Mothers and Newborns Extracted from the Perinatal Database and Medical Records

Characteristics	N =44 (%)	Mean ± SD or Median (IQR) (if applicable)
Maternal age		32.6 ± 3.24
Relationship Status		
Married/Common-law	63.6	
Single	20.5	
Unknown	9.1	
Median Household Income (continuous,$)[a]		64,431 ± 10788
Median Household Income (categorical)[a]		
Below Canadian Median (≤ $61, 348)	34.9	
Above Canadian Median (> $61,348)	65.1	
Low-Income Cut-Off-After Tax (continuous, %)[a]		7.91 ± 4.11
Low-Income Cut-Off-After Tax (categorical, %)[a]		
Below Canadian Prevalence (≤ 9.2%)	60.5	
Above Canadian Median (> 9.2%)	39.5	
Additional Children*		
One	15 (34.1)	
Two or more	2 (4.6)	
Pre-pregnancy BMI (continuous)+		Median= 23.0 kg/m^2 (6.25)
Pre-pregnancy BMI (categorical)+		
Underweight (<18.5 kg/m^2)	1 (2.3)	
Normal Weight (18.5 – 24.9 kg/m^2)	25 (56.8)	
Overweight (25.0 – 29.9 kg/m^2)	7 (15.9)	
Class 1 Obesity (30.0 – 34.9 kg/m^2)	3 (6.8)	
Class 2 Obesity (35.0 – 39.9 kg/m^2)	3 (6.8)	
Class 3 Obesity (≥40 kg/m^2)	1 (2.3)	
PRE-PREGNANCY CONDITIONS-(Yes)	N (%) – "Yes"	Mean ± SD or Median (IQR) (if applicable)
Medical History		
Hypertension	0	
Liver/GI disease	1 (2.3)	
Diabetes Mellitus	0	
Thyroid disease	9 (20.5)	
Renal disease	0	
Thrombophilia	0	
Autoimmune disease	1 (2.3)	
Cigarette Use**	0	
Alcohol Use**	0	
Cannabis Use**	1 (2.3)	
INDEX PREGNANCY INFORMATION	N (%) – "Yes"	Mean ± SD or Median (IQR) (if applicable)
Gravida		
Primigravida	22 (50.0)	

Multigravida	33 (50.0)	
Pregnancy complications		
Gestational Diabetes Mellitus	4 (9.1)	
Gestational Hypertension	4 (9.1)	
Pre-eclampsia	0	
IUGR	2 (4.5)	
Method of delivery/complications	N (%) – "Yes"	Mean ± SD or Median (IQR) (if applicable)
Vaginal Birth	31 (70.5)	
Spontaneous	19 (43.2)	
Induced	12 (27.3)	
Caesarean-section	13 (29.5)	
Planned	4 (9.1)	
Unplanned	9 (20.4)	
Baby Information	N (%) – "Yes"	Mean ± SD or Median (IQR) (if applicable)
Gestational age of baby at delivery		39.02 weeks ± 1.21
Birthweight (g) – Continuous[++]		3391.84 ± 480.19
Birthweight (g) – Categorical[++]		
2500 – 2999	9 (20.5)	
3000 – 3499	17 (38.6)	
3500 – 3999	13 (29.5)	
≥ 4000	4 (9.1)	

a: N= 43 as one participant had a FSA that was not registered within the 2016 Census forward sortation area
+ N = 40 as scores for 4 of the participants were not available
++ N = 43
*Number of children excluding the child from recent delivery
**During pregnancy
IQR = Interquartile range

4.2 Specific Objective 1: To Measure and Compare the Prevalence and Severity of Perceived Stress and Postpartum Depressive Symptoms in Recently Delivered Women during the COVID-19 Pandemic to Pre-COVID-19 MES Cohort

This section first discusses the findings for the levels of perceived stress and postpartum depressive symptoms in the current COVID-19 cohort and then compares it with the MES cohort prior to the pandemic.

4.2.1 Prevalence and Severity of Perceived Stress during the COVID-19 Pandemic

Perceived stress was assessed in three ways within the questionnaire: the PSS-4, the adapted Life Events Inventory, and one question that asked about the participant's overall stress level during the 12 months before their baby's birth. Upon testing for normality using the Shapiro-Wilk test,

PSS-4 scores were not normally distributed (p-value < 0.05). The scores from the PSS-4 for this cohort ranged from 1 to 11, with a median score of 5 (6.25). According to the standard cut-off score of 5 [133], 28 out of the 44 women (63.6%) reported a score ≥ 5, suggesting high levels of perceived stress. As seen in **Figure 2**, the distribution of PSS-4 scores for this cohort exhibited a local maximum at the score of 8, suggesting a second cut-off point for the score categorization. Upon separating the scores into 3 categories, the sample was more evenly divided among the three categories. Life Events Inventory scores were computed for only 40 out of the 44 women, as four of the participants did not fully complete that section. Out of the 40 responses, 25.0% of women experienced one event and 20.0% experienced three or more stressful life events within the 12 months before their baby was born. In terms of overall feelings of stress, 30 out of the 44 women reported that the 12 months before their baby was born was "Somewhat stressful", while 7 reported the 12 months to be "Very stressful". **Table 2** presents the scoring for all three assessments of perceived stress.

Figure 2 Distribution of PSS-4 scores for COVID-19 cohort
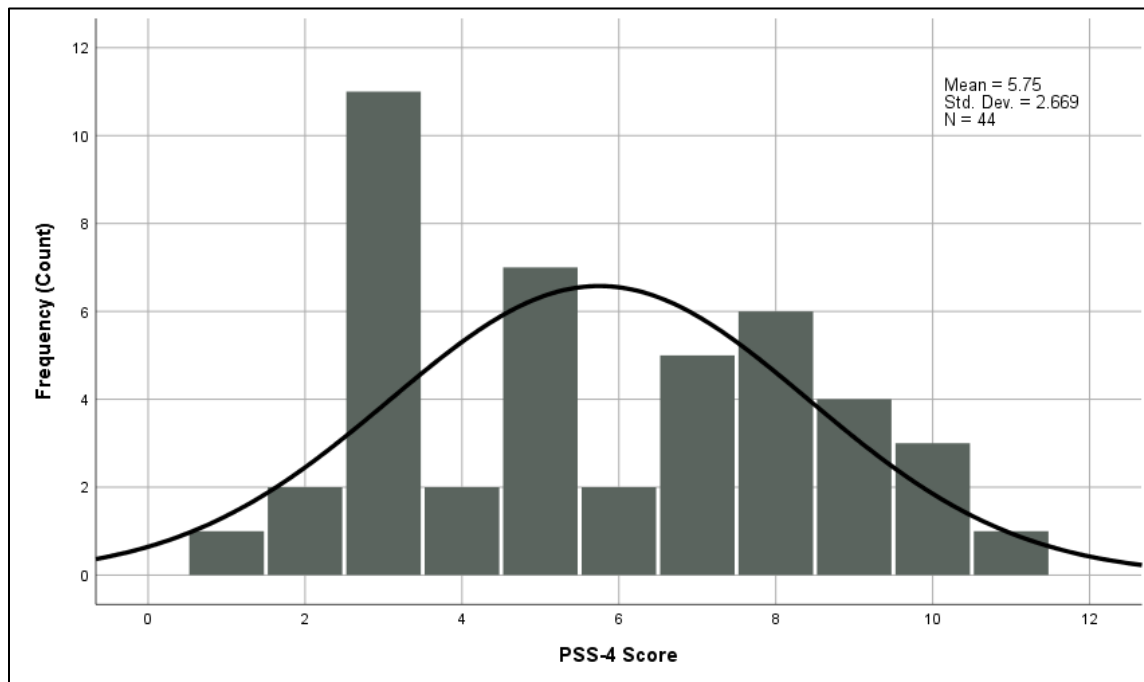
Table 2 Descriptive Statistics for Perceived Stress and Postpartum Depressive Symptoms in the COVID-19 Cohort

	N (%)	Mean score ± SD and Median score (IQR)	Normality (W, p-value)
Perceived Stress Scale-4 (PSS-4) - Continuous		Median: 5 (5)	0.936, p= 0.017
PSS-4 – Categorical			
Score < 5 (Low)	16 (36.4%)		
Score 5 > 8 (Medium)	14 (31.8%)		
Score ≥ 8 (High)	14 (31.8%)		
Life Events*			
None	14 (31.8%)		
One	11(25.0%)		
Two	7 (15.9%)		
Three and more	8 (20.0%)		
Overall stress (12 months before baby's birth)			
Not stressful	7 (15.9%)		
Somewhat stressful	30 (68.2%)		
Very stressful	7 (15.9%)		
Edinburgh Postnatal Depressive Symptoms (EPDS) - Continuous		Mean:8.93 ± 5.28 Median: 8 (7.5)	0.947, p=0.044
EPDS - Categorical			
0-9 (Unlikely depression)	28 (63.6%)		
10-12 (Possible depression)	5 (11.4%)		
≥13 (Probably depression)	11 (25.0%)		

IQR = Interquartile range
*Only 40 scores for calculated for the number of stressful life events

4.2.2 Prevalence and Severity of Postpartum Depressive Symptoms during the COVID-19 Pandemic

The scores for postpartum depressive symptoms ranged from 1 to 21 for this cohort, and upon testing for normality using the Shapiro-Wilk test, EPDS scores were not normally distributed (p-value =0.044). **Figure 3** presents that the distribution of the EPDS scores was slightly skewed to the right. The sample reported a mean EPDS score of 8.93 ± 5.28 and a median of 8 (7.5) (Table 2). Since the EPDS scores were not normally distributed, the median and interquartile range were calculated. However, as the MES data reported a mean score for the EPDS, the mean EPDS score for our cohort was calculated for direct comparison [145]. According to the classification of the MES and as displayed in **Figure 4**, the EPDS scores were categorized into three categories: score 0-9, score 10-12, and score ≥ 13. Within the scores of the 44 women who completed the

entire EPDS questionnaire, 16 (36.4%) participants scored > 9, suggesting possible depression.

Within these 16, 11 had a score ≥ 13, suggesting a high possibility of depression.

Figure 3 Distribution of Postpartum EPDS Scores in the COVID-19 Cohort
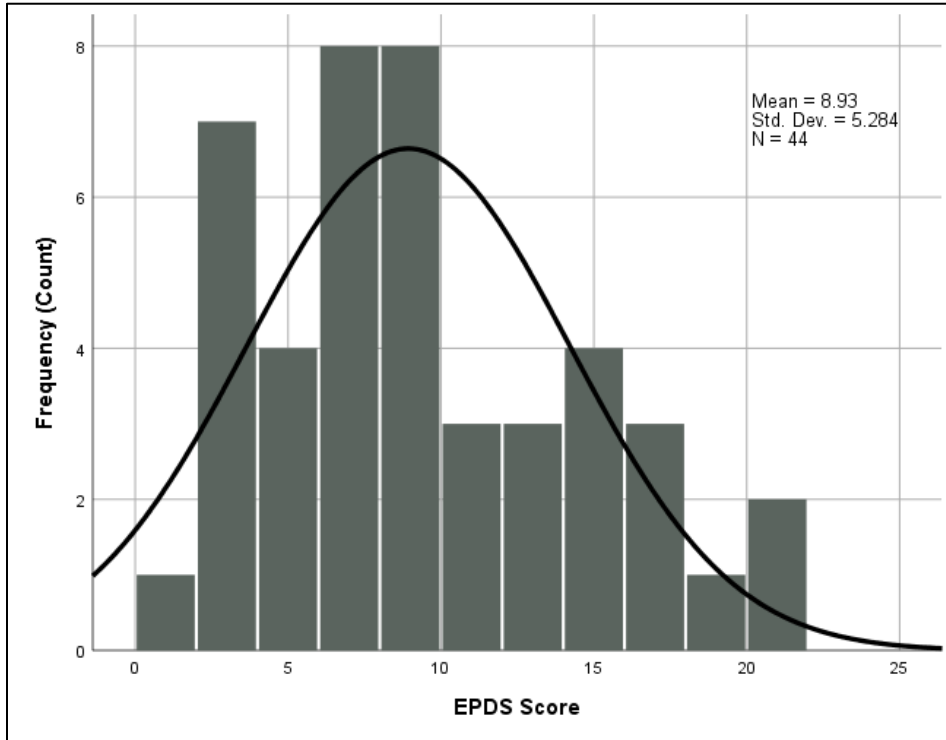
Figure 4 Postpartum EPDS Scores of the COVID-19 Cohort Categorized According to MES Categories
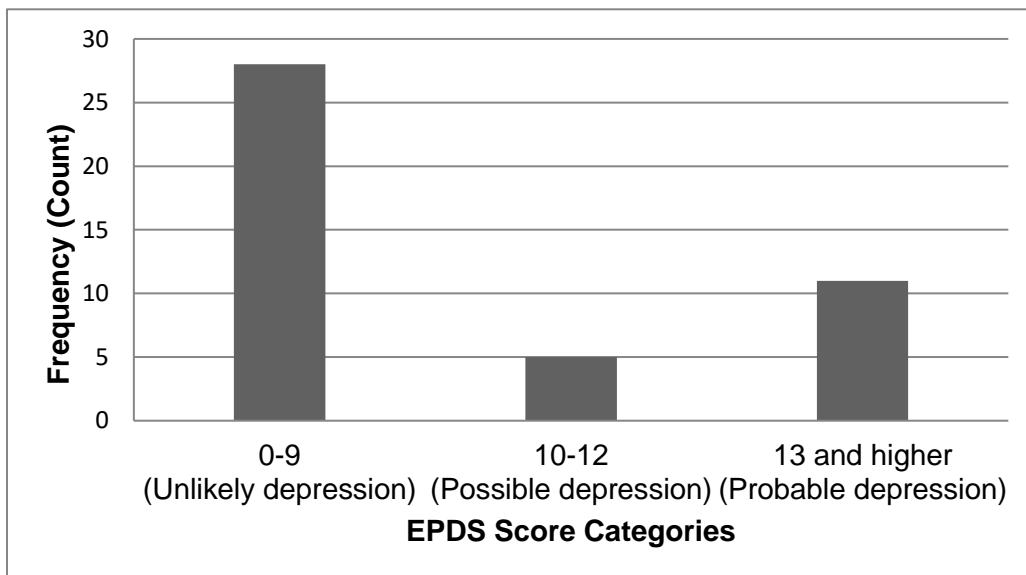
4.2.3 Comparison of Prevalence and Severity of Perceived Stress between 2007 MES and COVID-19 Cohort

The 2007 Canadian Maternity Experiences Survey (MES) assessed perceived stress with the number of stressful life events experienced as well as the woman's overall feelings of stress 12 months before the birth of their baby. A higher proportion of women in the COVID-19 cohort reported that most days during the 12 months before their delivery were "Somewhat stressful" (68.2%) compared to the 47.5% observed in the MES-Ontario data. Women who reported that most days during the 12 months were "Very stressful" were visually similar between the COVID-19 cohort and the MES cohort. Specific proportions of the two cohorts are presented in **Figure 5**. When the frequencies for the number of stressful life events experienced were compared, **Figure 6** presents the proportion of women from the Ontario MES compared to the current COVID-19 cohort. Although the proportion of women who experienced only one event was similar, slightly more women from the COVID-19 cohort experienced three or more events (20%) when compared to the 15.4% from the Ontario MES cohort visually.

Figure 5 Comparison of Overall Maternal Feelings of Stress within the 12 Months Before Baby's Birth in MES-Ontario and COVID-19 Cohorts

Figure 6 Comparison of the Number of Stressful Life Events Experienced by Mothers within the 12 Months Before Baby's Birth in MES-Ontario and COVID-19 Cohorts
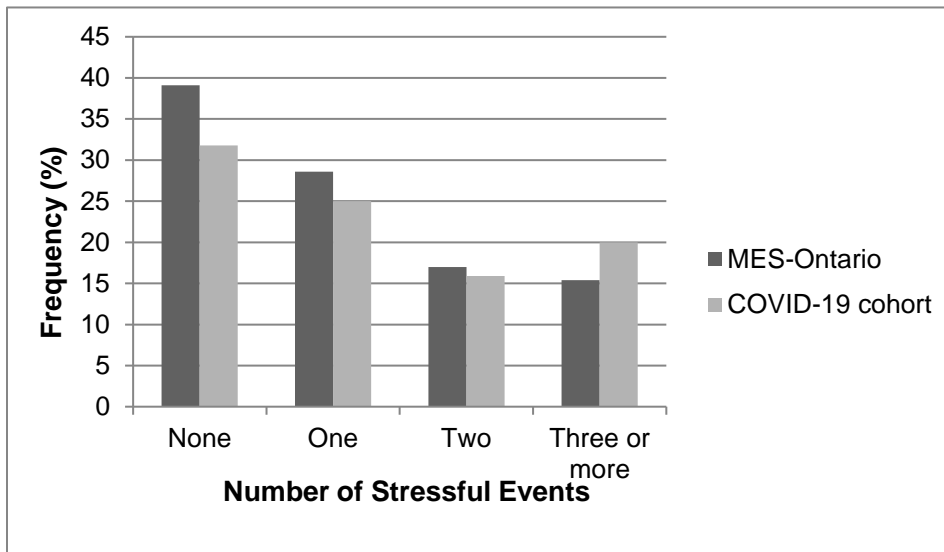
4.2.4 Comparison of Prevalence and Severity of Postpartum Depressive Symptoms between 2007 MES and COVID-19 Cohort

Using the same Ontario data from the 2007 MES, the EPDS scores between the MES cohort and the current COVID-19 cohort were compared and we observed that a higher proportion of women experienced depressive symptoms within the current cohort. According to the MES, approximately 17.5% of women had EPDS scores > 9, compared to the 36.3% observed in the current cohort. The proportion of those who scored ≥ 13 was also visually higher in the COVID-19 cohort when compared with the Ontario MES cohort (25.0% vs. 7.9%). Visual representation of the comparison is presented in **Figure 7**.

Figure 7 Comparison of Postpartum EPDS Scores in MES-Ontario and COVID-19 Cohorts
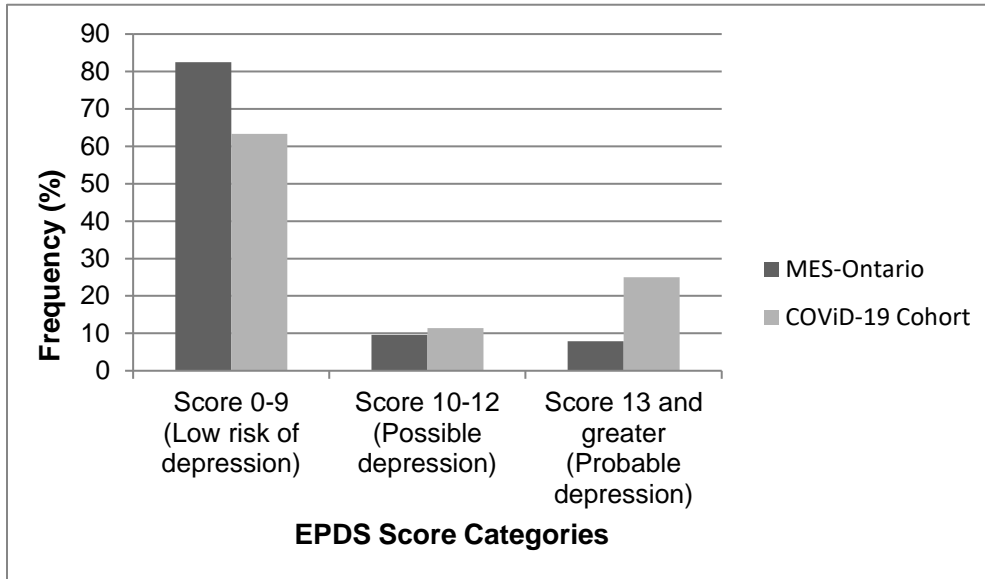
4.3 Specific Objective 2: To Explore the Associations between Individual Biological and Socio-environmental Health Factors, and the Prevalence and Severity of Perceived Stress, Postpartum Depressive Symptoms, and Pregnancy Outcomes in Postpartum Women during the COVID-19 Pandemic

4.3.1 Demographic Characteristics and Pre-pregnancy Medical Characteristics

The associations between socio-demographic variables such as age, gravida, marital status, and BMI were assessed with postpartum depressive symptoms and levels of perceived stress. Upon testing for normality using the Shapiro-Wilk test, the BMIs for this cohort were not normally distributed (W=0.863, p = 0.00,), but age was normally distributed (W=0.976, p = 0.46). No statistically significant associations were observed between EPDS scores and maternal age, gravida, marital status, and BMI. Similarly, no statistically significant associations were observed between PSS-4 scores and maternal age, gravida, marital status, and BMI. From the pre-pregnancy medical conditions reported, only thyroid disease was statically analyzed because a majority of the participants did not have the conditions extracted from their charts and no significant associations were observed between pre-existing thyroid disease and EPDS or PSS-4 scores (p>0.05). The relationship between income categories and PSS-4 score categories was analyzed with a chi-square test and observed no significant associations (p>0.05) between the level of neighbourhood income and levels of perceived

stress. The relationship between income categories and EPDS scores was analyzed with the Kruskal-Wallis test and observed no significant associations ($p>0.05$) between levels of neighbourhood income and postpartum depressive symptoms. Alcohol consumption, tobacco smoking, and cannabis use were not statistically analyzed as most of the participants did not participate in these activities during their pregnancy.

4.3.2 Associations between Perceived Stress and Postpartum Depressive Symptoms in the COVID-19 Cohort

Since both EPDS and PSS-4 scores are ordinal variables, non-parametric statistical tests were used to assess the association between the two. Based on Spearman's correlation analysis, EPDS was positively correlated with PSS-4 (coefficient $r= 0.722$, $p=0.01$). The Kruskal-Wallis test was performed to compare the EPDS scores between the three PSS-4 categories. *Post hoc* Dunn's pairwise test correction reported significant differences in EPDS scores between low and high levels of perceived stress, and between medium and high levels of perceived stress ($p<0.05$). **Figure 8** presents that the likelihood of postpartum depressive symptoms increased as levels of perceived stress increased. Finally, chi-square test analysis also reported a significant association between EPDS and PSS-4 scores ($p< 0.05$), suggesting that postpartum depressive symptoms were associated with levels of perceived stress. No statistically significant associations were observed between postpartum depressive symptoms and the number of life events based on Spearman's correlation analysis ($p> 0.05$).

Figure 8 Comparison of Median Postpartum EPDS Score based on PSS-4 Categories in COVID-19 Cohort
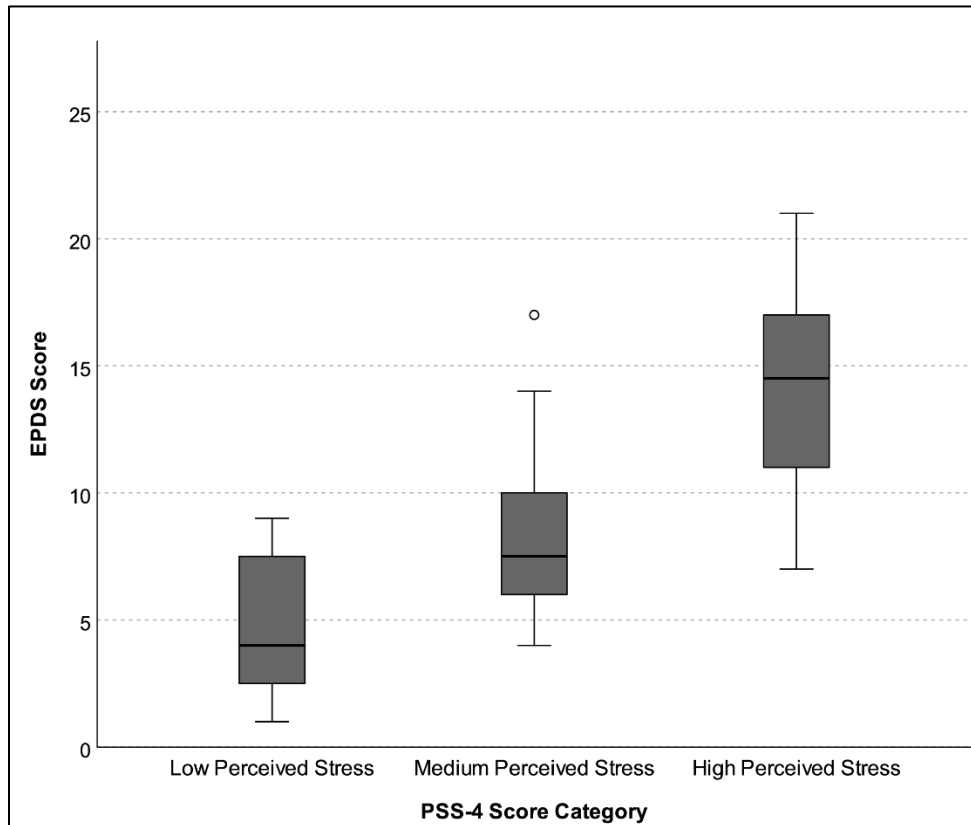
4.3.3 Pregnancy Outcomes

Since only 9 out of the 44 participants experienced any pregnancy complications (gestational Diabetes Mellitus (GDM), gestational hypertension (GH), PE, and IUGR), the complications were grouped into the category of "pregnancy complications" for analysis. EPDS and PSS-4 scores were categorized into two categories (EPDS: score of 0-9 and score greater than 9; PSS-4: score less than 5 and ≥ 5) to perform chi-square analysis. No associations were observed between PSS-4 or EPDS scores and pregnancy complications ($p > 0.05$). Additionally, no significant associations were observed between the method of delivery and perceived stress or postpartum depressive symptoms ($p > 0.05$). Kruskal-Wallis test was performed on birthweight categories and no significant associations were observed between the newborn birthweight and EPDS score ($p > 0.05$). No significant correlation was observed between EPDS scores and birthweight as a categorical variable either ($p > 0.05$). Similar non-significant associations were observed between the newborn's birthweight and maternal PSS-4 scores ($p > 0.05$).

4.3.4 Perceived Social Support

Perceived social support was analyzed using the total scores from the MSPSS portion of the questionnaire. The overall score was calculated as the sum of the 12-items, with the total score ranging from 12 to 84. Upon testing for normality using the Shapiro-Wilk test, MSPSS scores were not normally distributed (W=0.811, p = 0.00). From the 44 responses, 43 participants completed the entire section and received a total score, which resulted in a median total score and interquartile range of 72 (14.0). As seen in **Figure 9**, 34 out of the 44 scores fell within the high levels of perceived social support (scores between 61 and 84).

Figure 9 Distribution of MSPSS Scores in COVID-19 Cohort separated into Categories
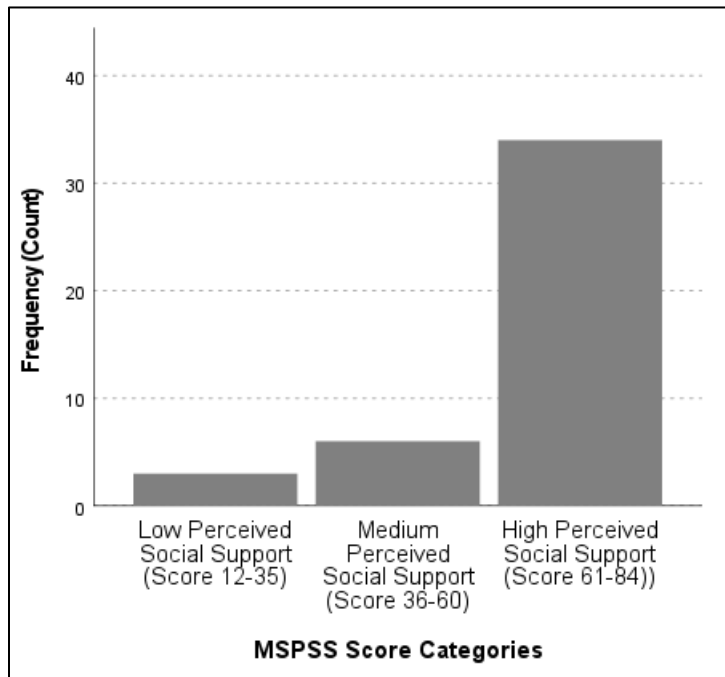
Based on Spearman's correlation analysis, EPDS scores were significantly associated with MSPSS scores (r=-0.461, p < 0.01), suggesting a negative correlation between postpartum depressive symptoms and perceived social support. However, the results from the Kruskal-Wallis test and **Figure 10** presents that there were no significant differences between EPDS scores and the three levels of perceived social support. Contrary to EPDS scores, no significant correlation was observed between PSS-4 scores and MSPSS scores after Spearman's correlation analysis.

Figure 10 Comparison of Median Postpartum EPDS Score based on MSPSS Categories in COVID-19 Cohort
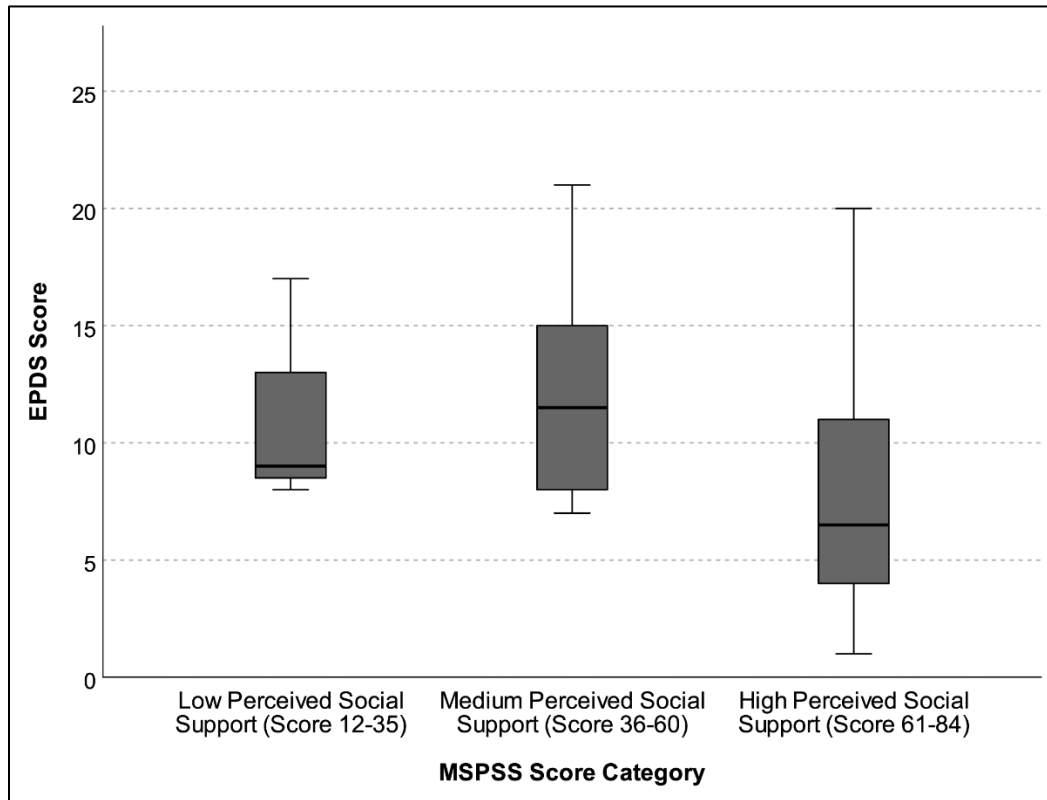
4.3.5 COVID-19 Pandemic Factors

The questionnaire asked about the impact of the pandemic on various factors such as employment, financial difficulty, childcare, and concerns about the health of their family and themselves. This section also discusses the changes in healthcare access due to the COVID-19 pandemic.

Prior to the pandemic, 81.8% of women were employed full-time and worked outside of their homes. After the pandemic started, 20.5% of them continued to work at their usual workplace, with no changes, while 27.3% transitioned to working from home at least part of the time, and 11.4% were on maternity leave. Similar trends were seen in the women's partners as a majority of them worked full-time outside of the home before the pandemic, where only 22.7% of them transitioned to working from home and 50.0% continued at their workplace with no change. When asked about whether household income has been reduced such that financial concerns arose, 15.9% of participants responded "Yes". However, no significant associations were

observed between reduced household income and perceived stress scores (PSS-4), or postpartum depressive symptoms (EPDS), as presented in **Figure 11** and **Figure 12** respectively. Financial difficulty was also assessed by whether the participant had any difficulties buying groceries, and the majority (84.1%) of the women stated that they did not have any difficulties. For those who stated they had difficulty, the most common reason was due to inability to leave the house because they were taking care of children or someone else.

Figure 11 Relationship between COVID-19 Household Income Reduction and PSS-4 Scores
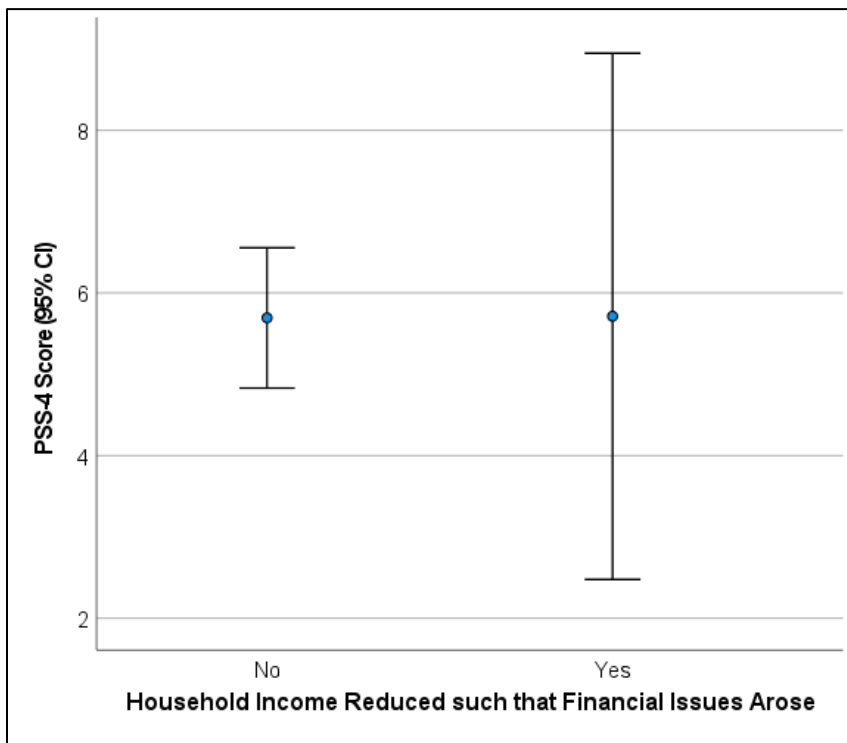
Figure 12 Relationship between COVID-19 Household Income Reduction and Postpartum EPDS Scores
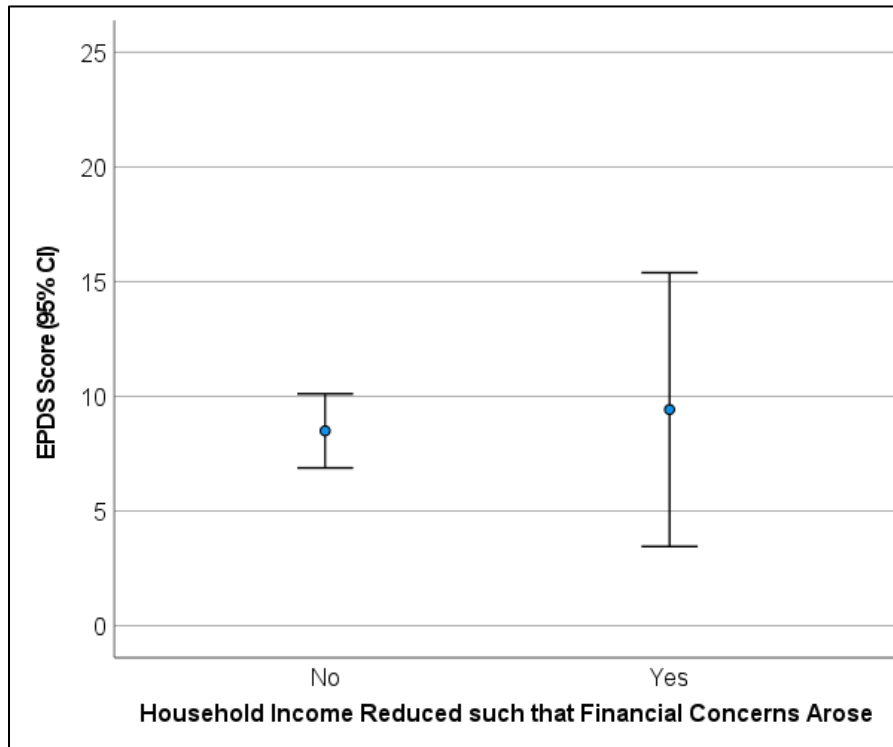
When asked about their concern for the impact of COVID-19 on their health, five participants stated they were "Somewhat concerned", two were "Very concerned", and 37 did not respond. Similar figures were observed when asked about their concern on the impact of COVID-19 on their family's health. In addition, 45.5% of participants responded that they had a family member or close friend affected by COVID-19.

As mentioned earlier, to prevent and stop the further spread of the virus, many transitioned to working from home if possible. Although prenatal and postpartum healthcare visits were traditionally in-person, we wanted to study if the pandemic brought on any changes as to how pregnant and/or recently delivered women accessed their perinatal care. As presented in **Table 3**, only 25.0% of the participants' providers offered virtual prenatal care and 12% to 40% of the providers offered virtual postpartum routine and non-routine care for both mother and the newborn. Most (88.6%) prenatal care and over 80% of routine postpartum care were done in person, and a majority of the participants reported that they were mostly satisfied with the care they received. In addition, a majority of the women reported it was at least "Somewhat easy" to

see their healthcare provider for routine care. As some of the questions that explored healthcare and breastfeeding behaviours were adapted from the 2007 MES, the Ontario subset of data from the survey provides a potential comparison that puts the findings of this study into context. However, only percentage comparisons are mentioned here as no statistical testing was done to compare the current COVID-19 cohort and the MES Ontario subset to avoid the problem of multiple comparisons, in addition to the fact that it is not a part of the aims of this project. As seen in **Table 3**, 22.7% of women received their pregnancy care primarily from midwives during the past year compared to the 9.2% reported in 2007. This was tied with the decreased number of women who received their care primarily from obstetrician-gynaecologists within the COVID-19 cohort (45.5% vs. 66.0%). Interestingly, similar statistics were reported between the current cohort and the 2007 MES-Ontario subset in terms of prenatal care access, postpartum maternal care satisfaction, and breastfeeding behaviours despite the current pandemic.

Table 3 Impact of COVID-19 Pandemic on Pregnancy Healthcare Access with Comparisons between current COVID-19 Cohort and 2007 MES-Ontario Cohort

Questions	2007 MES Ontario subset (%) – if available	COVID-19 (%) N= 44
Type of healthcare provider received most care from		
Obstetrician/Gynaecologist	66.0	45.5
Family Physician	24.0	22.7
Midwife	9.2	22.7
Nurse/Nurse Practitioner	0.4	0
Other	0.4	2.3
Attended prenatal classes? (Yes)	28.4	20.5
PRENATAL CARE		
Received prenatal care	n/a	97.9
Offered virtual prenatal care? (Yes)	n/a	25.0
Most often type of prenatal care		
In person	n/a	88.6
Telephone visit	n/a	9.1
First prenatal visit		
First visit before 14 weeks gestation	95.4	93.2
Did you get prenatal care as early as you wanted? (Yes)	88.9	93.2
Satisfaction with prenatal care		

Very satisfied	n/a	38.6
Mostly satisfied	n/a	54.5
Neither satisfied nor unsatisfied	n/a	2.3
Mostly unsatisfied	n/a	2.3
POSTPARTUM CARE - MOTHER		
Contacted by healthcare provider following birth? (Yes)	87.7	75.0
Did you have routine postpartum visit? (Yes)	n/a	68.2
Ease of routine healthcare provider visit		N=30
Very easy	n/a	43.3
Somewhat easy	n/a	33.3
Neither easy nor difficult	n/a	23.3
Provider provided virtual routine visits postpartum? (Yes)	n/a	33.33
Majority of routine postpartum care	n/a	
In person	n/a	100
Satisfaction with routine postpartum care		
Very satisfied	67.9	60.0
Mostly satisfied	23.1	26.7
Neither satisfied nor dissatisfied	4.4	10.0
Somewhat dissatisfied/ very dissatisfied	4.5	3.3
Did you have non-routine postpartum visit? (Yes)	30.2	50.0
Provider provided virtual non-routine visits postpartum? (Yes)	n/a	45.5
Majority of non-routine postpartum care		N=22
In person	n/a	81.8
Telephone visits	n/a	18.2
Ease of non-routine healthcare provider visit (Very easy)		
Very easy	n/a	50.0
Somewhat or very difficult	12.9	9.1
Satisfaction with non-routine postpartum care		
Very satisfied	n/a	45.5
Mostly satisfied	n/a	36.4
Neither satisfied nor unsatisfied	n/a	13.6
Somewhat dissatisfied/ very dissatisfied	n/a	4.5
POSTPARTUM CARE - BABY		
Breastfeeding		
Intention	90.4	95.4
Initiation	90.6	97.7
Did your baby have routine postpartum visit? (Yes)	n/a	97.7

POSTPARTUM CARE – BABY (CONT.)	2007 MES Ontario	COVID-19 Cohort
Provider provided virtual routine visits postpartum?	n/a	13.9
Majority of routine postpartum care		N = 43
In person	n/a	97.7
Ease of routine healthcare provider visit (Very easy)	n/a	62.8
Satisfaction with routine postpartum care		
Very satisfied	n/a	69.8
Somewhat satisfied	n/a	23.3
Neither satisfied nor dissatisfied	n/a	2.3
Somewhat dissatisfied/ very dissatisfied	n/a	4.6
Did your baby have non-routine postpartum visit? (Yes)	46.0	36.4
Majority of non-routine postpartum care		N=16
In person	n/a	87.5
Telephone visits	n/a	12.5
Provider provided virtual non-routine visits postpartum? (Yes)	n/a	12.5
Ease of non-routine healthcare provider visit		
Very easy	69.2	43.8
Somewhat easy	16.2	50.0
Neither easy or difficult	4.5	6.25
Somewhat difficult or very difficult	10.2	0
Satisfaction with non-routine postpartum care		
Very satisfied	77.6	62.5
Somewhat satisfied	17.2	12.5
Neither satisfied nor dissatisfied	1.7	0
Somewhat dissatisfied/ very dissatisfied	3.4	6.25

4.4   Specific Objective 3: To Identify Relevant Stakeholders within Different Disciplines Involved in Investigating, Preventing, and Managing Maternal Perceived Stress and Postpartum Depressive Symptoms.

The search [143] for relevant stakeholders identified 22 stakeholders in total from the three identification processes and comprised of 6 persons and 16 organizations. The initial round of identification reported 12 stakeholders, the subsequent round of snowball sample resulted in six stakeholders after removing duplicates, and the final round of snowball sample resulted in four stakeholders. The identified stakeholders were categorized into five major domains: academia,

government, industry, media, and the public. This classification was based on a multisectoral concept to include stakeholders from various disciplines to explore and improve overall maternal mental health. The identified stakeholders were analyzed using the basic stakeholder analysis technique [146], and information about each stakeholder's role, type, field of activity, and level of activity was extracted and presented in **Table 4.** The academia sector was comprised of personnel and organizations directly involved in patient care and/or scientific research related to maternal perceived stress, depressive symptoms, and pregnancy outcomes. The government sector was comprised of federal, provincial, and municipal agencies that have a stake in maternal mental health with regards to knowledge management or health policy regulation. The industry section was comprised of both private and public companies, not-for-profit organizations, and any national and/or local societies that were involved in financial or instrumental support and education of the importance of maternal mental health. The media sector was comprised of stakeholders who were involved in communication and dissemination of information related to maternal perceived stress, postpartum depressive symptoms, and pregnancy outcomes to the general public. Finally, the public sector was comprised of individuals affected by stress, postpartum depressive symptoms, and adverse pregnancy outcomes. The following sections will briefly discuss the stakeholders identified.

Academia

Stakeholders within the academia sector that have been identified as relevant were individuals and organizations that are currently involved in scientific research on perceived stress, postpartum depression and pregnancy outcomes, or clinical care as obstetricians and/or gynaecologists. Most of the stakeholders from this sector were from my initial network of stakeholders as they are the researchers and clinician-scientists within the research team. These stakeholders have extensive knowledge on stress, depression, and pregnancy outcomes from their previous research and training and were, therefore essential stakeholders that ensured the scientific foundation of this project was sound and evidence-based. Aside from being a clinician-scientist involved in the Pregnancy Research Group at Western University, Dr. Barbra de Vrijer also served on the advisory group for the perinatal section of Better Outcome Registry and Network (BORN), a provincial maternal, newborn, and child registry aimed to facilitate quality care for families across the province of Ontario.

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Government

Six of the identified stakeholders were classified as government stakeholders. The Canadian Institute of Health Research (CIHR), Middlesex/London Health Unit (MLHU), the Provincial Council of Maternal and Child Health (PCMCH), the Better Outcomes Registry & Networks (BORN), Public Health Ontario (PHO), and the Public Health Agency of Canada (PHAC) are all relevant stakeholders involved in the funding, management, and regulation of health information and policy. Other than CIHR, which is primarily responsible for ensuring funding for research related to health, the other five government organizations have similar missions of ensuring that the most up-to-date health information and support resources are made available for easy access to the general public. These organizations also ensure that the healthcare systems at the municipal, provincial, and federal levels are following the mandated policies, in addition to having sections on their website dedicated to educating both the public and healthcare providers on pregnancy-related mental health issues, along with resources and contact information. Finally, BORN Ontario currently contributes significantly to improving maternal health as a comprehensive registry with the mother's medical and obstetric records that will be useful in assessing the health of women in the future. In addition, a comprehensive health database across the province will also allow for population-level research to be done on different topics surrounding maternal and newborn health.

Table 4 List Of Identified Stakeholders with Descriptions of Roles, Type, Field(s) Of Activity, Domain, and Level of Involvement

Stakeholders	Role	Type	Field of Activity/Role				Domain	Level		
			Healthcare	Research & Development	Education	Community Engagement		Municipal	Provincial	National
Initial Network										
Barbra de Vrijer	OB/GYN researcher	Person	x	x	x		Academia	x	x	
Genevieve Eastabrook	OB/GYN researcher	Person	x	x	x		Academia	x	x	
Stephanie Frisbee	Researcher in cardiovascular and mental health	Person		x	x		Academia			
Victoria Hospital/ LHSC	Hospital network	Organization	x	x			Industry	x		
Mei Yuan (self)	Student researcher of maternal mental health	Person		x			Academia	x		
Jefferson Frisbee	Researcher of cardiovascular and mental health	Person					Academia	x		
Western University	University institution	Organization		x	x		Industry	x		
Recently postpartum women	Study participants	Person				x	Public			
CTV News	News outlet, provides information to public	Organization				x	Media	x	x	x
Global News	News outlet, provides information to public	Organization				x	Media	x	x	x
London Free	News outlet,	Organization				x	Media	x		

Press	provides information to public									
Canadian Institute of Health Research (CIHR)	Canadian funding agency for health research	Organization	x	x	x	x	Government	x	x	x
1st Snowball Sample										
Society of Obstetricians and Gynecologists of Canada (SOGC)	Lead the advancement of women's health through excellence and collaborative professional practice	Organization	x	x	x		Industry			x
Middlesex/London Health Unit (MLHU)	To identify and address public health issues in Middlesex/ London area	Organization	x		x	x	Government	x		
Public Health Ontario – Maternal and Infant Health (PHO)	Collaborates with the government, public health, and health care to prevent maternal illness and improve maternal health	Organization	x	x	x	x	Government	x	x	
Pre-eclampsia Foundation Canada	To reduce maternal and infant illness and death due to PE and	Organization		x	x	x	Industry			x

	other hypertensive disorders of pregnancy through patient education, public awareness and research.									
Postpartum Support International (PSI)	To promote awareness, prevention and treatment of mental health issues related to childbearing in every country worldwide	Organization	x			x		Industry	x	x	x
Better Outcomes Registry & Network (BORN)	Facilitate and improve care for mothers and children by linking information and providers throughout Ontario	Organization		x	x			Government	x	x	
2nd Snowball Sample										
Canadian Foundation for Women's Health (CFWH)	Registered charity that funds research, education and advocacy in obstetrics and gynaecology.	Organization	x	x	x			Industry	x	x	x
Canadian Mental Health Association (CMHA)	Facilitate access to resources required in maintaining and improving	Organization	x	x	x	x		Industry	x	x	x

	mental health, community integration, and support recovery from mental illness									
Public Health Agency of Canada- Maternal and Infant Health (PHAC)	Focused on preventing disease and injuries, responding to public health threats, promoting good health, and providing information to support informed decision making at a federal level	Organization	x	x	x	x	Government			x
Provincial Council for Maternal and Child Health (PCMCH)	To develop and facilitate programs to improve the health mothers and children in the province of Ontario	Organization	x		x	x	Government	x	x	

Professional Organizations (Industry)

Stakeholders within the industry sector were identified to be associated with various public and not-for-profit organizations that research, fund, and promote the importance of maternal mental health. These included the Canadian Foundation for Women's Health (CFWH), the Society of Obstetricians and Gynaecologists of Canada (SOGC), Pre-eclampsia Foundation Canada, and Postpartum Support International (PSI). These are crucial stakeholders to include within the discussion of improving maternal mental health as their mission statements revolve around improving the health of the public, with a specific focus on women. They provide financial and instrumental resources to support the development of strategies to improve maternal mental health and pregnancy outcomes. The Canadian Mental Health Association (CMHA) is involved in supporting research, as well as the design and implementation of resources that help support Canadians. Particularly, they have a section on their website that describes and offers resources and solutions for postpartum depression management. As postpartum depressive symptoms and pre-eclampsia are the primary and secondary outcomes of my research, the Pre-eclampsia Foundation Canada and Postpartum Support International are relevant stakeholders to include for discussion and collaboration. Specifically, support personnel within the Southwestern Ontario branch are in direct involvement with women who may be experiencing pregnancy-related mental health issues. These individuals are also crucial in translating the findings of this study to other support persons during training or directly to the affected women. Improving and updating their current knowledge on topics such as COVID-19, perceived stress, and postpartum depressive symptoms will have spill-over effects on other staff within the organization.

Media

The media sector is typically associated with newspapers, broadcasting stations, and magazines that provide timely distribution of information to the general public. These organizations can capture their usual listener's attention and heighten the impact of the information they share with the public. The news stations that were identified as stakeholders within the media were CTV News, Global News, and London Free Press. These organizations reached out to publish a story about this project to inform the public that maternal perceived stress and postpartum depressive symptoms are important factors that are being investigated within the pandemic. With the increasing prominence of technology, social media represents a large section of media

consumption as almost everyone in developed countries has access to smart devices and the internet. A benefit from this increasing popularity is the allowance for information to reach a broader population much more quickly, as seen with the various sectors discussed above utilizing social media as platforms to perform outreach to different populations, especially in the age 15-40 population, including women of childbearing age. Despite its potential to be an important stakeholder, no specific social media platform was identified as a stakeholder.

Public

The public sector can be interpreted as the largest sector out of the five mentioned above as it encompasses every citizen within the community and population. For this project, the primary stakeholder within the public sector is pregnant women within London, Ontario. As the project aimed to investigate how their levels of perceived stress and postpartum depressive symptoms have been impacted by the COVID-19 pandemic, it is crucial to acknowledge that they are one of the major stakeholders as our findings will be based on their input and experience.

4.4.1   Existing Collaborations

From the 22 stakeholders identified, several connections or collaborations were identified between various sectors. First, the Canadian Foundation for Women's Health (CFWH) collaborates with the Society of Obstetricians and Gynaecologists of Canada (SOGC) as many of the physicians and research scientists are members of SOGC that participate in research with funding from the CFWH. One of the primary goals of CFWH is to increase medical research on women's health issues, making the input from members of the SOGC extremely valuable as these physicians are often directly interacting and working with women at different stages of their lives. This allows them to witness firsthand some of the gaps in current medical research and healthcare as different factors continue to impact perceived stress and depressive symptoms in pregnant women. Secondly, physicians like Dr. Barbra de Vrijer collaborate with the provincial government by serving as a part of provincial committees for BORN. This includes updating the Ontario Perinatal Record to mandate the inclusion of more information to be collected from attending physicians to work towards a comprehensive provincial database. The research team of this project: myself, Dr. Stephanie Frisbee, and Dr. Jefferson Frisbee, collaborated with the Pregnancy Research Team at LHSC to conduct interdisciplinary research

that investigated how COVID-19 has impacted maternal perceived stress and postpartum depressive symptoms. The Canadian Institute of Health Research funded a part of this research project through my federal scholarship. Additionally, our research team also collaborated with the various news stations through interviews and raised awareness of the importance of this study. BORN partners with Public Health Ontario and SOGC to strengthen the database by encouraging its affiliates and members to fill out the necessary medical records when attending to patients. Finally, the Pre-eclampsia Foundation Canada offers opportunities for volunteers to collaborate with them to help spread awareness on the importance of monitoring and managing women who may be at increased risk of developing PE.

4.5   Specific Objective 4: Develop Connection Map of Identified Stakeholders

The identified stakeholders were transformed into a connection map that provided a visual representation of how the different organizations and personnel currently interact with one another. I am at the center of the connection map, as I was the starting point of the stakeholder identification process. The web then expanded outward to also include the first and second snowball samples. As seen in the complex network presented in **Figure 13**, relevant persons are represented as circles and relevant organizations are represented as rectangles. Each stakeholder is colour-coded based on the domain they primarily belong to: academia (orange), industry (red), government (blue), media (green), and the public (purple). The solid lines represent connections and affiliations between various stakeholders and their organizations. The results from the search allowed for a sufficiently balanced map as stakeholders were identified within each of the five domains, with at least one stakeholder from each domain. In addition, this map presents a good starting point for future collaborations on maternal mental health as it indicates which individuals and organizations could be contacted as they are already engaged in work related to maternal mental health.

Figure 13 Visual Connection Map of Identified Relevant Stakeholders Involved in Maternal Mental Health and Pregnancy Outcomes

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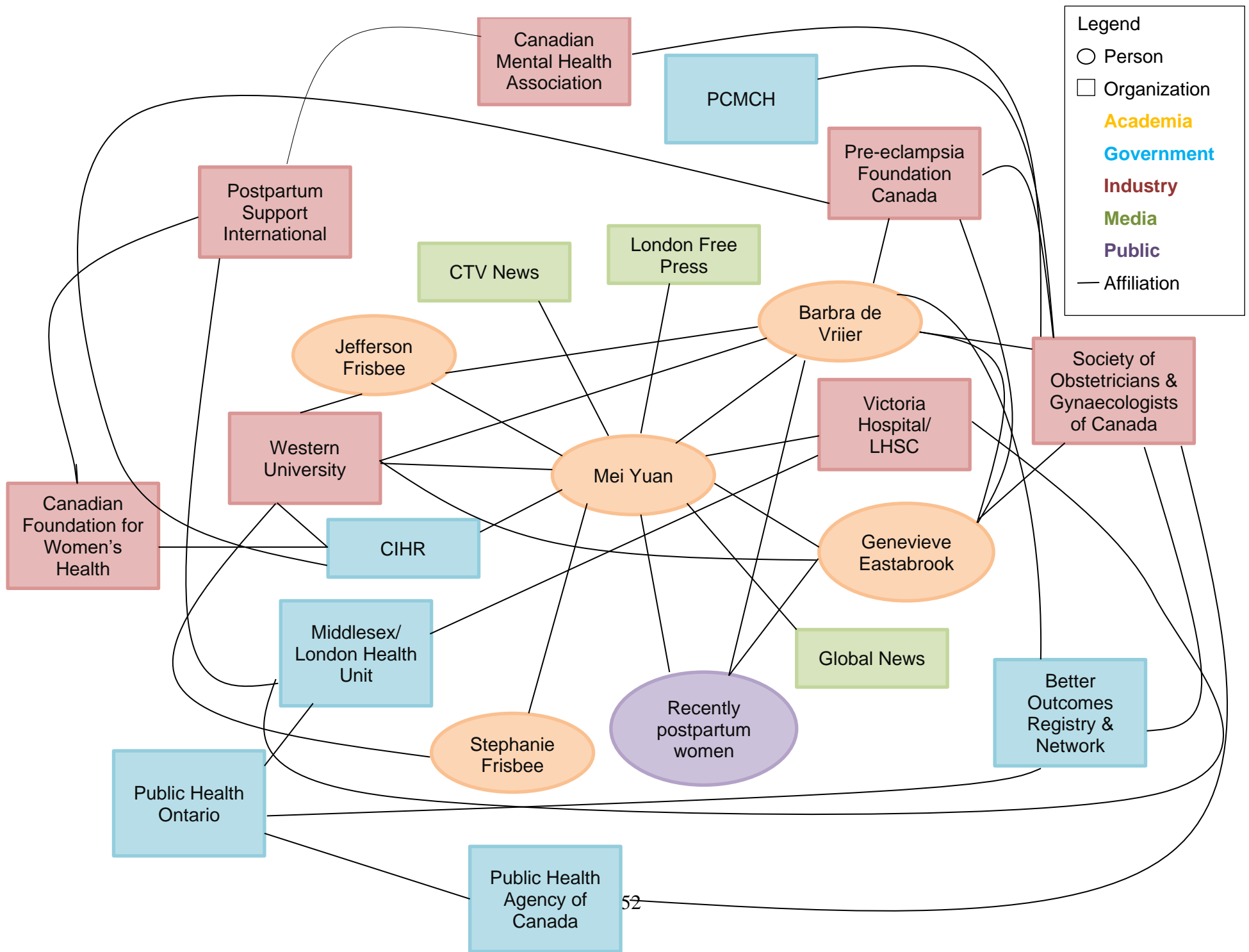
CHAPTER 5

5. Discussion

This study investigated the impact of the COVID-19 pandemic on levels of perceived stress, postpartum depressive symptoms, and pregnancy outcomes in women in Southwestern Ontario using a prospective cohort design, with a sample size of 44. Elevated levels of perceived stress and postpartum depressive symptoms were observed in this cohort of women compared to a pre-pandemic cohort from the 2007 Maternity Experiences Survey (Ontario-subset). Perceived social support was observed to be negatively associated with postpartum depressive symptoms. However, none of the biological, socio-environmental, and COVID-19 factors or pregnancy outcomes were significantly associated with levels of perceived stress and postpartum depressive symptoms. Lastly, the women from this cohort reported similar access to health care despite the pandemic. The following sections provide a more detailed discussion addressing each of the aims.

5.1 Specific Objective 1: Prevalence and Severity of Perceived Stress and Postpartum Depressive Symptoms during COVID-19 and Comparison with the 2007 Maternity Experience Survey

Perceived stress was assessed in three different ways within this study. The median PSS-4 score observed within this cohort was similar to other studies that investigated levels of perceived stress within pregnant women [55,147]. Based on the distribution seen within this cohort, another cut-off point of 8 and above was added as half of the scores within the original high-stress category fell into this new group. This adjustment changed the categories to 1) scores below 5, 2) $5 <$ scores < 8, and 3) scores ≥ 8. Based on the new categories, roughly a third of the population experienced medium and high levels of perceived stress, respectively. The Life Events Inventory and the additional question that asked about the women's overall feeling of stress during the 12 months before the birth of their baby were the comparison measures for perceived stress to the MES cohort. As our study population was strictly those who delivered at Victoria Hospital in London, Ontario, our comparison group was only the Ontario subset of data from the MES. From the study results, 82.5% of women reported that most of their days were somewhat stressful or very stressful during the 12 months that led up to their delivery. This is higher than the 61.7%

observed within the Ontario data of the MES [145], suggesting that there may be other factors that have increased levels of perceived stress within the COVID-19 cohort. Although the proportion for the number of stressful life events experienced was similar in both groups, it is important to note that visually, more women from the current cohort experienced three and more events during the year before their delivery. Previous studies have reported the number of stressful life events experienced to be predictive of perceived stress [58,105], and that stressful life events often preceded episodes of major depressive disorder [58]. As studies have reported that high levels of stress were associated with increased risk of other morbidities such as hypertension [148], diabetes [149], and depression [51,76], screening for levels of stress within pregnant women will identify those who may benefit from additional support and resources.

Postpartum depressive symptoms were assessed using the EPDS. Our results reported that 25% of the women had a score of 13 and greater, which indicated a high probability of depression and that they should be referred to a specialist for further examination. When compared to the MES-Ontario data, the proportion of women who scored 13 and above were visually higher in the COVID-19 cohort, suggesting again that there may be additional factors that this cohort had experienced that the MES cohort had not. The findings from this study were similar to the findings of previous studies that investigated stress and depressive symptoms during the pandemic, which reported higher levels of stress, depression, and anxiety when compared to pre-pandemic times [77,100,150,151]. Based on the visual comparisons between our cohort and the MES Ontario subset, we are predisposed to reject our null hypothesis that there were no differences in the levels of perceived stress and postpartum depressive symptoms between women who were pregnant during COVID-19 and those from the 2007 MES Ontario subset until study completion and a method to account for the weighting of the MES data is identified.

5.2   Specific Objective 2: Relationships between Biological and Socio-environmental Factors, Perceived Stress, and Postpartum Depressive Symptoms during COVID-19

5.2.1   Demographic and Pre-Pregnancy Medical Characteristics

Demographic characteristics such as maternal age, gravida, income, pre-pregnancy BMI, and relationship status as well as pre-existing medical conditions were assessed. No statistically significant associations were observed between these factors and levels of perceived stress or

postpartum depressive symptoms. These results were contrary to previous studies that reported older women (≥ 30 years old) [152,153], those with lower SES [91], and those with higher pre-pregnancy BMI were associated with increased perceived stress and postpartum depressive symptoms [149,154]. However, it is important to note that the participant's SES in our study was defined as the median household after-tax income and prevalence of poverty, as established by the LICO-AT thresholds, in their FSA (place of residence) rather than their actual household income. This may have contributed to the non-significant associations as our findings reported that almost 40% of participants were considered to live in a "high-poverty" neighbourhood. This suggested that the city of London may have higher rates of poverty compared to other cities within Canada. Interestingly, this finding aligned with the higher poverty rate of 15.2% within London that was reported in 2017 compared to the national rate of 9.5% and the Ontario provincial rate of 10.2% [132,155]. The small sample size of 44 from this cohort may have impacted the statistical analyses of the biological and socio-environmental factors with perceived stress and depressive symptoms. An online application from the University of British Columbia was used to calculate the power of this study based on our sample size [156]. With a sample size of 44, the power of the statistical analyses from this study is approximately 16%, meaning that around 84% of the time, our data would not find any significant differences in the analyses.

Furthermore, most of the women did not have any of the pre-existing medical conditions assessed: hypertension, diabetes, GI/liver disease, or autoimmune disease. Thyroid disease was the only pre-existing condition assessed that was diagnosed in nine out of the 44 women (20.5%), but it was not observed to be significantly correlated with perceived stress or postpartum depressive symptoms. Finally, none of the women reported smoking tobacco or drinking alcohol during their pregnancy and only one person reported using cannabis. Therefore, the associations between perceived stress, depressive symptoms, and these behaviours were not assessed. The lack of these behaviours may be due to the women taking precautions to avoid these behaviours for the health of their pregnancy.

5.2.2 Associations between Perceived Stress and Postpartum Depressive Symptoms in the COVID-19 Cohort

In addition to analyzing the prevalence of perceived stress and postpartum depressive symptoms, the association between the two factors was also analyzed. PSS-4 scores were significantly correlated with EPDS scores, suggesting that women who scored high on the PSS-4 may have also scored high on the EPDS scale. This finding supported the associations reported from previous studies [30,65,157]. In addition, our study also observed significant differences in EPDS scores between the three different categories of perceived stress, suggesting women who experienced high levels of perceived stress also experienced high levels of postpartum depressive symptoms when compared to women who have low levels of stress.

5.2.3 Pregnancy Outcomes

With regards to pregnancy complications such as gestational hypertension, GDM, IUGR, and PE, no statistically significant associations were observed between them as a cluster and perceived stress or postpartum depressive symptoms. These results were contrary to findings from previous studies as pregnancy complications, such as gestational hypertension, PE, and IUGR were significantly associated with levels of perceived stress and postpartum depressive symptoms [158–160]. The non-significant associations may be associated with the fact that complications such as PE and IUGR are typically considered rare events, so our small sample size may not be able to accurately represent the pregnant population. Additionally, women who chose to participate in this study may have been in better health conditions than the general pregnant population as the exclusion criteria of this study excluded any women whose baby was admitted to the neonatal intensive care unit or the paediatric critical care unit. This reason may also explain why no significant associations were observed between the birthweight of the newborn and perceived stress or postpartum depressive symptoms as high levels of stress during pregnancy have been associated with lower birthweight in previous studies [34,161].

5.2.4 Perceived Social Support

Within the group of women who were pregnant during the COVID-19 pandemic, levels of perceived social support were mostly high, with approximately 78% of the women indicating

that they have high levels of social support. This is surprising as some of the women noted that the pandemic has heavily impacted social interactions with friends and family as a response to an open-ended question about other ways that the pandemic has impacted them. When assessed for associations between perceived social support and postpartum depressive symptoms, the results observed a significant negative correlation between the two factors. Women who perceived themselves to be receiving more social support reported fewer depressive symptoms, suggesting that perceived social support may have a potential "buffering effect" that lessened postpartum depressive symptoms. No significant differences were observed when comparing depressive symptoms between the three levels of perceived social support, but the results may have been affected by the limited sample size as previous studies have reported levels of social support to be correlated with differences in EPDS scores [10,162]. The lower statistical power from the small sample size may have affected the significance of the association between perceived stress and perceived social support as those that scored high on the MSPSS tended to also score low on the PSS-4, even though the correlation was not significant. This finding is contrary to those of the study conducted by Iranzad *et al.*, who reported that women with more social support had lower levels of stress compared to those with less social support who experienced higher levels of stress [163].

5.2.5 Impact of COVID-19 on Recently Delivered Women

The COVID-19 pandemic seemed to have some effects on our study population with regards to employment, household income, and healthcare access, but none of them were significantly associated with levels of perceived stress and postpartum depressive symptoms. While a majority of the women were working full-time before the pandemic, only around a quarter of them transitioned to working from home during the pandemic. This may have effects on their mental health as they may have been worried about infection of COVID-19 for themselves, their fetus, and their family. In addition, while almost half of the women had young children at home during the pandemic, no significant associations were observed between having kids or the number of kids, and levels of perceived stress or postpartum depressive symptoms. Financially, 16.7% of women stated that the pandemic has reduced their household income to the point of where financial concerns arose as they and their partners have been laid off due to the pandemic, but no significant associations were observed between household income reduction and levels of

perceived stress and postpartum depressive symptoms. Although this finding was contrary to trends seen within the general population as people were losing their employment due to COVID-19 restrictions affecting business operations [79], it may be due to our limited sample size and our tool for assessing reduced income that affected the significance of the association. In terms of healthcare access, the results reported that only about a quarter of healthcare providers offered virtual prenatal care. This is important to note as prenatal care and access to care have impacted stress and anxiety in pregnant women during the pandemic in other studies [78,80,81]. Despite not having alternatives for routine visits, a majority of the women still attended in-person care with no difficulties and were mostly satisfied with the care they received, which was similar to the findings from the 2007 MES [145]. This finding was both surprising and unsurprising as some of the previous studies reported that women had fewer prenatal visits due to the pandemic [79], while others suggested that women still attended healthcare visits due to concerns for their pregnancy and baby [80]. Another interesting observation from comparisons with the MES was that more women from the current cohort received their pregnancy care primarily from their midwives compared to the 2007 MES cohort. This increase may be linked with more women seeking care from midwives because they can provide a continuous model of care for the women throughout the entire pregnancy, birth, and puerperium [164].

In conclusion, our findings reported a significant negative association between perceived social support and postpartum depressive symptoms, with no associations between various biological and socio-environmental factors and the levels of perceived stress or postpartum depressive symptoms in this cohort of pregnant women. Thus, we were unable to reject null hypothesis 2, and we conclude that the various biological, socio-environmental, and COVID-19 factors did not increase levels of perceived stress, postpartum depressive symptoms, and pregnancy outcomes in this cohort of women.

5.3 Specific Objectives 3 and 4: Identification and Mapping of Relevant Stakeholders and Contributions to One Health

Stakeholders who are currently engaged in events, research, management, and care of maternal mental health were identified and then subsequently converted into a visual connection map. Since a major aspect of the One Health approach is to translate scientific findings into actionable

items that could improve overall maternal mental health through collaborations with disciplines outside of academia and health care, this section will focus on ideas for potential collaborations between the stakeholders identified. Limited collaborations between academia, the media, and the public were identified from the stakeholder analysis. While academic research is important as the foundation of improving health, it is just as important to focus on translation and dissemination of information to relevant stakeholders beyond academia so that the research findings are made aware and understood by decision-makers as well as the pregnant population. Proper knowledge translation can increase understanding of the problem as well as increase efficiency for developing strategies and implementing action plans to reduce maternal perceived stress and postpartum depressive symptoms. As social media is becoming more and more integrated into our daily lives, there is a need to increase uptake of this tool when trying to engage the public and other organizations when creating strategies to improve maternal health.

5.3.1   Potential Ideas for Collaboration and Engagement between Different Stakeholders

Although the ongoing collaborations between the various stakeholders are critical to improving maternal health, other potential collaborations could further facilitate the necessary awareness to increase support maternal mental and physical health. In this section, I will propose several potential ideas and collaborations that could strengthen and extend the knowledge integration that currently exists from the research stage to ultimately improve maternal physical and mental health.

The following ideas focus on improving maternal health through collaborations with organizations such as the Canadian Foundation of Women's Health (CFWH) and the Pre-eclampsia Foundation. These organizations affect women's health by providing grants, scholarships, and fundraising events to support individuals and organizations that aim to improve women's health. First, funding from these organizations can be used by Western University to support research that explores early indicators of poor mental health and PE. This can aid to identify women who may be at higher risk of developing the pathology earlier in the pregnancy, so they can be subsequently monitored to prevent adverse outcomes. Further, if the research findings are clinically significant to improving maternal health, collaborations with the SOGC may positively affect the implementation of early screening of risk factors in pregnant women

since the SOGC develops guidelines to help obstetricians and gynaecologists provide the best care possible. Secondly, collaborations between fundraising organizations, the Provincial Council of Maternal and Child Health (PCMCH), and local hospitals could improve maternal health by increasing accessibility of perinatal care visits. Implementation of childcare and support programs for mothers during their clinical visits or more flexible hours of care are potential solutions for women who cannot seek care during regular business hours. Additional funding may also further facilitate the development and implementation of increased virtual maternal and mental health care availability. Particularly during the pandemic, virtual perinatal visits can ease concerns regarding childcare and fears of COVID-19 infection, while still allowing for in-person follow-up visits to be scheduled if necessary. Similarly, these virtual meetings can be extended to collaborations with PSI to facilitate sessions online that offer advice and support for new mothers.

In addition to research and access to health care, socio-environmental factors should also be considered when developing solutions to reduce maternal stress. Job loss and reduced financial stability may lead to potential struggles in affording groceries, rent, and other living necessities. Having to choose between various necessities may increase levels of stress and negative affect in pregnant women. One potential solution is programs that pair pregnant or postpartum women with social workers and/or community volunteers that are familiar with navigating government and community resources. These programs may have a positive effect on reducing maternal stress as the program navigators can guide the women through the application process for resources that currently exist. Another potential solution to ease financial burdens is collaborations between the city of London, local organizations, and LHSC to invest funding into municipal programs that offer partial grocery or rent subsidization for families who may be struggling financially due to the inability to find work. A potential idea could be a bi-weekly or monthly grocery program that provides women with financial aid in the form of grocery store gift cards. This could help to reduce some of the financial burdens that may increase maternal stress while preventing any stigmatization that accompanies specifically labelled "aid" cards.

Lastly, my search displayed few media collaborations that advocate for maternal mental health. Since social media and technology are prominent in our everyday lives, using these platforms to advocate and raise awareness on the importance of physical and mental maternal wellbeing can

aid in reaching broader audiences. For example, celebrities like Adele and Hayden Panettiere took the courage to discuss their postpartum mental health journey with the public through media interviews. Celebrity-driven media coverage can have a positive effect on public awareness and may drive healthcare organizations to focus on community outreach as scientific research findings are only as beneficial as the number of people who can understand and act upon them.

In conclusion, a key part of the One Health approach is to extend beyond academic research into actionable items to improve overall health. Collaborations with stakeholders from different disciplines will allow for innovative ideas and the ability to create a broader impact on improving the mental and physical health of pregnant women. The stakeholders and collaborations identified within this project are a key stepping stone along the path to transdisciplinary work that could ultimately build an environment that supports maternal mental health.

5.4   Limitations

While this study was one of the first to investigate the impact of perceived stress and postpartum depressive symptoms with implications on pregnancy outcomes during the COVID-19 pandemic using a One Health approach, several limitations may have impacted its findings.

The main limitation of this study is the small sample size. This is partly because a majority of the recruitment process was completed virtually due to COVID-19 restrictions, combined with a limited time frame, and that the study population was limited to those who delivered in a single hospital in London, Ontario. All of these factors contributed to the small sample size available at the time of analysis of this thesis. The small sample size limited the breadth and depth of analysis that could be performed (removal of original objective 3) and reduced the statistical power of the analyses that were completed for the revised objectives. Secondly, our study population is a convenient sample of women who gave birth in London, Ontario, which has a relatively high poverty rate compared to other areas of Ontario. It would be helpful to understand potential selection bias by comparing the sociodemographic characteristics of the women in our study sample to a) all women who gave birth at LHSC, and b) all women in the MES-Ontario, which which was representative of women giving birth in Ontario in 2006 [138]. Understanding potential selection bias is important because the lack of associations observed between COVID-19 factors,

healthcare access, and levels of perceived stress and postpartum depressive symptoms may be due to "healthier" women participating in the study, whereas women who experienced high levels of stress and depressive symptoms chose not to participate in the study.

5.5   Suggestions for Future Research

While this study assessed the impact of the COVID-19 pandemic on levels of perceived stress, postpartum depression, and pregnancy outcomes in women in Southwestern Ontario, the particular time frame only allowed for a brief investigation. However, it presented the need for future research to holistically investigate maternal health, taking into account various biological and socio-environmental factors that may affect maternal mental health. Although this study investigated socio-environmental factors such as socioeconomic status, education and employment were not assessed. Studies have observed that both education and employment heavily impact one's SES and how they cope with stressful events, so the inclusion of these factors within the assessment may be relevant to fully understand how the pandemic has impacted maternal health.

Secondly, partner characteristics have also been reported to influence maternal mood and stress [165–167]. This includes the partner's demographic information such as age, education, and employment, or medical history and lifestyle behaviours such as smoking, alcohol consumption, existing morbidities, and levels of social support. Just as the pandemic has affected the pregnant women, their partner may have also experienced changes that would lead to spill-over effects onto the women. Other risk factors whose impact on stress and depressive symptoms may be exacerbated by the COVID-19 pandemic are the previous history of depression and anxiety, and adverse childhood trauma. A previous history of depression or anxiety has been linked with increased risks of postpartum depression [60,88], while adverse childhood events have been associated with increased risks of depression, avoidant coping skills during stressful situations, cardiovascular disease, and adverse pregnancy outcomes [168–170]. Investigating whether previous histories of mental health illnesses and adverse childhood events mediate the associations between the COVID-19 pandemic and levels of perceived stress and postpartum depressive symptoms would be beneficial for future maternal care. Lastly, future studies can also investigate potential long-term impacts of the COVID-19 pandemic as social isolation has been previously

reported to impact maternal and newborn mental and physical health later in life. For example, social isolation and the lack of social support have been associated with neuro-behavioural and developmental disorders for children [171].

CHAPTER 6

6. Conclusion

In conclusion, women who were pregnant during the COVID-19 pandemic have increased levels of perceived stress and postpartum depressive symptoms when compared to a pre-pandemic cohort. Significant positive associations were observed between levels of perceived stress and postpartum depressive symptoms as women who experienced high levels of stress also had high levels of depressive symptoms. Perception of received social support was reported to have a slight buffering effect on depressive symptoms while no significant association was reported between perceived stress and perceived social support. Similarly, no significant associations were observed between various biological and socio-environmental factors and perceived stress or postpartum depressive symptoms. Brief analyses also reported that the COVID-19 factors identified did not significantly impact levels of perceived stress and postpartum depressive symptoms in this cohort of women. Future studies should investigate these associations with a larger sample size and also assess potential long-term impacts of the pandemic on maternal and newborn health. Lastly, this thesis used a One Health approach to help answer the research question and explore relevant stakeholders and collaborations to encourage transdisciplinary work outside of academia to improve maternal mental health.

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Appendix A

Impact of COVID-19

Due to the healthcare restrictions put in place to combat COVID-19, some of the original objectives are no longer feasible as patient care and participant recruitment has been impacted so we were not able to recruit and enrol as many participants as we would have liked. Therefore, the original objectives have been revised to account for these disruptions. Specifically, the analysis of objectives 1 and 2 may be significantly underpowered due to the pandemic restrictions limiting participant recruitment and thus heavily impacting sample size. Secondly, due to the insufficient sample size for multivariate statistical analysis, specific objective 3 has been removed. Below are the original specific aims and objectives of the study.

Original Specific Objectives and Hypotheses

Specific objective 1: To measure and compare the prevalence and severity of postpartum depressive symptoms and perceived stress in recently delivered women during the COVID-19 pandemic to a pre-COVID-19 cohort from the Maternity Experiences Survey in 2006

Hypothesis 1: The prevalence and severity of postpartum depressive symptoms and perceived stress in the current COVID-19 cohort of postpartum women will be elevated due to external factors from the pandemic when compared to a pre-COVID-19 cohort from the Maternity Experiences Survey in 2006

Specific objective 2: To explore the association between individual physical, mental and socio-environmental health factors and the prevalence and severity of postpartum depressive symptoms, perceived stress, and pregnancy outcomes in postpartum women during the COVID-19 pandemic

Hypothesis 2: Increased burden of individual physical, mental, and socio-environmental health factors will be positively associated with prevalence and severity of postpartum depressive symptoms, levels of perceived stress, and adverse pregnancy outcomes in postpartum women during the COVID-19 pandemic

Specific objective 3: To explore the interactive associations between multiple physical, mental, and socio-environmental health factors and the prevalence and severity of postpartum depressive

symptoms, perceived stress, and adverse pregnancy outcomes in post-partum women during the COVID-19 pandemic

Hypothesis 3: Increased burden of multiple physical, mental, and socio-environmental health factors will interact to have additive and multiplicative adverse effects on the prevalence and severity of postpartum depressive symptoms, perceived stress, and adverse pregnancy outcomes in postpartum women during the COVID-19 pandemic

Specific objective 4: To identify key stakeholders pertinent to monitor and optimize health throughout pregnancy.

Specific objective 5: Develop connection map of identified stakeholders

Appendix B

1.One Page Information Sheet

London Health Sciences Centre   Western UNIVERSITY·CANADA

Has COVID-19 impacted you and your pregnancy?

We are looking for volunteers to take part in a study to better understand how COVID-19 may have impacted your pregnancy.

What is the study about? At 6-12 weeks after your delivery, we will ask you to complete several questionnaires. The questionnaires take about 30 minutes to complete and will ask questions about stress, depression, social support, healthcare access, and pregnancy outcomes. The questionnaires can be completed online or by telephone.

You are **eligible** to participate if:

❖ You delivered one baby
❖ You are 18 years of age or older
❖ Your baby was **not** admitted to NICU, and you both will be discharged home together

Interested in learning more about the study?

Consent to be contacted is entirely voluntary and will not impact care. If you are **not interested in being contacted, no further information is required.**

☐ Yes, I am interested and would like to be contacted.

Name: _____

Month/year of **your** birth: _____

Date of delivery: _____

A member of the research team will contact you to give you additional information.

Preferred method of contact:

☐ Phone:_____

Best time to reach you during the day:_____AM/PM

Is it okay to leave a message? ☐ Yes ☐ No

☐ Email:_____

Thank you!

Title: Impact of COVID-19 on perceived stress, postpartum depression, and pregnancy outcomes for mothers in Southwest Ontario (REB 116453)   Version: Mar 24, 2021

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2.Letter of Information

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LETTER OF INFORMATION

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Study Title: Impact of COVID-19 pandemic response on perceived stress, postpartum depression, and pregnancy outcomes for mothers in Southwestern Ontario

Principal Investigator:
Dr. Barbra de Vrijer, Obstetrics & Gynaecology, LHSC,

Co-Investigators:
Dr. Genevieve Eastabrook, Obstetrics & Gynaecology, LHSC,
Stephanie Frisbee, Assistant Professor, Western University

INVITATION TO PARTICIPATE
You are being invited to participate in this research study because you have recently delivered your baby at London Health Sciences Centre.

PURPOSE OF THIS LETTER
The purpose of this letter is to provide you with information required for you to make an informed decision about whether you would like to participate in this study. This study is being done to satisfy the MSc thesis requirements of the student Mei Yuan.

BACKGROUND
The 2019 novel-coronavirus (COVID-19) has globally affected everyone physically, mentally, socially, and economically. The challenges posed by COVID-19 have led to increased feelings of stress and worry. The pregnant population may be especially vulnerable to additional stress as they have to manage all of the changes that come with pregnancy as well as the changes brought on by COVID-19. Past studies have shown that higher stress may be linked with higher levels of depression and challenges to pregnancy health. We will be conducting a study to investigate how the current COVID-19 situation is affecting stress and mood in people who have recently given birth in Southwest Ontario.

In our study, we will ask you to answer some questions at about 6-12 weeks after you have delivered your baby. We will ask questions about your stress, emotions, and the supports you have. You will be able to complete these questions in the way that is easiest for you– online or via telephone. We will compare the answers of our participants to answers in "pre-COVID-19" groups to get a sense of how the current COVID-19 situation has affected health during pregnancy.

The results from our study will contribute to a better understanding of different factors that affect how people feel during and after their pregnancy and help us to think about strategies to promote, support, and improve health during pregnancy.

PURPOSE

To investigate and quantify the impact of the COVID-19 pandemic response on perceived stress, postpartum depressive symptoms, and pregnancy outcomes in women in Southwestern Ontario.

WHAT DOES THE STUDY INVOLVE?

If you agree to participate, we will ask you complete the following questionnaires which will take about 30 minutes. When you start the questionnaires, you will have 24 hours in which to complete.

Questionnaires

COVID-19 Impact questionnaire asks about how the COVID-19 pandemic has impacted your employment, childcare, and lifestyle.

Stressful Life Events questionnaire asks about stressful life events you experienced in the 12 months before your baby was born.

Perceived Stress Scale questionnaire asks about feelings and thoughts you have had.

The Multidimensional Scale of Perceived Social Support questionnaire asks about your social supports.

Edinburgh Postnatal Depression Scale questionnaire asks questions related to symptoms commonly found in depression and anxiety during pregnancy.

Breastfeeding intent and behaviour questionnaire will ask you how you intended to feed your baby prior to birth, and your current feeding behaviours.

Healthcare access questionnaire asks about how you accessed healthcare.

Chart Review

The team will access your paper and electronic hospital charts to collect data on: demographics, pregnancy information (e.g., pre-pregnancy weight, estimated date of birth, etc.), pregnancy history/outcome/complications (e.g., diabetes treatment/results, preeclampsia, gestational diabetes, preterm birth, etc.).

500 pregnant persons with one baby who are 18 years of age or older and plan to deliver at LHSC will be recruited.

BENEFITS

There are no known benefits to you associated with participating in this research study. Information learned from this study may improve our understanding of the impact of COVID-19 on the prevalence and severity of postpartum depressive symptoms and

perceived stress so that further research and strategies can be implemented to improve maternal health.

Risks

Feelings of stress and anxiety may arise from completing certain questions from the questionnaires. A message containing ways for you to speak to someone (if needed) will be displayed at the end of the questionnaires. The options listed include contacting your primary care provider, and phone numbers to crisis management lines for immediate assistance, or you have the option of contacting Dr. de Vrijer or Dr. Eastabrook.

As personal identifiers (for example, your name, partial postal code, telephone number, email, obstetrician, maternal age, date of delivery, infant sex, hospital PIN) are being collected, there is the risk of privacy breach although all measures will be undertaken by all members of the research team to ensure this does not occur.

Possible Discovery of Unexpected Findings

The questionnaires completed in this study are for research only and may not be sufficient to diagnose.

This survey asks about self-harm. Dr. de Vrijer and Dr. Eastabrook, both obstetrician/gynecologists, will be notified should you respond 'yes, quite often' or 'sometimes' to the self-harm question in the Edinburgh Postnatal Depression Scale, and you will be contacted to discuss how you would like to proceed (such as referral to a psychologist). If you cannot be reached your family physician or obstetrician will be contacted. While responses will be monitored and Dr. de Vrijer and Dr. Eastabrook will be notified from 8am-4pm Monday to Friday, outside of these times your responses will not be monitored. If you feel that you would like to or need to speak to someone about how you are feeling, please consult the following resources:
* The London Mental Health Crisis Service at the LHSC
* Contact the CMHA Middlesex Support line   . The toll-free number is
                . This service is available 24/7 and can also be accessed via the "webchat" link found here: https://cmhamiddlesex.ca/programs-services/support-line/

Compensation

You will not receive any compensation for your participation.

Voluntary Participation

Your participation in this study is voluntary. You may leave the study at any time without affecting your care.

Withdrawal from Study

If you request to be withdrawn from the study, you have the right to request withdrawal of your information. Study data collected prior to analysis may be withdrawn. Let your study doctor know.

CONFLICT OF INTEREST
The doctor treating you also may be an investigator in the study.

CONFIDENTIALITY
The study team will keep any personal health information about you in a secure and confidential location for 15 years. A list linking your study number with your name will be kept by the study team in a secure place, separate from your study file. You will not be named in any reports, publications, or presentations that may come from this study.

Email may be used as a form of communication for this study; please note that it is not a secure form of communication.

Your research records will be stored in the following manner: paper records will be kept in a locked filing cabinet at LHSC; electronic files will be stored on the hospital secure network drive and LHSC Cloud Storage (LHSC Microsoft Teams/OneDrive). De-identified data may also be stored at Western University.

If you choose to withdraw from this study, study data collected prior to analysis will be removed and destroyed.

Identifiable information collected during this study will be kept confidential and will not be shared with anyone outside the study unless required by law. Representatives of the Western University Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the way the research is being conducted. The Quality Assurance and Education Officers from Lawson Health Research Institute (Lawson) may audit this research study for quality assurance purposes.

Open Access Data
All identifiable information will be deleted from the dataset collected so that individual participant's anonymity will be protected. The de-identified data will be accessible by the study investigators as well as the broader scientific community. The study investigators may re-analyze the de-identified data to gain knowledge and understanding for different research questions. The de-identified data may also be made available to other researchers upon publication so that data may be inspected and analyzed by other researchers.

WHOM DO PARTICIPANTS CONTACT FOR QUESTIONS
If you require any further information regarding this research project or your participation in the study you may contact Dr. de Vrijer at

If you have any questions about your rights as a research participant or the conduct of this study, you may contact the Patient Experience Office at LHSC at

3.Verbal Consent Form

London Health Sciences Centre   Western
                                                 UNIVERSITY · CANADA

DOCUMENTATION OF VERBAL CONSENT

Study Title: Impact of COVID-19 pandemic response on perceived stress, postpartum depression, and pregnancy outcomes for mothers in Southwestern Ontario

Principal Investigator:
Dr. Barbra de Vrijer, Obstetrics & Gynaecology, LHSC,

Name of Participant: _____

Date of Discussion: _____

Duration of Discussion: _____

Has this study been explained to you and all your questions been answered?	☐ Yes	☐ No
Do you allow the study team to access your paper and electronic hospital chart?	☐ Yes	☐ No
Do you agree to take part in this study?	☐ Yes	☐ No

_____ _____ _____
Signature of Person   Printed Name and Role   Date
Conducting the Consent
Discussion

4.Research Ethics Board Letter of Approval

Western Research

Date: 21 December 2020

To: Dr. Barbra de Vrijer

Project ID: 116453

Study Title: Impact of COVID-19 on perceived stress, postpartum depression, and pregnancy outcomes for mothers in Southwest Ontario

Application Type: HSREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 12/Jan/2021

Date Approval Issued: 21/Dec/2020 07:16

REB Approval Expiry Date: 21/Dec/2021

_____

Dear Dr. Barbra de Vrijer

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
116453_Qualtrics Survey_Nov 10, 2020	Online Survey	10/Nov/2020	
116453_Protocol_Dec 18, 2020	Protocol	18/Dec/2020	
116453_Data Collection Form_Dec 18, 2020	Other Data Collection Instruments	18/Dec/2020	
116453_One-page Information Sheet_Dec 18, 2020	Recruitment Materials	18/Dec/2020	
116453_Poster_Dec 18, 2020	Recruitment Materials	18/Dec/2020	
116453_Email Script_Dec 18, 2020	Email Script	18/Dec/2020	
116453_Telephone Script_Dec 18, 2020	Telephone Script	18/Dec/2020	
116453_LOI_Dec 18, 2020	Written Consent/Assent	18/Dec/2020	
116453_Verbal Consent_Dec 18, 2020	Consent Documentation	18/Dec/2020	

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

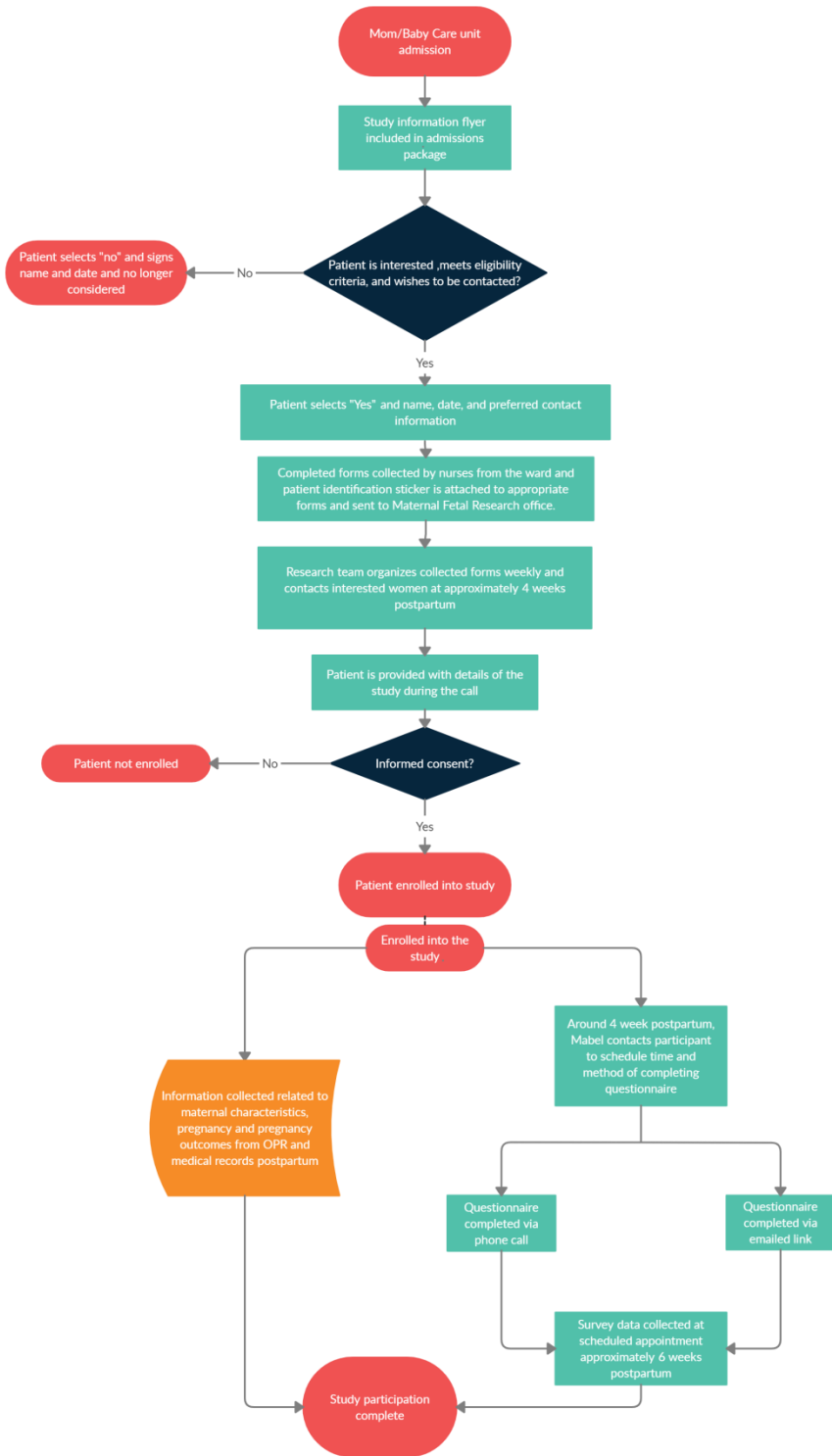Please do not hesitate to contact us if you have any questions.

Sincerely,

Ms. Nicola Geoghegan-Morphet , Ethics Officer on behalf of Dr. Philip Jones, HSREB Vice-Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix C

5. Study Protocol Flowchart

Mom/Baby Care unit admission

Study information flyer included in admissions package

Patient is interested, meets eligibility criteria, and wishes to be contacted?

No → Patient selects "no" and signs name and date and no longer considered

Yes

Patient selects "Yes" and name, date, and preferred contact information

Completed forms collected by nurses from the ward and patient identification sticker is attached to appropriate forms and sent to Maternal Fetal Research office.

Research team organizes collected forms weekly and contacts interested women at approximately 4 weeks postpartum

Patient is provided with details of the study during the call

Informed consent?

No → Patient not enrolled

Yes

Patient enrolled into study

Enrolled into the study

Information collected related to maternal characteristics, pregnancy and pregnancy outcomes from OPR and medical records postpartum

Around 4 week postpartum, Mabel contacts participant to schedule time and method of completing questionnaire

Questionnaire completed via phone call

Questionnaire completed via emailed link

Survey data collected at scheduled appointment approximately 6 weeks postpartum

Study participation complete

6.Study Questionnaire

Introduction

<u>Study Title:</u> Impact of COVID-19 pandemic response on perceived stress, postpartum depression, and pregnancy outcomes for mothers in Southwestern Ontario.

_____

Principal Investigator:
Dr. Barbra de Vrijer, Obstetrics & Gynaecology, LHSC,

Co-Investigators:
Dr. Genevieve Eastabrook, Obstetrics & Gynaecology, LHSC
Stephanie Frisbee, Assistant Professor, Western University

_____

Thank you for agreeing to participate in this study to investigate and quantify the impact of the COVID-19 pandemic response on perceived stress, postpartum depressive symptoms, and pregnancy outcomes in women in Southwestern Ontario.

As we have described to you during the informed consent process:

- We estimate that these questions will take approximately 30 minutes to complete but you will have 24 hours from now to complete the survey;
- Your participation is completely voluntary. You do not have to answer all the questions. You may skip questions or you may stop answering questions altogether by simply "exiting" the survey and closing your web browser;
- You may also withdraw from the study at any time by contacting one of the study team;
- Your participation in this study will not affect your health care in any way;
- Your responses to these questions and your identity will be kept confidential.

If you have any questions regarding this research project or your participation in the study, please contact Dr. de Vrijer at   .

To begin this research study, please click the "Start Study" button below. By clicking the "Start Study" button, you are agreeing to continue your consent to participate in this research study.

Before you click the "Start Study" button, please be sure to have your assigned study number with you -- you will need to enter this number on the next screen.

Thank you!

Participant ID

Study Title: Impact of COVID-19 pandemic response on perceived stress, postpartum depression, and pregnancy outcomes for mothers in Southwestern Ontario.

_____

Principal Investigator:
Dr. Barbra de Vrijer, Obstetrics & Gynaecology, LHSC,

Co-Investigators:
Dr. Genevieve Eastabrook, Obstetrics & Gynaecology, LHSC
Stephanie Frisbee, Assistant Professor, Western University

_____

Please enter your assigned study number here:
(*this question is required)

Please enter the first 2 letters of your FIRST NAME:
(*this question is required)

Please enter the first 2 letters of your LAST NAME:
(*this question is required)

Please select the month of your birthday:
(*this question is required)

To begin the questionnaires that are part of this research study, please click the "Start Surveys" button below to begin

Impact of COVID-19 Pandemic

We are interested in learning about how the COVID-19 pandemic has affected you. The next set of questions will ask about how the pandemic has affected your employment, childcare, and lifestyle.

Prior the COVID-19 pandemic, please select the one option that best describes your employment status (working for wages or a salary):

- O Employed full-time working outside of the home
- O Employed part-time working outside of the home
- O Employed full-time working from home
- O Employed part-time working from home
- O Employed full-time, working a combination of outside the home and from home
- O Employed part-time, working a combination of outside the home and from home
- O Unemployed, but looking for employment
- O Not employed and not looking for employment

After the COVID-19 pandemic started, please tell us how your employment changed. Please select all the options that apply.

- ☐ I continued to work at my usual place of work, no change occurred
- ☐ I kept working, but transitioned to working from home, at least part of the time
- ☐ I kept working, but had my hours reduced
- ☐ I was temporarily laid off or had unpaid leave of absence because of COVID-19
- ☐ I lost my job permanently because of COVID-19
- ☐ I was laid off or permanently lost my job for reasons other than COVID-19
- ☐ I am currently on maternity leave from my job
- ☐ Not employed outside the home
- ☐ [   ] Other:

Prior to the COVID-19 pandemic, please select the one option that best describes your partner's employment status (working for wages or a salary):

- O Employed full-time working outside of the home
- O Employed part-time working outside of the home
- O Employed full-time working from home
- O Employed part-time working from home
- O Employed full-time working a combination of outside the home and from home

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○ Employed part-time working a combination of outside the home and from home

○ Unemployed but looking for employment

○ Not employed and not looking for employment

○ Not applicable or prefer not to answer

After the COVID-19 pandemic started, please tell us how your partner's employment changed. Please select all the options that apply.

☐ My partner continued to work at my usual place of work, no change occurred

☐ My partner kept working, but transitioned to working from home, at least part of the time

☐ My partner kept working, but had their hours reduced

☐ My partner was temporarily laid off or had unpaid leave of absence because of COVID-19

☐ My partner lost their job permanently because of COVID-19

☐ My partner was laid off or permanently lost their job for reasons other than COVID-19

☐ My partner is currently on paternity leave from their job

☐ Not employed outside the home

☐ [　　　　　　　　] Other (please specify):

During the COVID-19 pandemic, have you had any children at home?

○ Yes

○ No

Please indicate how many children in each age group have been at home:

☐ [　　　　　　　　] Less than 12 months of age:

☐ [　　　　　　　　] 1 - 6 years of age:

☐ [　　　　　　　　] 7 - 12 years of age:

☐ [　　　　　　　　] 13 - 18 years of age:

☐ [　　　　　　　　] Older than 18 years of age AND living with you:

During the COVID-19 pandemic, have you had a difficult time buying groceries?

○ Yes

○ No

Why have you have a difficult time buying groceries?

☐ Financial reasons

☐ Could not leave the house because I was taking care of children or someone else

☐ Could not leave the house because of my own health

☐ [   ]Other:

☐ Prefer not to answer

How concerned are you about the impact of COVID-19 on:

	Not concerned at all	Somewhat concerned	Very concerned	Extremely concerned
Your health?	O	O	O	O
The health of someone in your household?	O	O	O	O

During the COVID-19 pandemic:

	Yes	No
Did you have a relative or other person come to live with you?	O	O
Have you had to provide significant personal and / or supportive care to someone else?	O	O
Has your household income been reduced such that financial concerns arose?	O	O
Have you had a family member or close friend who was affected by COVID-19?	O	O

Are there other ways that the COVID-19 pandemic has impacted your life that you would like to share with us?

[   ]

Stressful Events

The following questions deal with experiencing stress in the 12 months before your baby was born. That is, from about 3 months before your pregnancy until the birth.

Thinking about the amount of stress in your life during the 12 months before your baby was born, would you say most days were?

O Not stressful

O Somewhat stressful

○ Very stressful

The following questions are things that might happen to people in their lives. Please answer if any of the following events happened to you in the 12 months before your baby was born. If you feel a question does not apply to you, answer "no".

In the <u>12 months before your baby was born</u>...

	Yes	No
A close family member was very sick and had to go into the the hospital	○	○
You got separated or divorced from your husband or partner	○	○
You moved to a new address	○	○
You were homeless	○	○
Your husband or partner lost their job	○	○
You lost your job even though you wanted to keep working	○	○
You and your husband or partner argued more than usual	○	○
Your husband or partner said that they did not want you to be pregnant	○	○
You had a lot of bills you couldn't pay	○	○
You were involved in a physical fight	○	○
Your husband or partner went to jail or a detention centre	○	○
Someone very close to you had a bad problem with drinking or drugs	○	○
Someone very close to you died	○	○

Prenatal Healthcare Access

The next few questions will ask you about your visits to a doctor, nurse, or other healthcare provider for check-ups and advice on your pregnancy **before your baby was born**. They will be referred to as **prenatal care**.

Did you have prenatal care?

○ Yes, I had prenatal care

○ No, I did not have prenatal care

How many weeks pregnant with your baby were you when you had your first visit for prenatal care (this may have been the first time your pregnancy was confirmed by a healthcare provider)?

[ ]

Did you receive prenatal care as early as you wanted to?

O Yes

O No

What prevented you from getting prenatal care as early as you wanted to (please select all that apply)?

☐ The doctor or healthcare provider was not available

☐ Doctor or healthcare provider would not start care earlier

☐ I didn't know I was pregnant

☐ I didn't have child care

☐ I was too busy

☐ I didn't have transportation

☐ I couldn't take time off work

☐ [ ] Other (please describe)

Did your health care provider offer "virtual" prenatal care visits during the pandemic?

O Yes

O No

Thinking of the majority of your prenatal care visits, please select the most common type you received.

O In-person visits

O Telephone visits

O "Virtual" visits using video conferencing over the internet

From which type of healthcare provider, such as an obstetrician, family doctor or midwife, did you receive most of this care?

O Obstetrician

O Gynaecologist

O OBGYN

O Family doctor

O General practitioner / GP

O Midwife

○ Nurse or nurse practitioner

○ [ ] Other (please describe)

How satisfied are you with the prenatal care you received?

○ Very satisfied

○ Mostly satisfied

○ Neither satisfied nor unsatisfied

○ Mostly unsatisfied

○ Very unsatisfied

During your pregnancy, did you attend prenatal or childbirth education classes?

○ Yes

○ No

Postnatal Healthcare Access – Routine Care

The following questions are about **routine care** (well-care check-up or a scheduled follow-up visit) for yourself and your baby **since you have been home from the hospital**.

Following the birth, were you contacted at home by a healthcare provider, such as a public health nurse or midwife, to see how you and your baby were doing?

○ Yes

○ No

Since you have been home from the hospital, have you had any routine healthcare visits with a doctor or healthcare provider?

○ Yes

○ No

Overall, how easy or difficult was it to see a healthcare provider for yourself for routine care since you have been home from the hospital?

○ Very easy

○ Somewhat easy

○ Neither easy nor difficult

○ Somewhat difficult

○ Very difficult

Why was it difficult?

○ Doctor or healthcare provider unavailable

○ I didn't have child care

○ I was too busy

○ I didn't have transportation

○ I couldn't take time off work

○ [   ] Other (please describe)

Did your healthcare provider offer "virtual" visits for routine care <u>for yourself</u> since you have been home from the hospital?

○ Yes

○ No

Thinking of the <u>majority</u> of the routine care visits you have had <u>for yourself</u> since you have been home from the hospital, please select the most common type you received.

○ In-person visits

○ Telephone visits

○ "Virtual" visits using video conferencing over the internet

How satisfied are you with the routine care visits you have received <u>for yourself</u> since you have been home from the hospital?

○ Very satisfied

○ Mostly satisfied

○ Neither satisfied nor unsatisfied

○ Mostly unsatisfied

○ Very unsatisfied

Since you have been home from the hospital, has <u>your baby</u> had any routine healthcare visits with a doctor or healthcare provider?

○ Yes

○ No

Overall, how easy or difficult was it to see a healthcare provider for <u>your baby</u> for routine care since you have been home from the hospital?

O Very easy

O Somewhat easy

O Neither easy nor difficult

O Somewhat difficult

O Very difficult

Why was it difficult?

O Doctor or healthcare provider unavailable

O I didn't have child care

O I was too busy

O I didn't have transportation

O I couldn't take time off work

O [   ]Other (please describe)

Did your healthcare provider offer "virtual" visits for routine care <u>for your baby</u> since you have been home from the hospital?

O Yes

O No

Thinking of the <u>majority</u> of the routine care visits you have had <u>for your baby</u> since you have been home from the hospital, please select the most common type you received.

O In-person visits

O Telephone visits

O "Virtual" visits using video conferencing over the internet

How satisfied are you with the routine care visits you have received <u>for your baby</u> since you have been home from the hospital?

O Very satisfied

O Mostly satisfied

O Neither satisfied nor unsatisfied

O Mostly unsatisfied

O Very unsatisfied

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Postnatal Healthcare Access – Non-Routine Care

The following questions are about **non-routine care** for yourself and your baby **since you have been home from the hospital**. Non-routine care is when you need to see a doctor or healthcare provider outside scheduled well-baby visits or scheduled 6-week postpartum visit.

Since you have been home from the hospital, have <u>you</u> had any non-routine healthcare visits with a doctor or healthcare provider?

O Yes

O No

Overall, how easy or difficult was it to see a healthcare provider for <u>yourself</u> for non-routine care since you have been home from the hospital?

O Very easy

O Somewhat easy

O Neither easy nor difficult

O Somewhat difficult

O Very difficult

Why was it difficult?

O Doctor or healthcare provider unavailable

O I didn't have child care

O I was too busy

O I didn't have transportation

O I couldn't take time off work

O [   ]Other (please describe)

Did your healthcare provider offer "virtual" visits for non-routine care <u>for yourself</u> since you have been home from the hospital?

O Yes

O No

Thinking of the <u>majority</u> of the non-routine care visits you have had <u>for yourself</u> since you have been home from the hospital, please select the most common type you received.

O In-person visits

O Telephone visits

○ "Virtual" visits using video conferencing over the internet

How satisfied are you with the non-routine care visits you have received <u>for yourself</u> since you have been home from the hospital?

○ Very satisfied

○ Mostly satisfied

○ Neither satisfied nor unsatisfied

○ Mostly unsatisfied

○ Very unsatisfied

Since you have been home from the hospital, has <u>your baby</u> had any non-routine healthcare visits with a doctor or healthcare provider?

○ Yes

○ No

Overall, how easy or difficult was it to see a healthcare provider for <u>your baby</u> for non-routine care since you have been home from the hospital?

○ Very easy

○ Somewhat easy

○ Neither easy nor difficult

○ Somewhat difficult

○ Very difficult

Why was it difficult?

○ Doctor or healthcare provider unavailable

○ I didn't have child care

○ I was too busy

○ I didn't have transportation

○ I couldn't take time off work

○ [   ] Other (please describe)

Did your healthcare provider offer "virtual" visits for non-routine care <u>for your baby</u> since you have been home from the hospital?

○ Yes

○ No

Thinking of the majority of the non-routine care visits you have had for your baby since you have been home from the hospital, were they mostly:

*(*please "check" the one type of visit that was most common or the "majority" of your baby's non-routine healthcare visits)*

☐ In-person visits

☐ Telephone visits

☐ "Virtual" visits using video conferencing over the internet

How satisfied are you with the non-routine care visits you have received for your baby since you have been home from the hospital?

○ Very satisfied

○ Mostly satisfied

○ Neither satisfied nor unsatisfied

○ Mostly unsatisfied

○ Very unsatisfied

Edinburgh Postnatal Depression Scale

As you recently had a baby, we would like to know how you are feeling. Please select the answer which comes closest to how you have felt in the **past 7 days** – not just how you feel today.

I have been able to laugh and see the funny side of things.

○ As much as I always could

○ Not quite so much now

○ Definitely not so much now

○ Not at all

I have looked forward with enjoyment to things.

○ As much as I ever did

○ Rather less than I used to

○ Definitely less than I used to

○ Hardly at all

I have blamed myself unnecessarily when things went wrong.

○ Yes, most of the time

○ Yes, some of the time

○ Not very often

○ No, never

I have been anxious or worried for no good reason.

○ No, not at all

○ Hardly ever

○ Yes, sometimes

○ Yes, very often

I have felt scared or panicky for no very good reason.

○ Yes, quite a lot

○ Yes, sometimes

○ No, not much

○ No, not at all

Things have been getting on top of me.

○ Yes, most of the time I haven't been able to cope

○ Yes, sometimes I haven't been coping as well

○ No, most of the time I have coped quite well

○ No, I have been coping as well as ever

I have been so unhappy that I have had difficulty sleeping.

○ Yes, most of the time

○ Yes, quite often

○ Not very often

○ No, not at all

I have felt sad or miserable.

○ Yes, most of the time

○ Yes, quite often

○ Not very often

○ No, not at all

I have been so unhappy that I have been crying.

○ Yes, most of the time

○ Yes, quite often

○ Only occasionally

○ No, never

The thought of harming myself has occurred to me.

○ Yes, quite often

○ Sometimes

○ Hardly ever

○ Never

Breastfeeding Behaviour

The follow questions will ask you about how you intended to feed your baby before giving birth as well as current feeding behaviours.

Prior to giving birth, did you intend to feed your baby by formula alone, breastfeeding alone, or a combination of both?

○ Formula feeding alone

○ Breastfeeding alone (including pumping breast milk)

○ A combination of formula feeding and breastfeeding

Did you breastfeed or try to breastfeed your baby, even if only for a short time?

○ Yes

○ No

Are you still breastfeeding, even if occasionally?

○ Yes

○ No

In weeks or months, how old was your baby when you stopped breastfeeding?

☐ [_____] Weeks:

☐ [_____] Months:

Multidimensional Scale of Perceived Social Support (MSPSS)

We are interested in how you feel about the following statements.

Since the birth of your baby, how often has support been available to you when you have needed it? Include companionship, assistance and other types of support you may have needed.

- ⭕ None of the time
- ⭕ A little of the time
- ⭕ Some of the time
- ⭕ Most of the time
- ⭕ All of the time

Read each statement carefully. Indicate how you feel about each statement.

	Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very Strongly Agree
There is a special person who is around when I am in need.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
There is a special person with whom I can share my joys and sorrows.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
My family really tries to help me.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
I get the emotional help and support I need from my family.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
I have a special person who is a real source of comfort to me.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
My friends really try to help me.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
I can count on my friends when things go wrong.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
I can talk about my problems with my family.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
I have friends with whom I can share my joys and sorrows.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
There is a special person in my life who cares about my feelings.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
My family is willing to help me make decisions.	⭕	⭕	⭕	⭕	⭕	⭕	⭕
I can talk about my problems with my friends	⭕	⭕	⭕	⭕	⭕	⭕	⭕

Perceived Stress Scale

The next set of questions will ask you about your feelings and thoughts **during the last month**.

Please select the answer that best aligns with how often you felt or thought a certain way in the last month.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
In the last month, how often have you felt that you were unable to control the important things in your life?	O	O	O	O	O
In the last month, how often have you felt confident about your ability to handle your personal problems?	O	O	O	O	O
In the last month, how often have you felt that things were going your way?	O	O	O	O	O
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	O	O	O	O	O

Block 11

THANK YOU!

You have now completed all of the questions in this research study. We sincerely appreciate your participation!

If you require any further information regarding this research project or your participation in the study you may contact Dr. de Vrijer at   . If you have any questions about your rights as a research participant or the conduct of this study, you may contact the Patient Experience Office at LHSC at   .

Feelings of stress and anxiety may arise from completing certain questions in this research study. If you feel that you would like to or need to speak to someone about how you are feeling, you can:

- Contact your primary care provider
- Call the London Mental Health Crisis Service at the London Health Sciences Center at
- Contact the CMHA Middlesex Support line at   . The toll-free number is   . This service is available 24/7 and can also be accessed via the "webchat" link found here: https://cmhamiddlesex.ca/programs-services/support-line/
- You can also have a follow-up consultation with Dr. de Vrijer or Dr. Eastabrook. If you would like to request this consultation, please call   and request a post-research study consultation.

Again, we sincerely thank you for your participation in this study.

Curriculum Vitae

EDUCATION

Candidate for Masters of Science *(One Health in Pathology and Laboratory Medicine)*   **2021**

The University of Western Ontario, London, Ontario

Bachelor of Science *(Honours in Health Studies with minor in Psychology)*   **2018**

The University of Waterloo, Waterloo, Ontario

RESEARCH EXPERIENCE

One Health Research Student   **September 2019 to 2021**

University of Western Ontario, London, Ontario

Neurobehavioral laboratory Volunteer Research Assistant   **September 2017 to April 2018**

University of Waterloo, Waterloo, Ontario

TEACHING EXPERIENCE

Chemistry Laboratory Teaching Assistant   **September 2016 to April 2019**

University of Waterloo, Waterloo, Ontario

SCHOLARSHIPS & ACADEMIC HONORS

Dutkevich Award for potential for research excellence   **April 2021**

University of Western Ontario

Frederick Banting and Charles Best Canada Graduate Scholarship-Masters   **2020**

University of Western Ontario

- Awarded for academic excellence, high potential research proposal, and strengths in interpersonal characteristics and collaboration

Applied Health Sciences Upper Year Scholarship   **2017**

University of Waterloo

- Awarded for a grade point average in the top 3 of all 2nd, 3rd, and 4th year students in the faculty of Applied Health Sciences in the previous year

Dean's Honor List   **2014/2018**

University of Waterloo

- Awarded for academic excellence on overall average grade of above 80% at the end of each term for 4 consecutive years

WORK & VOLUNTEER EXPERIENCES

Pharmacy Assistant   **October 2018 to July 2019**

Guardian Pharmalinx Pharmacy, Toronto, Ontario

EXTRA-CURRICULAR & VOLUNTEER EXPERIENCES

Vice-President of Social Events – WPA   **September 2020 – present**

University of Western Ontario, Ontario

Vice-President of Finance and Communications – WPA   **September 2019 – August 2020**

University of Western Ontario, Ontario

Hospital Volunteer   **May 2015 to December 2016**

Grand River Hospital, Kitchener, Ontario

CONFERENCE & WORKSHOP PARTICIPATION

19th Annual Paul Harding Research Awards Day   **May 2021**

University of Western Ontario, Ontario

- Will facilitate a 10-minute presentation on my current master's research on maternal mental health and the impact of the pandemic response, followed by question period

Pathology and Laboratory Medicine Research Day   **April 2021**

University of Western Ontario, Ontario

- Will present current master's research on the impact of the COVID-19 pandemic response on perceived stress, postpartum depression, and pregnancy outcomes in women within Southwestern Ontario

Annual One Health Day Conference   **November 2019 & 2020**

University of Guelph, Guelph, Ontario

- Gained currently knowledge on Canadian One Health related projects through keynote speakers and researchers passionate about conducting research with the One Health approach
- Presented research poster on Masters research project progress in person in 2019 and virtually in 2020

Own Your Future Workshops– Professional Development Program   **2019-2020**

Careers & Experience, University of Western Ontario, Ontario

- Gained tip and skills in academic writing, presentations, and career development through a series of different online seminars and workshops