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Comparing the Uncharted: Data Analytics and Insights into Maternal and Neonatal Health Outcomes in Australia

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Full research paper

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Abstract

This paper presents a conceptual framework for examining maternal and neonatal health outcomes in Australia, focusing on the Australian Capital Territory (ACT). Secondary data from the Australian Institute of Health and Welfare (AIHW) and Australian Bureau of Statistics (ABS) were used to explore health outcomes in relation to maternal age, smoking habits, gestational health, indigenous heritage, geographic remoteness, access to healthcare facilities, and income levels. The study highlights the adverse effects of maternal smoking on perinatal mortality and the significant role of socio-demographic factors like maternal age, ethnicity, and socioeconomic status in shaping these outcomes. Findings also

indicate how persistent disparities affect health outcomes across different demographic groups, emphasizing the need for targeted interventions. These insights offer guidance for policy enhancements in maternal and infant health in Australia, particularly within the ACT, and recommends for a National Digital Maternal and Neonatal Program to enhance maternal and neonatal literacy.

Keywords Maternal and neonatal health outcomes, Australia, Conceptual framework, Socio-demographic factors, Public health interventions.

1 Introduction

Maternal and neonatal wellbeing and health outcomes are critical indicators of societal health. Investigating the trends and risk factors associated with it is crucial for developing effective interventions. In their article, Roser and Ritchie (2013) highlight the significant progress that has been made towards reducing child mortality over the past few decades. They note that there is still a long way to go, particularly in low-income countries, but also, that further improvements could be made to reduce maternal and perinatal mortality rates in developed countries. During the period of 1990 and 2015, the global maternal mortality ratio (MMR) at 44% failed to meet the millennium development goal (MDG) 5 which was set to 75% (Bongaarts 2016). The sustainable development goal (SDG) 3.1 and 3.2 aims to reduce the global maternal mortality ratio to less than 70 per 100,000 live births by 2030 and end preventable deaths of newborns and children under 5 years of age, while all countries are aiming to reduce neonatal mortality to a rate at least as low as 12 per 1,000 live births and under 5 mortality rate to at least as low as 25 per 1,000 live births.

While progress has been made in reducing maternal and perinatal mortality rates globally, disparities still exist within and between countries. In Australia, stillbirth rates are higher than in many other developed countries, while maternal mortality rates have been relatively stable (Flenady et al. 2020; Jardine et al. 2021; Roser and Ritchie 2013). In general, Australia has low maternal and perinatal mortality rates, but stillbirth remains a concern as neonatal deaths have mainly contributed to the decline in the perinatal rates. Hence, maternal and child health is a crucial aspect of public health in Australia, with a focus on ensuring equal access to quality healthcare services, education, and resources to support healthy pregnancies, births, and early childhood development (Australian Institute of Health and Welfare 2023). The government has implemented various policies and programs to enhance maternal and child health outcomes, including maternal and child health services, immunisation programs, and contraception accessibility (Department of Health 2018).

Although demographics of maternal and infant characteristics have remained relatively stable, trends over time reveal significant patterns such as a decrease in birth rate, an increase in the average maternal age during childbirth, and a reduction in maternal smoking during pregnancy (Australian Institute of Health and Welfare 2023). Despite significant improvements in maternal and neonatal health outcomes in recent years, there are still significant disparities in health outcomes among different demographic groups in Australia. These disparities are particularly pronounced among disadvantaged groups, including Aboriginal and Torres Strait Islander communities and women living in remote and rural areas (McCalman et al., 2023; Sivertsen et al. 2020). Thus, it is essential to comprehend the causes, maternal characteristics, timing, and investigate the outcomes to develop effective public health policies and interventions.

To address this notable gap and progress beyond this point, the primary goal of this research is to develop a comprehensive statistical and in-depth data analysis based on quantitative secondary data collected from various national databases including the Australian Bureau of Statistics (ABS) and the Australian Institute of Health and Welfare (AIHW) in order to identify factors that impact the health outcomes of a mother and child. Particularly, the study aims to answer the following question: *What are the key determinants of maternal and neonatal health in the Australian Capital Territory (ACT), and how can targeted interventions improve these outcomes?* To answer this question, the study will focus on factors such as maternal age, smoking habits, gestational health, indigenous identity, remoteness, access to health facilities, and income. This research will not only provide valuable insights about the interplay and intricate relationships between these factors on birth outcomes in Australia, but also contribute towards the development of targeted policies and initiatives aimed at promoting better health outcomes for mothers and babies and provides recommendations in which technology can be harnessed to support maternal and perinatal health.

In what follow, we will first present a review of existing literature on maternal and perinatal health outcomes to establish the groundwork of our study. Following that, we will outline the methodological approach adopted in the collection, analysis, and presentation of study data. Key findings relating to the factors impacting mother and child health will be presented next within the result section, highlighting the significant role of maternal age, indigenous identity, and gestational health on birth outcomes. Finally, this will be followed by a discussion section outlining the implications of these findings for policymaking and healthcare practices and a conclusion.

2 Literature Review

This section aims to provide a comprehensive review of existing literature, focusing on three key themes: Social determinants of health, technological interventions, and health disparities.

2.1 Social Determinants of Health

The wellbeing of a child during the first thousand days of their life is linked to the health status of the mother during pregnancy, as well as the conditions in which the mother lives and works (Venkatesh et al. 2016). Maternal health during pregnancy, as reflected by excessive gestational weight gain, gestational diabetes mellitus, and obesity can have significant effects on the health of newborns, including the risk of preterm birth. Therefore, to ensure the healthy development of a child during this period, it is essential to have a healthy mother and a healthy pregnancy. A comprehensive review conducted by Simoncic et al. (2022) found that various maternal, parental, and contextual characteristics can affect the health of foetuses and newborns. Social determinants and factors like maternal age, education, marital status, pregnancy intention, and socioeconomic status have been found to play a significant role in foetal and newborn health outcomes. These social factors are also linked to health inequalities, particularly for pregnant women. Socioeconomic and other factors like employment status, low household income, history of abortion, multiple births, and inadequate antenatal care also contributed to exacerbating the effect (Nik Hazlina et al. 2022).

A systematic review conducted by Nik Hazlina et al. (2022) on the prevalence of risk factors for maternal morbidity suggests that the risk factors of history of caesarean section, advanced maternal age, multiple pregnancies, co-existing medical conditions, and caesarean birth relative to planned vaginal deliveries, were associated with severe maternal morbidity (SMM) and maternal mortality (Liu et al. 2007; Nik Hazlina et al. 2022). Nik Hazlina et al. (2022) observed that studies conducted in both developed and developing countries show that younger adolescent girls, especially those aged 15 or younger, face higher mortality rates during childbirth than older adolescents. Adolescent pregnancies are more common among poor and less educated women, which disrupts their education and future career prospects. In developed countries, the prevalence of stillbirths is higher among mothers aged over 35 years, those who are overweight or obese, those with pre-existing hypertension, and those who consume tobacco-related products. Lawn et al. (2016) state that detecting fetal growth restriction early on remains a challenge even in high-income countries. In their study, they found that prolonged pregnancy beyond 42 weeks is linked to a higher risk of stillbirth, accounting for around 14% of stillbirths worldwide. They also found that adolescent pregnancies, especially among those aged below 16 years, are also associated with an increased risk of stillbirth (Lawn et al. 2016).

Further, smoking during pregnancy has also been associated with an increased risk of adverse maternal and neonatal outcomes, including premature labor, premature rupture of membranes, preterm birth, intrauterine growth restriction (IUGR), and small for gestational age (SGA) infants. However, quitting smoking during the first trimester can reduce these risks (Hodyl et al. 2014; Kildea et al. 2013). The systematic review conducted by Avşar et al. (2021) found that smoking increased the risk for 20 conditions and the highest impact was observed for sudden infant death syndrome, asthma, low birth weight (LBW), stillbirth, and obesity in infants. The study indicated that maternal smoking not only increased the risk of the child's death during the prenatal period, neonatal period, and infancy, but also affected some long-term outcomes which could be detrimental for the offspring, such as birth defects and intellectual disability that would affect later stages of life (Avşar et al. 2021; Lange et al. 2018). Many studies have observed that smoking during pregnancy (SDP) is related to socioeconomic status, maternal age, partner smoking, and cultural and ethnic background of the pregnant mother and have further demonstrated that SDP is associated with an increased risk of adverse pregnancy outcomes (Avşar et al. 2021; Lange et al. 2018; Mohsin et al. 2011). Some of these risks include miscarriage, stillbirths, premature birth, low birth weight babies, neonatal morbidity, perinatal deaths, maternal mortality and even postnatal child health outcomes like sudden infant death syndrome, brain tumour, childhood cancer, hearing problem, asthma, and other respiratory infections (Avşar et al. 2021; Lange et al. 2018; Mohsin et al. 2011). The prevalence of SDP is around 10% in high-income countries compared to a lower 3% in low- and middle- income countries (Avşar et al. 2021). Smoking rates have decreased in Australia, but rates among indigenous women are three times higher than those among non- indigenous women.

2.2 Technological Interventions

Venkatesh et al. (2016) illustrate that an information and communication technology (ICT) intervention effectively addresses infant mortality, even in areas with limited resources and cautious attitudes toward technology. They highlight that social influence on mothers' health-related behaviours for the care of

their infants reduces infant mortality. An innovative approach by Blank et al. (2013) addresses primary maternal care enhancement in rural Sub-Saharan Africa using a Clinical Decision Support System (CDSS) to guide health workers and improve quality. This CDSS, aligned with WHO guidelines, emphasizes routine guidance, algorithmic alerts, and electronic tracking to augment care. In their study, Wu et al. (2021) explore the impact of web-based tools on pregnant adolescents, revealing positive influences on treatment-seeking behaviour for postpartum depression, while emphasizing the need for curated online platforms. Asi and Williams (2018) underscore the importance of digital health in conflict-affected areas, advocating for the use of mHealth and telehealth to overcome barriers, enhance health outcomes, and promote data collection aligned with Sustainable Development Goal 3.

2.3 Health Disparities

While Australia is considered to be one of the safest countries for giving birth (Department of Health and Aging 2008), there is however a disparity in the health outcomes of indigenous women and infants in comparison to other Australians. Indigenous women in Australia are at a higher risk of poor perinatal outcomes compared to non-indigenous women, regardless of smoking status. This disparity persists even after adjusting for potential confounding factors (McCalman et al. 2023; Sivertsen et al. 2020). Reducing maternal smoking during pregnancy is the most effective way to improve perinatal outcomes for indigenous women, but it is challenging due to socioeconomic disadvantage, low education levels, and stressful life circumstances. Regardless of smoking status, indigenous women had lower maternal age, higher rates of teenage pregnancies, and were more likely to reside in areas with low socio-economic indexes and become public hospital patients. Other factors such as health literacy, inequitable education, remote location, and limited access to healthcare contribute to the increased risk of adverse outcomes in indigenous populations. Verdezoto et al. (2020) highlights key challenges faced by indigenous women in a rural LATASM community in the use of antenatal care services and pregnancy complications such as gestational diabetes and preeclampsia. Compared with non-indigenous women, indigenous women attend their first antenatal appointment later in pregnancy, make fewer antenatal visits, and receive inconsistent antenatal care services (Kildea et al. 2013).

Numerous studies found that social factors such as education, income, and employment status are associated with the lifestyle and behaviours of pregnant women, including diet, physical activity, smoking, and alcohol consumption (Tessier et al. 2023; Van Lee et al. 2020; Zhou et al. 2022). These behaviours can lead to physiological disorders including obesity, gestational weight gain, and gestational diabetes, which can result in adverse pregnancy outcomes. This is more evident in socially disadvantaged women and unemployed women as they are not able to access healthcare services and lack health insurance which has also been associated with inadequate use of antenatal care.

Figure 1 illustrates a visual representation of the factors influencing maternal and perinatal health outcomes, as identified from previous studies presented in this section.

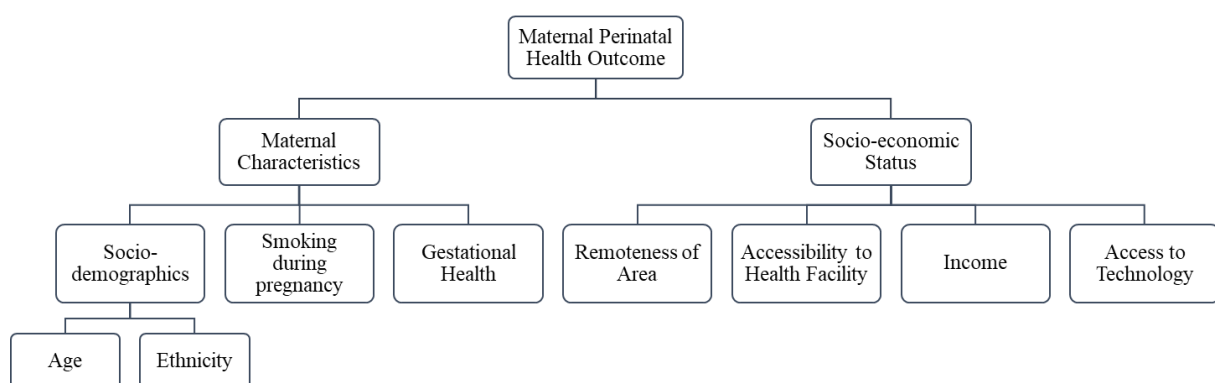


Figure 1: A conceptual framework for visualising maternal and perinatal health

With the aim of deepening our comprehension of factors impacting maternal and infant health outcomes, especially regarding the interaction between maternal characteristics and neonatal results, this study centres its investigation on the ACT. A deliberate selection, the ACT serves as a strategic foundation for conducting in-depth primary data collection and analyses in future follow up studies. By proactively choosing the ACT, this study aims to address existing research gaps and provide a comprehensive examination of the factors shaping maternal and neonatal health outcomes and pave the

way for well-informed interventions and strategies, ultimately, enhancing the health and wellbeing of both mothers and infants, particularly within Australia's ACT region and indigenous communities.

3 Methodology

In order to investigate the factors and maternal characteristics impacting the outcomes of maternal and neonatal health in the ACT in particular, our study adopts a quantitative approach that analysed secondary datasets. The methodological approach will be outlined next.

3.1 Data Collection

The data collection phase involved gathering quantitative secondary data from various sources, including national databases and government reports like the Australian Bureau of Statistics (ABS) and the Australian Institute of Health and Welfare (AIHW). Relevant information on maternal characteristics and medical histories such as maternal age, ethnicity, socioeconomic status, parity, pre-existing medical conditions, and pregnancy complications records from year 2001 - 2020 were collected. Perinatal and maternal mortality data were also obtained, with a focus on identifying the period of occurrence (prenatal, intrapartum, or postpartum). These data were collected in aggregated format and sourced from the AIHW. The datasets collected from ABS included records from 1991-2021 of birth data, encompassing information such as the age, ethnicity, and the birthrate of the area. Data obtained from AIHW was primarily used for the purpose of this study.

3.2 Data Preprocessing and Analysis

The data was processed and analysed using various analytics software tools including RStudio, PyCharm, Python 3.8, Microsoft Excel, and Tableau Public. RStudio with its robust statistical packages and user-friendly interface was utilized for data preprocessing and manipulation, statistical analysis and visualization of our data. Python 3.8 and PyCharm was used primarily for data pre-processing and manipulation especially for ABS data owing to its powerful data manipulation libraries, such as Pandas and NumPy. Tableau Public was instrumental in creating interactive data visualizations. This platform was selected for its intuitive interface, which allowed us to present our data in an engaging and accessible manner. As for Excel was used to tabulate the data and create simple charts. Exploratory data analysis (Pearson 2018) was conducted to examine the data distribution and detect any anomalies or data quality issues. Since the data we collected were all in aggregated format, we did not have many anomalies or outliers to deal with in our data. Trend analysis was conducted to explore the temporal patterns of maternal and infant mortality rates over different decades and between different states of Australia. A specific focus was placed on analyzing differences in maternal characteristics and baby outcomes among distinct groups including indigenous, teenage, older, and mothers with multiple births. In addition, a dynamic dashboard was created, incorporating interactive graphs, charts, and maps to visually represent the data and facilitate its interpretation by stakeholders and researchers.

Data set related to birth such as maternal age, geography, antenatal visits, smoking, body mass index (BMI), maternal medical conditions, gestational age, birth weight, birthweight for gestational age, apgar score at 5 minutes of liveborn babies, and admission to special care nursery were extracted for years ranging from 2001-2020. After loading the datasets to a suitable data frame format, rigorous cleanup was performed since the data was not ideal for the scope of analysis. This included data import and initial inspection, handling of missing values, correction of data types, isolation of actual data, systematic addressing of missing values and data types, and finally, preparation of data for statistical analysis. Next, the data was shaped and consolidated in a uniform order using libraries such as dplyr, stringr, and tidyr. Targeted exploration and focused multivariate analysis of the data was performed next. Finally, using plotly and ggplot2, the plots were displayed for visual presentation. After cleaning the data for analysis, statistical analysis and shaping were performed to facilitate interfacing the data to its related tool such as plotly and ggplot. Figure 2 illustrates a snippet of code used for plotting smoking related statistics.


```
##### Smoking #####
# Smoking Status
smoking_status <- c("Did not smoke","Smoked")

# Subset of smoking status
smoked <- subset(total_admissions_by_year, Topic_disaggregation %in% c(smoking_status,"Smoking status (any time during pregnancy)"))

# Plot Smoking status
ggplot(smoked, aes(x = Year, y = Per_cent, group = Topic_disaggregation, color = Topic_disaggregation)) +
  geom_line() +
  labs(x = "Year", y = "Total Admissions", title = "Total Admissions by Year and smoking") +
  theme_bw() +
  theme(plot.title = element_text(size = 16, face = "bold"),
        axis.text = element_text(size = 12),
        axis.title = element_text(size = 14),
        legend.title = element_blank(),
        legend.text = element_text(size = 12))

##### Country of birth #####
```

Figure 2: Snippet of code in R for data analysis and visualization

After feeding the shaped data to the noted tools, we generated human-readable visualizations that can be easily interpreted and inferred. The data analysis revealed several key findings such as the trend towards delayed childbearing, the high rate of gestational diabetes among mothers in ACT, the influence of a baby's BMI and gender on hospital admissions, and the role of socioeconomic factors in maternal and neonatal health. The results from our analysis will be presented next.

4 Results

The analysis of Australia’s mothers and newborns data revealed several crucial insights into the health outcomes of mothers and infants in the country. The study highlights the negative impact of maternal smoking on perinatal and neonatal mortality rates, stillbirths, and other adverse birth outcomes. The findings also shows that a range of socio-demographic factors including maternal age, ethnicity, and socioeconomic status also play a significant role in determining maternal and infant health outcomes.

The analysis of maternal age distribution over the years (Figure 3) reveals intriguing trends in childbirth preferences among different age groups. From 2014 to 2020, there has been a steady decrease in the proportion of mothers giving birth in the age categories 20-29. Similarly, there has been a slight decrease in mothers giving birth in age categories 19 and below. In contrast, the age category 30-39 has experienced an upward trend in the proportion of births during this period. Moreover, the proportion of mothers aged 40 and over has remained relatively stable across these years.

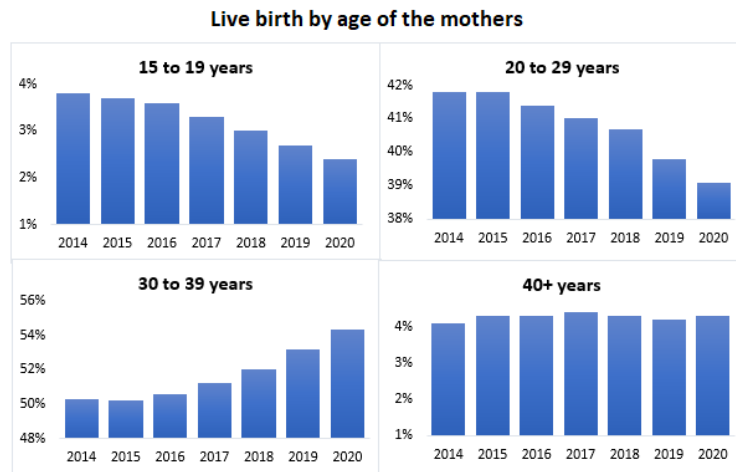


Figure 3: Proportion of mothers by different age groups in Australia

These findings point to shifting patterns in maternal age preferences, suggesting an increasing trend of mothers opting for childbirth in their thirties. Such changes may be attributed to various factors including the growing emphasis on delaying pregnancy due to educational and career pursuits as well as the availability of assisted reproductive technology (ART). Notably, advanced maternal age often aligns with better health conditions and improved socio-economic status compared to previous decades. Figure 3 visually illustrates these trends, providing a clear representation of the changing maternal age landscape and the implications it may hold for maternal and neonatal health outcomes. However, many studies (Lawn et al. 2016; Liu et al. 2007; Nik Hazlina et al. 2022) reveal that older childbearing women

are at increased risk of a range of obstetric morbidities. Older nulliparous women are at the highest odds of gestational diabetes, placenta praevia, multiple birth, and caesarean delivery, whilst older multiparous women were at the highest odds of gestational diabetes and placenta praevia. Our analysis consistently corroborated these findings which have important implications for women during childbearing, maternity clinicians, and healthcare services and further contribute to the ongoing public discourse surrounding advanced maternal age.

In their study, Pettersson et al. (2020) confirm that age is a risk factor for higher morbidity for both maternal and infant. In recent years, there has been a trend towards delayed childbearing as women prioritize education, career advancement, and financial stability. Social norms and expectations regarding family planning have evolved, allowing women to postpone starting a family until later in life. Advancements in medical technologies such as in vitro fertilization (IVF) have made it possible for women to conceive later in life. Societal and economic factors such as increasing educational and career opportunities for women, economic stability, and changing cultural attitudes towards motherhood and marriage, can influence the decision to delay having children (Nneka et al. 2022). Older maternal age has been associated with a greater likelihood of having pre-existing medical conditions, a higher risk of obstetric complications, maternal morbidity, and an increased risk of progression from Severe Maternal Morbidity (SMM) to Death. As depicted in Figure 4, it can be concluded that advanced maternal age increases the risk of SMM or death of the mother. Contrary to the results of Nik Hazlina et al. (2022) and Liu et al. (2007), we found that maternal morbidity was higher in mothers at both ends of the age spectrum, such as those of age 35 years and over and adolescents.

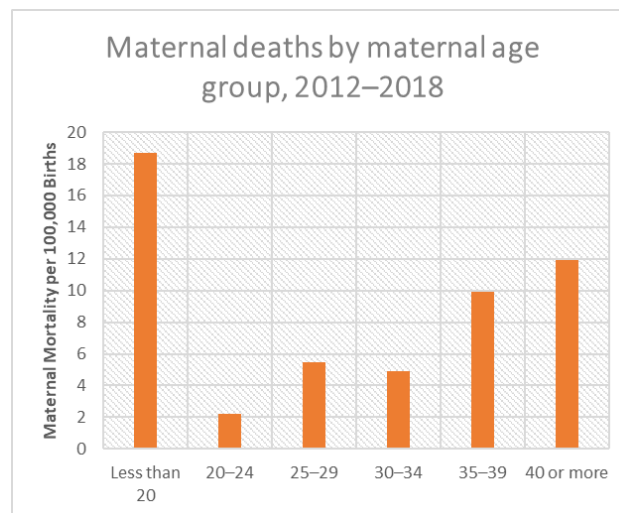


Figure 4: Proportion of maternal mortality per 100,000 births across various age groups

Age plays a substantial role in perinatal mortality. As depicted in Figure 5, the age factor influence on perinatal mortality is shown across different years. The data indicates a notably high perinatal mortality rate among mothers under 20 and those aged 40 and above. Conversely, the group aged between 20-39 consistently demonstrates lower rates of perinatal mortality.

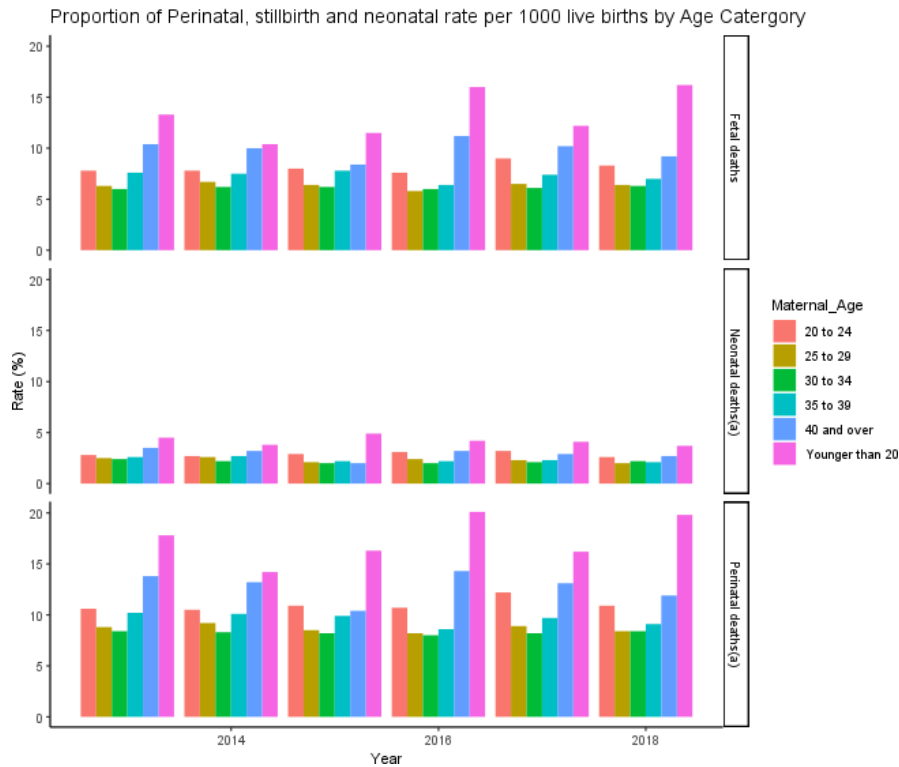


Figure 5: Perinatal death vs maternal age

An examination of mothers giving birth reveals a decline in the prevalence of being underweight over the years, decreasing from 3.8% in 2012 to 3.0% in 2020. Conversely, obesity among women giving birth exhibits a gradual increase, rising from 20.1% in 2014 to 22.9% in 2020. Similarly, the prevalence of being overweight among women giving birth shows a slight increase, shifting from 25.8% in 2014 to 27.7% in 2020. In contrast, the proportion of women giving birth with a normal weight witnessed a decrease over time, declining from 50.3% in 2015 to 46.5% in 2020. These findings underscore a concerning upward trajectory in obesity prevalence, marked by a gradual increase from 2014 to 2020. Maternal obesity and excessive weight gain emerge as critical risk factors impacting various maternal and infant health outcomes. This condition is strongly linked to gestational hypertensive disorders, gestational diabetes, medically induced preterm birth, caesarean delivery, and delivering a large-for-gestational-age infant (Gaillard et al. 2014). Furthermore, it heightens the risk of fetal death and a range of congenital anomalies by approximately 2 and 1.5 times, respectively (Stothard et al. 2009).

Compared to non-indigenous mothers, indigenous mothers have a higher likelihood of experiencing maternal mortality, whether it be due to direct or indirect causes. It is observed that mothers from indigenous communities tend to be more obese than mothers from non-indigenous communities. Further, the findings showed the prevalence of pre-existing diabetes, smoking during pregnancy, and proportion of liveborn babies weighing less than 2500 g were more in indigenous women than in non-indigenous women and the relative gap has been increasing over the years (Hodyl et al. 2014; Kildea et al. 2013). Concurrently, it is observed that each corresponding year, the prevalence of caesarean sections is increasing among mothers who are obese compared to vaginal birth which is decreasing gradually.

Successful childbirth often depends on parents' socio-economic status and geographical location since those determine accessibility to better healthcare, medication better antenatal visiting practices (Wulifan et al. 2022). To have a deeper understanding, we investigate the mother's socio-economic area in Figure 6. Quantile 1 means the most disadvantaged area and Quantile 5 means the least disadvantaged area. It can be observed that the most disadvantaged area has a high mortality rate for all categories of deaths and the least disadvantaged area has the least proportion of mortality rate.

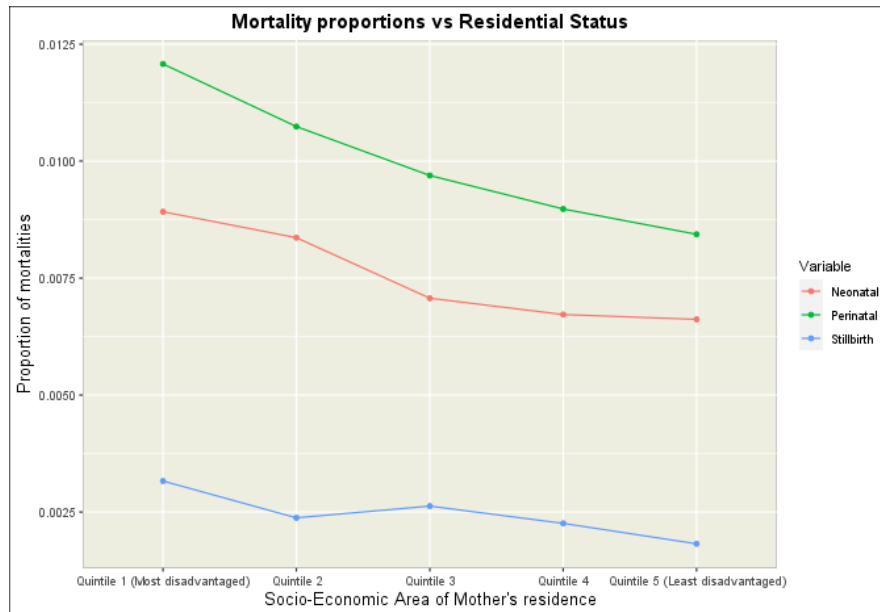


Figure 6: Socio-economic area of mother's residence

Similarly, it is observed that mothers living in remote areas had higher prevalence of child mortality in comparison to the major cities, as mothers living in remote areas do not have the kind of accessibility to better facilities than those living in cities. Simoncic et al. (2022) identifies several pathways and mechanisms that contribute to this disparity. Limited access to quality prenatal care, skilled medical professionals, and well-equipped healthcare facilities are key factors that hinder proper maternal care in remote areas. These mothers often face challenges in accessing timely medical interventions and emergency obstetric care, leading to increased risks during pregnancy, childbirth, and the postnatal period. Moreover, the paper suggests that socioeconomic factors also play a role in exacerbating the issue. Remote areas typically experience higher levels of poverty, limited educational opportunities, and inadequate infrastructure. These conditions can lead to poorer overall health among mothers, which in turn, influences the health of their newborns (Simoncic et al. 2022). Mothers who do not smoke during pregnancy exhibit a maternal mortality proportion of 3 per 100,000, whereas mothers who smoked throughout pregnancy exhibit a proportion of approximately 15 as depicted in Figure 7.

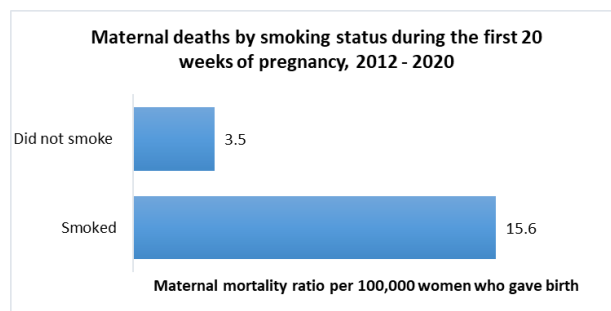


Figure 7: Maternal mortality vs. smoking

Additionally, we explored deeper into the ACT dataset. As depicted in Figure 8, we observe a comparable trend in the ACT to the overall trend in Australia. Notably, the age groups of 15-19 and over 40 represent the last two segments, with the majority of mothers falling within the age group of 30-34.

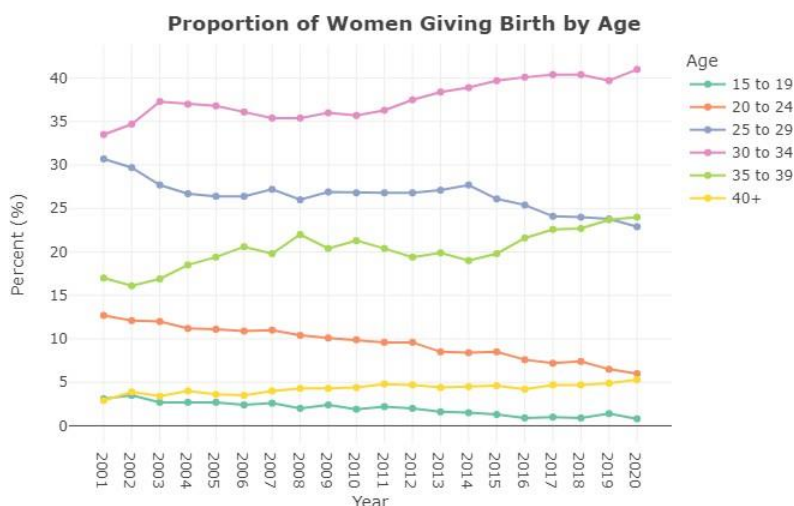


Figure 8: Proportion of woman giving birth by age in ACT

It is observed that women who gave birth with gestational diabetes has increased over the years. Investigating further into the correlation between mothers who smoke and their age among the mothers who live in ACT, we can see that smoking is more common among young mothers. Mothers aged 15-19 are significant in number when it comes to smoking habits, however the rate falls drastically as the age increases. Further, the data reveals that smoking during pregnancy is common among mothers of ACT in 2001 but the rate steadily decreased and came down to less than 5% in recent years. Further, it is observed that it was 8 times more prevalent among indigenous community than the non-indigenous community in 2020. The baby’s and mother’s health are an important factor during and after childbirth. Successful childbirth often depends on some key factors of the baby’s health such as gestational age, the weight of the baby when it was born, etc. We observed that indigenous community had higher prevalence of liveborn babies weighing less than 2500g than the non-indigenous community (Figure 9).

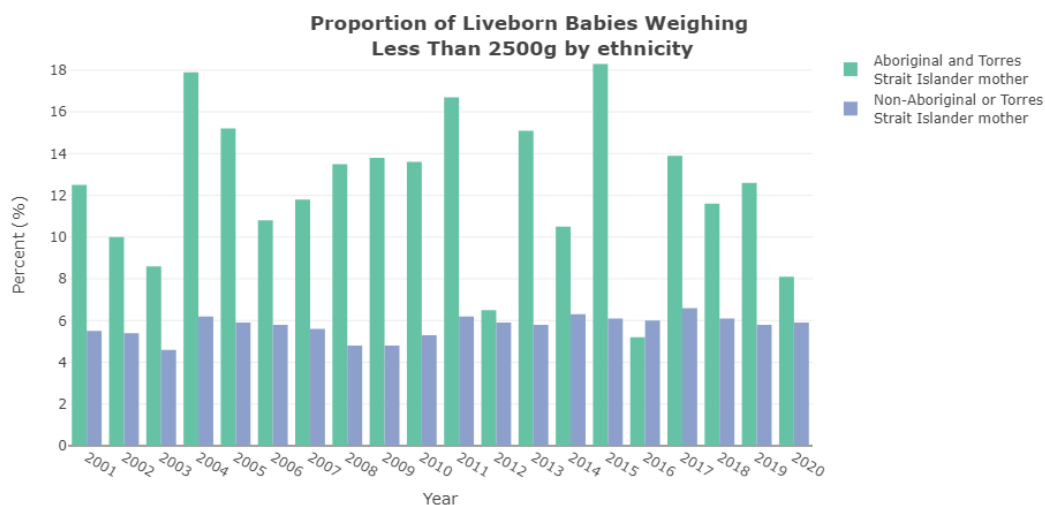


Figure 9: Proportion of Liveborn Babies Weighing Less Than 2500g by Ethnicity in ACT

Research conducted in high-income countries indicates that women with disadvantaged living conditions and community experience worse pregnancy outcomes. These socioeconomic inequalities disproportionately affect women, impacting both their own health and the health of their children. A meta-analysis of studies conducted in the UK and Ireland found that women in lower-level occupations or social classes had a 40% higher risk of stillbirth, neonatal mortality, perinatal mortality, preterm birth, and low birth weight. Additionally, unemployment is associated with an increased risk of stillbirth, maternal mortality, and preterm birth (Thomson et al. 2021).

5 Discussion and Implications

Our study findings provide valuable insights that can inform policies and initiatives aimed at promoting better health outcomes for mothers and babies across Australia, with a particular emphasis on

addressing the unique challenges and opportunities in ACT, a region often overlooked in national healthcare studies. Moreover, we pay special attention to the health outcomes of indigenous Australians, a demographic that has been historically underrepresented in healthcare research. Insights gained from the statistical data analysis supported by the use of IT tools in the design can be used to drive evidence-based interventions and recommendations aimed at reducing perinatal and maternal mortality rates and enhancing our understanding of maternal and neonatal health in the ACT region.

Based on our findings, we propose a set of recommendations centered around a National Digital Maternal and Neonatal Program. This program aims to address issues related to technology accessibility, enhance maternal and neonatal literacy, and implement targeted educational initiatives, particularly for indigenous and younger women. By leveraging digital tools and technology access such as the use of video conferences to replace in-person visits and remote consultation, use of IoT technologies and smart wearable devices based on electrocardiogram (ECG) devices for home monitoring of health, and others, several challenges can be mitigated, fostering a proactive approach towards maternal and neonatal health awareness and education (Venkatesh et al. 2016). This, in turn, could lead to a reduction in risks related to conditions like smoking, obesity, and diabetes that may have adverse long-term effects on both mothers and infants.

Accordingly, we propose the following recommendations:

- **Digital Platforms for Education and Connectivity:** Implementing accessible mobile applications and social media platforms can create a virtual space where women can access information, connect with healthcare providers, and enhance their understanding of maternal and neonatal health. These platforms can empower women to actively engage in their health journey and gain awareness about potential risk factors.
- **Telehealth and Remote Support:** The national program should facilitate telehealth services, allowing pregnant women, particularly those in remote areas, to consult healthcare professionals through digital means. This can bridge geographical gaps and ensure timely guidance and care.
- **Educational Content:** Developing comprehensive educational content on nutrition, recognizing symptoms that may lead to negative outcomes, and the impact of harmful behaviours like smoking is crucial. This content should be tailored to the specific needs of indigenous women and should address their unique challenges and concerns.
- **Support throughout Pregnancy:** The program should extend its support beyond pregnancy to provide guidance during the postpartum period, fostering a continuum of care that addresses the well-being of both mothers and infants.
- **Targeting Younger Women:** By extending its educational reach to younger women who plan to have children, the program can ensure that women are well-informed about maternal and neonatal health even before pregnancy. This proactive approach can contribute to healthier outcomes for future pregnancies.

6 Conclusion

Investigating maternal and neonatal health outcomes in Australia and ACT through quantitative analysis revealed trends such as delayed childbirth and the association of advanced maternal age with increased risks. By exploring the impact of various variables including maternal age, smoking during pregnancy, gestational health, indigenous identity, remoteness, accessibility to health facilities, and income, the findings of this study clearly highlight the need for various interventions towards improving the maternal and neonatal health in Australia and in ACT. Socioeconomic disparities, remote living, and smoking were linked to elevated mortality rates. Maternal obesity posed significant risks, while indigenous communities faced unique challenges. Recommendations for interventions include leveraging digital tools and targeted approaches. Despite the valuable insights, the study limitations stem from reliance on secondary data, however, the ACT focus serves as groundwork for future in-depth investigation using primary data. Acknowledging these limitations, the study underscores the need for focused efforts to enhance maternal and infant health outcomes. Collaborative endeavours by policymakers and healthcare professionals hold the potential to drive improvements not only within the ACT and Australia, but also globally.

7 References

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