Perinatal health inequalities between native-born and foreign-born women in Canada: A decomposition analysis

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Abstract

Background: Inequalities in perinatal health by maternal nativity status have been documented in various countries including Canada, whereby foreign-born mothers generally experience better perinatal outcomes than native-born mothers despite their relatively lower socioeconomic positions. However, the magnitude and direction of inequalities vary across outcomes, study settings (including originating and receiving countries of foreign-born mothers), and years of study. In this study, I examined the differences in fatal and non-fatal perinatal outcomes between native- and foreign-born women in a recent, nationally representative sample of Canadian births. The observed inequalities were further examined by decomposition analysis to quantify the contributions of parental important socioeconomic and demographic characteristics.

Methods: Using data from the 2016 Canadian Birth-Census Cohort, which contains information on births in the two years prior to the 2016 census date and detailed characteristics of the parents, I estimated the risk of preterm birth (PTB), small-for-gestational-age (SGA) birth, large-for-gestational-age (LGA) birth, stillbirth, and infant death by maternal nativity status, accounting for maternal ethnicity, maternal and paternal education, paternal nativity and employment, family income and homeownership as well as maternal age, marital status, activity limitations, and parity. I used the Kitagawa decomposition method extended to binary outcomes to decompose the inequality in each outcome by maternal nativity into group differences in the distribution and effect of the determinants and to quantify the contribution of each determinant to the inequalities.

Results: A total of 132,639 singleton births was included, of which 91,182 were born to native-born women and 41,457 to foreign-born women. Foreign-born women had a higher crude risk of all outcomes except LGA birth (Risk Ratio: 0.67, 95% CI: 0.65, 0.69), Risk Difference: -3.3%, 95% CI: -3.63, -2.97). The distribution of several determinants differed by nativity. For example, 90% of foreign-born women were married compared to 63% of native-born women; 22% of foreign-born women were White, compared to 92% of native-born women; and 61% of foreign-born women were homeowners, while 79% of native-born women owned their homes. However, associations from logistic regression analyses between the determinants and study outcomes were similar between nativity groups in magnitude and direction. For decomposition analyses, we found that maternal race and ethnicity was the highest contributor to the difference in non-fatal outcomes between nativity groups (PTB: 232%, SGA birth: 100%, LGA birth: 78%) and increased the gap between groups. For fatal outcomes, the fourth family income quartile contributed the most (stillbirth: -504%, death: -561%), and decreased the gap between groups, though the finding was not statistically significant for infant death.

Conclusion/Discussion: The results of this study show that foreign-born women had higher observed rates than foreign-born women, albeit by small magnitudes, for all perinatal health outcomes apart from LGA births in Canada. The results of this study suggest that foreign-born women would have lower rates of PTB, SGA birth, and LGA birth if they adopted the race and ethnicity distribution of Canadian-born mothers. Conversely, foreign-born women would have higher rates of stillbirth if they adopted the income distribution of Canadian-born women.

Résumé

Contexte: Des inégalités en santé périnatale selon le statut maternel à la naissance ont été documentées dans divers pays, dont le Canada, où les mères nées à l'étranger connaissent de meilleurs résultats périnatals que les mères nées au pays malgré leurs positions socioéconomiques relativement inférieures. Cependant, l'ampleur et la direction des inégalités varient selon les résultats, les contextes d'études et les années d'études. Dans cette étude, j'ai examiné les différences dans les issues périnatales mortelles et non mortelles entre les femmes nées au pays et à l'étranger dans un échantillon récent et représentatif à l'échelle nationale de naissances au Canada. Les inégalités observées ont été examinées par une analyse de décomposition afin de quantifier les contributions des caractéristiques socioéconomiques et démographiques parentales.

Méthodes: À l'aide des données de la cohorte canadienne des naissances du recensement de 2016, qui contient des informations sur les naissances entre 2014-2016 et des caractéristiques détaillées des parents, j'ai estimé le risque de naissance prématurée (PTB), petit pour-naissances en âge gestationnel (SGA), naissances grandes pour l'âge gestationnel (LGA), mortinaissances et décès infantiles par statut de nativité maternelle, en tenant compte de l'origine ethnique maternelle, de l'éducation maternelle et paternelle, de la nativité paternelle et de l'emploi, du revenu familial et de la propriété comme ainsi que l'âge maternel, l'état matrimonial, les limitations d'activité et la parité. J'ai utilisé la méthode de décomposition Kitagawa étendue aux résultats binaires. Cette méthode décompose l'inégalité de chaque résultat par nativité maternelle en différences de groupe dans la distribution et l'effet des déterminants et quantifie la contribution de chaque déterminant à l'inégalité de chaque résultat par statut de nativité.

Résultats: Un total de 132 639 naissances uniques a été inclut. Les femmes nées à l'étranger présentaient un risque brut plus élevé pour tous les critères, à l'exception de la naissance LGA (Rapport de risque: 0,67, IC à 95 % : 0,65, 0,69), Différence de risque: -3,3 %, IC à 95 % : -3,63, -2,97). La distribution de plusieurs déterminants différait selon la nativité. Par exemple, 92% des femmes nées à l'étranger étaient mariées contre 63% des femmes canadiennes par naissance; 22% des femmes nées à l'étranger étaient blanches, contre 92% des femmes canadiennes par naissance; et 61% des femmes nées à l'étranger étaient propriétaires, tandis que 79% des femmes canadiennes par naissance étaient propriétaires de leur maison. Cependant, les associations des analyses de régression logistique entre les déterminants et les résultats de l'étude étaient similaires entre les groupes de nativité. Pour les analyses de décomposition, nous avons constaté que la race et l'origine ethnique maternelles étaient les principaux contributeurs à la différence des résultats non mortels (PTB : 232%, naissance SGA : 100%, naissance LGA : 78%) et augmentaient l'écart entre les groupes. Pour les issues fatales, le quatrième quartile de revenu familial a le plus contribué (mortinaissance : -504%, décès : -561%), et a réduit l'écart entre groupes, mais le résultat n'était pas statistiquement significatif pour la mortalité infantile.

Conclusion/discussion: Les résultats montrent que les femmes nées à l'étranger affichaient des taux observés plus élevés que les femmes canadiennes par naissance, bien que de faible ampleur, pour tous les résultats de santé périnatale à l'exception des naissances LGA au Canada. Les résultats suggèrent que les femmes nées à l'étranger auraient des taux plus faibles de PTB, de naissance SGA et de naissance LGA si elles adoptaient la répartition raciale et ethnique des mères canadiennes par naissance. De plus, les femmes nées à l'étranger auraient des taux de mortinaissance plus élevés si elles adoptaient la répartition du revenu des femmes canadiennes par naissance.

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Contribution of Authors

Manuscript 1

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As the first author of this thesis, I, Melia Alcantara, composed the research question, conducted the literature review, and wrote and edited the thesis manuscript with the guidance of my supervisor, Dr. Seungmi Yang. Dr. Shapiro, Dr. Yang's postdoctoral student, derived several of the variables used for the analyses, and I further prepared the data and conducted all statistical analyses. I wrote the first draft of the manuscript in Chapter 5 and edited subsequent drafts with comments and suggestions from Dr. Yang and Dr. Harper.

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List of Abbreviations and Acronyms

PTB	Preterm birth
SGA	Small-for-gestational age
LGA	Large-for-gestational age
SEP	Socioeconomic position
USA	United States of America
CanBCC	Canadian Birth Census Cohort
AGA	Appropriate-for-gestational-age
CI	Confidence interval
LICO	Low-income cutoff
CCTB	Canada Child Tax Benefit
RR	Risk ratio
RD	Risk difference

Chapter 1 – Introduction

Perinatal health describes the health of women and their babies before, during, and after childbirth (1). It is often assessed, among others, by the occurrence of preterm birth (PTB), small-for-gestational-age (SGA) birth, large-for-gestational-age (LGA) birth, stillbirth, and infant death (2). Together, these outcomes offer a comprehensive overview of perinatal health for a population and provide insight into population health overall. Perinatal health varies across distributions of maternal and paternal demographic, socioeconomic, and ethnocultural characteristics (2, 3). For example, education impacts perinatal health often along a gradient, wherein mothers with lower education experience poorer outcomes (3-5). This is partly because lower educational attainment is associated with higher likelihoods of unhealthy behaviours coupled with less use of healthcare services (5). Lower education is also associated with limited employment opportunities and social capital, which can contribute to further poverty across the life course and consequently adverse health including perinatal outcomes (5).

In various high-income countries, including Canada, studies have shown that various ethnic and racial groups of foreign-born women experience better pregnancy outcomes than native-born women, despite foreign-born women's relatively lower SEP (2-4). This phenomenon has been referred to as an epidemiological paradox and has partially been explained by the healthy migrant effect (6), whereby foreign-born individuals are healthier upon arrival in their host country compared to the native-born population. Key to explaining this is the idea that countries may select immigrants who are more likely to succeed, such as those with higher education, higher language proficiency, and better overall health (6). Individuals who choose to immigrate may also have an underlying resilience or motivation to move or may be healthier than others who remain in their country of origin (6).

Importantly, there are also studies that have shown that foreign-born mothers experience poorer perinatal outcomes compared to native-born women (2, 7, 8). For instance, in a study of 1,178,848 live births in the Netherlands, the authors showed that cause-specific and all-cause infant death was higher amongst immigrant mothers (i.e., Turkish, Moroccan, Surinamese, and Antillean/Aruban women) compared to Dutch-born mothers, and the association remained after adjusting for infant sex and maternal demographic and socioeconomic characteristics (e.g., income, age, parity, etc.). The authors also showed that all immigrant groups occupied lower SEPs (measured via neighborhood income) than Dutch-born mothers (7). However, a meta-analysis of studies on foreign-born status and perinatal outcomes in the United States of America (U.S.A.) showed conflicting results (8). Specifically, foreign-born Black and Hispanic mothers experienced a lower risk of PTB and low birth weight than their U.S.A.-born counterparts, but foreign-born Asian and White mothers did not experience this protective effect of nativity. These studies show that the role of nativity is not monotonic, and it is important to assess multiple outcomes and consider both nativity and race and ethnicity in perinatal health research to better understand the role of maternal nativity status.

Other authors have suggested that the norms surrounding working and health from an immigrant's country of origin are important to account for, such as a lower percentage of women contributing to the workforce, significant social support surrounding pregnancy, or less risky behaviours (e.g., less smoking or alcoholism) (9). This implies that the typical measures of SEP, including income, education, and occupation, might not adequately encompass the living conditions of immigrants. For instance, lower educational attainment does not necessarily indicate a more precarious work situation for immigrant women who are not in the workforce. Further, immigrants are more likely to hold lower-level jobs upon immigrating than they held in their country of origin, regardless of their level of education (9). This means that high educational attainment for foreign-born women may not indicate a high-level occupation after immigrating (9). These arguments show the complexities of evaluating SEP and perinatal health amongst immigrant mothers.

The goal of this research was to better understand perinatal health differences between foreign- and native-born mothers in Canada by estimating inequalities by maternal nativity status in ***multiple*** perinatal health outcomes—PTB, SGA and LGA birth, stillbirth, and infant death based on the 2016 Canadian Birth Census Cohort (CanBCC), the most recent nation-wide perinatal health database in Canada. To explore this further, the inequalities between foreign- and Canadian-born women in Canada were decomposed using Kitagawa's decomposition analysis (10) extended to binary outcomes (11) to quantify the contributions of each of several determinants of perinatal health, including maternal and paternal demographic and socioeconomic characteristics, to the inequality by maternal nativity status.

In Chapter 2, I summarize the literature surrounding the epidemiological paradox and the risk factors associated with the outcomes of interest. Then, in Chapter 3, I state the study objectives followed by Chapter 4 where I describe the methods used to meet the study objectives, including a description of the 2016 CanBCC and the use of logistic regression and decomposition analysis models. Next, Chapter 5 consists of a manuscript wherein I recount the study results while discussing the discussion points for the project. In Chapter 6, I move to conclude the thesis by reiterating the study objectives and main findings and identifying some future directions.

Chapter 2 – Literature Review

In this chapter, I begin with the definition of each outcome, followed by descriptions of associated non-social risk factors. I then present existing evidence surrounding the social risk factors of adverse perinatal health outcomes including maternal nativity, which are of particular interest for this study. I end the section by summarizing the body of evidence on the epidemiological paradox in perinatal health.

2.1 Study outcomes and known risk factors

2.1.1 PTB

PTB is defined as birth before 37 completed weeks of gestation and is implicated in nearly 35% of global deaths amongst newborns aged less than 28 days and 18% of global deaths for children under the age of 5 years (12). Worldwide, PTBs are more prevalent amidst low- and middle-income countries than high-income countries, and often these countries experience a worse prognosis for infants born preterm due to insufficient resources or facilities to care for the infants (13). In 2020 in Canada, the prevalence of PTB was 8.2% (14). PTBs can occur spontaneously or be medically indicated and induced by a healthcare provider (15). When PTBs are induced, the induction is typically due to maternal or fetal distress or health risk such as preeclampsia, placenta previa, or multiple gestation. Four major conditions are associated with an elevated risk of PTB: intrauterine infection, maternal or fetal stress, decidual hemorrhage, and excessive uterine stretch (15). PTB tends to repeatedly occur within mothers. For instance, in a study of 8,542 Canadian women, Heaman et al. showed that women with a history of PTB, as well as abortion or miscarriage, were more likely to have a PTB in subsequent pregnancies compared to women with no such history (16). PTB is also more common amongst women with congenital or acquired uterine malformations, chronic medical disorders (e.g., renal insufficiency, hypertension, or type 1 diabetes mellitus), multiple births in a pregnancy, increased perceived stress, a history of smoking, and infections (15, 16). Studies have also shown that the risk of PTB was higher for women in both early and late child-bearing years, potentially due to physiological immaturity and lower SEP for young mothers and chronic disease for older mothers (15). Nevertheless, despite the known major risk factors for PTB, approximately two thirds of spontaneous PTBs occur in women with no known risk factors (15).

As there has been an increase in the survival rate for preterm infants with healthcare advancements, long-term outcomes of PTB have also been studied. PTB is associated with a heightened burden on healthcare and education systems (16) and multiple conditions such as respiratory distress, seizures, infections, apnea, and rehospitalizations in infancy (17). In childhood, infants born preterm are more likely to experience impairments in motor development, academic performance, and behaviour compared to their peers born at term (18). In adulthood, preterm infants continue to face medical and learning difficulties, and a host of other problems. For example, a Norwegian cohort study that followed more than 860,000 term and preterm infants from birth through adulthood and assessed several conditions reported that adults who had been born preterm were not only more likely to experience cerebral palsy, mental retardation, autism spectrum disorder, but also less likely to achieve higher education, hold jobs, and more likely to receive social security benefits including disability pension than adults who were born at term (19).

2.1.2 SGA and LGA birth

SGA birth is defined as infants who are born with birth weights below the 10^{th} percentile for sex and gestational age, and LGA birth is defined as infants who are born above the 90^{th}

percentile for sex and gestational age. In the present study, both outcomes are based on a Canadian population-based reference (20). Notably, Urquia et al. conducted a study using birth weight curves that were tailored to the region of origin of mothers to determine whether region-specific curves might better classify infants as SGA, appropriate-for-gestational-age (AGA), or LGA (21), than one curve for all infants. The authors found that SGA births to mothers of East and South Asian descent were often overestimated by the Canadian reference, while LGA births to these mothers were underestimated. Thus, the birth weight distribution is likely shifted to the left for Asian mothers. This study shows that a mother's country of origin is important to consider when defining SGA and LGA birth. For the current study, SGA and LGA birth are defined based on the Canadian population-based reference, instead of a reference based on maternal region of origin, because the former is typically used in perinatal health studies and has been used for previous studies using CanBCC data (2, 22, 23). Still, I consider region-specific birth weight distributions in discussing results.

There are several biological and behavioural risk factors associated with SGA birth, but the risk factors for LGA birth are relatively less examined. Women with a history of SGA birth or miscarriage (24), gestational hypertension or preeclampsia (25), multiple births in a pregnancy, low pre-pregnancy weight, low weight gain during pregnancy or short stature, are at a higher risk of giving birth to SGA babies (25). Conversely, it is logical then that the risk factors for LGA include high pre-pregnancy weight, high pregnancy weight gain, and gestational diabetes (24, 26). For behavioural risk factors, women who smoke during pregnancy are more likely to experience SGA birth (16).

Understanding the risk factors of SGA and LGA birth is important, as these infants are at risk for morbidity and mortality later in life. SGA infants are at higher risk of infant death compared to AGA infants and at risk of long-term health and cognitive deficits (27). For instance, in a British study that followed 14,189 full-term infants for 26 years, the authors found that SGA infants had lower academic achievement and more difficulties in school than AGA infants after adjustment for sex, region of birth, maternal and paternal social class, and neonatal distress (28). This study adds that even SGA infants who were born at term experienced long-term difficulties compared to AGA infants born at term. The authors also reported that SGA infants were more likely to work as unskilled, semiskilled, or manual laborers than their AGA counterparts. A higher number of SGA infants working in these occupations also meant that SGA infants had a lower income, on average, compared to infants born at term (28).

On the opposite end of the absolute birth weight spectrum, infants born LGA are also at an elevated risk for multiple conditions from birth through to adulthood. Starting at labour, LGA infants are susceptible to complications including shoulder dystocia, brachial plexus injury (29), and longer hospital stays compared to AGA births (30). Later in adulthood, LGA infants are more likely to experience obesity, diabetes mellitus (type 1 and 2), and cardiovascular and metabolic complications compared to AGA infants (29). The mothers of LGA infants are also at a higher risk of complications than AGA infants, such as postpartum hemorrhage (30).

2.1.3 Stillbirth and Infant Death

Stillbirth is defined as fetal death at a gestational age of at least 20 weeks or a birth weight greater than or equal to 500 grams in Canada. Infant death describes a death of a live birth before the age of one. Infant death is considered an important public health indicator, and stillbirth potentially allows for an assessment of avoidable deaths via identifying areas for improvement in perinatal care (31).

Two of the most important risk factors for infant death are gestational age and birth weight, as babies who are born too early (< 37 weeks of gestation) or too small (birth weight below the sex- and gestational age-specific 10^{th} centile) are at an elevated risk of death (32). Luque-Fernandez commented that being born prematurely (before 36 weeks of gestation) was the leading risk factor for infant death in their study of over 970,000 births in Spain (31), and elsewhere other researchers have noted that the risk of perinatal death increases as gestational age decreases (17). Infant sex is also associated with infant death, where the infant death rate for males is higher than for females (32). Mothers with multiple births also experience an elevated risk of infant death and the risk increases as the number of babies in a pregnancy increase (32).

For stillbirth, an elevated risk has been found amongst women who give birth after 41 weeks of gestation (33), who are over the age of 35 years, or who have late first antenatal care visits or no antenatal care, and in women who smoke or use illicit drugs during pregnancy (34, 35). Several maternal medical conditions influence the risk of stillbirth, where women experiencing diabetes mellitus (type 1 and 2), pre-existing hypertension, intrauterine growth restriction, oligo- or polyhydramnion, and acute sepsis are at an elevated risk compared to mothers without one of these conditions (34). Diabetes mellitus and hypertension, specifically, can increase the risk of stillbirth by approximately 5 times and 3 times, respectively (34).

2.2 Social risk factors of perinatal health outcomes

In this section, I delve into the social risk factors associated with each outcome. A logical place to begin is with SEP (e.g., education, income, and employment), as inequalities in perinatal health by SEP are consistent in the literature. These inequalities are present and persistent not only in countries like the U.S.A, where healthcare is private (5), but also in countries like Canada (16), Spain (36), and Norway (19), where healthcare is free and readily accessible.

2.2.1 Education

Education is often noted as one of the most important measures of SEP in predicting health (5). For parents, higher educational attainment impacts perinatal health by bettering the knowledge about and access to quality prenatal care, decreasing unhealthy behaviors such as smoking and poor nutrition, and increasing employment and thus, income earning opportunities (5, 23).

Studies have found that infants born to mothers with lower levels of education are at a higher risk of being born preterm (12, 16, 23, 36-38). For instance, compared to mothers with university degrees or above, both mothers who did not graduate high school and mothers who had only postsecondary diplomas or certificates had a higher risk of PTB (23). The protective effect of education has also been found for SGA birth. In two studies that compared the associations between maternal education and PTB and SGA birth, the authors showed that higher maternal education was associated with a lower risk of both outcomes (23, 39). Bushnik et al.'s study (23) was also interested in the role of income and found that, for SGA birth alone, the risk was slightly attenuated after adjusting for income, though it remained statistically significant.

For LGA births, the literature presents an opportunity for this project, as studies evaluating the impact of SEP (including education, income, and employment) and LGA birth are limited. Of the small body of literature, a large comparative population study examined the association between maternal education and SGA and LGA birth in all singleton births from the Medical Birth Registries for Denmark, Finland, Norway, and Sweden between 1981 and 2000 (40). The authors showed that low maternal education was associated with a decreased risk of LGA in all four countries, while low maternal education was associated with an increased risk of SGA (40). For instance, between 1981-1985 in Denmark, mothers with less than ten years of education experienced an excess of 44 cases of SGA birth (95% CI: 40, 48) per 1,000 births, compared to mothers with greater than 12 years of education. During the same time period, Danish mothers with less than ten years of education experienced 10 less cases of LGA birth (95% CI: -13, -8) per 1,000 births, compared to mothers with greater than 12 years of education (40). The strength and direction of associations was similar across years and across countries.

In the same way that parental education plays an integral role in PTB, education is often cited as an important risk factor for fatal perinatal outcomes. Lower levels of maternal education are associated with stillbirths, neonatal, and postneonatal deaths, and the risk decreases with increasing education (41-44). Luque-Fernandez showed, in their Spanish observational study, that the rate of stillbirth amongst mothers with secondary education or lower (1.71 per 1,000 births, 95% CI: 1.60, 1.82) was higher than amongst mothers with upper secondary or first stage of tertiary education (1.04, 95% CI: 0.90, 1.20) and completed tertiary education (0.75, 95% CI: 0.60, 0.90) (31). In a Swedish study, Gisselman et al. suggested that, as educational attainment amongst women increases over time, the risk of infant death amongst mothers with a high school education or lower may increase. This is because higher overall levels of education in society may demand higher educational attainment in the workforce and increase the inequality in infant death between women of high and low education levels (41). This study highlights the increasing importance of maternal education in perinatal health over time.

Lastly, Shapiro et al. used data including singleton births in Canada between 2004 and 2006 (the 2006 CanBCC) and sought to examine the role of paternal education as well as maternal education in various adverse perinatal outcomes (22). The authors found that births to mothers with a university degree or higher were associated with lower risks of PTB, SGA birth, and stillbirth. Maternal education, however, was not associated with infant death. For paternal education, infants of fathers with a level of education below university experienced a higher risk of PTB, and this risk was higher for very PTB (< 34 weeks) infants compared to late PTB (34-36 weeks) infants. For infant death, the elevated risk for fathers with less than a university degree was more pronounced for postneonatal death than neonatal death, which may be explained by higher deaths due to sudden infant death syndrome and accidents among the older infants (22). This study demonstrates that paternal education may impact adverse perinatal outcomes independently of maternal education and thus, should be additionally considered in perinatal studies.

2.2.2 Income

Another important measure of SEP and determinant of perinatal health is family income, which is related to parental education (23). For instance, individuals with higher education may have more high-paying job opportunities available and thus, have a higher income. However, it is well recognized that although education and income are positively correlated, they are not interchangeable and tap different aspects of one's socioeconomic circumstances (23).

Some studies have shown that lower income is associated with higher PTB, but others have found no association (16, 38). Using a sample of 8,542 women from the Canadian Maternity Experiences Survey, Heaman et al. reported that the odds of PTB for women under the low-income cutoff (LICO) compared to mothers above the LICO was 1.3 (95% CI: 1.0, 1.7), but as the CI included 1, income (dichotomized as at or below LICO and above the LICO) was not included in adjusted analyses (16). The authors also found that women under the LICO were more likely to experience SGA birth (OR: 1.5, 95% CI: 1.2, 1.8), however the association did not remain after adjustment for all maternal characteristics (e.g., age, marital status, medical history, etc.). This suggests that income is not associated with PTB and that other confounders may attenuate the association of income on SGA birth. Snelgrove et al. showed that women whose income fell into the fourth income quintile had a lower risk of PTB compared to women whose income fell in the lowest quintile, while the differences in PTB risks for the other quintiles (compared to the reference category of the lowest quintile) were not statistically significant (38). This shows that the role of income may not be monotonic.

Another income-related measure of material wealth to assess is homeownership (38). Snelgrove et al. found that women had a higher risk of giving birth preterm if they did not own their homes, compared to mothers who rented or did own their homes (38). This association remained after adjustment by maternal age and parity but was no longer statistically significant after adjustment for all maternal material and psychosocial determinants (e.g., ethnicity, alcohol consumption and smoking, mode of delivery, etc.). However, in a separate study examining racial inequities in SEP and infant death in the U.S.A., the authors showed that Black people were 37% less likely to own their homes and that this inequality in homeownership was associated with higher infant death rates for Black people. These studies show that the role of homeownership may differ by outcome being assessed and the racial and ethnic groups of the parents (45).

For SGA birth, Bushnik et al. found that, compared to mothers with family income in the highest quintile, all mothers in lower quintiles experienced an elevated risk (23). There was also an education gradient in the rate of SGA births within income quintiles, where rates decreased as education increased. This is consistent with income patterns seen for PTB. Li et al., in a Swedish study of over 800,000 births between 1990-2004, found that mothers with a lower familial income per capita experienced elevated odds of SGA birth (46). The authors suggested that mothers of lower income might be more prone to low social participation, smoking, and poor nutrition and thus, at higher risk of adverse perinatal health outcomes.

For LGA birth, one study conducted in Manitoba, Canada showed that low-income women who received an income supplement during their second or third trimesters were at an elevated risk of LGA birth compared to low-income women who did not receive the supplement (47). This study implies the role of elevated income in increasing LGA births amidst low-income women. The authors could not determine why the income supplement was associated with increased LGA births, though they suggested that poor prenatal nutrition may have been associated with the increase (e.g., purchase of unhealthy foods) (47).

Finally, using a compilation of data on all 50 American states from 2000-2004, Olson et al. analyzed death for infants that fell under the federal poverty level and illustrated that the risk of neonatal and infant death decreased as income increased (48). The authors further argued that PTB, low birth weight, and infant death amidst the poorest infants in the U.S.A. were impacted more heavily by absolute income (i.e., median family income) than relative income (i.e., income inequality measured using the Gini coefficient), suggesting that some infants may suffer from poor perinatal health due to their basic needs not being met (48). This highlights the role of income as a measure of one's ability to access basic needs, perhaps through purchasing power or material conditions. Similarly, Dallolio et al. evaluated the relationship of absolute and relative income with infant death in Italy and found that the infant death rate decreased as regional absolute income (i.e., mean household income) increased, while the infant death rate increased as the relative income (i.e., Gini Coefficient) increased, indicating that infant death was higher in regions with higher income inequality (49). These studies suggest that both one's access to material wealth and the distribution of wealth impact the association between income and fatal perinatal outcomes.

2.2.3 Employment

The third measure of SEP that is commonly used in health research and has been cited as a risk factor for adverse birth outcomes is parental employment and related characteristics such as the number of hours worked and parental occupation. Overall, both maternal and paternal employment during pregnancy seems to be protective for PTB (38, 50-52). For instance, a cross-sectional study of mothers in Poland showed that mothers who were unemployed at pregnancy were at a statistically significant higher risk of PTB compared to employed mothers, and the association remained after adjustment for several maternal characteristics (e.g., age, height, education, marital status, etc.) (52). The adjusted association between SGA birth and maternal unemployment showed a positive relationship, but was imprecise (OR: 1.42, 95% CI: 0.78, 2.60). The authors further noted that women who were not employed during pregnancy and were not looking for a job were at a lower risk for SGA birth than employed mothers. This finding is consistent with the idea that lower occupational exposures or work-related stress are protective against adverse birth outcomes (52). However, it is also possible that women who were not looking for employment were of a higher SEP, so a dichotomized employment status alone would not appropriately represent one's socioeconomic circumstances.

Parental employment is also associated with infant death and stillbirth. In a Korean study of over 1,300,000 births between 2004 and 2006, Ko et al. showed that both term and preterm infants with unemployed mothers or both unemployed parents experienced a higher risk of infant death compared to infants with both parents employed (44). Interestingly, father's unemployment was not statistically significantly associated with the outcomes, independent of maternal employment status. A study conducted in Spain found that maternal unemployment was associated with stillbirths at an individual-level and also showed that mothers residing in regions with the highest levels of unemployment experienced more than double the odds of stillbirth (53). Altogether, these studies suggest that parental unemployment is associated with a higher risk of adverse perinatal outcomes.

Evidence shows that several other employment-related characteristics are also implicated in perinatal health. For instance, the hours worked by a parent appear to be important in the literature. A meta-analysis of 16 studies found no association between shift work and PTB but a slightly elevated risk of PTB for mothers that worked long hours while pregnant (54). Women working more than 42 hours experienced a higher risk of PTB than their counterparts who worked 30-39 hours, showing that long hours can impact pregnancy outcomes (51).

Another factor to consider is the type of work partaken by parents. In a Swedish study of 725 stillbirths compared to live births, the authors showed that unskilled and skilled blue-collar workers and low-level white-collar workers had a higher risk of stillbirth compared to intermediate and high-level white-collar workers (55). They postulated that this finding came from how high-level white-collar workers sought antenatal care more frequently, were healthier, smoked less, and had not been exposed to social deprivation for as long, or at all, compared to their counterparts (55). Similarly, Li et al. showed, in a sample of more than 800,000 births in Sweden, that certain occupational groups, such as miners, welders, and glass, ceramic, and tile workers, are associated with a higher risk of PTB after adjustment for several covariates including maternal age, period of birth, family income, and smoking behaviours (56). This finding was true for both maternal and paternal occupation. The authors state that higher PTB risk may be due to workplace exposures or physically demanding work. Another author mirrored this finding and showed that both mothers or fathers working as manual workers (i.e. industrial or agricultural workers) had an elevated risk of PTB compared to working professionals or associates (51). In another study by Li and colleagues, evaluating the risk of various occupations on SGA birth, mothers who were manual workers (e.g., wood, beverage manufacture, warehouse workers, etc.) experienced an elevated risk compared to working professionals or associates (e.g., teachers, dentists, administrators, etc.) (46).

2.2.4 Race and ethnicity

Race is a biological construct which suggests that people can be categorized based on physical traits determined by genetic variations (e.g., skin colour). Conversely, ethnicity is a social construct that is based on peoples' social interactions, cultures, and how they perceive race in their environment (e.g., racism) (57). Today, researchers favour ethnicity, as the biological construct of race has been criticized due to a body of research showing that there is more genetic variation within a race than between races (57). This research suggests that, to understand differences in health between racial and ethnic groups, the wider social environment of the study must be considered. For instance, there is a body of research showing that Black women in the U.S.A., regardless of whether they were born in the U.S.A. or immigrated from elsewhere, experience a higher rate of adverse perinatal health outcomes than White women in the U.S.A., but also Black women that live outside the U.S.A. (58). This suggests that there may be other factors influencing worse health amidst Black women in the U.S.A. Beyond biological factors, the potential impact of both individual and structural determinants of health, such as SEP, structural racism, and sociopolitical barriers to health and wealth, must be considered (58). Unfortunately, information on race and ethnicity are often compounded into one variable, but as the previous example shows, it is essential to consider the social context of the study to situate research findings (57, 58).

Even though race and ethnicity are typically compounded into one variable, they are important to consider and are frequently adjusted for or examined in studies of perinatal health. This is because the prevalence of various outcomes differs by racial and ethnic groups. For instance, Almeida et al. showed that rates of PTB differed across racial and ethnic groups in the U.S.A.: 7.0% for non-Hispanic White mothers, 13.5% for non-Hispanic Black mothers, 10.4% for American Indian/Alaskan Native mothers, 9.1% for Hispanic mothers, and 8.4% for Asian/Native Hawaiian mothers (59). Using a sample of 9,470 women in the U.S.A., Grobman et al. also showed that non-Hispanic Black women were more likely to experience both PTB and SGA birth than non-Hispanic White women, and non-Hispanic Black, Hispanic, Asian women, and women of other racial and ethnic groups were more likely to experience SGA birth than non-Hispanic White women (60).

The prevalence of fatal outcomes also differs by maternal race and ethnicity. In a study of 554,234 singleton births in the Netherlands, the authors found that stillbirths (defined as death of an unborn child antenatally or during labour) were higher for South Asian, African, other non-Western (i.e., Surinam, African, Creole, South Asian, Hindustani), and Turkish/Moroccan women, compared to Dutch women (61). They also found that early neonatal death (death up to 7 days after birth) rates varied by racial and ethnic groups, where South Asian and African women experienced higher rates compared to Dutch women. Both the stillbirth and neonatal death models were adjusted for maternal age, low income, smoking and comorbidities, urbanization (based on number of addresses per square kilometer: very urban, intermediate urban/rural, and very rural), and neighborhood SEP (indicator based on the education, employment, and income of those living in the neighborhood). Of the racial and ethnic groups assessed in the study, the African, South Asian, Turkish/Moroccan and other non-Western mothers occupied lower SEPs than Dutch mothers (61). Canadian studies also report inequalities in perinatal health by maternal race and ethnicity. One study examined the risk of various birth outcomes in 237,293 Asian and White women in Ontario and found that Asian women experienced a higher risk of PTB, low birth weight, and SGA birth compared to White women while experiencing lower risks of LGA birth (62). These associations remained after adjustment for covariates including maternal age, household income, health comorbidities, and parity.

Taken together, these studies show that racial and ethnic inequalities in perinatal outcomes have been documented and suggest that race and ethnicity should be considered when examining perinatal health. Several authors have suggested that race and ethnicity are associated with perinatal health outcomes through stress models, where certain groups experience a higher risk of adverse perinatal health outcomes due to increased acute, psychosocial, or financial stress (59, 60). However, the literature is mixed on the role of stress (59, 60). It has also been suggested that the inequalities are due to socioeconomic differences between racial and ethnic groups, where mothers of racial and ethnic minorities are typically of lower SEP and thus, at an elevated risk of adverse perinatal health outcomes (61). These studies show the importance of considering and adjusting for maternal race and ethnicity in perinatal health studies.

2.2.5 Maternal nativity and an epidemiological paradox

Our understanding of the role of race and ethnicity in perinatal health is complicated as it is related to one’s nativity, country of origin, and socioeconomic conditions. In addition, the patterns of the complicated associations vary across outcomes. For instance, Mathews et al. showed that native-born mothers in the U.S.A. experienced an infant death rate that was 39%

higher than mothers born elsewhere (32). The authors showed that the influence of nativity on death differed by race and ethnicity and suggested that nativity may impact perinatal outcomes through differences in migration selectivity, social support networks, and risky behaviours (32). Moreover, there is evidence on potential interactions between nativity and SEP. In Brussels, foreign-born women in low SEPs had a lower risk of infant death and low birth weight than native-born mothers at similar SEPs, however this finding did not hold for mothers of higher SEPs (4). The authors further noted that their measures of SEP—education and employment status—had differential effects depending on the foreign-born group and suggested that various SEP measures, such as living conditions and social integration, need to be considered (4). For instance, when both parents were unemployed, all foreign-born groups had lower rates of low birth weight than Belgian mothers, but when both parents were employed, Turkish and Eastern European mothers had similar low birth weight rates to Belgian mothers, and sub-Saharan African mothers had a higher rate than Belgian mothers (4). This illustrates the importance of SEP in perinatal outcomes and the challenge of capturing the complexity of SEP for foreign-born populations, as several measures of SEP are not always readily available, and the impact of SEP may differ by population.

The country of origin of mothers may also impact perinatal health. In Spain, Stanek et al., found that mothers who had immigrated to Spain from Africa and Latin America had a lower likelihood of low birth weight than Spain-born mothers (3). Contrastingly, mothers from European countries had a similar low birth weight prevalence as Spain-born mothers, also illustrating that there are discrepancies in the paradox by racial and ethnic groups (3). Using multivariable survival analysis in a national Canadian study, Vang et al. showed that foreign-born women consistently had lower infant death rates than Canadian-born women, except for a few groups: Haitian, non-Spanish Caribbean, Pakistani, and Sub-Saharan African infants experienced elevated risks of neonatal death, and Pakistani and Haitian infants experienced elevated postneonatal death risk compared to infants born to Canadian-born women with the same racial and ethnic background (63).

We must also consider a paradox, whereby foreign-born women generally experience better perinatal health outcomes than native-born women, despite their relatively lower SEP (2-4). An epidemiological paradox in perinatal health has been observed in Canada, but also in countries like the U.S.A. (64), Spain (3), Sweden (37), Belgium (4, 9), and Taiwan (65). The paradox has been found across several perinatal outcomes and previous research provides a roadmap of factors to consider when studying the paradox. In a study examining singleton births in Canada between 2004-2006, Yang et al. found that foreign-born mothers experienced lower risks of PTB, LGA birth, stillbirth, and infant death and a higher risk of SGA birth compared to Canadian-born mothers across most racial and ethnic groups (2). They further noted that, although foreign-born women were often assumed to be socioeconomically disadvantaged compared to Canadian-born women, they were more likely to have earned university degrees than Canadian-born women (2). This finding reflects in part Canada’s priority for immigrants who are highly educated and have sound knowledge of the official languages of Canada. Further, consistent with Khanolkar et al. (37)’s study in Sweden, more recent immigrants experienced a lower risk of PTB, LGA birth, stillbirth, and infant death, highlighting the role of duration of residence and indicating possible effects of assimilation on health outcomes in Canada (2). However, this study did not examine other SEP indicators such as family income, and thus was limited in demonstrating whether foreign-born women were indeed at lower SEP overall.

Other studies in Canada have also highlighted the importance of assessing adverse outcomes and the paradox by racial and ethnic groups, along with differences by education level. In a study of births in Ontario, Canada, Park et al. found that, although foreign-born mothers as a single group experienced lower risk of PTB than Canadian-born mothers (66), the PTB of mothers from sub-Saharan Africa and the Caribbean were elevated compared to other racial and ethnic groups. The authors showed that infants whose parents were both immigrants experienced lower rates of PTB than infants whose parents were both Canadian-born, and immigrant couples were more likely to be in the two lowest income quartiles than Canadian-born couples (66). Auger et al. showed that being foreign-born in Montreal, Canada was associated with decreased SGA birth and low birth weight, but elevated PTB, again showing that the perinatal health differs by outcome (67). The authors noted that foreign-born mothers were less likely to be educated than Canadian-born mothers (42% versus 54%), thus supporting a paradox in perinatal health.

In the U.S.A., Garcia et al. showed that being foreign-born was protective for Black and Hispanic mothers, harmful for Asian mothers, and did not affect the risk of low birth weight for White mothers compared to native-born mothers within the same racial and ethnic groups (68). However, foreign-born status was found to be more protective for Black, Hispanic, and White women of lower levels of education compared to those of higher education, again showing an epidemiological paradox (68). It was suggested that foreign-born women of higher educational attainment experience extra stress when trying to find employment comparable to that in their country of origin and such stress and additional psychosocial challenges may be associated with worsened perinatal outcomes (9, 67).

2.3 Summary

Taken together, these findings call for a further understanding of the role of a mother's race and ethnicity, the differences in the paradox by outcome being assessed, and of the specific contribution of various SEP measures to perinatal health. Altogether, these factors form complex relationships, where adverse perinatal outcomes differ by maternal nativity status, SEP, and race and ethnicity, and potentially by specific outcomes, but each factor is inter-related with the next.

Most studies have examined associations between a single "exposure" of interest (e.g., nativity status) and perinatal outcomes in conventional multivariable regressions, estimating the direction and the strength of the association after controlling for other variables as covariates. Although these results help us understand the extent of perinatal inequality by nativity status while accounting for other important risk factors or covariates, they neither identify important contributing factors to the observed inequality in a specific outcome, nor estimate the contributions of the identified factors to the observed inequality. To fill this gap, I employed Kitagawa's decomposition analysis methods (10) for binary outcomes (11), which is a regression-based technique allowing for one to 'unpack' the inequality in outcomes between two groups by estimating variable-specific contributions to the inequality (11, 69).

Chapter 3: Objectives

Objectives of this study were two-fold:

(1) To examine differences in multiple perinatal health outcomes—PTB, SGA and LGA births, stillbirth, and infant death—between foreign- and Canadian-born women in a national representative sample of Canadian births between 2014 and 2016; and

(2) To quantify the contributions of several parental demographic, socioeconomic and ethnocultural characteristics to the observed inequality in the outcomes.

Chapter 4: Methods

4.1 Data

The current study was conducted using the 2016 CanBCC dataset accessed at the McGill-Concordia Laboratory of the Quebec Inter-university Center for Social Statistics. The 2016 CanBCC comprises Canadian births that occurred in the two years prior to the 2016 census date (May 10, 2014, to May 10, 2016) and whose parents completed the 2016 long-form census questionnaire. The cohort was created by linking the 2016 long-form census questionnaire data with the Canadian Vital Statistics – Birth database, the Canadian Vital Statistics – Death database, and the T1 Personal Master Files at Statistics Canada. The linkage was performed prior to this thesis project by Dr. Seungmi Yang's research team. The long-form census questionnaire collects detailed sociocultural, mobility, and market labour activity information, such as country of origin, self-identified ethnicity (including Indigenous identity), immigration status, education level, occupation, income, and housing characteristics, additional to the short-form census questionnaire that collects basic demographic information (e.g., individual household member names, address, date of birth, sex, mother tongue, marital status, and relationship to Person 1, the person filling out the questionnaire). The 2016 census long-form questionnaire was distributed to 25% of enlisted Canadian households. All enumerated households in Indigenous communities, including those enumerated in remoted and northern areas, received the long-form questionnaire. The 2016 CanBCC data, along with the 1996 and 2006 CanBCC, are unique national data sources with information on both perinatal health and detailed parental socioeconomic and ethnocultural background throughout Canada, enabling perinatal health inequalities to be examined at a national level.

To create the 2016 CanBCC dataset, several steps were undertaken at Statistics Canada (70). In brief, infant death records from the Canadian Vital Statistics – Death database were first probabilistically linked to live birth records using a linkage software. Next, live birth and stillbirth records eligible for the study period (i.e., 2 years prior to the census date) were identified from the Canadian Vital Statistics – Birth database and the Canadian Vital Statistics Stillbirth database, respectively. Before any data linkage, unwanted characters or words were removed and geographic variables were derived from the postal codes listed on records. File improvements were then performed, wherein scanned stillbirth registration forms were reviewed to fill in missing information on stillbirth records. For birth records, missing parental information was retrieved by linking birth records to the Canada Child Tax Benefit (CCTB) file, which includes information on the recipient of the benefit, their children, and their spouse. If there were successful matches to the CCTB file, then missing parental information on the birth record was filled in using the CCTB file.

Next, an internal record linkage of both birth and stillbirth files was conducted. For both mothers and fathers, birth and stillbirth records were separately linked to discern births and stillbirths born to the same mother and father. A probabilistic linkage was then completed; where non-unique identifiers (e.g., name and date of birth) were compared and the probability that each non-unique identifier referred to the same individual was calculated. Potential pairs of parents and corresponding births were selected using a combination of the following variables: social insurance number, date of birth, sex, surnames, given name, spouse's date of birth, dependents' dates of birth, postal code, city, and province. The live and stillbirth records were then linked to the census based on whether two records had unique combinations of the aforementioned variables. Several combinations were considered and then linkages were assigned a weight based on the number of combinations that matched between birth and parental records. From this step, some linkages were considered definitely linked, some definitely not linked, and some fell between the two categorizations. Any linkages that fell between the two categorizations required manual review. Once linkages were finalized, potential errors were assessed and reviewed by two Statistics Canada reviewers to assess the quality of the linkages.

The linkage rates for the dataset were 93% for live births with survival until age 1, 67% for stillbirths, and 83% for infant deaths that were linked to a birth registration. Infant deaths that were not linked to a birth registration were excluded (11.63%). The overall linkage had a false positive match rate of less than 1% (70).

4.2 Population

The study population was singleton live and stillbirths in the 2016 CanBCC (N = 195,947). Multiple births (n = 6,121) were excluded, as they tend to experience unique risk factors for the outcomes of interest and more than half of multiple births are born preterm (71). Births to mothers with missing nativity status were excluded (n = 253), as this was the main exposure of interest. Additional exclusions were made for births to Indigenous mothers (n = 21,336) because of the small sample size of foreign-born Indigenous mothers (n = 63), and for births with missing information on determinants or covariates of interest (n = 35,598).

4.3 Definition of variables

Outcome variables: Study outcomes included PTB, SGA and LGA birth, stillbirth, and infant death. PTB was defined as live births before 37 completed weeks of gestation according to birth registration. SGA was defined as a birth weight below the sex- and gestational age-specific 10^{th} centile of a Canadian reference, while LGA above the 90^{th} centile of the reference (20).

Stillbirth was defined as fetal death occurring at a gestational age of 20 weeks or more or a birth weight greater or equal to 500 grams, except for the province of Quebec where the birth weight criterion alone is used to define stillbirth. Infant death was examined as total infant death, which was death before 365 days of life.

Exposure variable: Maternal place of birth from birth registration was primarily used to classify mothers as foreign- or Canadian-born. This was done according to a mother's province of birth in Canada if native-born, or according to their country of birth if foreign-born. When maternal birthplace was missing on birth registration, it was substituted from the census data (n = 2,973). Mothers who were non-permanent residents of Canada, including individuals who had a work or study permit or who were refugee claimants, were included as foreign-born mothers.

Potential contributing variables (Covariates): Potential contributing factors to the perinatal health gap between foreign-born and Canadian-born mothers included education, family income, employment status, race and ethnicity, homeownership, marital status, paternal nativity, age, activity limitations (i.e., limitations due to long-term physical conditions, mental conditions, or health problems), parity, and infant sex.

For both parents, the highest education level attained from the census was categorized into less than secondary, secondary graduate, post-secondary diploma or certificate, and university degree or higher. Paternal education was later dichotomized into below university degree or university degree and above to avoid multicollinearity with maternal education.

The income variable used was the after-tax income of the economic family of the mother. An economic family refers to a group of two or more people who live together in the same dwelling, and are linked by marriage, common-law, adoption, blood, or a foster relationship (23).

The after-tax income of all members of the family were summed and adjusted for the number of family members to account for how members of the same economic family often share resources. The variable was also adjusted for Census Metropolitan Areas to account for regional variation in housing costs, as was previously done in the 2006 CanBCC (23).

Employment status was derived from the census question on all jobs held by each respondent who worked for pay or self-employment in 2015. If respondents held both a full-time and a part-time job in separate parts of the year, they were asked to report on the job where they held the most hours. The variable had four levels in the census: “Not applicable (<15 years of age),” “Did not work in 2015,” “Worked mainly full-time,” and “Worked mainly part-time.” For this study, “Not applicable” and “Did not work in 2015” were grouped into “Unemployed.” Paternal employment status was included in this study only, as maternal employment collected for 2015 did not account for mothers giving birth at various times between May 2014 to May 2016.

Race and ethnicity were collected from the census, originally categorized into White, South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.), Chinese, Black, Filipino, Latin American, Arab, Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai, etc.), West Asian (e.g., Iranian, Afghan, etc.), Korean, Japanese, Indigenous, and twelve categories of multiple or mixed ethnicities. For this study, categories were re-grouped into White, East Asian (Korean, Japanese, Chinese), Southeast Asian, South Asian, Black, Latin American, Arab/West Asian, Indigenous, and Multiple/Other to maximize the number of participants in each category. The Indigenous category included any individual who self-reported as being Indigenous in a separate question. If a respondent indicated multiple ethnicities (e.g., White and visible minority, multiple visible minorities, or White and another ethnicity), they were classified as

“Multiple/Other.” As described above, Indigenous mothers were not included in analyses (n = 21,216), as very few were foreign-born (n = 63). Maternal race and ethnicity were considered only owing to collinearity between maternal and paternal race and ethnicity.

Homeownership was defined according to maternal dwelling collected in the census as renter, band housing, or owner. The dwelling was considered rented if a member of the household did not own the dwelling, if the dwelling was being provided without cash rent or at a reduced rent, or if the dwelling was part of a cooperative. Band housing referred to housing on Indigenous reserves or in Indigenous settlements. As Indigenous mothers were excluded from analyses, band housing was also excluded (n = 120). Homeownership in this thesis was dichotomized as “Yes” if the mother owned the home or “No” if the mother rented the home.

Marital status was collected from the census and assessed de facto. That is, it was categorized into mutually exclusive categories of never married, married, living common law, separated, divorced, and widowed. Due to small numbers in some categories, marital status was assessed into three main categories: not married (including never married, separated, divorced, and widowed), married, or living common law.

Other covariates included parity, maternal age at childbirth, sex of the infant, and maternal comorbidities. Information on parity came from birth records and was categorized as no previous births, 1 previous birth, and two or more previous births. As health information was not directly collected in the census, a census question on activity limitations of daily living was used as a proxy for general maternal health. Any positive answer to the question of whether a respondent experienced limitations due to long-term physical conditions, mental conditions, or health problems was classified as having activity limitations. Paternal activity limitations were excluded due to collinearity with paternal hours worked.

4.4 Data Analysis

4.4.1 Preliminary analysis

First, the distribution of all study variables was examined for study participants, overall and by maternal nativity status. Rates for PTB, SGA, and LGA birth were calculated as the number of cases of each outcome divided by the total number of live births in the sample and were expressed for every 100 live births. The rate for stillbirth was calculated as the number of cases divided by the total number of live births and stillbirths in the sample and expressed for every 1,000 births. Lastly, the rate for infant death was calculated as the number of cases of infant death divided by total live births and expressed for every 1,000 births. Bivariate regression analyses were then conducted to examine the crude relationships between each independent variable including maternal nativity and outcomes. Crude associations were examined in the full sample and separately for Canadian- and foreign-born mothers to compare the relationships between the variables and each outcome by nativity status. Spearman correlations were also computed to consider the presence of multicollinearity between independent variables. Separate multivariable regression analyses were then performed for Canadian- and foreign-born mothers for each outcome to examine the adjusted associations between independent variables and outcomes. Multivariable regression analyses also helped ensure no multicollinearity in the final regression model that was used in the decomposition analysis.

4.4.2 Decomposition analysis

For the primary analysis of this project, I performed decomposition analyses to quantify the contributions of various determinants to the inequality in PTB, SGA and LGA, stillbirth, and infant death seen between Canadian- and foreign-born mothers. This, alongside estimation of risk ratios and risk differences between nativity groups, was undertaken to examine the inequality in outcomes between groups. Using the determinants from multivariable regression models coupled with determinants that have been indicated as important in the literature, I carried out decomposition analyses using the method extended by Fairlie to binary outcomes (11) from the Kitagawa decomposition method (10), later popularized in economics by Oaxaca and Blinder (69, 72).

The decomposition method involves several regression-based techniques to examine the determinants of inequality in an outcome. Specifically, the decomposition for a linear model (11) can be written in a simplified form as the following:

$$\bar{Y}^U - \bar{Y}^E = \left[(\bar{X}^U - \bar{X}^E)\hat{\beta}^U\right] + \left[\bar{X}^E\left(\hat{\beta}^U - \hat{\beta}^E\right)\right] \tag{1.1}$$

where $\bar{Y}^U$ and $\bar{Y}^E$ represent the average probability of the binary outcome of interest for the unexposed (Canadian-born) and exposed (foreign-born) groups, respectively. $\bar{Y}^U$ minus $\bar{Y}^E$ then represents the observed inequality in average health outcomes between the exposed and unexposed groups.

The extension of the standard linear Kitagawa decomposition to a non-linear model can be written as follows:

$$\bar{Y}^U - \bar{Y}^E = \left[\sum_{i=1}^{N^U} \frac{F(X_i^U \hat{\beta}^U)}{N^U} - \sum_{i=1}^{N^E} \frac{F(X_i^E \hat{\beta}^U)}{N^E}\right] + \left[\sum_{i=1}^{N^E} \frac{F(X_i^E \hat{\beta}^U)}{N^E} - \sum_{i=1}^{N^E} \frac{F(X_i^E \hat{\beta}^E)}{N^E}\right] \tag{1.2}$$

where F represents the cumulative distribution function from the logistic distribution for the binary outcome. N represents the sample size for each group. As shown in the equation (1.1), the inequality ($\bar{Y}^U$ - $\bar{Y}^E$) is decomposed into the two parts as described in the linear model. Thus, the first bracket represents distributional differences in determinants between groups and the second bracket represents effect differences between groups, with the non-linear outcome-specific distributional function.

To estimate the contribution of specific variables, the distribution of a specific determinant for foreign-born women (E) is replaced with the distribution of that same determinant for Canadian-born women (U). The resulting change in predicted probability for Y is then calculated, while holding the distribution of all other determinants constant. This allows for a counterfactual situation whereby the exposed group (foreign-born mothers) takes on the distribution of a determinant experienced by the unexposed group (Canadian-born mothers). The resulting estimate shows the difference in the predictive probability of Y for foreign-born mothers, despite being endowed with the distribution of the determinant of Canadian-born mothers. Decomposition involves repeating this replacement of distributions for each determinant to estimate the determinant-specific contribution to the health inequality observed between Canadian- and foreign-born women.

To endow foreign-born women with the distribution of Canadian-born women, women need to be matched one-to-one between groups (11). As there are more Canadian-born women than foreign-born women, a random sample of Canadian-born women equal in size to that of foreign-born women is drawn and an estimated change in predictive probability of Y for each sample is calculated. Within each random sample, women were ranked by their predictive probabilities for the outcome of interest and matched based on their respective rankings. This process was repeated numerous times (1,000 times in this study) and then an average of the estimates was calculated. The results of the decomposition also depend on the order that determinants are added to the model (11). To address this issue, random ordering of determinants for their contribution estimation was implemented following the recommendation of Fairlie (11, 73).

There are alternative ways to estimate contributions of determinants in the decomposition method (9). This is shown by the following expression (11):

$$\bar{Y}^U - \bar{Y}^E = \left[\sum_{i=1}^{N^U} \frac{F(X_i^U \hat{\beta}^E)}{N^U} - \sum_{i=1}^{N^E} \frac{F(X_i^E \hat{\beta}^E)}{N^E}\right] + \left[\sum_{i=1}^{N^U} \frac{F(X_i^U \hat{\beta}^U)}{N^U} - \sum_{i=1}^{N^U} \frac{F(X_i^U \hat{\beta}^E)}{N^U}\right] \qquad (1.3)$$

The expression above is very similar to equation 1.2 and is equally valid but is weighted differently. Specifically, equation 1.2 was weighted by $\hat{\beta}^U$ (the coefficient estimates for the unexposed group) in the first term and by X^E (the distribution of the determinants for the exposed group) in the second term, while equation 1.3 is weighted by $\hat{\beta}^E$ (the coefficient estimates for the exposed group) in the first term and by X^U (the distribution of the determinants for the unexposed group) in the second term. Similarly, we can weight using pooled coefficients from the two groups of interest. In the present study, I used this pooled sample approach and presented the results of a pooled analysis based on coefficient estimates for both foreign- and Canadian-born women, as we cannot make a case that the coefficients for either Canadian- or foreign-born women should be taken as the standard or reference.

R version 4.0.2 was used for preparation of the data, all exploratory analyses, and bivariate analyses. STATA version 16 was used to run multivariate analyses and Fairlie's decomposition analysis using the *fairlie* package for non-linear decomposition. All analyses were weighted by census weights in this thesis. Multivariate analyses were weighted using bootstrap weights to ensure the representativeness of all Canadian births over the 2-year period in the 2016 CanBCC data. Bootstrap weights were not incorporated for the decomposition analyses, as adding bootstrap weights is not a feature of the *fairlie* package in STATA. Nevertheless, given bootstrap weighting mainly affects variance estimates, the point estimates presented in this thesis would have remained unchanged, but with somewhat wider CIs around the point estimates.

Chapter 5 – Manuscript

This chapter includes a manuscript based on my thesis research, that is formatted for submission to the Journal of Epidemiology and Community Health. This journal is dedicated to research on socioeconomic determinants of health and population-level interventions.

The manuscript is aimed at filling a knowledge gap in the contributions of important maternal and paternal socioeconomic and demographic variables to inequalities in perinatal health between Canadian- and foreign-born mothers. It includes a summary of the literature and methodology previously described, alongside the results of my thesis and a discussion where I situate the results within the existing body of literature.

Perinatal health inequalities between native-born and foreign-born women in Canada: A decomposition analysis

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What is already known on this topic - Studies of perinatal health outcomes and maternal nativity have typically only examined the association between nativity status and perinatal outcomes but have not considered the contribution of various parental characteristics to the observed inequalities between nativity groups. In this study, we fill this gap by employing Kitagawa's decomposition analysis extended to binary outcomes by Fairlie.

What this study adds - Using a sample of 132,639 singleton births between May 2014-May 2016, we observed a higher rate of PTB, SGA birth, stillbirth, and infant death for foreign-born women compared to Canadian-born women, apart from LGA birth. We decomposed the inequality in perinatal health outcomes between foreign- and Canadian-born mothers and found that maternal race and ethnicity contributed most heavily to the difference in non-fatal outcomes between nativity groups, while the highest level of family income contributed most to the difference in fatal outcomes between groups.

ABSTRACT

Background: Foreign-born mothers generally experience better perinatal outcomes than native-born mothers, despite relatively lower socioeconomic positions. However, the magnitude and direction of inequalities by foreign-born status vary across outcomes and years. In this study, we examined differences in perinatal outcomes between Canadian- and foreign-born women in a recent, representative sample of Canadian births.

Methods: Using 132,639 singleton births from the 2016 Canadian Birth-Census Cohort, we estimated the risk of preterm birth (PTB), small-for-gestational-age (SGA) and large-for-gestational-age (LGA) birth, stillbirth, and infant death by maternal nativity. We used Kitagawa's decomposition method extended to binary outcomes to estimate the contribution of maternal ethnicity, maternal and paternal education, paternal nativity and employment, family income and homeownership and maternal age, marital status, activity limitations, and parity to inequalities in outcomes.

Results: Foreign-born women experienced a higher rate of all outcomes, except LGA birth. For non-fatal outcomes, maternal race and ethnicity was the largest contributor to the difference in outcomes by nativity (PTB: 232%, SGA: 100%, LGA: 78%) and increased the gap between groups. For fatal outcomes, the highest income quartile contributed the most (stillbirth: -504%, death: -561%), and decreased the gap, though the finding was not statistically significant for infant death.

Conclusion: Foreign-born women fared worse than Canadian-born women for all perinatal outcomes apart from LGA births. The results show that, if foreign-born women had the race and ethnicity distribution of Canadian-born women, they would experience fewer non-fatal outcomes. If foreign-born women had the income distribution of Canadian-born women, they would experience more stillbirths.

Keywords: immigrant health, perinatal health, epidemiological paradox

BACKGROUND

Inequalities in perinatal health outcomes by nativity status have been documented in several high-income countries, including Canada(1-5). Generally, foreign-born mothers experience better perinatal health outcomes than their native-born counterparts, despite often occupying lower socioeconomic positions (SEPs)(1). This phenomenon has been reported in several countries—including Belgium(4, 6), Taiwan(7), the United States of America (U.S.A.)(8), Sweden(9), and Spain(2)—and across various racial and ethnic groups.

A potential explanation for this counterintuitive pattern is the healthy migrant effect(10), which suggests that individuals that emigrate are healthier or better equipped for success (e.g., higher education and proficiency with official languages of the receiving country) than those who stay in their country of origin(6). However, the pattern of better outcomes among immigrant mothers varies across outcomes(1), by racial and ethnic groups(1, 11), and depending on the measures of SEP analyzed (e.g., education, income, or employment)(4). For instance, studies in Canada, where more than 20% of the population are immigrants(1), have shown lower risks of PTB, LGA birth, stillbirth, and infant death, and a higher risk of SGA birth for foreign-born women, compared to Canadian-born women(1), alongside differences in outcome rates across race and ethnicity groups(1, 12).

Furthermore, most studies have only examined the association between perinatal outcomes and maternal nativity and shed little light on which characteristics might explain the outcome differences by nativity. Therefore, we provide descriptive evidence for Canada on inequalities by nativity status across several fatal and non-fatal perinatal outcomes. We also estimate the contribution of potential determinants of perinatal health (race, ethnicity, and several measures of parental SEP) using Kitagawa's decomposition analysis(13), extended to binary outcomes by Fairlie(14, 15).

METHODS

Study population

This study was based on singleton live and stillbirths in the 2016 Canadian Birth-Census Cohort (CanBCC). The 2016 CanBCC consists of births in the two years prior to the May 2016 census date linked to the 2016 census long-form questionnaire to capture information on perinatal health and detailed sociodemographic, economic, and ethnocultural characteristics of the parents in Canada. The census long-form questionnaire was distributed to 25% of Canadian enlisted private households and 100% of enumerated households in First Nations communities and in remote and northern areas. Infant deaths from the Canadian Vital Statistics–Deaths database were probabilistically linked to live birth records. Then, live and stillbirth records from the Canadian Vital Statistics–Birth and Canadian Vital Statistics Stillbirth databases, respectively, were probabilistically linked to their parents using common identification variables. The linkage rates were 93% for births that survived until 1 year of age, 67% for stillbirths, and 83% for infant death, with an overall false-positive rate of less than 1%(16). Of the total 195,947 births in the cohort, the following births were excluded: 6,121 multiple births; 253 births with missing information on maternal birthplace; 21,336 births to Indigenous mothers; and 35,598 births with missing covariates or determinants of interest.

Measures

The study outcomes were from birth and death registration and defined as: PTB, which included all live births before 37 completed weeks of gestation; SGA and LGA birth, which included births with birth weight below the 10^{th} centile or above the 90^{th} centile, respectively, of the sex- and gestational age-specific Canadian population-based reference(17); stillbirth, which included fetal death before 20 weeks of gestational age or at a birth weight equal to or above 500 grams; and infant death.

Maternal nativity status was primarily taken from birth registration and, when not available, was filled with nativity reported on the census (n = 2,973; 1.52% of total births). It was categorized into foreign-born or Canadian-born.

Maternal education from the census was categorized as below secondary, secondary graduate, post-secondary diploma or certificate, and university degree or higher. The two lowest categories were combined to maximize sample sizes. Paternal education was dichotomized as below university or university degree and above due to collinearity (assessed via Spearman correlations) with maternal education. Household income was the after-tax economic family (i.e., group of two or more people living in the same dwelling, linked by marriage, adoption, blood, or a foster relationship(18)) income of the mother from the census. The income was adjusted for family size and Census Metropolitan Area to account for variation in regional housing costs(19). Paternal employment status was based on the census and categorized as unemployed, worked mainly part-time, and worked mainly full-time in 2015. Maternal employment status was excluded since the census collected information on employment in 2015, which did not account for changes in employment due to pregnancy and maternity leave.

Maternal race and ethnicity were based on the census and collected as White, East Asian, Southeast Asian, South Asian, West Asian, Black, Filipino, Latin American, Arab, Korean, Japanese, Indigenous, and several categories describing combinations of ethnicities. To minimize cell sparsity, we collapsed categories into White, East Asian, Southeast Asian, South Asian, Black, Latin American, Arab/West Asian, Indigenous, and Multiple/Other. Indigenous mothers were excluded, as few were foreign-born (n = 63).

Homeownership was derived from the census, which collected information on whether individuals owned or rented their homes, or lived in band housing (i.e., Indigenous reserves or settlements). As Indigenous mothers were excluded from analyses, band housing was also excluded. Marital status was based on the census and categorized as not married (including never married, separated, divorced, and widowed), married, or living common law. Other characteristics adjusted for as potential covariates in multivariable analyses and examined as determinants of health inequalities in decomposition included parity (no previous births, one, and two or more previous births), maternal and paternal age at childbirth, and infant sex from birth records. Maternal activity limitations from the census were dichotomized (no or yes) to indicate whether a respondent had indicated long-term physical conditions, health problems, or mental conditions. Paternal activity limitations were excluded due to collinearity with paternal employment status.

Statistical Analysis

The analyses for this study were weighted using census weights to account for the census sampling scheme(16). We first calculated weighted outcome rates, and crude risk ratios (RRs), and risk differences (RDs) by maternal nativity status.

We ran bivariate and multivariable logistic regression models stratified by maternal birthplace for each outcome to examine the crude and adjusted relationships between our outcomes and determinants. For our primary analysis, we ran Fairlie decomposition models(14,

15) to quantify the contribution of determinants to the inequality in binary outcomes between Canadian- and foreign-born mothers.

Decomposition analysis involves regression-based techniques to describe the contributions of each determinant to the health inequality. Differences in observed outcomes between nativity groups can be due to differences in the distribution of determinants between Canadian- and foreign-born mothers or differences in the effect of the determinants or unobserved determinants between groups. Our decomposition was weighted based on pooled regression coefficients, as we could not select either Canadian- or foreign-born coefficients as the gold-standard(20). To address previously noted issues of path dependency (the sensitivity of non-linear models to the ordering of variables), we repeated this process 1,000 times, while randomly ordering characteristics across each replication, as suggested by Fairlie(14, 21). Stata version 16 was used to run Fairlie's decomposition analysis using the *fairlie* package, and R version 4.0.2 was used for all other analyses.

RESULTS

Of 132,639 singleton births, 91,182 were born to Canadian-born mothers and 41,457 were to foreign-born mothers. The distribution of characteristics varied substantially by nativity (Table 1). Canadian-born women were mostly White, while more than half of foreign-born women were Asian, consistent with increasing immigration from Asia to Canada in recent years(22). Compared to Canadian-born women, foreign-born women were more likely to be married (90% versus 63%), university educated (51% versus 42%), and less likely to own their homes (61% versus 79%). Most Canadian-born women occupied the two highest income quartiles (63%), while most foreign-born women occupied the two lowest quartiles (61%). The fathers of infants born to foreign-born mothers were more likely to be foreign-born (80%) than the fathers of infants born to Canadian-born mothers (10%). These fathers were also more likely to be university educated (47% versus 28%) and less likely to work full-time (85% versus 93%) (Table 1).

Table 2 presents weighted outcome rates by maternal nativity, along with crude RRs and RDs associated with foreign-born status. Foreign-born women had higher rates of all outcomes compared to Canadian-born women, except LGA birth. The differences by nativity varied across outcomes. For instance, the difference was modest in PTB (0.47 more PTBs per 100 live births amongst foreign-born women), while substantially larger for SGA (3.87 more SGA births per 100 live births amongst foreign-born women) and LGA (3.30 fewer LGA births per 100 live births amongst foreign-born women). For fatal outcomes, the difference in rates was larger for stillbirth (1.47 more stillbirths per 1,000 live and stillbirths for foreign-born women), than for infant death (1.08 more infant deaths per 1,000 live births amongst foreign-born women). Foreign-born women had higher relative risk than Canadian-born women for all outcomes except LGA birth.

Supplementary tables 1 and 2 show results from multivariable models including all potential determinants, stratified by nativity status. Generally, the strength and direction of point estimates between determinants and outcomes varied little between nativity groups. For instance, the odds ratio for the association between PTB and secondary education or below was 1.28 (95% CI: 1.18, 1.4) for Canadian-born women and 1.17 (95% CI: 1.04, 1.32) for foreign-born women, compared to holding a university degree or above (supplementary table 1).

Figure 1 visually presents the decomposition results for all outcomes, with specific details in supplementary tables 3 and 4. In the supplementary tables, the coefficients represent the change in the predicted probability of the outcome (shown as rates) from replacing the foreign-born distribution of the characteristic with that of the Canadian-born characteristic, while holding all other variables constant. These coefficients are then summed to equal the total difference in the outcome rate (e.g., -0.47 for PTB indicates that Canadian-born women had 0.47 less PTBs per 100 live births than foreign-born women). Positive coefficient values indicate the amount that the outcome rate would increase for foreign-born mothers if the characteristic had the same effect for foreign-born mothers as Canadian-born mothers, thus increasing the difference. The percent contribution then is the percent of the difference contributed by each characteristic.

The characteristics in the model contributed to 87% of the SGA birth difference, 78% of the LGA birth difference, and 25% of the stillbirth difference. For PTB and infant death, the characteristics explained 200% and -4% of the difference, respectively. The high percentage for PTB and the negative percentage for infant death are likely due to the decomposition of small differences in rates. The percentages represent a total contribution, which is the sum of characteristics contributing in both positive and negative directions.

Across non-fatal outcomes, maternal ethnicity contributed substantially to the gap in perinatal health by nativity (Figure 1), which is consistent with the differences in the distribution of racial and ethnic groups by nativity status (8% of Canadian-born women were non-White, compared to 78% of foreign-born women). This contribution was highest for PTB, where the higher proportion of non-White ethnicity amongst foreign-born women contributed to 232% of the PTB gap between nativity groups and, if foreign-born women had the same proportion of non-White ethnicity as Canadian-born women, then the number of PTBs for foreign-born women would decrease by 1.09 (95% CI: -1.45, -0.73). The contribution of race and ethnicity is lowest for LGA birth, where more non-White foreign-born mothers contributed to 78% of the difference in LGA birth between groups and, if foreign-born women had the Canadian-born distribution of ethnicity, then the gap would increase, as foreign-born women would have more LGA births (2.56, 95% CI: 2.23, 2.88). The contribution of race and ethnicity to the stillbirth and infant death rate differences were not statistically significant.

For fatal outcomes, although maternal ethnicity made substantial contributions to the gap, family income made the largest contribution (stillbirth: -274 %, death: -291%). Interestingly, though lower income quartiles made negative contributions, indicating stillbirth and death in foreign-born women would have been lower if their income distribution was equal to that of Canadian-born women, the highest income quartile made a positive contribution, indicating that the foreign-born stillbirth and infant death rates would have been higher despite the large uncertainty (i.e., wide CI). This is, however, consistent with the increased risk of fatal outcomes in the highest income quartile among Canadian-born women (supplementary Table 2).

DISCUSSION

In this study, we found that foreign-born women were at an increased risk of PTB, SGA birth, stillbirth, and infant death and at a lowered risk of LGA birth compared to Canadian-born women. The decreased risk of LGA birth amongst foreign-born mothers is consistent with literature showing that Asian mothers have a birth distribution that is shifted to the left and thus, are less likely to give birth to LGA infants(23). The decreased risk of LGA birth for foreign-born mothers in this study is consistent with the finding that Asian mothers compose more than half of the foreign-born population in this study.

By decomposing the differences with multiple key individual characteristics, we found that the largest contributor to the difference in non-fatal outcomes between nativity groups was race and ethnicity, likely owing to large distributional differences in racial and ethnic groups by nativity status. It is important to acknowledge that race and ethnicity were collected into a composite variable due to pre-determined categorizations that are standard in the census. These categorizations are limited and may not represent the full social context of the study. For fatal outcomes, the largest contributor was family income, again due to distributional differences by nativity status coupled with an elevated risk of fatal outcomes amidst higher income groups. This higher risk seems counterintuitive but may be due to a higher rate of conception via assisted reproduction in women with more monetary resources(24), though this information is not available in the study data. The importance of race and ethnicity in non-fatal outcomes and income in fatal outcomes has been documented. Several authors have shown inequalities in adverse perinatal outcomes by race and ethnicity, where the risk of outcomes differs by nativity and racial and ethnic group(1, 11, 12, 25). In the U.S.A. and Italy, studies have shown that infant death increased with both higher absolute and relative income(26, 27), where income impacts health by influencing one's purchasing power and ability to access basic needs(26).

Another notable result was that we did not observe the typical pattern of better outcomes among the foreign-born. Foreign-born mothers had higher rates of all outcomes, except LGA birth. They were more likely to hold university degrees or higher but also more likely to occupy the two lowest income quartiles and less likely to own their homes. In a previous study of maternal nativity using the 1996 and 2006 CanBCC data, the authors did not find differences in adverse perinatal outcomes by nativity in 1996, but found lower risks of PTB, LGA birth, stillbirth, and infant death, and a higher risk of SGA birth amidst foreign-born mothers in 2006, compared to Canadian-born mothers(1).

When comparing the 2016 CanBCC and the published data of the earlier CanBCCs(1), changes in maternal characteristics over time may partially explain these discrepancies. First, across census years, the racial and ethnic composition of mothers has changed. In particular, the percentage of non-White Canadian-born mothers has increased since 1996 but decreased since 2006 (1996: 1%, 2006: 11%, 2016: 7%), while the percentage of non-White foreign-born mothers has consistently increased (1996: 63%, 2006: 72%, 2016: 78%). As non-White ethnicity was the largest contributor for non-fatal outcomes, these demographic shifts may have contributed to changes in adverse perinatal health outcomes. There is also a higher percentage of university-educated foreign-born mothers (1996: 21%, 2006: 37%, 2016: 51%), but decomposition analyses show that race and ethnicity are much larger contributors to perinatal health differences than education.

Our decomposition analyses suggest that income is another important factor to evaluate (particularly for fatal outcomes), and other studies have commented on the importance of employment in mitigating adverse perinatal outcomes, along with considering hours worked and the type of work undertaken(6, 28, 29). However, income and parental employment were not evaluated in previous CanBCC studies. Future work is required to see whether differences in the distributions of several SEP measures (e.g., education, employment, and income) contributed to differences in findings across study populations, including earlier CanBCC cohorts. This may elucidate the factors driving differences in perinatal health over time, which is of interest due to Canada’s growing and evolving immigrant population(22).

The results of this study should be considered with several limitations in mind. First, we should acknowledge the instability of decomposing a small difference in risk, as seen for our decompositions for PTB and infant death. Second, our measures of maternal SEP were not complete, as maternal employment status had to be omitted. In general, maternal employment is protective against adverse perinatal outcomes(30-32) and differences in employment and hours worked by nativity may shed light on our finding of higher adverse outcomes among foreign-born mothers. Relatedly, maternal and family characteristics in our study did not explain much of the difference in stillbirth rate by nativity—a total of 25% of the inequality explained—suggesting that the role of characteristics in our study varies across outcomes.

In summary, foreign-born mothers were more likely to experience all outcomes than Canadian-born mothers, except LGA birth. We found a large contribution from maternal race and ethnicity for non-fatal outcomes and income for fatal outcomes to the difference between nativity groups. Our study utilized the largest national-level data source available to examine birth outcomes and benefited from individual-level parental characteristics not typically collected on birth registrations. The census and birth registration linkage allowed us to examine the contributions of several measures of SEP (e.g., education, income, and employment), where previous studies have been limited in the SEP measures available(4). As our results differ from previous studies of maternal nativity based on earlier CanBCC data, future work examining contributions of parental characteristics to the differences in inequality over time would provide insight into how perinatal health is changing alongside Canada's population.

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Table 1: Characteristics (unweighted n (weighted %) or weighted mean (standard deviation)) of singleton births in the 2016 CanBCC.

	Overall (N = 131,943)	**Canada-born (N = 91,210)**	**Foreign-born (N = 40,733)**
Maternal Characteristics			
Age (years)	31.0 (4.8)	30.5 (4.7)	32.0 (4.8)
Ethnicity			
White	94160 (70)	84680 (92)	9490 (22)
South Asian	9520 (7.5)	1390 (1.6)	8130 (20)
East Asian	7300 (5.8)	1280 (1.5)	6020 (15)
Black	4930 (3.8)	790 (0.9)	4130 (9.9)
Southeast Asian	5540 (4.3)	720 (0.8)	4820 (12)
Latin American	2460 (1.9)	320 (0.4)	2130 (5.2)
Arab/West Asian	5260 (4.1)	360 (0.4)	4890 (12)
Other Multiple	3490 (2.7)	1650 (1.9)	1850 (4.5)
Education			
< Secondary	8380 (6.2)	4960 (5.3)	3420 (8.1)
Secondary graduate	22030 (16)	15080 (16)	6950 (17)
Post-secondary diploma/certificate	43770 (33)	33610 (37)	10160 (24)
University degree +	58460 (45)	37520 (42)	20940 (51)
Economic Family Income Quartile			
Quartile 1	24900 (19)	11970 (13)	12910 (31)
Quartile 2	34950 (26)	22340 (24)	12620 (30)
Quartile 3	36010 (27)	27320 (30)	8690 (21)
Quartile 4	36790 (28)	29560 (33)	7230 (18)
Marital Status			
Not Married	1540 (1.1)	1240 (1.3)	300 (0.7)
Married	94110 (72)	56670 (63)	37440 (90)
Living common law	36990 (27)	33280 (36)	3700 (8.9)
Homeownership			
Owner	97090 (73)	71900 (79)	25210 (61)
Renter	35540 (27)	19290 (21)	16250 (39)
Activity Limitations			
No	28920 (22)	23590 (26)	5340 (13)
Parity			
0	57760 (44)	41070 (45)	16690 (40)
1	48970 (37)	33680 (37)	15270 (37)
2+	25910 (19)	16420 (18.2)	9490 (22.7)

Table 1 continued

	Overall	Canadian-born	Foreign-born
<u>Paternal Characteristics</u>			
Nativity			
Foreign-born	41890 (32)	8770 (9.9)	33110 (80)
Age (years)	33.6 (5.8)	32.6 (5.4)	35.6 (6.2)
Table 1 continued			
Education			
< Secondary	11680 (8.6)	8050 (8.6)	3610 (8.6)
Secondary graduate	26730 (20)	19150 (21)	7580 (18)
Post-secondary diploma/certificate	49970 (37)	38950 (42)	11010 (26)
University degree +	44270 (34)	25040 (28)	19230 (47)
Hours Worked			
Did not work in 2015	6240 (4.8)	2980 (3.3)	3260 (7.9)
Mainly part-time	6100 (4.6)	3350 (3.7)	2760 (6.7)
Mainly full-time	120300 (91)	84850 (93)	35430 (85)
<u>Infant Characteristics</u>			
Sex			
Male	67880 (51)	46510 (51)	21370 (52)
Female	64760 (49)	44670 (49)	20080 (48)

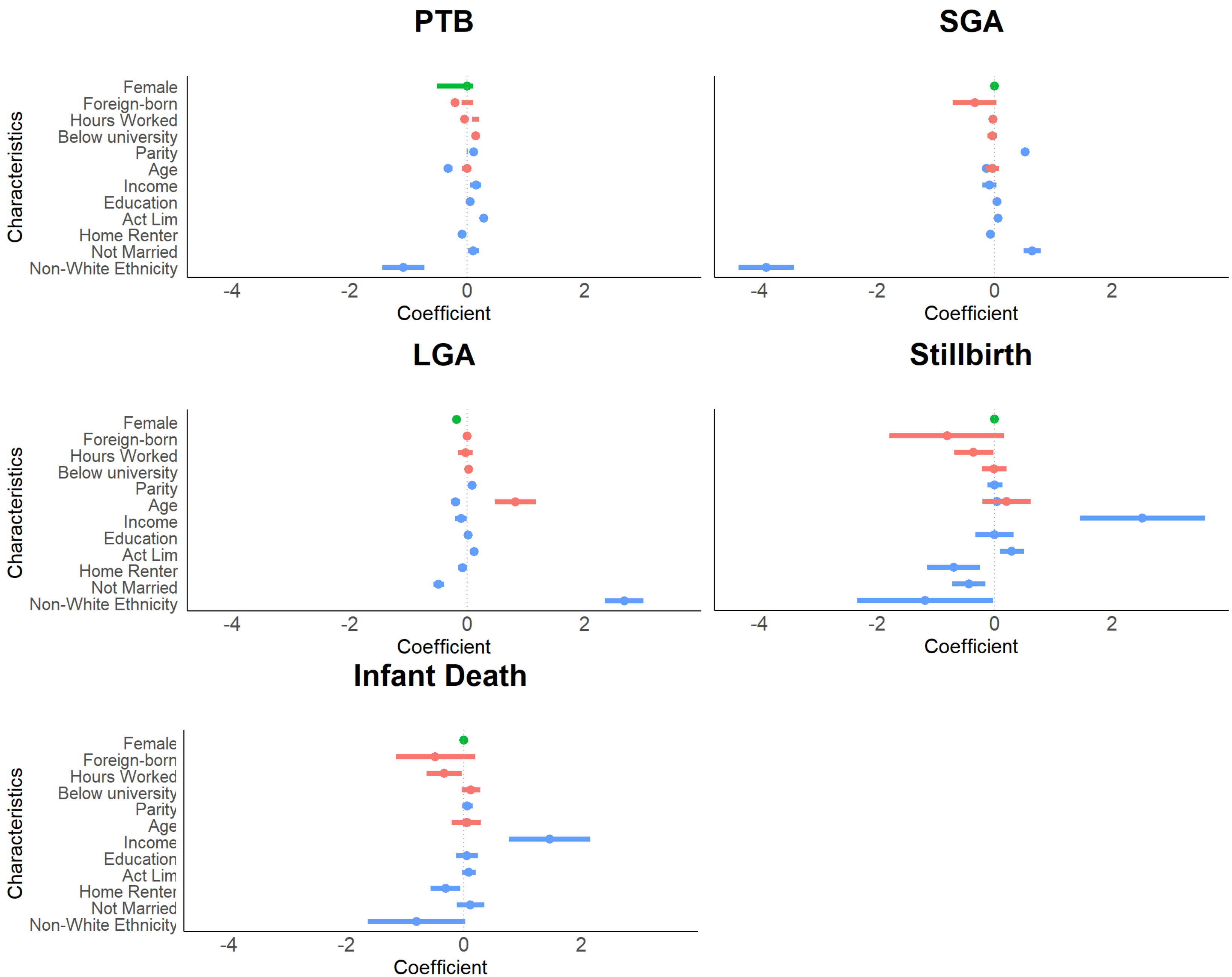
All unweighted frequencies are rounded up or down to the nearest 10 in line with regulations from Statistics Canada.

Table 2: Weighted outcome rates and crude and adjusted risk ratios and risk differences by maternal nativity

Outcome	Rate for Canada-born mothers	(95% CI)	Rate for foreign-born mothers	(95% CI)	Crude RR	(95% CI)	Crude RD (%)	(95% CI)
PTB	5.8	(5.68, 5.92)	6.27	(6.08, 6.46)	1.08	(1.04, 1.12)	0.47	(0.23, 0.71)
SGA	7.62	(7.49, 7.75)	11.49	(11.26, 11.71)	1.51	(1.46, 1.55)	3.87	(3.58, 4.15)
LGA	10.06	(9.59, 10.54)	6.77	(6.48, 7.06)	0.67	(0.65, 0.69)	-3.3	(-3.63, -2.97)
Stillbirth	3.81	(3.52, 4.11)	5.68	(3.86, 7.5)	1.49	(1.03, 1.95)	0.19	(0.01, 0.36)
Death	2.55	(2.25, 2.85)	3.62	(3.24, 3.99)	1.42	(1.19, 1.65)	0.11	(0.06, 0.16)

Weighted rates are shown per 100 live births for live outcomes (PTB, SGA, and LGA), per 1000 live- and stillbirths for stillbirth, and per 1000 live births for infant death.

Figure 1: Decomposition analyses results for non-fatal and fatal outcomes



Supplementary Table 1: Adjusted regression results (odds ratios) with maternal, paternal, and infant characteristics and non-fatal outcomes.

	PTB				SGA				LGA			
	Canada-born		Foreign-born		Canada-born		Foreign-born		Canada-born		Foreign-born	
Maternal Characteristics	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**
Ethnicity												
White	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
South Asian	1.35	(1.09, 1.67)	1.42	(1.24, 1.62)	2.87	(2.48, 3.32)	2.61	(2.36, 2.9)	0.34	(0.26, 0.45)	0.54	(0.47, 0.61)
East Asian	1.11	(0.87, 1.41)	1.02	(0.88, 1.19)	1.92	(1.62, 2.28)	1.47	(1.31, 1.65)	0.34	(0.26, 0.46)	0.53	(0.46, 0.61)
Black	1.32	(1.01, 1.72)	1.32	(1.12, 1.55)	1.7	(1.37, 2.11)	1.54	(1.35, 1.76)	0.5	(0.37, 0.68)	0.89	(0.78, 1.26)
Southeast Asian	1.66	(1.28, 2.15)	1.61	(1.4, 1.85)	1.78	(1.41, 20.24)	2	(1.78, 2.24)	0.45	(0.32, 0.63)	0.53	(0.46, 0.62)
Latin American	1.41	(0.94, 20.12)	1.18	(0.97, 1.44)	1.28	(0.88, 1.87)	1.1	(0.92, 1.31)	0.7	(0.46, 10.07)	0.82	(0.69, 0.98)
Arab/West Asian	1.1	(0.71, 1.72)	1.09	(0.92, 1.28)	1.22	(0.84, 1.77)	1.36	(1.2, 10.55)	0.73	(0.5, 1.77)	0.93	(0.81, 1.59)
Other Multiple	1.06	(0.86, 1.3)	1.22	(0.99, 1.51)	1.3	(1.1, 1.54)	1.46	(1.24, 1.73)	0.74	(0.62, 0.89)	0.77	(0.64, 0.93)
Marital Status												
Married	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Not Married	1.06	(0.83, 1.34)	1.23	(0.8, 1.88)	1.27	(1.05, 1.55)	0.92	(0.63, 1.34)	0.76	(0.61, 0.94)	1.31	(0.88, 1.94)
Living common law	1.06	(1, 1.13)	0.98	(0.84, 1.13)	1.27	(1.21, 10.35)	1.18	(1.06, 1.32)	0.75	(0.72, 0.79)	0.91	(0.79, 1.43)
Homeownership												
Owner	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Renter	1.1	(1.02, 1.19)	1.01	(0.92, 1.1)	1.1	(1.03, 10.17)	0.98	(0.91, 1.51)	1.09	(1.02, 1.15)	1	(0.91, 1.09)
Education												
University degree +	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Secondary graduate or below	1.28	(1.18, 1.4)	1.17	(1.04, 1.32)	1.2	(1.11, 1.3)	1.04	(0.95, 1.14)	1.06	(0.99, 1.14)	1.08	(0.97, 1.21)
Post-secondary diploma/certificate	1.17	(1.08, 1.25)	1.11	(0.99, 1.23)	1.09	(1.02, 1.16)	1.04	(0.96, 1.13)	1.02	(0.96, 1.77)	1.08	(0.97, 1.2)
Activity Limitations												
No	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Yes	1.38	(1.29, 1.46)	1.24	(1.11, 10.39)	1.04	(0.99, 1.11)	1.05	(0.95, 1.15)	1.13	(1.07, 1.18)	1.06	(0.95, 1.18)

Supp. Table 1 continued	**PTB**				**SGA**				**LGA**			
	Canada-born		**Foreign-born**		**Canada-born**		**Foreign-born**		**Canada-born**		**Foreign-born**	
Maternal Characteristics	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**
Economic Income Quartile												
Quartile 1	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Quartile 2	0.99	(0.89, 1.93)	1.06	(0.95, 1.19)	0.82	(0.76, 0.9)	0.97	(0.9, 1.57)	1.1	(1.02, 1.2)	1.07	(0.96, 1.19)
Quartile 3	1.05	(0.95, 1.17)	1.12	(0.98, 1.27)	0.82	(0.75, 0.95)	0.96	(0.88, 1.62)	1.05	(0.97, 1.14)	1.02	(0.9, 10.15)
Quartile 4	1.09	(0.98, 1.22)	1.04	(0.9, 1.2)	0.85	(0.78, 0.94)	1.05	(0.94, 1.17)	0.91	(0.83, 0.99)	0.94	(0.82, 1.79)
Parity												
0	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
1	0.7	(0.65, 0.74)	0.78	(0.71, 0.85)	0.53	(0.5, 0.56)	0.55	(0.51, 0.59)	1.68	(1.6, 1.77)	1.69	(1.54, 1.86)
2+	0.75	(0.69, 0.81)	0.82	(0.73, 0.91)	0.46	(0.42, 0.5)	0.45	(0.41, 0.49)	1.91	(1.79, 2.26)	2.09	(1.87, 2.33)
Age (years)	1.03	(1.02, 1.42)	1.04	(1.03, 1.52)	1.01	(1.01, 1.22)	1.01	(1, 1.17)	1.01	(1.01, 1.22)	1.02	(1.01, 1.03)
Paternal Characteristics												
Education												
University degree +	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Less than university	1.2	(1.11, 1.29)	1.1	(0.99, 1.21)	0.98	(0.92, 1.47)	0.99	(0.92, 1.66)	1.05	(0.99, 1.11)	1.08	(0.98, 1.18)
Hours Worked												
Mainly full-time	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Did not work in 2015	1.13	(0.98, 1.31)	1.02	(0.87, 1.21)	1.01	(0.89, 1.14)	1.04	(0.91, 10.17)	0.9	(0.8, 10.02)	1.04	(0.89, 1.22)
Mainly part-time	1.25	(1.08, 1.45)	0.97	(0.82, 1.14)	1.12	(0.98, 1.27)	1.03	(0.91, 1.16)	0.92	(0.81, 1.47)	1.08	(0.93, 1.25)
Age (years)	1	(0.99, 10)	1	(0.99, 1.97)	1.01	(1, 1.12)	1	(0.99, 1.48)	1	(1, 1.68)	1	(0.99, 1.92)
Nativity												
Canada-born	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Foreign-born	1.06	(0.96, 1.17)	1.02	(0.91, 1.14)	1.03	(0.95, 1.12)	1.1	(1.01, 1.2)	0.9	(0.83, 0.97)	0.81	(0.73, 0.9)
Infant Characteristics												
Sex												
Male	(Ref)		(Ref)		(Ref)		(Ref)		(Ref)		(Ref)	
Female	0.89	(0.84, 0.94)	0.89	(0.82, 0.96)	1.01	(0.96, 1.61)	0.94	(0.88, 1)	1.04	(0.99, 1.8)	1.09	(1.01, 1.18)

Supplementary Table 2: Regression results (odds ratios) with maternal, paternal, and infant characteristics and fatal outcomes.

	Stillbirth				Death			
	Canada-born		Foreign-born		Canada-born		Foreign-born	
Maternal Characteristics	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**
Ethnicity								
White	(Ref)		(Ref)		(Ref)		(Ref)	
Other	1.04	(0.65, 1.66)	1.45	(0.98, 2.14)	1.25	(0.71, 2.2)	1.55	(0.96, 2.5)
Marital Status								
Married	(Ref)		(Ref)		(Ref)		(Ref)	
Not Married	0.7	(0.54, 0.98)	0.61	(0.34, 10.11)	1.16	(0.86, 1.57)	0.87	(0.46, 1.64)
Homeownership								
Owner	(Ref)		(Ref)		(Ref)		(Ref)	
Renter	1.91	(1.42, 2.56)	2.01	(1.48, 2.75)	1.21	(0.83, 1.77)	1.96	(1.34, 2.88)
Education								
University degree +	(Ref)		(Ref)		(Ref)		(Ref)	
Secondary graduate or below	2.9	(2.06, 4.83)	1.8	(1.16, 2.78)	1.69	(1.08, 2.63)	1.53	(0.89, 2.63)
Post-secondary diploma/certificate	1.66	(1.23, 2.23)	1.51	(1.02, 2.22)	1.56	(1.09, 2.23)	1.26	(0.78, 2.03)
Economic Family Income Quartile								
Quartile 1	(Ref)		(Ref)		(Ref)		(Ref)	
Quartile 2	4.08	(1.93, 8.62)	11.45	(5.37, 240.42)				
Quartile 3	9.59	(4.62, 190.87)	25.04	(11.62, 53.96)	2.86	(1.88, 4.35)	4.31	(2.67, 6.95)
Quartile 4	26.36	(12.63, 550.03)	40.92	(18.48, 900.61)	5.34	(3.47, 8.21)	8.13	(4.89, 13.53)
Activity Limitations								
No	(Ref)		(Ref)		(Ref)		(Ref)	
Yes	1.62	(1.27, 2.67)	1.42	(0.95, 2.11)	1.24	(0.91, 1.69)	–	–

Supp. Table 2 continued								
	Stillbirth				Death			
	Canada-born		Foreign-born		Canada-born		Foreign-born	
Maternal Characteristics	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**	**OR_a**	**(95% CI)**
Parity								
0	(Ref)		(Ref)		(Ref)		(Ref)	
1	0.86	(0.66, 1.12)	0.71	(0.5, 1.11)	0.84	(0.62, 1.15)	0.83	(0.55, 1.26)
2+	0.94	(0.68, 1.29)	0.74	(0.49, 1.11)	0.77	(0.51, 1.18)	0.79	(0.48, 1.31)
Age (years)	1	(0.96, 1.38)	0.97	(0.93, 2)	0.97	(0.92, 1.01)	1.03	(0.98, 1.09)
Paternal Characteristics								
Education								
University degree +	(Ref)		(Ref)		(Ref)		(Ref)	
< University degree	1	(0.75, 1.34)	1.02	(0.72, 1.44)	1.79	(1.19, 2.69)	1.05	(0.69, 1.61)
Hours Worked								
Mostly full-time	(Ref)		(Ref)		(Ref)		(Ref)	
Part-time/Did not work in 2015	2.05	(1.31, 3.2)	2.22	(1.46, 3.39)	2.70	(1.72, 4.24)	1.79	(1.08, 2.97)
Age (years)	0.98	(0.94, 1.69)	1.02	(0.99, 1.51)	1.01	(0.97, 1.04)	0.98	(0.95, 1.02)
Nativity								
Canada-born	(Ref)		(Ref)		(Ref)		(Ref)	
Foreign-born	0.89	(0.58, 1.37)	1.92	(1.23, 2.99)	0.88	(0.51, 1.52)	1.82	(1.07, 3.08)
Infant Characteristics								
Sex								
Male	(Ref)		(Ref)		(Ref)		(Ref)	
Female	0.67	(0.53, 0.85)	0.94	(0.7, 1.26)	0.93	(0.7, 1.23)	1.01	(0.71, 1.43)

Supplementary Table 3: Decomposition analysis results for non-fatal outcomes

	PTB			SGA			LGA		
	Difference	**-0.47**		**Difference**	**-3.87**		**Difference**	**3.3**	
	Total Explained	**-0.94**		**Total Explained**	**-3.36**		**Total Explained**	**2.58**	
Maternal Characteristics	**Coefficient**	**(95% CI)**	**%**	**Coefficient**	**(95% CI)**	**%**	**Coefficient**	**(95% CI)**	**%**
Non-White Ethnicity	-1.09	(-1.45, -0.73)	232.43	-3.89	(-4.36, -3.42)	100.43	2.56	(2.23, 2.88)	77.56
Not Married	0.1	(0.01, 0.2)	-21.65	0.64	(0.49, 0.78)	-16.43	-0.47	(-0.56, -0.38)	-14.32
Home Renter	-0.09	(-0.15, -0.02)	18.85	-0.07	(-0.14, 0)	1.8	-0.08	(-0.16, 0)	-2.36
Activity Limitations	0.28	(0.22, 0.34)	-60.27	0.06	(0, 0.12)	-1.64	0.13	(0.08, 0.17)	3.79
Education									
Secondary grad. or below	-0.05	(-0.07, -0.02)	9.66	-0.02	(-0.04, -0.01)	0.63	-0.04	(-0.07, -0.01)	-0.74
Post-secondary	0.09	(0.05, 0.14)	-19.65	0.07	(0.01, 0.12)	-1.72	0.05	(-0.01, 0.11)	1.18
Family Income Quartiles									
Quartile 2	-0.02	(-0.05, 0.01)	4.44	0.05	(0.01, 0.08)	-1.26	-0.06	(-0.1, -0.01)	-1.16
Quartile 3	0.05	(0.01, 0.1)	-11.43	-0.07	(-0.12, -0.02)	1.86	0.04	(-0.02, 0.11)	0.96
Quartile 4	0.11	(0.03, 0.2)	-24.02	-0.07	(-0.16, 0.03)	1.7	-0.14	(-0.25, -0.03)	-2.95
Age (years)	-0.33	(-0.4, -0.25)	69.44	-0.14	(-0.21, -0.06)	3.5	-0.19	(-0.27, -0.12)	-5.91
Parity									
1	0.02	(0, 0.04)	-4.18	0.14	(0.09, 0.18)	-3.5	0.13	(0.07, 0.19)	2.97
2+	0.09	(0.06, 0.12)	-19.41	0.39	(0.33, 0.44)	-10.03	-0.44	(-0.52, -0.36)	-8.47
Paternal Characteristics									
Below university degree	0.14	(0.08, 0.2)	-29.64	-0.04	(-0.12, 0.04)	1.01	0.07	(0.01, 0.14)	2.22
Hours Worked in 2015									
Did not work	0	(-0.02, 0.03)	-0.76	0.01	(-0.02, 0.04)	-0.19	0.01	(-0.03, 0.05)	0.31
Mainly part-time	-0.05	(-0.11, 0)	11.49	-0.03	(-0.09, 0.02)	0.85	0.01	(-0.07, 0.1)	0.17
Age	0	(-0.1, 0.1)	69.44	-0.04	(-0.15, 0.07)	1.1	-0.02	(-0.14, 0.09)	-0.68
Foreign-born	-0.21	(-0.52, 0.1)	45.46	-0.34	(-0.71, 0.03)	8.67	0.83	(0.49, 1.17)	25.29
Infant Characteristics									
Female	0	(-0.01, 0.01)	-0.05	0	(0, 0)	0.02	0	(0, 0.01)	0.07

Supplementary Table 4: Decomposition analysis results for fatal outcomes

	Stillbirth			Death		
	Difference	**-1.87**		**Difference**	**-1.07**	
	Total Explained	**-0.47**		**Total Explained**	**0.04**	
Maternal Characteristics	**Coefficient**	**(95% CI)**	**%**	**Coefficient**	**(95% CI)**	**%**
Non-White Ethnicity	-2.28	(-5.06, 0.49)	122.38	-1.73	(-3.99, 0.53)	161.64
Not Married	-0.84	(-1.56, -0.12)	44.88	0.23	(-0.35, 0.81)	-21.43
Home Renter	-1.24	(-2.86, 0.37)	66.52	-0.69	(-1.77, 0.39)	64.46
Activity Limitations	0.54	(0.06, 1.01)	-28.75	0.16	(-0.11, 0.43)	-15.02
Education						
Secondary grad. or below	-0.44	(-1.71, 0.84)	23.39	-0.21	(-0.96, 0.55)	19.36
Post-secondary	0.37	(-0.03, 0.78)	-20.07	0.24	(-0.12, 0.6)	-22.41
Family Income Quartiles						
Quartile 2	-3.61	(-7.83, 0.62)	193.39	-2.38	(-5.69, 0.93)	222.79
Quartile 3	-0.68	(-6.13, 4.77)	36.23	-0.51	(-5.05, 4.03)	47.66
Quartile 4	9.41	(-0.54, 19.36)	-504.16	6	(-2.12, 14.12)	-561.05
Age (years)	0.07	(-0.5, 0.64)	-3.68	0.12	(-0.36, 0.59)	-10.8
Parity						
1	-0.01	(-0.13, 0.11)	0.42	0	(-0.1, 0.1)	0.22
2+	0.01	(-0.32, 0.35)	-0.66	0.13	(-0.12, 0.38)	-12.05
Paternal Characteristics						
Below university degree	-0.02	(-0.5, 0.47)	0.98	0.22	(-0.22, 0.66)	-20.73
Did not work in 2015	-0.54	(-1.23, 0.16)	28.78	-0.59	(-1.5, 0.32)	55.3
Age	0.36	(-0.48, 1.19)	-19.17	0.08	(-0.51, 0.67)	-7.51
Foreign-born	-1.58	(-3.88, 0.72)	84.57	-1.03	(-2.86, 0.81)	96.11
Infant Characteristics						
Female	0	(-0.13, 0.13)	-0.16	0	(-0.03, 0.03)	0.09

Chapter 6 – Conclusion

6.1 Summary of Objectives

The objectives of this thesis study were to assess the differences in PTB, SGA and LGA birth, stillbirth, and infant death observed between Canadian- and foreign-born mothers in a representative sample of singleton Canadian births, and to quantify the contribution of several parental variables to the differences in outcomes to better understand which parental characteristics are important in observed outcome-specific differences by maternal nativity. I accomplished these objectives by calculating the rates, and relative and absolute risk for the outcomes and by using the decomposition analysis method.

6.2 Summary of Findings

Through descriptive statistics, I found large distributional differences in nearly every characteristic considered, where foreign-born mothers were less likely than Canadian-born mothers to be White, and more likely to have a university degree, to be married, and to fall into the two lowest income quartiles. The fathers of infants born to foreign-born mothers were more likely than the fathers of infants born to Canadian-born women to be foreign-born, to hold a university degree or above, and were less likely to work full-time. Though these parents were more highly educated than their Canadian-born counterparts (51% foreign-born mothers are university educated versus 42% of Canadian-born mothers and 47% of fathers of infants born to foreign-born mothers compared to 28% of fathers of infants born to Canadian-born mothers), studies have shown that income and employment status may be more pressing characteristics to consider for immigrants, as immigrants are at a higher risk of unemployment than non-immigrants, regardless of their level of education (9). This implies that our foreign-born mother population, though more educated, is likely of a lower SEP than Canadian-born mothers. This highlights the importance of including other SEP indicators in addition to education when studying perinatal health by nativity, as education may not reveal the full story. Unfortunately, maternal employment information was not complete for this study, as it was only available for 2015 and did not account for differential hours worked due to childbirth and maternity leave. As such, our measures of SEP were not complete. Maternal employment tends to be associated with a lower rate of adverse perinatal outcomes (38, 44, 52), but may differ by nativity status, though this information was not available in this study. Canada offers a period of up to 15 weeks maternity leave for new mothers, along with up to 40 weeks of standard parental leave or up to 69 weeks of extended parental leave, which can be split between both parents (74). Future studies should venture to include maternal employment as a measure of SEP, while accounting for maternity leave and differential employment after childbirth.

I also found that foreign-born mothers experienced a higher crude risk of PTB, SGA birth, stillbirth, and infant death, but a lower risk of LGA birth. The lowered risk of LGA birth for foreign-born mothers is consistent with previous literature showing that Asian mothers are less likely to give birth to LGA infants, as their birth weight distribution is shifted to the left (21). This lowered risk of LGA birth for foreign-born mothers is consistent with the finding that Asian mothers compose more than half of the foreign-born mothers assessed in this study.

From the multivariable regression analyses stratified by maternal nativity status, I found that there were minimal differences in the effect of characteristics between nativity groups. The direction of effect estimates between the two groups was consistent with only small differences in the magnitude of estimates. This suggests that the role of the characteristics selected did not substantially differ by nativity status, at least in the 2016 CanBCC. This also indicates that inequalities in outcomes by maternal nativity were mainly due to differential distributions in individual characteristics.

From my primary analyses, the decomposition analysis models, I found that the largest contributor to the inequality in outcomes by nativity status for non-fatal outcomes was maternal race and ethnicity. Specifically, the contribution estimated by maternal race and ethnicity to the inequality for PTB was 232%, and the corresponding results were 100% for SGA birth and 78% for LGA birth. The positive contribution indicates that, if foreign-born mothers were to adopt the non-White distribution of Canadian-born mothers, they would experience less non-fatal outcomes and thus the inequality by nativity status would have been smaller. This finding is fascinating if we consider the evolving makeup of foreign-born mothers in Canada, where immigration from countries with primarily non-White populations (e.g., China, Mexico, and India) is increasing every year (75). Thus, it is likely that Canada's non-White population will continue to grow over time. As Canada's population becomes increasingly diverse, the finding that race and ethnicity greatly contributes to poorer perinatal health amongst immigrants calls for more research to better understand these inequalities and to promote better perinatal health amongst foreign-born mothers.

For fatal outcomes, maternal economic family income, particularly the highest income quartile, contributed the most, though the results were imprecise and thus in need of confirmation from other studies. The fourth quartile contributed -504% for stillbirth and -561 for infant death. These negative contributions mean that, if foreign-born women were to have the identical income distribution of Canadian-born mothers, their stillbirth and death rates would increase. This finding is counterintuitive, as one would think that having access to more monetary resources and having higher material wealth would decrease fatal outcomes. Alternatively, it has been shown that Canadian-born mothers of higher income are more likely to conceive via assisted reproduction and are hence at an increased risk of adverse outcomes (76), though I was not able to investigate this for lack of the relevant information in the study data. Nevertheless, this finding of the substantial contribution of income requires further investigation.

6.3 Conclusion

According to 2016 Census report, more than 1 in 5 people in Canada are foreign-born, encompassing more than 7.5 million people that have come to Canada through immigration (77). Canada has one of the highest rates of immigration in the world, admitting between 200 and 250 thousand immigrants each year (75). Thus, understanding differences in perinatal health outcomes by nativity and the factors that contribute to these differences is important for population health.

In this study, I contributed to previous literature that has shown the complexities of maternal nativity and perinatal health with quantification of the extent of perinatal health inequalities by maternal nativity across different outcomes and of outcome-specific contributions of key determinants of perinatal health identified in literature. I found that maternal race and ethnicity was the largest contributor to the inequality in non-fatal outcomes by nativity groups, while income was the largest contributor for fatal outcomes. These findings are likely due to large distributional differences in the variables between Canadian- and foreign-born mothers, with minimal contributions from differences in the effect of determinants between groups. As noted in the manuscript chapter, results differ from a previous study of maternal nativity using the 1996 and 2006 CanBCC data. As such, future research would benefit from examining the changing contributions of parental characteristics to the inequalities in perinatal health by nativity, in Canada, over time.

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