School of Population Health Faculty of Health Science

Early Life Morbidity and Mortality and Associated Risk Factors and Maternal Lived Experiences in the Solomon Islands

Lydia Sandrah Kuman Kaforau

0000-0001-7350-0645

This thesis is presented for the Degree of
Doctor of Philosophy
of
Curtin University

August 2023

Declaration

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. The research presented and reported in this thesis was conducted in accordance with the Solomon Islands Health Research and Ethics Review Board with full research ethical approval (number HRE039/19). The proposed research study received Human Research Ethics approval from the Curtin University Human Research Ethics Committee (number HRE2020-0530). The author undertook the work described in this thesis and is original. The study design, ethics approval, data collection and analysis, writing of manuscripts for publication, and writing of the thesis were conducted under the supervision of Professor Jonine Jancey, Professor Gavin Pereira, Dr Gizachew Assefa Tessema, and Professor Hugo Bugoro.

Lydia Sandrah Kuman Kaforau

23 August 2023

Acknowledgement to Country

I acknowledge that Curtin University works across hundreds of traditional lands and custodial groups in Australia, and with First Nations people around the globe. I wish to pay my deepest respects to their ancestors and members of their communities, past, present, and to their emerging leaders. My passion and commitment to work with all Australians and peoples from across the world, including our First Nations peoples, is at the core of the work I do, reflective of my institution's values and commitment to our role as leaders in the Reconciliation space in Australia.

Dedication

This thesis is dedicated to my beloved parents: my first teachers and mentors.

Moses Idumaoma Kaforau (retired RN)

Dad is the pillar of my nursing career and academic journey, who always encouraged me to seek my dreams of pursuing a Doctor of Philosophy within the discipline of health. I am forever grateful for his dedication and best guidance.

And to my beloved late mother, who is my spirit guide from heaven:

Marylyn Sapolau Kaforau

It has been 19 years since you left, and I still carry your earnest wish for me: to be a role model, live my life to the fullest potential, and excel academically.

Abstract

Aim

The aim of this research is to estimate the burden of the most critical birth outcomes (early life mortality and morbidity) in the Solomon Islands, the contribution of risk factors to this burden, and to gain an understanding of the context that influences the risks. To achieve this aim, four substudies were undertaken based on four corresponding objectives.

Background

Early life morbidity and mortality are major global public health concerns. Early life morbidity encompasses various adverse birth outcomes such as Small for Gestational Age (SGA), preterm birth, and Low Birth Weight (LBW), while early life mortality includes perinatal mortality, stillbirth, and under-five mortality. These conditions are highly prevalent in low- and middle-income countries (LMICs) due to inadequate health and social resources. The Solomon Islands, being an LMIC, has poor health and social infrastructure, leading to an increased risk of this burden. Furthermore, early life morbidity and mortality and the associated risk factors of both in the Solomon Islands are not well studied, with few estimates available. For example, the prevalence of LBW was 12.4% in 2006, preterm birth was reported to be 24%, and under-five mortality was 28 per 1,000 live births, being amongst the highest in the Pacific Island region. Therefore, this thesis focuses on the prevalence of early-life morbidity and mortality specifically on LBW and under-five mortality. Furthermore, it aims to investigate the extent to which various risk factors contribute to this burden, and to comprehend the contextual elements that influence these risks.

Method

The thesis employed four substudies, which correspond to four objectives, using a concurrent mixed-method study design. The four studies incorporated a scoping review, two quantitative analyses of the Solomon Islands Demographic and Health Survey 2015 (SIDHS 2015) data on LBW and under-five mortality, and a descriptive qualitative study.

Substudy One: Scoping Review

The objective of Substudy One, the scoping review, is to map the available literature on the prevalence of adverse birth outcomes and associated risk factors in the Pacific Island countries and develop additional insights and recommendations from the perspective of health professionals. The scoping review followed the five-staged Arksey and O'Malley's framework[1] with clinicians'

consultation in the region, and analysed 20 primary studies retrieved from five scholarly databases and online searches. The consultation exercise included 18 health professionals in four Pacific Island countries: Fiji, Papua New Guinea, Solomon Islands, and Vanuatu.

Substudy Two: Quantitative Analysis of the SIDHS 2015 Data on Low Birth Weight

Substudy Two utilised the SIDHS 2015 data, a population-based cross-sectional study conducted in the Solomon Islands between April and September 2015. The objective of this analysis was to investigate potential and contextual risk factors, and the prevalence of LBW in the Solomon Islands based on this data. The analysis focused on women who gave birth within five years of the survey, which included a total of 4,272 births. Twenty exposure variables with known or hypothesised associations with LBW in the literature related to sociodemographic, reproductive, health service, and behavioural factors were included. Generalised linear models with a log link were used as the statistical analysis method to estimate relative risks with a 95% confidence interval between LBW and pertinent risk factors.

Substudy Three: Descriptive Qualitative Study

Substudy Three is a qualitative descriptive study of postnatal mothers with LBW infants in the Solomon Islands. The study objective was to understand the lived experience during the most recent pregnancy of women in the Solomon Islands who gave birth to LBW infants by exploring and describing their personal (sociodemographic and health), behavioural, social, and environmental context during their pregnancy. A total of eighteen postnatal women who had given birth to LBW infants in the Solomon Islands were purposely selected for an in-depth interview. The data collected were analysed using thematic analysis in NVivo (Version 20).

Substudy Four: Quantitative Analysis of the SIDHS 2015 Data on under-five mortality

Linked to Substudy Two, Substudy Four used the SIDHS 2015 data and the same population of women. The objective of the study was to estimate prevalence, risk factors, and population attributable risk for neonatal, infant, child, and under-five mortality using nationally representative data from SIDHS 2015. The analysis also concentrated on women who had experienced childbirth within the most recent five-year period covered by the survey, encompassing a total of 4,272 births. Twenty-five exposure variables with measures relating to sociodemographic, women, and child health and behavioural factors were used. The study also used generalised linear log-link models to estimate relative risks at a 95% confidence interval between LBW and pertinent risk factors.

Results

Substudy One: Scoping Review

The 20 studies included in the review represented 11 of the 22 Pacific Island countries. The estimated mean prevalence for LBW and preterm births were 12% and 13% respectively. LBW were found to be associated with malaria in pregnancy with an Adjusted Odds Ratio (AOR) of 3.3 (1.00, 10.60) and betel nut and tobacco use [AOR 2.4 (1.00, 6.00)]. Preterm births were associated with malaria in pregnancy [AOR 6.6 (2.46, 17.62)] and maternal obesity [AOR 1.5 (1.00, 2.30)]. SGA were associated with short stature [AOR 1.7 (1.22, 2.41)] and no antenatal bookings [AOR 4.0 (2.12, 7.57)]

Substudy Two: Quantitative Analysis of the SIDHS 2015 Data on Births

The estimated LBW prevalence for the Solomon Islands, based on the SIDHS 2015 data, was 10%. After adjustment for potential confounders, the risk of LBW for maternal history of marijuana and kava use was 2.6 times, with an Adjusted Relative Risk (ARR) of 2.64 at a 95% confidence interval (0.64, 10.95), and 2.5 times [ARR 2.50 (0.63, 9.88)] than among unexposed women, respectively. A polygamous relationship, no antenatal care, decision-making by another person were 84% [ARR 1.84 (1.15, 2.93)], 73% [ARR 1.73 (0.96, 3.13)], and 73% [ARR 1.73 (0.96, 3.13)] higher than among unexposed women, respectively. The study also found that 10%, and 4% of LBW cases in the Solomon Islands were attributable to a household of more than five members and tobacco and cigarette use history.

Substudy Three: Descriptive Qualitative Study

The findings suggest that women in the Solomon Islands are exposed to various personal, behavioural, social, and environmental risk factors during pregnancy that can impact birth outcomes, particularly LBW. Six major themes were identified under these factors as relating to LBW, and they included health issues, diet and nutrition, substance use, domestic violence, environmental conditions, and antenatal care.

Health issues the women were exposed to during pregnancy included malaria, non-specific infections, antepartum haemorrhage, chest pain, sexually transmitted infection, and urinary tract infection. The women also reported engaging in hard physical work, physical stress and falls during pregnancy. Poor diet and nutrition and lack of knowledge of good nutrition were also reported as health risks. The use of substances during pregnancy reported by the women were betel nut, tobacco, and marijuana. The majority of the women also reported experiencing domestic violence

during pregnancy. The poor environmental conditions the women experienced included poor access to antenatal care facilities and a lack of good water supply and proper sanitation.

Substudy Four: Quantitative Analysis of the SIDHS 2015 Data on Births

The study yielded estimates of mortality rates for neonates, infants, children, and those under-five years were eight per 1,000 live births, 17 per 1,000 live births, 12 per 1,000 live births, and 21 per 1,000 live births, respectively. Following adjustments for possible confounding variables, the findings indicate that neonatal mortality was linked to factors such as no breastfeeding [ARR 34.80 (13.60, 89.03)], no postnatal check [ARR 11.36 (1.22, 106.16)], and adherence to the Roman Catholic [ARR 3.99 (1.34, 11.88)] and Anglican [ARR 2.78 (0.89, 8.65)] doctrines. Infant mortality was associated with no breastfeeding [ARR 11.85 (6.15, 22.83)], being Micronesian [ARR 5.54 (1.67, 18.35)], and a higher birth order [ARR 2.00 (1.03, 3.88)]. Child mortality was associated with multiple gestations [ARR 6.15 (2.08, 18.18)], being Polynesian [ARR 5.80 (2.48, 13.53)] or Micronesian [ARR 3.65 (1.46, 9.10)], smoking cigarettes and tobacco [ARR 1.77 (0.79, 3.96)] or using marijuana [ARR 1.94 (0.43, 8.73)], and residing in a rural area [ARR 1.85 [0.88, 3.92)]. Under-five mortality was associated with no breastfeeding [ARR 8.65 (4.97, 15.05)], being Polynesian [ARR 3.23 (1.09, 9.54)] or Micronesian [ARR 5.60 [2.52, 12.46)], and multiple gestations [ARR 3.34 (1.26, 8.88)]. The study also found that 9% of neonatal and 8% of under-five mortality were due to a lack of maternal tetanus vaccination, according to our population attribution fraction.

Conclusion

Based on the analysis in this thesis, it can be inferred that LBW and under-five mortality in the Solomon Islands are predominantly influenced by behavioural, health, and sociodemographic risk factors. This assertion is supported by the experiential accounts of women residing in the Solomon Islands gathered through the in-depth interviews undertaken. Additionally, these identified risk factors bear resemblance to the outcomes of the literature review conducted on LMICs, as well as insights shared by healthcare professionals interviewed in the Pacific Island region. The implications of the findings of this study are critically significant in terms of the potential to guide health policies and practices, and the findings provide a solid groundwork for future investigations. However, it is worth noting that the findings may be susceptible to recall bias, thus suggesting the need for subsequent studies to corroborate and affirm these conclusions.

List of Peer-Reviewed Publications as Part of this Thesis

The following publications are the main component of this thesis:

1. **Kaforau LSK**, Tessema GA, Jancey J, Dhamrait GK, Bugoro H, Pereira GF. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review protocol. *BMJ Open*. 2021;11(4):e042423. doi.org/10.1136/bmjopen-2020-042423
2. **Kaforau LSK**, Tessema GA, Jancey J, Dhamrait GK, Bugoro H, Pereira GF. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review. *Lancet Reg Health: West Pac*. 2022;21:100402. doi.org/10.1016/j.lanwpc.2022.100402
3. **Kaforau LSK,** Tessema GA, Jancey J, Dhamrait GK, Bugoro H, Pereira GF. Prevalence and factors associated with low birth weight in the Solomon Islands: evidence from the 2015 Solomon Islands demographic and health survey data. *Asia Pac J Public Health*. 2023;35(2-3):136-144. doi:10.1177/10105395231158868
4. **Kaforau LSK,** Tessema GA, Bugoro H, Pereira G, Jancey J. Lived experiences of women with low birth weight infants in the Solomon Islands: a descriptive qualitative study. *PLOS Glob Public Health*. 2022;2(12):e0001008. doi.org/10.1371/journal.pgph.0001008
5. **Kaforau LSK,** Tessema GA, Jancey J, Bugoro H, Pereira G. Prevalence and risk factors associated with under-five mortality in the Solomon Islands: an investigation from the 2015 Solomon Islands demographic and health survey data. *Lancet Reg Health: West Pac*. 2023;33:100691. doi.org/10.1016/j.lanwpc.2023.100691

List of Conference and Seminar Presentations

1. **Kaforau LSK,** Tessema GA, Jancey J, Dhamrait G, Bugoro H, Pereira G. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review, preterm births prevalence and exposures in the Pacific Islands: scoping review findings. Paper presented at: Preterm Mini Symposium 2021, November 19, 2021; Telethon Kids Institute, Perth. [oral presentation]
2. **Kaforau LSK,** Tessema GA, Jancey J, Dhamrait G, Bugoro H, Pereira G. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review. Paper presented at: Consortium of Universities for Global Health, March 29, 2022; via Satellite; [oral -poster presentation]
3. **Kaforau LSK,** Tessema GA, Jancey J, Bugoro H, Pereira G. Prevalence and factors associated with low birth weight in the Solomon Islands: evidence from the 2015 Solomon Islands Demographic and Health Survey data. Paper presented at: Mark Liveris Seminar, September 15, 2022; Curtin University, Perth [oral presentation]

List of Figures

List of Tables

List of Abbreviations and Acronyms

APH	Antepartum Haemorrhage
CINAHL	Cumulated Index to Nursing and Allied Health Literature
CNMI	Commonwealth of the Northern Mariana Islands
DHS	Demographic Health Survey
EAs	Enumeration Area(s)
FGR	Foetal Growth Restriction
HBsAg	Hepatitis B Surface Antigen
HIV-AIDs	Human Immune Deficiency Virus – Acquired Immunodeficiency Syndrome
IMCI	Integrated Management of Childhood Illness
LBW	Low Birth Weight
LMIC /LMICs	Low and Middle-Income Country/ies
MDG/s	Millennium Development Goal/s
MeSH	Medical Subject Headings
MHMS	Ministry of Health and Medical Service
NCDs	Non-communicable Disease(s)
PAF	Population Attributable Fraction
PCC	Population Concept Context
PNG	Papua New Guinea
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
PRISMA-ScR	Preferred Reporting Items for Scoping Review and Meta-Analysis
RMCAH	Reproductive Adolescent Maternal Child Health
SDG	Sustainable Development Goal
SGA	Small for Gestational Age
SIDHS 2006	Solomon Island Demographic and Health Survey 2006
SIDHS 2015	Solomon Island Demographic and Health Survey 2015
STIs	Sexually Transmitted Infections
UTI	Urinary Tract Infection
WHO	World Health Organization

Table of Contents

Chapter One: Exegesis

1.1 Introduction

Chapter One introduces the thesis background, presenting an overview of the thesis context of early life morbidity and mortality, followed by an explanation of the study setting, the existing knowledge gap, the research aims and objectives, and the significance of the study. The chapter concludes with a summary of each chapter to define the organisation of this thesis.

1.1.1 Early life Morbidity and Mortality

Early life morbidity and mortality represent significant global public health concerns(Early life morbidity and mortality is an all-encompassing term that refers to all outcomes measured in the thesis). In the literature, the terms are commonly described as the occurrence of diseases or death during the early stages of life[2-4]. Early life morbidity and mortality are prevalent in low- and middle-income countries (LMICs) with high poverty levels, poor living standards, and the lack of quality health services[3, 4]. The burden of early life morbidity and mortality is high from the onset of the early neonatal period to the age of five years, placing a significant burden on families, the healthcare system, and the government[5].

Early life morbidity and mortality can result from adverse birth or pregnancy outcomes. Low Birth Weight (LBW) and preterm birth are the two most common precursors of early childhood mortality and complications in later life[6-9]. LBW is commonly classified as birth with a weight of less than 2,500 grams, irrespective of gestational age[10]. It is a widely used perinatal benchmark in LMICs where ultrasound technology may be limited to distinguish other early life morbidities, such as Foetal Growth Restriction (FGR) or Small for Gestational Age (SGA)[9]. Early life mortality includes stillbirths, early neonatal deaths, and under-five mortality[11, 12] and is commonly monitored and studied in LMICs. It has been estimated that, on average, LBW increases six-fold the risk of dying by the age of five in LMICs[13]. Common causes of mortality among these children include infections and malnutrition[13-15].

1.1.2 LBW and Under-Five Mortality

LBW and under-five mortality remain significant public health challenges in LMICs. The LMICs in Africa, Southeast Asia, and the Pacific Island region exhibit the highest prevalence rates of LBW, with figures reaching up to 20%[16]. Similarly, under-five mortality is prevalent in LMICs, with sub-

Saharan Africa, Asia, and the Pacific Island region reporting some of the highest rates, reaching up to 133 deaths per 1,000 live births[11, 17-20].

Despite the overall global decline in under-five mortality rates, it is evident that a significant number of LMICs have not successfully attained the predetermined target established by the Millennium Developmental Goal 4 (MDG-4)[11, 21]. The MDGs were first announced in 1990, with MDG-4 specifically aiming to achieve a reduction of two-thirds in under-five mortality rates between 1990 and 2015. Scholarly literature has provided evidence supporting the notion that LMIC regions in East Asia, Southeast Asia, Latin America, or the Caribbean, and Europe have made considerable progress toward meeting MDG-4. However, South Asia continues to grapple with high child mortality rates, suggesting that the MDG-4 target may not have been realised by the stipulated deadline of 2015[22]. While more than half of the Pacific Island countries have achieved the MDG 4, some nations, including the Solomon Islands, lack sufficient data to substantiate a positive trajectory[23]. This limitation is primarily attributed to the inadequate presence of a comprehensive database and monitoring system within the region[23].

Factors associated with LBW and under-five mortality can be multifaceted and interrelated, as women can be exposed to them during pre-pregnancy, pregnancy, or following birth (Figure 1). The exposure to risk factors during pre-pregnancy is equally crucial, as exposure during pregnancy and may both have potential implications for child health outcomes. Evidence from studies in LMICs found optimal pre-pregnancy and antenatal care reduced LBW and under-five mortality, though the available care may be limited due to a lack of health resources[24]. Several studies conducted in LMICs have identified a range of risk factors associated with LBW and under-five mortality. These risk factors span various domains, including sociodemographic, behavioural, and maternal health factors, that women may be exposed to before conception, during pregnancy, and following births[10, 14, 18, 25-35]. LBW and preterm births significantly contribute to various complications and childhood sequelae, which includes stunted growth, metabolic and cardiovascular disorders that can ultimately result in mortality before the age of five[36]. In this thesis, I present maternal, health, behavioural, and sociodemographic risk factors as plausible contributors to under-five mortality, thereby increasing the risk of LBW and under-five mortality in the Solomon Islands.

Figure 1: Theoretical Framework on the Risk Factors and Effects on LBW and Under-Five Mortality[i]

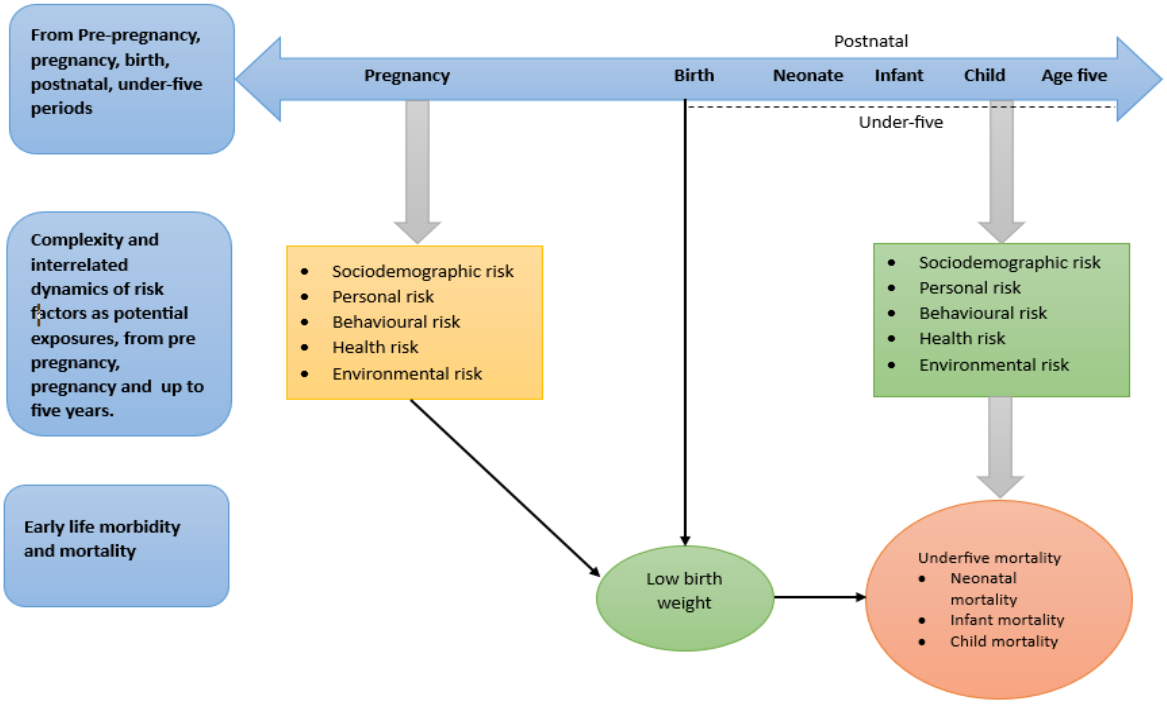
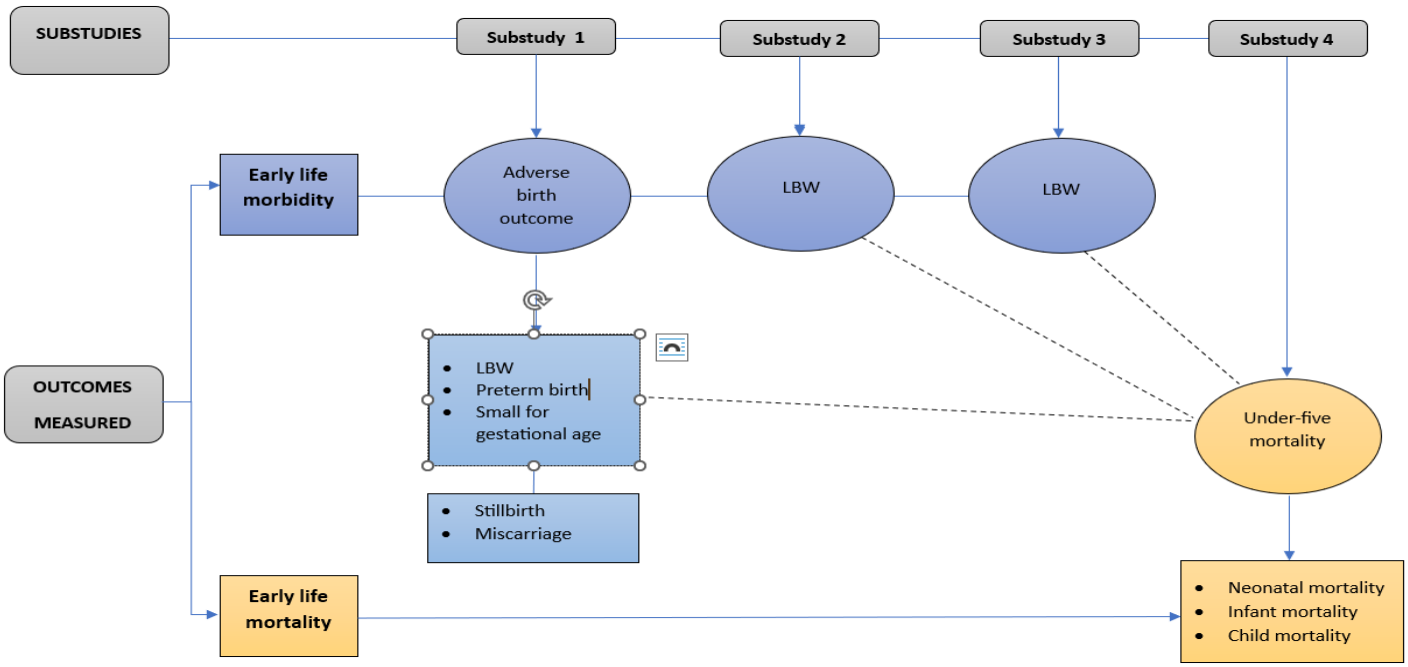


Figure 2: Theoretical Framework of Early Life Morbidity and Mortality[ii]

[i] Theoretical framework showing the association of the dynamics of the risk factors women are exposed to during pre-pregnancy, pregnancy, and post-delivery that are associated with LBW and under-five mortality.

[ii] Theoretical framework outlining the outcomes measured for early life morbidity and mortality from the four substudies in this thesis. The scoping review measured the outcomes as adverse birth outcomes and will be used synonymously as early life morbidity where appropriate throughout the thesis.

1.2 Study Context Overview



The Solomon Islands is a small developing Island nation in the Pacific with a population of 721,455 people of predominantly Melanesian ethnicity[37]. It is one of the least developed countries in the South Pacific, ranked by the world bank in 2016 as a LMIC with a developing economy[38]. Being an LMIC, there is widespread poverty, unemployment, and underdeveloped social and health infrastructure and services, significantly impacting the vulnerable populations, such as women and children[37].

1.2.1 LBW and Under-Five Mortality and Study Gap in the Solomon Islands

LBW and under-five mortality remain a significant public health burden in the Solomon Islands[37]. However, there are no reliable estimates from quality peer-reviewed population-based studies for LBW and under-five mortality trajectory in the Solomon Islands. This is due to the lack of quality studies and proper database and monitoring systems in the Solomon Island's healthcare system. However, the prevalence and exposure to various risk factors in women in this context are likely to be extremely high, particularly for LBW and under-five mortality, which have remained understudied. The few studies that have estimated the prevalence of LBW and under-five mortality were conducted on small-scale basis and included hospital-based data. For instance, small-scale and hospital-based studies estimated an LBW prevalence of 12% and preterm births of 23%, which may not represent the population, given the significant volume of referrals of cases at high risk of LBW to hospitals[39, 40]. The Solomon Islands Demographic and Health Survey (SIDHS) 2006 study reported the prevalence of LBW as 12.5 %[41]. Past studies have also predicted that

under-five mortality in the Solomon Islands has declined since the 1990s. However, these data have come from various sources that may not be reliable and must be interpreted with caution[37, 42]. For example, case-specific mortality from the hospital-based study showed very high perinatal and postnatal mortality rates of 40 and 36 per 1,000 live births, respectively, which do not represent the general population[43].

Although numerous studies have been undertaken on adverse birth outcomes worldwide, most of these studies have been conducted in diverse cultural contexts not pertinent to the Solomon Islands. The Solomon Islands has a unique environment, culture, geography, and climate, and the influence of sociodemographic and health factors on LBW and under-five mortality may vary from studies that do not account for this specific context. As such, an independent exploration of these risk factors locally is required. As the lead researcher, my enthusiasm to undertake this study transpired after more than ten years of caring for LBW and sick children in paediatric practice in the Solomon Islands. I became interested in understanding the causes of LBW and under-five mortality in the local Solomon Islands context, particularly given the dearth of literature in this area. I was also keen to investigate and understand women's experiences during pregnancy, which may have contributed to early life morbidity and mortality outcomes.

1.3 Study Aims

The overall aim of this thesis is to estimate the burden of the most critical birth outcomes, early life mortality and morbidity in the Solomon Islands, the contribution of risk factors to this burden, and to gain an understanding of the context that influences the risks. To effectively pursue this overarching aim, the thesis has been organised into four distinct substudies, all serving a broad objective, with each including more specific objectives to achieve the more expansive aim.

Objective 1: To map the available literature on the prevalence of adverse birth outcomes and associated risk factors in the Pacific Island countries.

> ***Specific objective 1:*** *To understand the current evidence and determine gaps in the literature in the region.*
>
> ***Specific objective 2:*** *To gain additional insights from the perspective of health professionals working with women and children in the Pacific Island countries.*

Objective 2: To explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on LBW in the Solomon Islands.

Specific objective 1: *To estimate the prevalence of LBW.*

Specific objective 2: *To investigate the impact of sociodemographic, health, obstetric, and behavioural risk factors on LBW.*

Objective 3: To gain an understanding of the behaviours and social and environmental context that mothers of LBW infants experience during their pregnancy.

Specific objective 1*: To explore mothers' experiences of exposure to behavioural, social, and environmental risk factors, such as poor diet, substance use, domestic violence, and poverty that may contribute to having an LBW infant.*

Specific objective 2*: To explore mothers' understanding of behavioural, social, and environmental risk factors that may contribute to having an LBW infant.*

Objective 4: To explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on under-five mortality in the Solomon Islands.

Specific objective 1: *To estimate the prevalence of under-five mortality.*

Specific objective 2: *To investigate the impact of sociodemographic, health, obstetric, and behavioural risk factors on under-five mortality.*

1.4 Study Significance

While studies on early life morbidity and mortality in LMICs have made substantial progress, there remains a dearth of research explicitly focused on the Solomon Islands. This study addresses this critical gap in knowledge by examining birth outcomes and assessing the prevalence, burden, and associated risk factors of early life morbidity and mortality in the Solomon Islands. The findings from this study provide valuable insights into the unique context of the Solomon Islands. The results of this study contribute to informing antenatal health practice and policy and provide direction for further research on early life morbidity and mortality in the Solomon Islands.

1.5 Thesis Organisation

This thesis is structured into nine chapters, each focusing on different aspects of the study:

Chapter One serves as the exegesis and provides an overview of the study. This chapter introduces the study context, identifies the research problem, states the research objectives, highlights the significance of the study, and presents the organisation of the thesis.

Chapter Two is dedicated to the literature review, presenting an examination of existing literature on adverse birth outcomes, early life morbidity and mortality prevalence, and global risk factors. There is a particular focus on literature dedicated to LMICs and the Pacific Island region.

Chapter Three focuses on the study setting, delving into the geographical location of the Solomon Islands, its social, economic, and political environment, and historical and existing challenges. This chapter also provides insights into the healthcare system, the level of healthcare service delivery, and the associated challenges regarding maternal and child health.

Chapter Four describes the methodology employed in the study, outlining the study setting, design, and methods utilised, along with the data analysis techniques employed in the four substudies.

Chapters Five to Eight present the copyedited versions of the four substudies, which have been published in peer-reviewed journals. Each chapter is preceded by a short preface that contextualises the content and provides the online URL to the journal publications of the respective substudies.

Substudy One encompassed a scoping review that resulted in two published peer-reviewed journal articles. This review aimed to identify the prevalence and risk factors associated with adverse birth outcomes in the Pacific Island region. Substudies Two and Four are quantitative analyses of the SIDHS 2015 data, which have also been published as two peer-reviewed journal articles. These substudies estimated the prevalence of, and identified risk factors associated with, LBW and under-five mortality in the Solomon Islands. Substudy Three constitutes a qualitative study that explored the lived experiences of women who had given birth to LBW infants during their most recent pregnancy. This substudy was also published as a peer-reviewed journal article and gained insight into the behaviours and the social and environmental context that mothers of LBW infants experienced during pregnancy.

Chapter Nine serves as the thesis discussion, examining the overall findings of the research in light of current literature. This chapter also synthesises the findings derived from the four substudies through the application of data triangulation, thereby enhancing the credibility and reliability of the results the study's significance, strengths, and limitations are highlighted, areas requiring further research are identified, and finally, conclusions are drawn based on the overall findings.

Chapter Two: Literature Review

Chapter Two introduces early life morbidity and mortality and the various types, including SGA as a proxy for FGR, preterm birth, LBW, and under-five mortality. The occurrences of SGA and FGR, preterm birth, LBW, and under-five mortality regionally and globally in LMICs are examined. This chapter also presents the prevalence and risk associated with LBW, and under-five mortality in LMICs from the survey of literature: the two types of early life morbidity and mortality on which the thesis focuses.

2.1 Definition of Terms

Early life morbidity or adverse birth outcomes are unfavourable pregnancy results with negative consequences for newborns[44]. These include FGR , used as a proxy for SGA, preterm birth, and LBW[45-48]. FGR is a pathological condition characterised by an interruption in the expected biological rate of foetal growth within the uterus during pregnancy[49]. SGA refers to infants smaller than expected for their gestational age at birth, with their weight typically falling below the 10th percentile[49-51]. FGR can be clinically defined as SGA if the birth weight is less than percentile of this distribution, or as the 2nd or 3rd standard deviation from the mean[49]. Hence, an infant can be growth restricted but not an SGA if the birth weight is above 10th percentile. Preterm births occur before 37 weeks of completed gestation[50-52]. LBW is defined as a birth weight of less than 2,500 grams, irrespective of gestational age, which may also include preterm, SGA, and growth-restricted babies[53]. Early life mortality includes perinatal and under-five mortality[54]. Under-five mortality can be sub-classified as neonatal, infant, and child mortality, defined respectively as death before one month of age (neonatal mortality), death before one year of age (infant mortality), death between one year and five years (child mortality), and these three classifications form the total number of child deaths before the age of five (under-five mortality)[27, 55-57].

2.2 Global Occurrence of Early Life Morbidity and Mortality

The elements of early life morbidity and mortality, including SGA as a proxy for FGR, preterm births, LBW, and under-five mortality occur globally in high-income and LMICs. Nevertheless, a more pronounced occurrence of these adverse outcomes is discernible within LMICs compared to high-income countries. Considering this intrinsic interconnection, the associated risks exhibit a level of global comparability, though there are unique risk factors for different cultural and geographical contexts.

2.2.1 SGA and Foetal Growth Restriction

FGR as a proxy for SGA is one of the major causes of early life mortality[58-60]. Bocca-Tjeertes, Bos, Kerstjens, de Winter and Reijneveld [61], defined FGR as the restriction to growth affecting the ability for the foetus to thrive in the uterus. The authors have also stated that disruption of growth is relative to genetically determined growth potential that the growing foetus inherited from its parents. Further, other external factors, such as exposure to maternal infections, contribute to this disruption[62.] FGR occurs in both high-income countries and LMICs, although the prevalence is higher in LMICS[63]. Of the 20 million LBW infants born each year globally, 30% to 40% are growth restricted, increasing the risk for subsequent infant mortality and morbidity[60].

FGR can be described as symmetrical, asymmetrical, or mixed[48]. Symmetrical FGR is characterised by proportionally small foetal body parts, while asymmetrical FGR typically indicates that the infant's head is larger in proportion to the rest of the body, and mixed FGR incorporates features of both symmetrical and asymmetrical[48, 61]. After birth, the head, chest, and abdominal circumference is used to identify symmetrical or asymmetric FGR[63]. A study in Europe in 2014 based in the Netherlands focused on preterm FGR, and found no significant disparity in weight and height gain between symmetrical and asymmetrical FGR infants[61]. However, the researchers also observed that the likelihood of developmental delays was higher in symmetrical FGR infants compared to their asymmetrical FGR counterparts[61]. In contrast, an earlier study carried out in the United States in 2000, discovered that infants with asymmetrical FGR exhibited a higher likelihood of developing major anomalies, such as respiratory distress, intraventricular haemorrhage, sepsis, or neonatal mortality, when compared to symmetrical FGR and infants without FGR[48]. Genetic variations also affect birth size as newborns can be constitutionally smaller, which is often the case for symmetrical FGR, and for this reason, infants categorised as such may be physiologically normal[61, 62iii]. Conversely, asymmetrical FGR is commonly attributed to placental insufficiency, which can significantly impact physiological development[48]. Consequently, defining and diagnosing FGR in a broad, diverse population can be a complex undertaking[58, 64].

The optimal approach for detecting FGR involves the utilisation of an ultrasound scan. In underfunded settings with low resources, such as in LMICs where ultrasound technology is not

[iii] A physiologically normal newborn refers to an infant who displays the typical and healthy characteristics of gestational age and weight, and normal body systems and organs immediately after birth. This encompasses various aspects of the infant's condition, including vital signs, physical features, and behaviour, for example, a heart rate within the normal range, regular breathing patterns, appropriate muscle tone, and responsive reflexes.

readily available, fundal height measurements and the last menstrual period can serve as a viable alternatives for monitoring FGR during pregnancy[51, 65, 66]. Fundal height measurements are typically performed by a healthcare provider using a tape measure to assess the distance from the top of the fundus to the pubic bone[51, 66]. The measurement is usually taken in centimetres and can provide an estimate of foetal growth and gestational age. Although validation techniques have been created to determine FGR by utilising birth weights and risk factors identified during the birth process, these approaches are not easily adaptable within LMIC contexts[67].

2.2.2 Preterm Births

According to studies from Vogel, Chawanpaiboon, Moller, Watananirun, Bonet and Lumbiganon [65], it is estimated that 15 million infants were born preterm worldwide in 2020, at a rate of 11%. Out of these 60% occurred in LMICs[52, 68]. Preterm births are the main cause of LBW in LMICs, with prevalence ranging from 5% to 23%, while high-income countries tend to be less than 5%[69, 70]. Preterm births are categorised into four groups according to gestational age: extremely preterm (<28 weeks), very preterm (28-31 weeks), moderately preterm (32-33 weeks), and late preterm birth (34-36 weeks)[71]. This categorisation is strongly associated with viability and infant survival[71]. The smaller the gestational age, the lesser the likelihood for survival[71].

Preterm birth can also be classified according to clinical presentations as *idiopathic* (spontaneous) and *iatrogenic* (medically indicated)[72]. An *idiopathic* preterm birth can be related to lifestyle and socioeconomic factors. In contrast, an *iatrogenic* preterm birth can be related to foeto-maternal conditions leading to induced labour or caesarean section[72]. The gold standard method for determining preterm birth is an ultrasound scan, ideally measured in the first trimester[71]. Nonetheless, as previously established, this procedure frequently remains inaccessible in LMICs. As a result, an alternative methodology employed for diagnosing preterm births involves ascertaining the mother's most recent menstrual cycle and acquiring fundal height measurements[71]. These measurements have demonstrated both practicability and efficacy[73]. In cases where the last menstrual period is uncertain, the Ballard score serves as a complementary approach, which should be performed by a skilled clinician[74]. This is a physical assessment performed after birth to evaluate the physical appearance and neuromuscular development of the newborn, which aids in estimating the final gestational age[51, 74].

2.2.3 Low Birth Weight

An estimated 20 million infants, approximately 15% to 20% globally, are born annually with LBW, of which 96% occur in LMICs, increasing the risk of infant mortality and morbidity[46, 75]. Among all LBW cases in LMICs, 70% occur in South Central Asia, 15% in Africa, and the remaining 15% in Central and South America and the Pacific region[76]. Conversely, high-income countries in Europe and Asia, as well as Australia and New Zealand, have a relatively low LBW prevalence, ranging from 4% to 8%[77, 78].

In LMICs, LBW is the main classification commonly used due to the difficulty in obtaining accurate estimates for gestational age and other foetal anthropometries, such as SGA and FGR, which are common causes of early life morbidity. As previously noted, this is primarily due to inadequate healthcare equipment and diagnostic facilities available in these settings, such as ultrasound scans, to determine gestational age[71]. Studies and reports from LMICs use the World Health Organization (WHO) standard classification range for LBW infants: LBW is classified as weighing between 2,499 to 1,500 grams, very LBW between 1,499 to 1,000 grams, and extremely LBW of less than 1,000 grams[79]. There can be considerable overlap between LBW and preterm births because infants born early tend to have lower birth weights as they spend less time in utero[9] . Furthermore, LBW can also result from preterm birth or FGR, yet not all foetal growth-restricted and preterm infants are LBW[80, 81]. Despite this complexity in defining the different levels of early life morbidity, LBW remains a useful indicator of perinatal morbidity attributable to early delivery or growth restriction in a setting when reliable estimates of gestational length are unavailable[46].

2.2.4 Under-Five Mortality

Every year, approximately five million children die before the age of five worldwide, with 98% of these deaths taking place in LMICs[28, 55, 82]. Under-five mortality, which includes neonatal, infant and child mortality, remains a global burden in LMICs due to a lack of health resources and preventive measures[55, 56].

In 1990, the WHO launched the Millennium Development Goals (MDGs), with the fourth MDG aim being to reduce child mortality by two-thirds by 2015[22]. However, after 25 years of global effort, most countries in LMICs could not reach the targets[28, 83]. Succeeding the MDG, the Sustainable Development Goal (SDG), a new global effort, was established to expand and continue the achievements of the MDG period[22]. Through the Sustainable Development Goal three, the United

Nations and the WHO aim to reduce global neonatal mortality to 12 deaths per 1,000 live births and under-five mortality to 25 deaths per 1,000 live births by 2030[84, 85].

2.2.5 Risk Factors Associated with Early Life Morbidity and Mortality

The various elements of early life morbidity and mortality, including SGA, FGR, preterm births, and under-five mortality, are closely linked as observed globally. Consequently, the risk factors associated with these conditions are also interconnected. SGA, preterm births, and LBW tend to be associated with sociodemographic factors, such as low educational status and/or poverty; health-related factors, such as gestational diabetes or pregnancy-induced hypertension; and behavioural risk factors, such as substance use during pregnancy, for example, tobacco and alcohol consumption and environmental factors such as poor diet and nutrition[75, 86-88]. However, there are also unique and specific intrinsic causes for certain early life morbidity, such as symmetric FGR. Intrinsic factors, caused by genetic variation in human size, result in symmetric growth restriction[58, 60, 62]. There are also extrinsic, or external factors such as non-genetic, maternal, foetal, and sociodemographic and environmental factors, which may be similar to those of LBW and preterm births[60, 62]. FGR may arise from multiple aetiologies, including maternal, placental, and foetal causes.

Early life mortality, including neonatal and infant mortality, can be the result of early life morbidity factors such as LBW, preterm, and SGA[9, 59, 82]. Globally, one million infants, or 18% of all births, will die before the age of five due to preterm birth[68]. Under-five mortality can also be associated with LBW, preterm birth, and SGA[80]. Over 90% of under-five deaths in LMICs are due to LBW and preterm births, exacerbated by the lack of life-saving medical equipment[56]. Infants who survive LBW have an elevated risk of death before the age of five due to underlying preventable factors, such as malnutrition and infection, which contribute to 80% of under-five deaths.

2.2.6 LBW and Under-Five Mortality in the Pacific Island Region

The Pacific Island region, including the Solomon Islands, is characterised by its remote and isolated islands. It consists of around 22 independent states and territories, some of which are administered by Western countries such as the US, Australia, France, and New Zealand[89]. Many of the Pacific Island countries have economies classified as low- and middle-income, which translates into limited availability of healthcare resources and poorer birth and child outcomes[20, 90]. Although data on the adverse birth outcomes in the region may be limited and unreliable, several of these

countries, particularly in the Melanesian and Micronesian region, reported some of the highest under-five mortality and morbidity in the world. For instance, the prevalence of LBW in Papua New Guinea (PNG) is 14%, and 27% in Nauru[91, 92], while the prevalence of preterm birth in the Solomon Islands is 24%, and PNG is 22%[40, 93]. PNG and Nauru showed the highest under-five mortality of 53 and 55 per 1,000 live births, respectively[20]. The Solomon Islands exhibits a slight decline in under-five mortality from 28 to 21 per 1,000 live births since the 1990s, although these figures are still relatively high[41]. The risk factors associated with adverse birth outcomes in the Pacific Islands region may be comparable to those from other LMICs, which include common sociodemographic, health, and behavioural risks such as educational status, infection such as malaria, anaemia, and pregnancy-induced hypertension, or the lack of antenatal care[93-101]. However, there are also specific risk factors in these diverse cultural contexts that need to be studied further, for example, the use of betel nut and kava, practices that are unique to Solomon Islanders.

Chapter Three: Background of the Solomon Islands

Chapter 3 presents an overview of the Solomon Islands' demography, social, and geopolitical setting, healthcare system, and the challenges that may have an influence on early life morbidity and mortality, providing context for this study.

3.1 Demography

The Solomon Islands is the third largest archipelago in the South Pacific, following New Zealand and the Bismarck (PNG) archipelago[102, 103]. It is made up of approximately 992 islands inhabited by 721,455 people[37, 38]. The country spans over a land area of 28,400 square kilometres of mountainous, heavily forested land, in addition to hundreds of small low-lying islands and coral atolls spread over a 1.3 million square kilometres Exclusive Economic Zone[37, 104, 105]. The predominant ethnicity of the Solomon Islanders is Melanesian (95%), followed by Polynesian and Micronesian (5%)[37].

The population of the Solomon Islands is young and[14] increasing at a significant rate. It has been reported that 41% of the population is under the age of 15[37], with a median age of 19.6 years[38, 106]. The Solomon Islands has experienced a considerable increase in population over the last few decades, with growth rates reaching up to 3.5%. Since the 1930s, the population has increased by eightfold, from 90,000 to 720,000 people in 2019[38]. The rapid population growth and major demographic transition can be attributed to the improved healthcare system, which has led to enhanced health outcomes, reduced mortality, and increased life expectancy for Solomon Islander peoples[38]. Since the 1960s, there has been a significant decrease in early life mortality rates. In the 1960s, the estimated infant mortality rate was reported to be over 120 deaths per 1,000 live births, reflecting a dire situation in the country's healthcare system[106]. However, based on the 1999 census data, the infant mortality rate had significantly declined to 66 deaths per 1,000 live births in the Solomon Islands[41]. This progress continued, and as per the SIDHS 2006 report, the infant mortality rate further decreased to 24 deaths per 1,000 live births, indicating a significant improvement in the healthcare system of the Solomon Islands[41]. The rapid population growth can also be attributed to the increase in average life expectancy at birth, which rose from an estimated 54 years for both men and women in 1976, to 60 years in 1986[107] 66 years in 1999[108], and currently 73 years[109].

Over the course of the past decade, there has been a substantial shift in the urban population growth, increasing from 15% to 26%[38]. This growth has led to the proliferation of shanty settlements, high employment rates, and an increase in crime rates in urban areas[110]. Living in urban shanty settlements can often result in adverse health and social outcomes[111] due to poor sanitation and living standards. People living in shanty urban settlements may also face challenges in accessing basic clean water and sanitation conditions, which can significantly impact their quality of life, increasing the risk of diseases and illnesses which contribute to early life morbidity and mortality[38, 111]. Despite the increase in urbanisation, the majority of the population (74%) still reside in rural areas as subsistence farmers, depending entirely on subsistence agriculture, fishing, and forestry for livelihood and sustainability[38]. Most of these people in rural areas also face challenges of lack of basic sanitation and water supply, and poor access to health and social infrastructure[112, 113].

3.2 Geographical Location and Challenges

The Solomon Islands is located within the Pacific Ring of Fire in the equatorial region, where it is susceptible to heightened levels of tectonic activity and an increased risk of climate change impacts. This location increases the predisposition to natural hazards and disasters, such as earthquakes and tsunamis, which pose a significant threat to the population[114]. Additionally, as an island nation in the equatorial region, there is an elevated risk of other natural disasters, including tropical cyclones, heavy rains, floods, and rising tides. These events have tangible impacts on the livelihoods of the islanders, and climate change increases their frequency and intensity[115]. Since the 1980s, the Solomon Islands have been subject to the various natural disasters[116, 117]. The rising sea levels are also gradually impacting livelihoods–causing destruction of homes and crops, and adversely affecting people's physical and mental health[114, 116]. These events have had both short-term and long-term adverse effects on the social, economic, and health conditions of the local populace. The natural topography of the islands and the geographical isolation inevitably contributes to the inaccessibility to health and social services that the dispersed population and communities experience in everyday life. However, due to lack of developed social and health infrastructure, these factors have contributed to major challenges for trade, local income, health services, and education among a population that the government can barely manage especially in the rural areas where most islanders live[37, 113, 116].

3.3 Political and Social Challenges

Since gaining independence in 1978, the Solomon Islands has gone through political, economic, and social instability. Weak political and policy cohesion and poor public administration contributed to a major setback for the slow socioeconomic growth, with substantial repercussions on the health system[37, 118]. The World Bank ranked the Solomon Islands as a lower middle-income country in 2019, with one of the lowest gross national incomes per capita of USD $1,036–4,045[119]. Also, most recently, the Solomon Islands was positioned at the forefront of the world's geopolitical competition between the Peoples' Republic of China and the democratic countries of the West, which many have seen as a threat to the country and regional security and stability[120].

The Solomon Islands is composed of diverse sub-cultures rooted in its prehistoric feudal-tribal society, which gave birth to the *wantok* system, a social and political network[121]. The *wantok* system has both benefits and drawbacks. It is a system that is based on kinship and shared language spoken by clan or tribal groups[121]. The system also allows tribes and clans to share land and natural resources for mutual benefit[121, 122]. Some recognised benefits of the *wantok* system are social and moral support and dependency for livelihood. This includes working together as clans and tribes for material wealth, educational and moral support by fostering a sense of community and solidarity, and sharing of resources, knowledge, and skills[121-123]. Other benefits include providing avenues for warring parties of different tribal groups, or *wantok* clans can resolve issues within cultural and customary law instead of formal justice systems, although these processes can be tainted with corruption and favouritism[124]. Reciprocity plays an important part in maintaining an amicable relationship within *wantok* groups. On the other hand, the *wantok* system was coined to downplay bureaucratic and systemic corruption in the country, as it also influences politics in the Solomon Islands[121, 122, 124]. This may include abuse of power through nepotism and cronyism, which can be defined as favouring relatives over merit-based individuals for education and employment opportunities[121, 122, 124].

Ethnic tension was one significant social and political event that altered and shaped the history of the Solomon Islands, a period of civil unrest from 1998 to 2003 between warring ethnic groups of Guadalcanal and Malaita people who inhabited the two largest and most populated islands. The unrest was deeply rooted in a clash for land and property, which resulted in serious nationwide violence and the destruction of numerous lives and public infrastructure. The conflict contributed to severe long-term economic volatility and political instability with a long-term impact on the

healthcare system[116]. Over the last 20 years, after the period of ethnic tension, the Solomon Islands have also gone through a series of social and political unrest, which continues to affect the economic growth. A recent example involved businesses targeted by arsonists in November 2021[125]. The riot and civil unrest in Honiara had a substantial impact on the Solomon Islands economy, resulting in an estimated loss of SBD$227 million (US$28.3 million) according to the Central Bank of Solomon Islands[125]. As the nation's capital, Honiara contributes about 30% to the country's GDP, and more than half of its wholesale and retail, manufacturing, and services industries were destroyed by fire and looting[125].

The Solomon Islands is also a melting pot of indigenous subcultural diversity, embracing modern development while clinging to its cultural heritage. Subcultural diversity is manifested in multilingualism with over 90 indigenous dialects, which often causes challenges in channelling health information and communication[37]. Most local dialects in the Solomon Islands are passed down orally from generation to generation, and they have not been standardised into a written form. Consequently, these dialects are not utilised as the language of instruction in the formal education and healthcare system[126]. While 82% of women and 90% of men in the Solomon Islands are literate in Pidgin and English, 16% of women cannot read either dialect, which may have significant impacts on health behaviour and practices[37].

Education status and levels among the Solomon Islanders vary, depending on factors including sex, age, and place of residence[37]. Specifically, men tend to have attained higher educational levels than women, with 45% of men and 39% of women having completed secondary school education[37]. The lack of education is more pronounced in rural areas where 11% of the population attained no education level, compared to 5% in urban areas. Additionally, a significant proportion of the population (24%) aged between 45 and 49 years lacks any form of education. Among the female population who have obtained an education, 58% have only achieved primary school or lower levels, while 42% have attained higher levels of education, including secondary school education and beyond[37].

The unemployment rate in the Solomon Islands is high. Although there were limited reports on the national employment rate, the National Provident Fund Superannuation recorded that a mega portion of the population of approximately 92% lacks formal employment. This suggests that only 8% of the population is formally employed in various government and private industries[127]. Poverty in the Solomon Islands is also ubiquitous with recent national data indicating that

approximately 12% of the population lives under the poverty line, as measured by Foster, Greer, and Thorbecke's poverty model[128], in which the levels and prevalence of poverty are assessed by measuring the living standards as total consumption expenditure equivalent to the total monetary value of all food and non-food goods consumed by households[128]. Furthermore, poor sanitation is a major issue, with 58% of the rural population lacking proper toilet facilities[37]. Additionally, access to clean drinking water is a concern, as 36% of the rural population does not have such access, while 90% of the urban population has good access to clean drinking water and proper sanitation[37, 129].

The Solomon Islands is a patriarchal society where men are typically leaders of the traditional governance system. Most Solomon Islanders live in large households, often with extended family members, with men heading 82% of the households[106]. This patriarchal system may give rise to the suppression and violence directed toward women and children. Research conducted within the Solomon Islands has revealed an alarmingly high prevalence of domestic violence, with approximately two-thirds of women experiencing violence[130, 131]. Patriarchal dominance is also institutionalised in most public sectors, where men predominantly hold senior executive roles, including parliamentary positions[106]. Although polygamous unions (marriage) are not acceptable in the Solomon Islands, the prevalence of polygamy is nonetheless estimated to be at 6%, which has the potential to cause family instability[37]. The prevalence of teenage marriage is estimated at 23%, with young women tending to marry before the age of 18 years. Early marriages force these women to leave school and contribute to high fertility rates[37]. Substance use in the Solomon Islands is markedly widespread, especially with betel nut use as a norm, which exhibits a chewing rate of up to 90%[132-134]. There is also evidence of elevated use of other legal and illegal drugs, such as *kwaso* (homemade distilled alcohol) and marijuana. This poses substantial risks to women's health[132, 133].

3.4 Healthcare System in the Solomon Islands

The Ministry of Health and Medical Services (MHMS) orchestrates the healthcare system in the Solomon Islands. This administrative body is structured into three distinct divisions and oversees the comprehensive management of healthcare services and dissemination at the national, provincial, and rural levels.

3.4.1 The Ministry of Health and Medical Service (MHMS)

The MHMS is the corporate body that governs all the health services in the Solomon Islands. Based on the Health Services Act 1979, MHMS aims to improve healthcare and coordinate health and medical services in the Solomon Islands[135]. MHMS is made up of three major divisions: 1) the corporate services, which oversee human resources, financial control, supplies, logistics, and infrastructure development, 2) the healthcare division or curative services, which oversee the clinical, diagnostics, and allied health services, and 3) public health, which manages environmental and family health and health promotion and rehabilitation programs[129]. The Solomon Islands Government is the main funder of the MHMS, with 51% of its budget annually going to the health ministry[109]. This include funding sourced from other stakeholders include Australia Aid, the WHO, and the Republic of Taiwan, recently replaced by the People's Republic of China[129]. Government-funded health services are free to all Solomon Islanders[116].

3.4.2 Levels of Healthcare Service Delivery

Healthcare services are delivered through a hierarchical system comprising five government tiers, extending from the rural and provincial levels up to the national level: 1) nurse aid posts (NAPs), 2) rural health clinics (RHCs), 3) area health centres (AHCs), 4) provincial hospitals, and 5) the National Referral Hospital[116, 136]. There are 135 NAPs, each located in the rural area across the islands, and manned by nurse aids or village health workers providing basic first aid care, child immunisation, and treatment of mild ailments[116, 129]. The 115 RHCs provide basic primary care, public health, and health promotion services, and are staffed by a registered nurse and a nurse aide[116, 129]. The 27 AHCs provide advanced basic outpatient care, obstetric, antenatal, and child healthcare services, a community outreach program, and a dispensary of basic medications, usually operated by a team of a registered nurse, midwife, nurse aide, and microscopist[116, 129]. There are 12 hospitals in the Solomon Islands run by the government and church-based organisations, and 11 are located in 10 provinces[116, 129]. The National Referral Hospital is the largest 300-bed facility that provides several specialised care services, receives referrals from provinces, and serves the Honiara urban population.

3.5 Double Burden of Communicable and Non-Communicable Diseases

The Solomon Islands also grapples with the sudden increase of non-communicable and communicable diseases, which also contribute to early life morbidity and mortality[137]. The rapid

changes in the dietary pattern due to the increase in the importation of rice, wheat, and flour products have contributed to an increase in diseases such as obesity, diabetes, and hypertension, which adversely impacts pregnancy and birth outcomes[138]. Iron deficiency anaemia due to poor diet and malnutrition is highly prevalent in the Solomon Islands and is a major threat that contributes to adverse birth and pregnancy outcomes. An estimated 41% of women of childbearing age in the Solomon Islands have some degree of iron deficiency anaemia[37]. The common communicable and infectious diseases in the Solomon Islands with potential adverse impact on pregnancy are malaria, STIs, hepatitis B, and tuberculosis. Malaria is endemic in the Solomon Islands and poses a major threat to pregnancy, although limited studies have been conducted locally on this[37]. Malaria infection is widespread in the Solomon Islands, where malaria cases and deaths are among the highest in the Western Pacific region, according to the WHO[139]. *Plasmodium falciparum* malaria is the predominant species, although *Plasmodium vivax* also exists in the Solomon Islands[140]. STIs can have adverse effects on pregnancy and childbirth, and they are highly prevalent in the Solomon Islands. A study of women of childbearing age in the Solomon Islands found that the prevalence of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and syphilis was 20%, 5.1%, and 4.1%, respectively[141]. Another study found that one in 210 live births had clinical and serological evidence of congenital syphilis, and the *treponema* infection was associated with stillbirths[142]. Hepatitis B infection is hyper-endemic in the Solomon Islands. In a large study conducted at the national referral hospital in 1994, the prevalence of the hepatitis B surface antigen was 19.6%, ranging from 14.6% in females to 23.4% in males[143]. A small study of pregnant women reported an overall prevalence of 13.8% positive for hepatitis HbsAg (Hepatitis B Surface Antigen), with a higher rate of 22% reported in women between 30–34 years of age[144]. Tuberculosis still remains a prevalent public health issue in the Solomon Islands, with a notification rate[iv] of 66 per 100,000 population in 2012[145]. Tuberculosis infection poses a risk for early life morbidity and mortality, though limited literature reported tuberculosis in pregnancy, affecting mother and infant, in the Solomon Islands.

3.6 The Healthcare System and Challenges

The Solomon Islands' healthcare system is affected by numerous challenges, such as a shortage of human resources, health infrastructure, and medical supplies, particularly in rural areas[109, 116]. In response, the Solomon Islands Government gave MHMS the remit to initiate the role delineation

[iv] TB notification' refers to a TB diagnosis in a patient which is reported within the national surveillance system, and then to the WHO.

policy to improve the quality of health service delivery to rural populations[116, 129, 137, 146]. The guiding principle for the role delineation policy was universal health coverage to ensure that every Solomon Islander had access to a package of quality health. To achieve this goal, key strategies were outlined in the 2011-15 National Health Strategic Plan to improve healthcare services at various levels[147]. This initiative was continued in the 2016-20 National Health Strategic Plan, focussing on improving child and maternal health outcomes and addressing communicable and noncommunicable diseases, with the aim of improving population health, especially for those most vulnerable and isolated[129, 137, 146]. Despite these national interventions, the current healthcare system in the Solomon Islands encounters various difficulties, including deficiencies in human resources, particularly with a shortage of doctors and midwives, insufficient health facilities, and medical equipment that is notably lacking in rural areas, which requires a major overhaul to improve service delivery.

Maximising healthcare services to an optimal level in the community was constantly hampered by the challenging geography across land and sea, workforce, and infrastructure limitations, especially those in the rural areas, which remained an inevitable challenge the government continues to grapple with. Health services were also crippled by the government's inability to provide decent staff housing in the rural areas, especially for doctors' establishment and posting and the lack of basic medical equipment and supplies[137, 148]. Other than an optimal workforce, the right skills are also needed, and there is a lack of properly trained health workers for the majority of the population in rural areas and remote outlying islands[116]. The centralisation of health budget and service spending can also be seen as a cause as more than 60% of budgets are spent on the central health ministry and NRH, while the remainder cannot cater to 74% of the population living in rural areas[137].

3.7 Reproductive, Maternal, Newborn, Child, and Adolescent Health and Challenges

The Reproductive, Maternal, Newborn, Child, and Adolescent Health (RMNCAH) division of MHMS is responsible for overseeing maternal and child health services and programs in the Solomon Islands. RMNCAH plans reproductive health programs and services to improve health outcomes for women and children in the Solomon Islands. It operates under a five-year plan through the conceptual framework of the WHO Global Reproductive Health Strategy, founded on social equity, delivery of primary healthcare, and education to ensure that all mothers are healthy and cared for

throughout pregnancy and childbirth[42, 116, 149]. This division also manages the immunisation program, integrated management of childhood illness, hospital care for children, neonatal care, and nutrition[42, 116, 149]. Despite the efforts made, socioeconomic and geographical inequities remain as significant barrier that impede these initiatives, resulting in the consistently poor maternal and child health outcomes[20]. The unique geographic context of the Solomon Islands and the lack of timely access to quality healthcare for women and children also pose a significant challenge[116]. These factors have a substantial impact on maternal and child health services, resulting in poor access to antenatal care and coverage, as reflected in the poor antenatal care indicators. For instance, although 94% of women in the Solomon Islands received antenatal care, 85% of those had a very late booking during the second and third trimesters, and 25% had less than four visits[37, 42]. Such poor antenatal attendance may hinder the detection of complications and foetal growth monitoring, which affects pregnancy outcomes, early life morbidity, and mortality. It is estimated that approximately 49 babies are born every day in the Solomon Islands, and 10% of those are LBW[37, 129]. In spite of the establishment of the Integrated Management of Childhood Illness (IMCI) program, on an average, it is estimated that one child under the age of five dies every four days[37, 129].

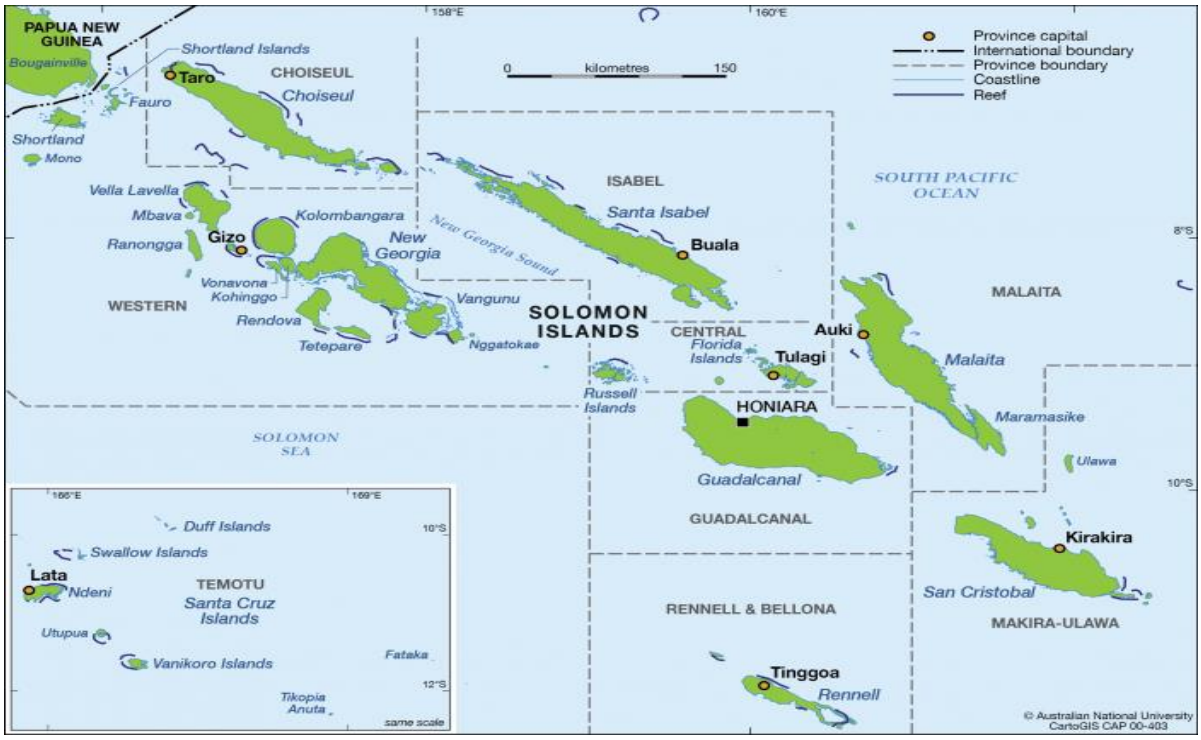
Chapter Four: Study Setting, Design, and Methods

Chapter Four outlines the study setting, methods and recruitment, designs, and justifications. To achieve the overall aim and objectives of the thesis, four interrelated substudies were employed. Substudy One was a scoping review, Substudies Two and Four involved secondary quantitative analyses of the SIDHS 2015 data, and Substudy Three was a descriptive qualitative study. The quantitative studies were based on the philosophical concept of positivism[150] to deductively observe the risk factors associated with early life mortality and morbidity, specifically under-five mortality and LBW in the Solomon Islands. The qualitative study used the relativism philosophy[150] as a rationale to explore the experiences of women with LBW infants during their latest pregnancy[150, 151].

4.1 Study Setting

The Solomon Islands as a small independent state in the South Pacific is made up of 10 provinces, including Honiara, where the capital city and the national government and administrative offices are located (Figure 2)[38]. The population included in Substudies Two and Four involved five domains, which included the four major provinces of the Solomon Islands (Honiara, Malaita, Guadalcanal, and Western), and a combination of seven smaller provinces (Santa Isabel, Makira/Ulawa, Central, Choiseul, Temotu, and Rennell/Bellona provinces). Population sources for Substudy Three included two of the largest populations of the Solomon Islands: Honiara and the Guadalcanal province. Honiara is comprised of inhabitants originating from all 10 provinces of the Solomon Islands.

Figure 2: Map of the Solomon Islands[v]



Map of the Solomon Islands. Source: Mapsland [online]: https://www.mapsland.com/oceania/solomon-islands/detailed-map-of-solomon-islands-with-relief-large-cities-and-airports.

4.2 Study Design and Methods

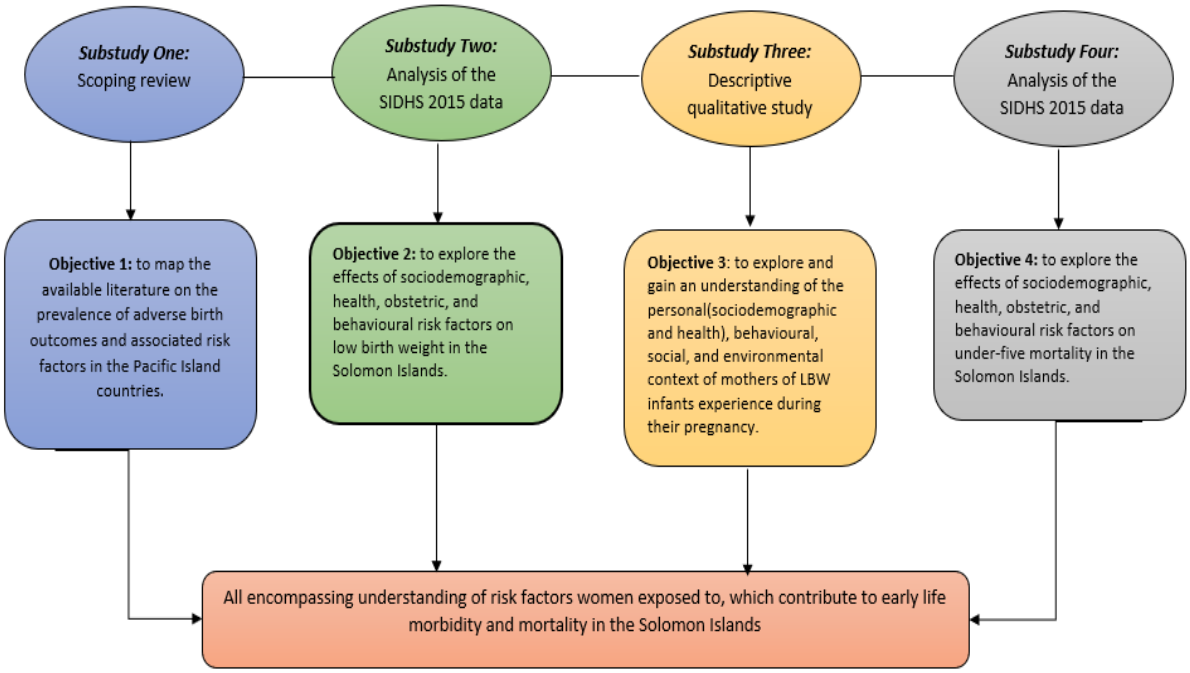
This was a concurrent mixed-method study design adopting a pragmatic approach to explore and understand the burden and risk factors associated with early life mortality and morbidity, specifically LBW and under-five mortality[150, 151]. The study involved an in-depth investigation of sociodemographic, environmental, and behavioural risks associated with LBW and under-five mortality. The mixed-method study design was used to explore the occurrence of early life mortality and morbidity in the Solomon Islands and lived experiences of women during their recent pregnancies[150, 151].

Four substudies were employed to address the thesis aims and objectives. Substudy One is a systematic scoping review incorporated with a consultation of clinicians through in-depth interviews to gain their perspectives on the adverse birth outcome in their respective settings. The copyedited version of the peer-reviewed journal publication for this substudy is presented as publications in Chapter Five (Scoping review) and protocol (Appendix A). Substudy Two and Four were secondary analyses of the SIDHS 2015 data on LBW and under-five mortality. The copyedited versions of the peer-reviewed journal publication for these substudies are presented in Chapters

[v] Figure 2 shows the map of the Solomon Islands archipelago.

Six and Eight. Substudy Three was a descriptive qualitative study on the lived experience of women with LBW infants in the Solomon Islands. The copyedited version of the peer-reviewed journal publication for this substudy is presented in Chapter Seven. Figure 3 illustrates a summary of the studies employed and objectives.

Figure 3: Summary of studies and corresponding objectives



4.3 Substudy One: Scoping Review

Substudy One is a scoping review, which comprises a scoping review protocol that guided and steered the review process. The review mapped the available literature on the prevalence and risk factors associated with adverse birth outcomes in the Pacific Island region. The review also incorporates consultations with health professionals in the region who were engaged for the purpose of in-depth interviews to gain their perspectives on the issues of adverse birth outcomes in their setting and area of practice. All data collected was processed via numerical and thematic summaries.

4.3.1 Scoping Review Protocol

A scoping review protocol was first developed as *a priori* with pre-defined objectives and methods and published in BMJ Open (Appendix A)[152]. The title of the scoping review was registered with the

Joanna Briggs Institute to ensure transparency and prevent redundant duplication of research efforts by other scholars[153].

4.3.2 Scoping Review

The scoping review mapped the existing available evidence on adverse birth outcomes, namely LBW, preterm birth, and SGA prevalence, and their corresponding risk factors in the region. The review followed the five-staged Arksey and O'Malley framework[154] and included an additional stage that involved consultation with 18 clinicians from four Pacific Island countries of the Solomon Islands, including PNG, Fiji, and Vanuatu. Five scholarly databases and non-indexed studies were searched, and extracted data were analysed as numeric and thematic summaries of outcomes and risk factors. The rationale for the review was to allow a better understanding of the gaps in the literature and underexplored areas in the Pacific Island region, and to gauge the perceptions of professionals on adverse birth outcomes and associated risk factors in the Pacific Island region.

4.4 Substudies Two and Four: Quantitative Analysis of the SIDHS 2015 on Births

Substudies Two and Four encompass a quantitative examination of the SIDHS 2015 dataset, which originates from the survey conducted in 2015. The analytical approach involved the utilisation of a sample comprising 4,272 births. Data were analysed using adjusted a log-binomial regression model to estimate relative risks associated with LBW and under-five mortality. Additionally, the analysis also computed the PAF for the portion of the population at risk.

4.4.1 Study Design and Data Source

Substudies Two and Four used birth data from SIDHS 2015[37], a population-based, cross-sectional, nationally representative survey conducted in the Solomon Islands. The survey followed the Demographic and Health Survey international and standard questionnaire, tailored to the Solomon Islands context. SIDHS 2015 was a collaborative effort between the Solomon Islands Government National Statistics Office, the Ministry of Health and Medical Services, and the Secretariat of the Pacific Community[37]. The objective of the survey was to provide reliable data on health and population characteristics regarding households, maternal and child health, and mortality.

4.4.2 Sampling and Sample Size

Study participants were recruited by trained data collectors from the 2009 Solomon Islands national census Enumeration Areas (EAs) or primary sample units following a two-stage stratified sampling strategy to identify a nationally representative sample of households[37]. The primary sampling frame from which the sample population was drawn comprised 211 EAs. The EAs were made up of households from five sub-regions of four major provinces. The five sub-regions were Honiara, Malaita, Guadalcanal, Western provinces, and a combination of seven smaller provinces, including Santa Isabel, Makira/Ulawa, Central, Choiseul, Temotu, and Rennell/Bellona provinces[37]. At each EA, systematic random sampling was undertaken by a team of trained supervisors with probability proportional to the estimated number of households, and participants were then randomly selected within each household[37]. A total of 5,046 households were selected, containing 6,657 eligible women aged 15 to 49 years, whom each provided informed consent. From that sample, 6,266 were interviewed with a 99.8% response rate. Our analysis focused on women who have given birth in the last five years of the survey. The last five years of the survey included were the years 2010 to 2015. During this period, a total of 4,272 births or children aged 0-5 years were included for the analysis.

Substudy Two (LBW analysis) used two separate study populations to investigate 1) social, demographic, and behavioural risk factors (n=3,584 births) and 2) antenatal care risk factors (n=1,892 births). Substudy Four (under-five mortality analysis) also used two separate study populations to investigate risk factor groups (1) and (2), with slightly larger samples (n=4,078 and 2,579, respectively).

4.4.3 Outcome and Independent Variables (Substudies Two and Four)

The outcome variable for Substudy Two was LBW, defined as birth weight less than 2,500 grams. All birthweights up to 4,000 grams were included in the analysis. Infants with a birth weight over 4,000 grams were excluded. Birthweights for the survey were collected either from medical records from children's baby books[vi] (76%), or mothers' recall (24%) when birth records were not available. Substudy Two used 20 exposure variables, with known or hypothesised associations

[vi] Children's baby books in the Solomon Islands record all the details of an infant's birth and delivery, and development information about the infant. It is issued to parents at birth. The book also keeps records of immunisations and the health history of a child from birth through to the age of five, as mothers present the book to the health worker upon presentation to a health facility.

with LBW in the literature that were related to sociodemographic, reproductive and health service-related, and behavioural risk factors.

The outcome variables of interest for Substudy Four were under-five mortality (all deaths before five years), including its three subgroups which included neonatal (death before one month), infant (death before one year), and child (death between one and five years)[27]. Substudy Four included 25 exposure variables with measures relating to sociodemographic, obstetric risk factors and health services, child-related risk factors, and behavioural factors. The selection of the variables was based on those relevant to the local context and hypothesised in the literature to be associated with neonatal, infant, child, and under-five mortality.

In both studies, the history of substance use assumed that women who have ever tried or had used any of the substances in the last 30 days or one year have an increased probability of being strong users during the last pregnancy. Selections of exposure variables were based on those relevant to LBW and under-five mortality and its subgroups from literature reviews of past studies in other LMICs, those that are likely to influence LBW and under-five mortality, and those pertinent to the local Solomon Islands context.

4.5 Statistical Analysis

A complete case analysis was conducted. Sample probability weights were applied to account for the non-response rate and complex sampling strategy. The final selected outcome variables and independent variables were cross-tabulated, and frequencies and percentages were reported. Next, the unadjusted association between each independent and dependent variable was estimated. All covariates with p-values of less than 0.20 were selected and included in the final adjusted log-binomial model to estimate relative risks, reported with 95% confidence intervals. Multicollinearity checks were also undertaken to identify highly correlated variables, which were subsequently excluded from the adjusted model. Stata Version 17 was used for all analyses[155]. Population-attributable fractions (PAF) were estimated to identify the proportion attributable to LBW and under-five mortality attributable to each risk factor using the following formula. If *P* represents the proportion of the cohort exposed to the risk factor and *RR* is the adjusted relative risk:

$$PAF = \frac{P \times (RR-1)}{P \times (RR-1)+1}$$

4.6 Substudy Three: Descriptive Qualitative Study

Substudy Three employed a descriptive qualitative study on postnatal women with LBW infants in the Solomon Islands. Interviews were conducted through international telephone calls with the support of two trained research assistants. Data were analysed through thematic analysis.

4.6.1 Study Design and Recruitment

Substudy Three used a descriptive qualitative study to explore the lived experiences during the most recent pregnancies of women with LBW infants in the Solomon Islands. Purposive sampling was used, and 18 women were recruited to participate in the in-depth interviews. This methodology was deemed appropriate to allow the women to tell their stories and experiences during pregnancy[156]. The women aged 15 to 39 years were recruited from the special care nursery of the National Referral Hospital in the Solomon Islands. Participants were mothers of LBW infants weighing less than 2,500 grams irrespective of final gestational age, who had given birth within the last week prior to recruitment, and whose health and the health of the infant were stable. Women also needed to be fluent in Pidgin English, the Solomon Islands *lingua franca*, and recruitment was halted when the data reached saturation level.

4.6.2 Data Collection

One-on-one in-depth semi-structured interviews were conducted, primarily by the PhD scholar, with the women within one week of delivery. This allowed the women to recall their experiences during pregnancy with optimal clarity. A one-week period was chosen to allow ample time for the mother and baby to settle following delivery. Additionally, the researcher aimed to conduct interviews with individuals who may be discharged before the week concluded. This is particularly relevant for infants weighing over two kilograms, as they typically go home within a week once the infant has achieved stability and breastfeeding is established successfully. As a result of the global COVID-19 pandemic and travel restrictions, all interviews were conducted via international telephone calls. The telephone interview process was assisted by two locally trained Research Assistants (RAs) well-versed in ethical research methods. JT (RA1), a clinical nurse instructor in the paediatric and neonatal ward of the National Referral Hospital in the Solomon Islands, and LMK (RA2), an academic at the University of South Pacific Solomon Island Campus. JT (RA1) recruited women and explained the interview procedures from the participant information sheet. LMK (RA2) supported the interviews by arranging telephone call logistics and incentives for the women.

An expert panel assessed the interview schedule for face and content validity. Later it was trialled with four Solomon Islands women living in Australia to ensure the content was understandable and the collected data informed the research objectives. A further three interviews were conducted with women of LBW infants in the Solomon Islands. This allowed further assessment of the credibility of the interview schedule and the feasibility of the telephone interview method. The team of researchers also employed bracketing, which was undertaken through dialogue about the various potential preconceived notions that might influence the data[157], and a list of preconceived notions on a memo was used as a checklist guide during the data analysis process.

The women who provided consent to participate in the study were interviewed in a secure private room with the audio recorded. The average interview duration was 54 minutes. Confidentiality and privacy were strictly maintained for all participants throughout the interview process. RA1 escorted each participant into the room and assisted them to answer the telephone if they were unfamiliar with the handset. Once they were comfortable, RA1 left the room and ensured the door was closed before the interview commenced.

4.6.3 Data Transcription and Translation

All interviews were conducted in Pidgin English, the main spoken language of the Solomon Islands. Interviews were transcribed by the principal investigator within two weeks from the Pidgin transcriptions directly into the written English language. This procedure entails meticulous listening to each audio recording of the participants and their corresponding responses to questions in the Pidgin language. These responses were subsequently transcribed verbatim into the English language. To uphold translation precision, this process was iterated three times for every interviewee. Direct transcriptions were made because the principal investigator is fluent in both languages and familiar with the cultural context. Furthermore, the Solomon Islands Pidgin creole is a derivative of the English language combined with local languages[158]. Therefore, direct transcribing and translation were considered optimal, as both languages are to some extent analogous in most terms. To ensure validity and credibility in the translation process, three translated scripts were reviewed by three colleagues from the Solomon Islands who were fluent in Pidgin and English.

4.6.4 Data Analysis

Data were analysed using Braun and Clark's six-stage thematic analysis, which included familiarising of data, generation of the initial codes, generation of themes, review of the themes, defining themes, and write-up[159, 160]. This included the repetitive reading of the datasets to become immersed and intimately familiar with its content and annotating meanings arising from the information set, identifying succinct labels (codes) by grouping essential and similar features of the data that were relevant to answering the research question, examining and collating of codes to identify significant broader patterns of meaning and potential themes, weaving candidate themes against the dataset to determine whether they tell the data's convincing story to the research question, naming and defining themes and weaving together the analytic narrative and data extracts, which contextualised the analysis from existing literature and provided quoted content to illuminate the themes. The final list of codes and themes was reviewed and refined, and consensus was reached with the supervisory team. The consolidated criteria for reporting qualitative research (COREQ) checklist[161] was also used to ensure high-quality research findings were reported for this study (Appendix N). NVivo Version 20 software was used to extract codes and create themes from the data.

4.7 Ethics Approval

Ethics approval for all four substudies was sought from relevant bodies by submitting study protocols. Approval was first obtained from the Solomon Islands Health Research and Ethics Board of the Ministry of Health and Medical Services, with ethics approval number HRE039/19 (Appendix U). Reciprocal ethics were also granted by Curtin University Human Research Ethics Committee (HREC), with approval numbers HRE2020-0530 and HRE2021-0250 for the study in the Solomon Islands and consultation of health professional in the Pacific Island region (Appendix U). Individual consent was granted by all participants in the qualitative study and stakeholder consultation exercise.

Chapter Five: Scoping Review (Substudy One)

Substudy Objective Addressed in This Chapter:

Objective 1: To map the available literature on the prevalence of adverse birth outcomes and associated risk factors in the Pacific Island countries and gain additional insights and recommendations from the perspective of health professionals.

This chapter presents a pre-copyedited version of Publication 2, entitled “Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: A scoping review”. This article was produced by the author and was accepted for publication by *The Lancet Regional Health: Western Pacific* following a robust peer-review process. It is pertinent to note that any disparities between this version presented in the thesis, and the final published version of record, is due to the copyediting process. The version of record, Kaforau LSK, Tessema GA, Jancey J, Dhamrait GK, Bugoro H, Pereira GF. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review. *Lancet Reg Health: West Pac*. 2022;21:100402., is available at: doi.org/10.1016/j.lanwpc.2022.100402

Abstract

Background: Prevalence and exposures of adverse birth outcomes is well studied in low- and middle-income countries but not well-established for the Pacific Island region. Our study mapped the available evidence on LBW, preterm birth, and Small for Gestational Age (SGA) prevalence and the corresponding risks of each in the region.

Methods: We followed the five-staged Arksey and O'Malley's framework with clinicians' consultation in the region. Five scholarly databases and non-indexed studies were searched, and extracted data were analysed as numerical and thematic summaries mapping the outcomes and exposures.

Findings: We include 20 studies representing 11 Pacific Island countries with the following mean prevalence and associations at (95% confidence interval). Estimated mean prevalence for LBW and preterm births were 12 % and 13 % respectively. LBW were associated with malaria in pregnancy [AOR 3.3 (1.00, 10.60)], and betel nut and tobacco use [AOR 2.4 (1.00, 6.00)]. Preterm births were associated with malaria in pregnancy [AOR 6.6 (2.46, 17.62)] and maternal obesity [AOR 1.5 (1.00, 2.30)]. SGA were associated with short stature [AOR 1.7 (1.22, 2.41)] and no antenatal bookings [AOR 4.0 (2.12, 7.57)].

Interpretation: Several significant factors identified were malaria infection, obesity, betel nut, tobacco, and no antenatal care, also validated by health professionals consulted.

Funding: Australia National Health and Medical Research Council.

Research in Context

Evidence Before This Study

Adverse birth outcomes such as LBW, preterm birth, and SGA as a proxy for FGR are the primary cause of infant and child mortality and morbidity in low- and middle-income countries, including the Pacific Island region. At the outset, we conducted a literature review and initial searches on scholarly databases and online using Google and Google Scholar search engines to survey the current literature on the topic using key concept terms such as adverse "birth outcomes", "pregnancy risk factors", and the "Pacific Island region". We found no systematic or narrative, or scoping reviews conducted in the Pacific region on this topic. We also found a minimal number of primary studies that reported on the prevalence and measures of association of exposures and adverse birth outcomes in the region.

Added Value of This Study

To our knowledge, this is the first comprehensive scoping review exploring the prevalence and factors of adverse birth outcomes in the Pacific Island regions. There is limited number of research in the region on the prevalence and risk of adverse birth outcomes. Of the few studies conducted, which we reviewed in the current study, malaria in pregnancy, betel nut and tobacco use during pregnancy, obesity in pregnancy, and no and low antenatal care were notable exposures associated with adverse birth outcomes. The findings were also validated by 18 health professionals consulted working in maternal and neonatal healthcare from four countries in the region.

Implications of all the Available Evidence

Despite limited studies in the Pacific region, we found several important risk factors such as malaria infection, obesity, betel nut and tobacco use, and no antenatal care during pregnancy to be associated with the adverse birth outcomes, which are essential to inform the literature and evidence for clinical practice. Also, further study is needed to investigate the burden of adverse birth outcomes in the region.

Introduction

Adverse birth outcomes contribute to poorer childhood outcomes and are the primary cause of child mortality and morbidity in LMICs. Adverse birth outcomes, including preterm birth, SGA, LBW, stillbirths, and miscarriage, are associated with a range of social, biological, and environmental risk factors[44, 162-164].

Early birth, most commonly defined as preterm birth before 37 weeks of gestation, is a major determinant factor for neonatal mortality and morbidity[65]. Preterm birth often necessitates therapy, and its prevention requires treatment, both of which are less accessible in LMICs, and can contribute to excess morbidity burden[9, 45]. Growth restriction while *in utero* can contribute to morbidity with preterm birth. SGA, a retrospective proxy for FGR, occurs when the birth weight falls below a cut-point in the gestational age and sex-specific birth weight distribution. This cut-point is commonly the lowest 10th centile or a multiple of standard deviations below the mean weight[165]. In LMICs, retrospective proxies for FGR–such as SGA–are determined at birth due to the lack of a foetal monitoring system during pregnancy, no routine recording of gestational dates and start of the last menstrual period, and limited availability to conduct ultrasound dating[9]. The most common proxy for both preterm birth and FGR in LMICs is LBW, which is defined as birth weight of less than 2,500 grams. The terms LBW, defined as Low Birth Weight from 37 weeks of completed gestation, and SGA are the preferred indicators for FGR as newborn weight is also a consequence of time spent in utero[77]. It is well established that infants that are preterm, term LBW and SGA are at elevated risk of early childhood mortality[16, 166].

Most of the deaths attributable to FGR and preterm birth occur as miscarriages before the gestational age of viability or stillbirths, occurring from viability to delivery. Although there is no global consensus on when a foetus is viable, the most well adopted gestational age cut-off to discern miscarriages from stillbirths in LMICs is 28 weeks of gestation[66]. According to the global burden of disease study, the prevalence of stillbirths in LMICs has been reported to be as high as 20 per 1,000 live births, with Papua New Guinea (PNG) reporting 16.3 per 1,000 live births[166].

The Pacific Island region comprises countries with developing economies with potentially high infant and child mortality rates resulting from poor pregnancy and birth outcomes. The region consists of 22 Melanesian, Polynesian, and Micronesian countries with 12 independent sovereignties and 10 dependant or unincorporated territories either by the United States, France, or New Zealand[167]. It is a diverse territory in terms of socioeconomic development, culture, population and geography, with a myriad of risk factors relevant to perinatal health and early childhood mortality[168]. Most Pacific Island countries are under-resourced with inadequate health facilities that affect maternal and infant health to various extents across the region, signified in several health indicators[169]. For example, infant mortality has been reported to be higher in the PNG region of Melanesia (70/1,000 live births) compared to the Cook Islands of Polynesia (10/1,000 live births)[170]. Antenatal care coverage and skilled birth attendance in Tonga and Samoa

are over 95%[171-173], compared to 49% in PNG[92]. Geographical challenges across land and sea magnified by infrastructure limitations in PNG and countries of Melanesia are some of the barriers contributing to low antenatal attendance and skilled birth[168, 174]. Trends in morbidity and mortality due to communicable and non-communicable diseases (NCD) varies across the different subregions[168]. Obesity-related NCD and morbidities and mortalities in Polynesian countries of Tonga and Samoa have significantly increased[173]. While in the Melanesian region, PNG and the Solomon Islands have seen a two-fold increase in the burden of NCD and communicable diseases such as diabetes and malaria across adult populations[175], and severe malnutrition among women and children[176].

Maternal health in the Pacific Islands is challenged by geographical disparities and dynamics in the various parts of the region. Most Pacific Island communities are isolated by sea or land, which limits access to health services, which is added to a background of already elevated risk from socio-economic disadvantage[168, 174]. The low lying islands of Polynesia and Micronesia and elsewhere in the region are continually faced with the health challenges associated with global warming[177]. The wider Pacific Island countries are frequently affected by natural hazards, such as cyclones, floods and coastal erosion, earthquakes, and tsunamis, affecting the people's livelihood and overstretching the limited health resources[174, 178]. Vector-borne disease such as malaria and dengue are prevalent due to the climate, recurrent heavy rains, and tropical cyclones[179, 180]. Women and children are often vulnerable to malnutrition due to food shortages and diarrhoeal diseases in the aftermath of natural disasters[168, 177].

Cultural and social practices also precipitate various health risks. Betel nut use is practised in PNG, the Solomon Islands, Palau, and the Marshall Islands[181]. Studies have reported that betel nut use is associated with oral cancers in the region and elsewhere[181, 182]. Studies in LMIC countries outside the Pacific Island region (Southeast Asia) have also shown betel nut use to be adversely associated with adverse birth outcomes[181]. Kava, a traditional drink made from *Piper methysticum,* is another unique exposure to many Pacific Islanders, including those from Fiji, Vanuatu and Samoa[183]. There is a dearth of studies on kava use and its impact on birth outcomes[184], and to date, there has been no systematic assessment of the burden of, and risk factors for, adverse birth outcomes in the Pacific Island region. This scoping review aimed to map the available literature on the prevalence of adverse birth outcomes and associated risk factors in the Pacific Island countries, and further, gain additional insights and recommendations from the perspective of health professionals.

Methods

Study Design and Protocol

The systematic scoping review was registered with the Joanna Briggs Institute[153], and a detailed description of the methods was published as a protocol[152]. Our review followed the Joanna Briggs Institute Reviewers Manual[185], derived from Arksey and O'Malley's five-staged methodological framework[154]. We also included a consultation exercise, interviewing health professionals from four countries in the region.

Research Question

Our review was guided by the following research questions: (i) what is the prevalence of adverse birth outcomes in the Pacific Island region? and (ii) what are the risk factors for adverse birth outcomes in the Pacific Island region?

Study Selection and Inclusion

We selected studies that corresponded to the population, concept, and context (PCC) criteria. In the review, "population" includes women and births from the Pacific countries and "concept" includes the various social, health and behavioural risk factors associated with adverse birth outcomes. The "context" included 22 sovereign island states and territories of the region, namely: American Samoa, Cook Islands, Easter Islands, Federated States of Micronesia, Fiji, Guam, Kiribati, Commonwealth of the Northern Mariana Islands (CNMI), Marshall Islands, Nauru, New Caledonia, Niue, Palau, PNG, Samoa, Solomon Islands, Tahiti, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna[186]. We considered studies published between 1 January 2000 and 28 February 2021. Studies with populations from high-income countries located in the Pacific region (e.g., Australia, New Zealand, the United States) were excluded.

Literature Search

The authors consulted the Curtin University Health Science librarian to design the search strategy. Prior to the search, a preliminary literature review was undertaken to understand the extent of literature on the subject in the context. The literature search was carried out in three stages as outlined by the Joanna Briggs Institute[1, 187]. In stage one, key concept terms were selected from the Cumulated Index to Nursing and Allied Health Literature (CINAHL) to identify Medical Subject Headings (MeSH), or text terms contained within the titles and abstracts of articles. Key concept terms used were adverse "birth outcomes", "pregnancy risk factors", and the "Pacific Island region". In stage two, all MeSH terms, key concept terms, and their synonyms were combined

with Boolean operators, truncations, and wildcards to develop search strings and applied across the selected databases such as CINAHL, Medline, ProQuest, SpringerLink, and Scopus. In this stage, search strings were either general or specific with their corresponding key concept terms and synonyms combined with MeSH terms identified before applying them to the database. Stage three involved searching using Google and Google Scholar for non-indexed studies on regional websites of the World Health Organization (WHO), the Secretariat of Pacific Community, and United Nation International Children Emergency Fund, and hand searching reference lists of studies initially retrieved. A table of full search strategies is outlined in Appendix B.

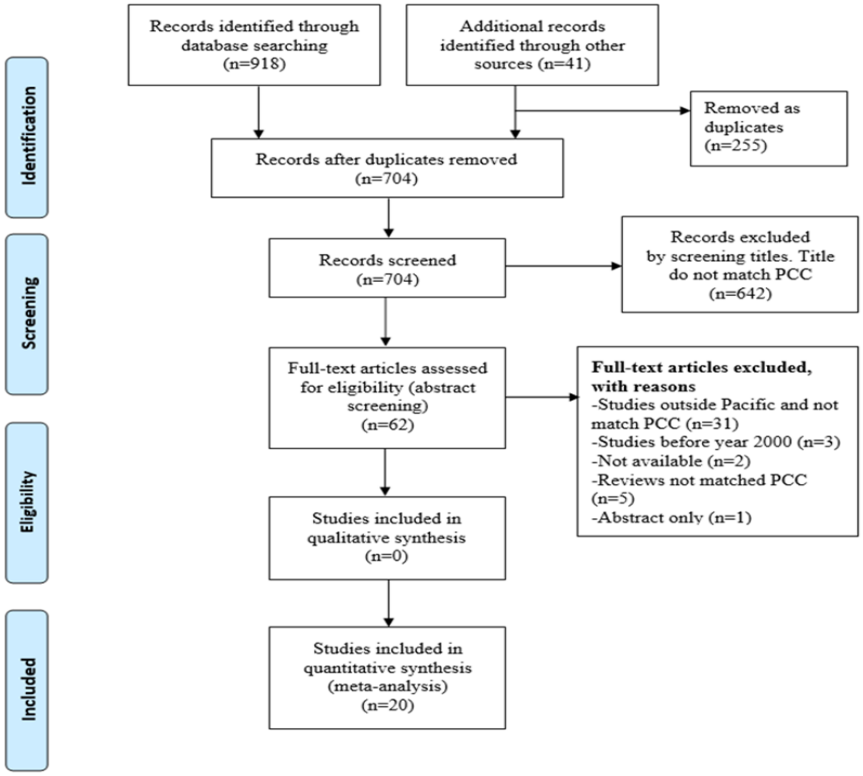
Data Charting Process

Once all retrieved records that matched the PCC criteria were exported to Endnote 9, we conducted data extraction based on an *a priori* data extraction tool developed by the PhD scholar and discussed with the co-authors (Appendix C). During the data extraction, all results were entered into Excel spreadsheets alongside standard bibliographic information that included author(s), year of publication, country where the study were conducted, aims and purpose, study population, intervention type, intervention duration, outcomes, and details of key findings, including prevalence on the outcomes identified in the study and associated risk factors. The PhD scholar conducted the data extraction and later reviewed and discussed with co-authors. All arising questions and uncertainty during the process was discussed with the research team to reach an agreement.

Summarising and Reporting the Results

The findings presented as tables, were obtained by mapping the data extracted from the selected articles and guided by Arksey and O'Malley[154]. Information on the prevalence of LBW, preterm birth, and SGA were presented in a table (Appendix D). We also summarised and presented the risk factors associated with adverse birth outcomes from the included studies. We presented our findings following the preferred reporting items for scoping review and meta-analysis (PRISMA-ScR)[188] (Appendix E).

Figure 4: PRISMA Flow Diagram



Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097. doi.org/10.1371/journal.pmed.1000097

Health Professionals' Consultation

The consultation stage was conducted via one-on-one face to face or telephone interviews. Consultants were required to be health professionals (nurses, midwives, and obstetricians) from Pacific Island countries working in antenatal care, births, and neonatal units. Recruitment was purposeful and incorporated snowball sampling, with 18 health professionals originally recruited from hospitals and health clinics. The interview schedule was informed by the literature review preliminary findings and the research team who are experienced in qualitative research and the topic area. The interview questions asked about risk factors, adverse birth outcomes, and recommendations to improve birth outcomes in Pacific Island countries.

After informed consent was obtained, interviews were conducted in English, Solomon Island Pidgin English, PNG Tok Pisin, or Vanuatu Bislama, as the principal investigator was fluent in all languages and creoles. Collected data were both quantitative (counts of nominated risk factors and adverse outcomes) and qualitative data (health professionals' perspectives on issues). Recorded data were translated from the creoles to English. NVivo Version 20 was used to manage the interview data and undertake the content and thematic analysis, which involved data

familiarisation, formulation of codes, and development of themes[189, 190]. Content and thematic analysis were deemed appropriate for this study[191] as this approach enabled the identification and quantifying of nominated adverse birth outcomes and risk factors and supported the generations of themes. Narrative summaries and quotes were used to illuminate the meaning of the themes [189, 190]. Demographic data (age, qualification, profession, country) were collected. Ethical approval was obtained from Curtin University.

Ethics Approval

The part of the study which involved consultation of clinicians was approved by Curtin University human research committee with approval number: HRE2020-0530 (Appendix U/iii).

Role of the Funding Source

The funding source was not involved in the study design; collection, analysis, or interpretation of the data; and in writing of the manuscript or in the decision to submit the manuscript for publication.

Results

Selection Process and Characteristics of Studies

A total of 959 records were identified in the initial search of which 918 were retrieved from scholarly databases and 41 from additional website searches. After excluding 255 duplicates, 704 remained for titles and abstract screening, of which 62 were retrieved for full-text screening. Next, we excluded studies that did not meet the PCC criteria (n=36), those conducted before 2,000 (n=3), not able to be accessed (n=2), and abstract articles (n=1). After all exclusions, 20 studies remained for the final review (Figure 4 illustrates the selection process using a PRISMA flow diagram).

We identified 20 studies, 11 peer-reviewed articles[40, 93-100, 192, 193], and nine demographic health survey reports[37, 91, 92, 171, 194-198], conducted in 11 countries in the Pacific Island region, with a total population of 38,148 singleton births (Table 1). Of the reported studies, seven were cohort studies[93-95, 97, 100, 192, 193], 11 were cross sectional studies[37, 40, 91, 92, 99, 171, 194-198], one case control study[98] and one randomised clinical trial[96]. Nine of the studies were conducted in PNG[92, 93, 96-100, 192, 193], and others were conducted in other sub-regions: CNMI (n=1)[95], Kiribati (n=1)[198], Marshall Islands (n=1)[195], Nauru (n=1)[91], Palau (n=1)[94], Samoa (n=1)[171], Solomon Islands (n=2)[37, 40], Tonga (n=1)[196], Tuvalu (n=1)[194], and Vanuatu (n=1)[197] (Table 1).

Table 1: Summary of Studies Included in the Review[vii]

Author(s)	Year	Study Context	Study Aims	Study Design	Population (Mother and Infants, Births)	Adverse Birth Outcomes	Risk Factors Investigated
i) Journal							
Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	2019	PNG, Madang Province	To evaluate the associations between malaria infection and haemoglobin in PNG women	Prospective cohort study	1,976	LBW, preterm birth, SGA	Plasmodium falciparum malaria infection (microscopic sub-microscopic), and plasmodium vivax malaria infection
Dela Cruz, Grant, Heck and Cash [95]	2018	CNMI	To explore the racial/ethnic disparities that exist among Pacific Islander women residing in the CNMI and newborns.	Retrospective cohort study	8,918	preterm birth, LBW	Race of CNMI, Filipino, Chinese, other Pacific Islander, maternal age, number of antenatal, and number of visits
Fowkes, Davidson, Agius and Beeson [93]	2018	PNG, Madang Province	To determine the association between iron deficiency and birth outcomes, and malaria	Longitudinal cohort study	279	preterm birth, LBW	Iron deficiency anaemia, iron deficiency (Hb < 11 g/dL), moderate anaemia, severe anaemia (Hb < 7 g/dL*), and plasmodium falciparum malaria (peripheral blood)

[vii] *Grams per decilitre
**Grams per litre
***Not applicable: these surveys did not present measure of associations between the independent and dependant variables.

Lufele, Umbers, Ordi, Ome-Kaius, Wangnapi, Unger, Tarongka, Siba, Mueller, Robinson and Rogerson [96]	2017	PNG, Madang Province	To investigate the prevalence of Plasmodium malaria its risk factors, maternal anaemia and birth outcomes associated with women receiving at least one dose of Intermittent preventive treatment in pregnancy (IPTp)	Randomised clinical trial	1,451	LBW, preterm birth	Plasmodium malaria infection, active placenta malaria, acute malaria infection, chronic malaria infection, past plasmodium malaria infection and anaemia
Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	2015	Palau	To determine the effects of betel nut with tobacco use on pre-pregnancy obesity and adverse birth outcomes	Retrospective cohort	1,171	preterm birth, LBW, preterm LBW, term LBW, preterm normal weight	Betel nut chewing, tobacco use, combined use of tobacco and betel nut, and obesity in pregnancy-Body Mass Index (BMI) >30
Cafaro, Randle, Wyche, Higgins, Fink and Jones [40]	2015	Kirakira, Solomon Islands	To calculate the incidence of LBW and prematurity and proportion of women receiving antenatal care	Retrospective audit and cross-sectional study	1,295	LBW, preterm birth	Betel nut and tobacco use, and urinary tract infection in pregnancy
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller	2015	PNG, Madang Province	To access the effects of areca nut chewing on pregnancy outcomes, birth weight, anaemia in a large cohort of pregnant women	Longitudinal cohort	1,769	LBW, stillbirth, preterm birth	Betel nut, smoking and alcohol use, low mid upper arm circumference (MUAC), maternal height, malaria prophylaxis, primigravida and fewer antenatal visits

and Rogerson [97]							
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	2015	PNG, Madang Province	To identify risk factors for LBW, anaemia, and preterm in pregnant women of PNG	Prospective cohort study	328	LBW, preterm birth	Malaria infection, parasitemia, severe anaemia, multigravida, tobacco smoke, education and MUAC
Unger, Ome-Kaius, Karl, Singirok, Siba, Walker, Wangnapi, Mueller and Rogerson [192]	2015	PNG, Madang Province	To evaluate factors with FGR among pregnant woman enrolled in randomised control trial evaluating IPTp malaria prophylaxis in pregnancy	Cohort study with clinical trial	671	LBW, SGA, preterm birth low weight gain	Low MAUC (<22cm), short stature (<150cm), low BMI, anaemia (<90g/l),** malaria infections, plasmodium falciparum malaria, and plasmodium vivax malaria (peripheral or sub-microscopic infections)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	2009	PNG, Madang Province	To investigates the habits of betel nut chewing and possible impact on pregnancy	Cross-sectional study	310	Reduced mean birth weight	Primigravity, betel nut, smoke, alcohol, and BMI

Peters, Vince and Friesen [98]	2001	PNG	To identify risk factors associated with LBW in the Western highland Province of PNG	Prospective case-control	299	LBW	Maternal age, birth interval, no antenatal bookings, low antenatal attendance, fever during Pregnancy, pre-eclampsia, antepartum haemorrhage, maternal smoking, short stature, BMI, low haemoglobin, and low education
ii)Nine Grey Literatures							
National Statistics Office [92]	2019	PNG	To provide information indicators of fertility, fertility preferences, family planning practices, childhood mortality, maternal and child health, knowledge and awareness of human immunodeficiency virus-acquired immunodeficiency syndrome (HIV/AIDS), domestic violence, and other related health issues	Demographic Health Survey	4,672	LBW, and smaller than average babies	Not applicable ***
SINSO [37]	2015	Solomon Islands	To provide current and reliable data on fertility and family planning behaviour, child mortality, adult and maternal mortality, children's nutritional status, the use of maternal and child healthcare services, knowledge of HIV and AIDS, and other health-related issues	Demographic Health Survey	3,535	LBW, smaller than average baby, and very small baby	Not applicable
Bureau of Statistics [171]	2014	Samoa	To provide information for policymakers, planners, researchers, and program managers, for use in planning, implementing, monitoring, and evaluating population and health programs within the country	Demographic Health Survey	3,192	LBW, smaller than average baby, and very small baby	Not applicable
Ministry of Health [197]	2013	Vanuatu	To furnish policymakers and planners with detailed information on fertility, family planning, infant and child mortality, maternal and child health and nutrition, and knowledge of HIV and AIDS and other sexually transmitted infections	Demographic Health Survey	1,562	LBW	Not applicable
Ministry of Health [196]	2012	Tonga	To ensure better understanding and use of these data and widely dissemination of results at different planning levels	Demographic Health Survey	1,703	LBW, smaller than average baby, and very small baby	Not applicable
National Statistic Office [198]	2009	Kiribati	To provide information for policymakers, planners, researchers, and program managers, for use in planning, implementing, monitoring, and evaluating population and health programs in the country	Demographic Health Survey	1,099	LBW, and very small baby	Not applicable

Bureau of Statistics [91]	2007	Nauru	To provide information for policymakers, planners, researchers, and program managers, for use in planning, implementing, monitoring, and evaluating population and health programs in the country	Demographic Health Survey	322	LBW, and very small baby	Not applicable
Central Statistics Division [194]	2007	Tuvalu	To provide information for policymakers, planners, researchers, and program managers, for use in planning, implementing, monitoring, and evaluating population and health programs in the country	Demographic Health Survey	447	LBW, smaller than average baby, and very small baby	Not applicable
Economic Policy [195]	2007	Marshall Islands	To provide information for policymakers, planners, researchers, and program managers for use planning, implementation, monitoring and evaluation of population and health programs in the country	Demographic Health Survey	1,173	LBW, smaller than average baby, and very small baby	Not applicable

Prevalence of Adverse Birth Outcomes

Prevalence of the various adverse birth outcomes was reported for 11 countries in the region (Appendix D). Nineteen studies[37, 40, 91-98, 100, 171, 192-198] representing 11 countries reported the prevalence of LBW which ranged from 3% in CNMI[95] to 27% in Nauru with a mean of 12%[91]. Polynesia and Micronesia countries such as CNMI[95], Palau[94], Samoa[171], Tonga[196], and Tuvalu[194] reported LBW prevalence of less than 10%. Six studies[40, 93-95, 100, 193] reported the prevalence of preterm births which ranged from 7% in CNMI[95] to 24% in the Solomon Islands with estimated mean of 13%[40]. The Palau study reported a prevalence for preterm LBW of 5%, term LBW of 4%, and a prevalence for preterm *normal* weight of 4%[94].

Risk Factors for Adverse Birth Outcomes

Low Birth Weight

Six studies, five from PNG[96, 98-100, 193] and one from Palau[94], reported the risk factors for LBW. LBW was associated with malaria infection in pregnancy[96, 100, 193]. These studies investigated acute and chronic, and microscopic and sub-microscopic malaria infections, which were all associated with an increased risk of LBW[96, 100, 193]. Southeast Asian *ovalocytosis* infection in pregnancy was associated with LBW[100], as was betel nut and tobacco use in pregnancy[94, 98]. Low maternal mid-upper arm circumference (<23cm) and short stature (<150cm)[97] were also associated with LBW. Young and advanced maternal ages (< 22 years and > 35 years)[98] were associated with LBW. Other risk factors associated with LBW were birth intervals less than two years, no antenatal booking, fever during pregnancy[98], and female infant and *primigravida* (Appendix F)[97].

Preterm Birth

Six studies reported risk factors for preterm births from PNG[93, 97, 100, 193], CNMI[95], and Palau[94]. Three studies reported that malaria infections during pregnancy were associated with preterm birth[96, 100, 193]. Two of the studies that showed that acute and chronic placental malaria were associated with preterm birth, with chronic infection showing a stronger association[96, 100]. Microscopic malaria infections were also associated with preterm birth[193]. Three studies reported preterm birth were associated with demographic, health risk factors such as maternal obesity[94], maternal age (age <20 years and ≥ than 35 years) and insufficient antenatal care (one–eight visits) in the CNMIs[95]. Pacific Islands, Filipino women, and CNMI women living in CNMI were associated with higher risk of preterm birth than women in CNMI of Chinese descent (Appendix G)[95].

Small for Gestational Age

Only one study showed the risk factors associated with SGA. This study reported that low maternal haemoglobin level (Hb<9mg/L) during pregnancy, maternal upper arm circumference (<22 cm), short maternal stature (<150 cm) and primigravida were associated with SGA (Appendix H)[192].

Changes in Mean Birth Weight

Six studies[93, 96, 97, 99, 100, 192] reported associations with mean birth weight. Acute placental malaria during pregnancy was associated with reductions in mean birth weight[96]. Primigravid and tobacco smoking during pregnancy were also reported as factors that were associated with reductions in mean birth weight (Appendix I)[100].

Stillbirth and Miscarriage

Only one study investigated associations with stillbirth and miscarriage[97]. In this study, there was marginal evidence for an association between heavy betel nut use and stillbirth and miscarriage (Appendix H)[97].

Health Professionals

Demographic Profile

We interviewed 18 health professionals from the Pacific Island countries of the Solomon Islands (n=11), PNG (n=3), Fiji (n=2) and Vanuatu (n=2). They were midwives (n=7), neonatal care nurses (n=5), obstetricians (n=3), registered nurses (n=2), and a paediatrician (n=1) practising in major tertiary hospitals (n=15) and rural community practice (n=3). Eleven health professionals had qualifications equivalent to a master's degree, postgraduate or above, while seven had an undergraduate degree or diploma. The health professional mean age was 42 years, and their average work experience was 17 years. The data provided by the health professionals were quantified and categorised and presented under the following themes: a) adverse birth outcomes and risk factors; b) mitigating risk factors during pre-pregnancy; and c) mitigating risk factors during pregnancy.

Adverse Birth Outcomes and Risk Factors

The most frequent adverse birth outcomes reported by the health professionals were preterm birth (n=14), followed by LBW (n=12), and SGA (n=11). The most frequently nominated risk factors for adverse birth outcomes were physical and emotional stress (n=13), teenage pregnancy (n=11), malaria (n=11), and poverty (n=11) (Appendix J).

Mitigating of Risk Factors During Pre-Pregnancy

Most health professionals (n=13) reported the risk of adverse birth outcomes could be reduced during pre-pregnancy. They believed that actions to reduce the risk of adverse birth outcomes could be the development of pre-pregnancy healthcare policy, provision of holistic health care, effective health education for women and girls, and incorporating sexual and reproductive health into the school curriculum. Health education orientated to informing women of the importance of, family planning, antenatal care, good nutrition, substance use avoidance, and the raising of awareness of sexually transmitted infections (STIs) would be beneficial.

> *"Educate young women and girls on good care before pregnancy … collaborate and implement program on sexual and reproductive health on safe sex practice … establish community participation with churches and social organisations."* (Midwife, PNG)
> *"Health education is essential for mothers before pregnancy, on good nutrition, danger signs, early antenatal care, personal hygiene, prophylaxis and delivery at the health facilities."* (Midwife, Vanuatu)

Health professionals also suggested that the current health system should focus on health promotion. This was reflected when a midwife from Solomon Islands said:

> *"The health system should also focus on public health and care for women during pre-pregnancy … pre-pregnancy healthcare is the public health profession's role and should be integrated with clinical care."* (Midwife, Solomon Islands)
> *"We should have a special clinic for women to seek advice if they* [women are] *planning to get pregnant."* (Neonatal care nurse, Solomon Islands)

Mitigating Risk Factors During Pregnancy

Health providers reflected on how risk factors leading to adverse birth outcomes could be mitigated at the time of pregnancy. Most health professionals (n=13) called for comprehensive and ethical antenatal care involving health assessments, physical examinations, provisions of screening for STIs and malaria and provision of malaria prophylaxis and drug supplements (e.g., iron tablets and folic acid).

> *"We must monitor vital signs such as blood pressure, foetal heart rate, glucose, and protein to detect any underlying health condition ... we monitor mothers' weight, no weight gain would mean growth restriction* [to the foetus], *if the weight increases abnormally, it could mean gestational diabetes."* (Midwife, Vanuatu)

"Screen all antenatal mothers for syphilis, malaria, and anaemia, and treat them early." (Midwife, Solomon Islands)

"[nurses or health care providers should] *provide malaria prophylaxis, ferrous sulphate with folic acid, albendazole, and tetanus vaccine to prevent illness during pregnancy."* (Neonatal nurse, Solomon Islands)

Health professionals also suggested the need to improve antenatal health services in rural areas, improve health professionals' practices, and the need for the provision of health education during antenatal care in local dialects as a means of reducing exposure to risk factors and adverse birth outcomes.

"Problems with birth outcomes occur mostly in rural area … therefore the government should focus on rural health." (Midwife, PNG)

"Trained midwives should see the pregnant woman not as a task but as a whole person." (Midwife, Solomon Islands)

"Use brochures, posters, and pamphlets in local dialects … where lacking in staff, use of pre-recorded speech and videos in antenatal education." (Neonatal care nurse, Vanuatu)

Discussion

Summary of Findings from this Scoping Review

To our knowledge, this scoping review is the first to examine the available evidence on the burden of adverse birth outcomes and their risk factors in the Pacific Island region. Our review of 22 countries and territories located in the region found a dearth of published peer reviewed studies (n=11) and grey literature (n=9) that met our inclusion criteria. Studies that did not follow standard reporting guidelines were excluded. Nonetheless, the included studies were informative in (i) identifying the adverse birth outcomes most and least well-studied; (ii) providing an indication of the expected burden of adverse birth outcomes; and (iii) identifying the range of risk factors that have been investigated in the Pacific Island region. In summary, we identified that (i) LBW and preterm birth were the most well-studied outcomes but there were relatively few studies conducted on mortality endpoints; (ii) the prevalence of the adverse birth outcomes varied considerably both within and between regions, and very high for some locations such as the Solomon Islands; and (iii) although health, obstetric, social and behavioural risk factors have been investigated, several, such as betel nut chewing, are relatively unique to the region and require further investigation. Outside PNG few studies have been conducted.

Prevalence of Adverse Birth Outcomes in the Pacific Island Region

There are several plausible explanations for the wide range for prevalence of LBW. Firstly, relatively lower prevalence of LBW and preterm birth in the Polynesia and Micronesia may reflect better maternal health, higher antenatal coverage and greater likelihood of presence of a skilled birth attendant[171, 173, 196]. The estimated mean LBW prevalence (12%) in the Pacific island countries is comparable to those[16] from LMICs of Africa and Asia[199]. The mean estimated prevalence for preterm birth was 13% is comparable to WHO estimates of 14% for Pacific region[200], which is also similar to estimated prevalence for preterm birth (10-15%) in LMICs by the WHO[200]. The true prevalence of preterm birth and LBW were hampered by lack of routine accurate records of pregnancy dates, underreporting of stillbirths, lack of availability of measurement instruments, and small sample sizes. These two adverse birth outcomes were both the most investigated and identified by the health professionals as those most frequently occurring of concern in the region.

Risk Factors for Adverse Birth Outcomes in the Pacific Island Region

Malaria

Malaria infections reported in PNG showed significant associations with LBW, preterm births, and changes in mean birth weights[96, 100, 193]. Malaria infection was also reported as a major cause of preterm birth, LBW, miscarriage, and stillbirth by the consulted health professionals. Malaria is endemic in all coastal areas of the three Melanesian countries of PNG, Solomon Islands, and Vanuatu[201-204] with PNG as the epicentre of malaria infection in the Western Pacific region[202, 205]. Malaria is also endemic in Vanuatu but infection fluctuates across the different seasons[197], while most countries of Polynesia and Micronesia have been declared as malaria-free by the WHO[206]. Successful administering of malaria prophylaxis to pregnant women in these areas has been a challenge due to drug shortages and poor access to woman in isolated rural areas[202, 205]. We conclude that malaria is a risk factor in pregnancy and adverse birth outcomes in the malaria-endemic areas of the Pacific Island region, although the magnitude of the association remains unclear.

Anaemia and Worm Infestation

Clinicians interviewed nominated anaemia and worm infestation to be associated with the adverse birth outcomes of which both conditions were prevalent in the region[93, 207]. Oral iron supplements and albendazole stat dose during pregnancy are part of the antenatal care protocol in most Pacific Island countries[93]. Accessing these medications can be challenged due to consistent drug shortages, poor access for women in rural and isolated areas, and low antenatal care attendance

resulting in a significant portion of pregnant women not taking these medications[174]. The clinicians have called for a step-up in antenatal care and health education on prophylaxis and supplements during pre-pregnancy and pregnancy, reaching all levels, including public health and social organisations, and churches as an innovative approach mitigation strategy.

Substance Use

Betel nut and tobacco use in PNG and Palau were associated with LBW[94, 98], birth weight reduction[100], stillbirth and miscarriage[97]. Studies from Southeast Asia have also reported betel nut chewing during pregnancy as having an impact on birth weight, foetal length, and preterm birth[169, 181, 205]. The magnitude of the effects of betel nut chewing on birth outcomes remains unclear. Reductions in birth weight from betel nut use appear to be at least as large as those reported for smoking during pregnancy. The health professionals that we consulted also perceived betel nut, tobacco and kava use as having a negative impact on pregnancy and birth outcomes. Although the impact of kava use has been rarely studied in the peer-reviewed literature, health professionals reported its detrimental effects on pregnancy outcomes. Given the increase in kava use in the region[183], there is a need for future investigation on its impact on births and pregnancies.

Maternal Obesity and Obesity-Related Conditions

A study in Palau reported maternal obesity to be positively associated with preterm birth[94]. This finding was also supported by the interviewed health professionals who reported obesity-related diseases, such as Type 2 diabetes, gestational diabetes, hypertension, and pregnancy-induced hypertension, as risk factors for adverse birth outcomes. The health professionals also reported pre-eclampsia, a hypertensive disorder of pregnancy[208], as a notable cause of LBW and preterm birth. We conclude that obesity, which occurs among 36% of women in the Pacific Island region[168, 173], is likely to have a role in maternal health during pregnancy, whether or not it is a direct cause of adverse birth outcomes in the region[209].

Poor Antenatal Care and Access

Our literature review found no antenatal bookings and lower number of antenatal visits was associated with LBW[98] and preterm birth[95]. This was also reflected in the health professional's concerns about poor presentation for antenatal care, influenced by poor access to health facilities and health seeking behaviours. Health professionals were concerned that shortage of staff and lack health facilities especially in rural areas have contributed to lack of quality in antenatal care.

Our findings were also validated by recent studies in the region which showed poor quality maternal care in the region lead to poor outcomes in newborns[174, 210].

Quality of Reporting and Number of Studies in the Pacific Island Region

Our review found a dearth of studies for all countries, for all risk factors and for all birth outcomes that have been investigated to date in the Pacific Islands region. Of all the 20 studies representing the 11 Pacific Island countries (CNMI, Kiribati, Marshall Islands, Nauru, Palau, PNG, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu), the measure of association for risk factors and adverse birth outcomes were reported in ten studies, which came from only three countries (PNG, Palau, and CNMI)[40, 93-100, 192, 193]. Also, the association of risk factors and adverse birth outcomes was reported by nine population-based cohort studies[93-95, 97-100, 192, 193], and a randomised control trial[96] of which four had small study populations[93, 98-100]. Two DHS reports from Nauru[91] and Tuvalu[194] also used small samples to produce prevalence estimates. Many studies did not report measures of uncertainty (confidence intervals or variance), control for confounding, or attempt to identify potential sources of bias. This assessment stems from limited research capacity in the region[181, 211], and limited resources for health administration[170]. Consultation with health professionals was essential, assisting in illuminating the findings from the literature, contributing additional insights and recommendations to reduce exposure to risk factors and adverse birth outcomes in the Pacific region**.**

Limitations of This Scoping Review

We could not access health reports and grey literature that were only published in hardcopy. It is plausible that many health systems in the region do not disseminate health information online. We were also unable to obtain the views of health professionals from the Polynesian and Micronesian regions.

Conclusion

Despite the limited studies, the review identified a range of risk factors and adverse birth outcomes relevant to the Pacific Island region. The prevalence of adverse birth outcomes is not well-ascertained for countries within the region, although LBW and preterm birth were relatively more frequently investigated. There were a range of risk factors for adverse birth outcomes–such as malaria, substance use, obesity, and poor antenatal care–that are either relatively prevalent or somewhat unique to the Pacific Islands region. These risk factors have not been comprehensively investigated in the region and were confirmed by health professionals as risk factors of concern.

Contributors

Lydia Sandrah Kaforau, Gavin Pereira, Gizachew Tessema, and Jonine Jancey conceived and conceptualised study design. Kaforau conducted searches and the initial study selection. Kaforau, Pereira, Tessema, and Jancey did the final study selection. Kaforau conducted study analysis under guidance of Pereira and Tessema. Kaforau and Jancey designed the stakeholder consultation study and Kaforau conducted interviews and data analysis. Kaforau wrote the first draft, which was reviewed by Pereira, Tessema, and Jancey. Hugo Bugoro and Gursimran Dhamrait read and approved the final paper.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest.

Acknowledgement

We want to acknowledge all 18 health professionals from Fiji, PNG, Solomon Islands, and Vanuatu who wholeheartedly participated in the study. We also acknowledge JT, Nurse instructor of the Paediatrics and Neonatal care of the National Referral Hospital, for skilfully conducting the one-on-one interviews in the Solomon Islands.

Funding

Pereira was supported with funding from the National Health and Medical Research Council Project and Investigator Grants #1099655 and #1173991, institutional funding for the WA Health and Artificial Intelligence Consortium, and the Research Council of Norway through its Centres of Excellence funding scheme #262700. Tessema was supported with funding from the National Health and Medical Research Council Investigator Grant #1195716. Kaforau is the recipient of an Australia Award scholarship, which was awarded in 2019 from the Department of Foreign Affairs.

Chapter Six: Quantitative Analysis of the SIDHS 2015 Data on Births (Substudy Two)

Substudy Objective Addressed in This Chapter:

Objective 2: To explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on LBW in the Solomon Islands.

This chapter presents a pre-copyedited version of Publication 3, entitled "Prevalence and factors associated with low birth weight in the Solomon Islands: evidence from the 2015 Solomon Islands demographic and health survey data". This article was produced by the author and was accepted for publication in the *Asia Pacific Journal of Public Health* following a robust peer review process. It should be noted that any disparities between this version presented in the thesis, and the final published version of record, is due to the copyediting process. The version of record, Kaforau LS, Tessema GA, Jancey J, Dhamrait GK, Bugoro H, Pereira GF. Prevalence and factors associated with low birth weight in the Solomon Islands: evidence from the 2015 Solomon Islands demographic and health survey data. *Asia Pac J of Public Health*. 2023;35(2-3):136-144., is available at: doi.org/10.1177/10105395231158868.

Abstract

LBW has contributed to more than 80% of under-five deaths worldwide, most occurring in low and middle-income countries. We used the 2015 Solomon Islands Demographic and Health Survey (SIDHS 2015) data to identify the prevalence and risks associated with LBW in the Solomon Islands. LBW prevalence estimated was 10%. After adjustment for potential confounders, we found the risk of LBW for women with a history of marijuana and kava use was 2.6 times, adjusted relative risk (ARR) 2.64 at a 95% confidence interval (0.64, 10.95), and 2.5 times [ARR 2.50 (0.63, 9.88)] than among unexposed women, respectively. Polygamous relationship, no antenatal care, decision making by another person were 84% [ARR 1.84 (1.15, 2.93)], 73% [ARR 1.73 (0.96, 3.13)] and 73% [ARR 1.73 (0.96, 3.13)] than among unexposed women, respectively. We also found that 10%, and 4% of LBW cases in the Solomon Islands were attributable to a household of more than five members and tobacco and cigarette use history. We concluded that LBW in the Solomon Islands relied more on behavioural risk factors, including substance use, and health and social risk factors. We recommended further study on kava use and its impact on pregnancy and LBW.

Keywords

Low birth weight; Risk factors; Solomon Islands; Solomon Islands Demographic and Health Survey 2015; SIDHS 2015.

What We Already Know

- LBW is the main driver for infant and under-five mortality and morbidity in low- and middle-income countries.
- LBW accounts for 15% to 20% of births worldwide.
- LBW contributes to 80% of under-five deaths worldwide.

What This Article Adds

- The estimated LBW prevalence for the Solomon Islands is 10%.
- Substance use such as marijuana, kava, polygamous relationship, no antenatal care, and decision-making by another person were modifiable exposures associated with LBW in the Solomon Islands.
- 10% and 4% of LBW cases in the Solomon Islands were attributable to a household of more than five members and tobacco and cigarette use history.

Introduction

LBW is a global health problem accounting for 15–20% of births worldwide. It is defined as a birth weight of less than 2,500 grams irrespective of gestational age, and is a widely used perinatal morbidity measure in LMICs[212]. In LMICs, birth weight can be the only reliable and affordable anthropometric measurement due to the lack of foetal ultrasound dating equipment or accurate information for the last menstrual period[9]. Over 20 million babies annually are born with LBW, and 96% of these babies are born in LMICs[213]. Despite efforts by the WHO to reduce LBW by 30% by the year 2025, LBW remains a significant public health problem worldwide and the leading cause of infant mortality and morbidity in LMICs[199]. More than 80% of infant deaths globally are attributable to LBW, with two-thirds being preterm and one-third being term SGA[212].

Studies in LMICs reported that LBW is broadly associated with demographic, obstetric, and environmental risk factors[181, 212, 214-216]. However, there is a dearth of studies on LBW locally on relevant exposures in the Solomon Islands. The Solomon Islands may have a unique culture, environment, and geography compared to other LMICs[37]. Consequently, the sociodemographic and environmental risk factors affecting maternal health and their effects during pregnancy may differ from other LMICs. The Solomon Islands is a small developing island state of the South Pacific, with approximately 721,455 people distributed over 992 islands[38]. Most of the rural population have poor access to health services, a vulnerability that is exacerbated by its low economy, fragile healthcare and political system[37]. The country is located in the most environmentally vulnerable region globally–the equatorial region, within the Pacific ring of fire and a large expanse of ocean impacted by natural disasters such as cyclones, floods, earthquakes, and tsunamis[37].

The Solomon Islands population is predominantly of the indigenous Melanesian ethnicity (95%), with the remainder identifying as Polynesians, Micronesians, Asians, and Europeans[37]. Although a small country, it has diverse cultures embracing its indigenous traditions intertwined with introduced modern culture[217]. Patriarchal dominance, male-controlled culture, is an accepted norm in the Solomon Islands and has become a conduit for domestic violence, a well-established risk factor for perinatal morbidity[130]. The Solomon Islands remains politically unstable with frequent instances of civil unrest since 1998[37, 218], which adversely affect social and health service development[219]. Rapid urbanisation and high cost of living have also contributed to increasing poverty and poor living standards, imposing social and health risks on women. Although accurate estimates are not available, substance use is putatively prevalent in the Solomon Islands. Based on previous studies, the prevalence of betel nut chewing (legal) and marijuana use (illegal) has been

reported to be as high as 93%, and 24%, respectively. Consumption of any form of alcohol, including manufactured beer, home-brewed and *kwaso*, or illegal homemade distilled alcohol among women has been reported to be as high as 54%[133]. It is unclear as to the prevalence of such exposure during pregnancy, and to date, no studies from the Solomon Islands on the prevalence of kava use has been conducted[220]. While studies in LMICs have shown betel nut, marijuana, and use of alcohol may have a direct impact on birth weights[181, 221], effects of kava use on pregnancy have not been studied[222]. Kava is a traditional Pacific Island beverage made from the *Piper methysticum* plant and is becoming increasingly consumed in the Solomon Islands.

The main objective of this study was to investigate the potential and contextual risk factors and prevalence of LBW in the Solomon Islands based on the 2015 Solomon Islands Demographic and Health Survey (SIDHS 2015). Understanding these risks in the local context is essential to inform evidence-based practice relevant to the Solomon Islands and the Pacific region.

Materials and Methods

Study Design and Data Source

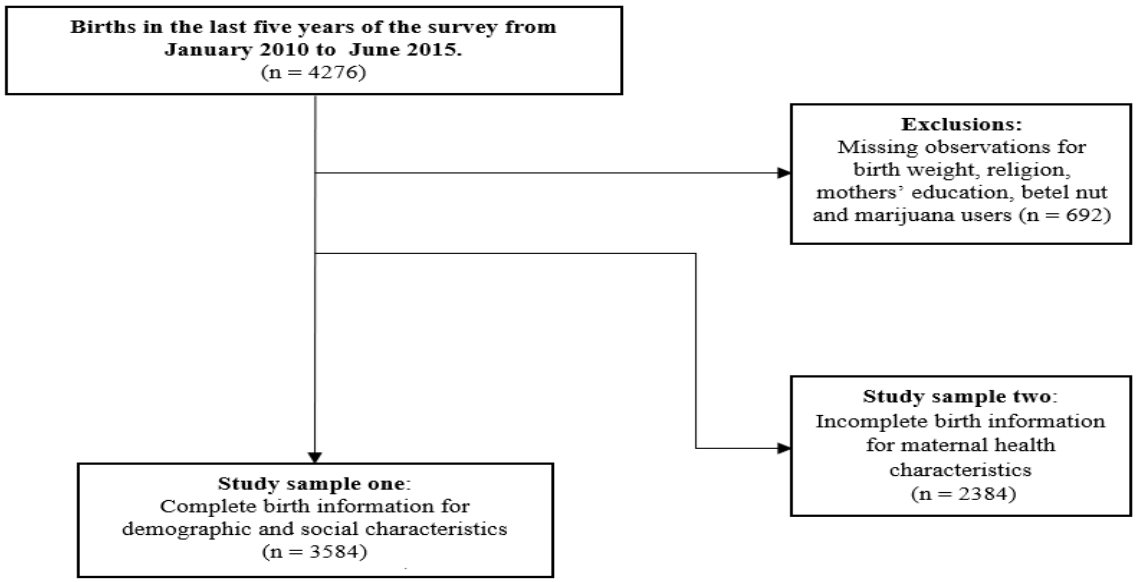
The study used birth data from SIDHS 2015, a population-based cross-sectional study. The Solomon Islands Demographic and Health Survey 2015 was conducted between 6th April to 18th September 2015, with a full report published online[37]. SIDHS 2015 followed the Demographic and Health Survey standard questionnaire tailored to the Solomon Islands context and implemented by the Solomon Island Government through the Solomon Islands National Statistics Office, the Ministry of Health and Medical Services, and the Secretariat of the Pacific Community[37]. The survey's objective was to provide reliable data on health and population characteristics regarding household, maternal and child health and mortalities. Ethical approval for this study was first approved by the Solomon Islands Health Research and Ethics Review Board with full ethical research approval number HRE039/19. A reciprocal ethics was later approved from Curtin University Human Research Ethics Office with approval number HRE2020-0530

Sampling and Sample Size

The study participants were recruited based on the 2009 Solomon Islands national census Enumeration Areas (EAs) and a two-stage stratified and nationally representative sample of households[37]. The primary sampling frame comprises 211 EAs or primary sampling units of households by five provinces, including Honiara, Malaita, Guadalcanal, Western, and seven smaller provinces, including Santa Isabel, Makira/Ulawa, Central, Choiseul, Temotu, and Rennell/Bellona

provinces[37]. At each EA, a systematic random sampling with probability proportional to the estimated number of households was made, and participants were also randomly selected from each household[37]. A total of 5,046 households were selected, with 6,657 eligible women aged 15 to 49 years with informed consent obtained from each participant. Of them, 6,266 were successfully interviewed, with a 99.8% response rate. Our analysis focused on women who have given birth in the last five years of the survey that included 4,272 births. We separated this population into two study populations: an unweighted sample population, one which comprised of social and demographic characteristics (n=3,584), and sample population two of maternal characteristics (n=2,384). Unweighted sample one was reached after excluding missing observations for birth weight, religion, maternal education, history of betel nut and marijuana use (n=692), and unweighted sample two after exclusion of missing observations and restricting only to women with last births or those with antenatal care information (n=1,892) (Figure 5).

Figure 5: Flow Chart Showing the Selection Process of Sample Population for the LBW Infant Study



Outcome Variable

The outcome variable for this study was LBW, and it was defined as birth weight less than 2,500 grams. Those babies born with birth weights between 2,500 grams and 4,000 grams were considered to have normal birth weights. Babies with a birth weight over 4,000 grams were excluded from the analysis. Birth weights for the survey were collected either from medical

records from children's baby books (76%) or mothers' recall (24%) when birth records were not available.

Exposure Variables

We included 20 exposure variables, with known or hypothesised associations with LBW in the literature, that were sociodemographic (household members, marital status, religion, household wealth, place of residence, mother's age, mother's education, decision-making, women with polygamous husbands), reproductive and health service-related (parity, sex of the child, antenatal visits, iron supplement, malaria infection during pregnancy), and behavioural (substance use history including betel nut, kava, marijuana, tobacco and cigarette and alcohol use). Our examination of substance use for this study assumed that women who have ever tried or had used any of the substances in the last 30 days or one year have an increased probability of being strong users during the last pregnancy. Our selection of variables was based on those relevant to LBW from literature reviews of past studies in other LMICs, those that are likely to influence LBW, and those pertinent to the local Solomon Islands context (see Table 1).

Statistical Analysis

After excluding records with missing observations, we cross-tabulated selected covariates with the outcome variable (LBW) to report frequencies and percentages. Next, we performed bivariate analyses to estimate the unadjusted association between each exposure variable and LBW. Based on the bivariate analyses and post estimation tests, we selected 14 covariates for the final adjusted model, which included all covariates with p-values of less than 0.20. We then ran adjusted generalised linear models with log link to estimate relative risks at a 95% confidence interval. Multicollinearity tests indicated that marital status was highly correlated with other variables and consequently this variable was excluded from the adjusted model (Table 1). Finally, we calculated the PAFs, defined as the proportion of LBW cases attributable to each risk factor. All analyses were conducted by applying sample probability weighting to account for the non-response rate and complex sampling strategy. All analyses were undertaken with Stata Version 17.

Sensitivity Analysis

We also conducted an additional sensitivity analysis that excluded all birth weights from mothers' recall. The interval estimates from the sensitivity analysis largely overlapped those from the original analysis indicating minimal influence of recall on overall inference. In general, point

estimates were attenuated by inclusion of records with recall of birthweights, particularly for estimates of the effects of kava and marijuana exposure (Appendix K).

Results

Characteristics of Study Sample

We analysed two weighted study samples: 1) demographic and social characteristics of all births in the last five years of the SIDHS 2015 survey (n=3,729), and 2) maternal health characteristics of last births in the last five years of the DHS survey (n=2,432). Of the sample one weighted population, 81% (n=3,018) were from women residing in rural areas, 41% (n=1,517) were from the poorest households, 54% (n=2,027) were of primary level of education or lower, and a small proportion of 6% (n=220) were borne by women younger than 20 years old (Table 2).

Table 2: Social, Demographic, Behavioural, and Maternal Health Characteristics of Births of the 2015 Solomon Islands Demographic and Health Survey Data (n=3729)[viii]

Risk Factors	n=3,729, n (%)
Sample 1: Social and Demographic Characteristics	
Household members	
1-5 members	1,403 (38)
>5 members	2,326 (62)
Parity	
1st child	613 (16)
2nd-4th child	2,203 (59)
>5th child and above	914 (25)
Sex of child	
Male	1,932 (52)
Female	1,797 (48)
Mothers' marital status	
Married/de facto	3,389 (91)
Not in union	340 (9)
Religion (Churches)	
Anglican	1,126 (30)
Roman Catholic	751 (20)

[viii] The population consists of all births (weighted n=3,729) and last births (weighted n=2,432) born between 2010 and 2015 of the Solomon Islands demographic health survey.
Protestant and Pentecostal churches include South Seas Evangelical, Seventh Day Adventist, and United churches.
Betel nut, kava, marijuana, tobacco and cigarette, and alcohol use history represents the women who have ever tried any of these substances, or used them in the last 30 days, or one year, preceding the interview.
The decision-making variable represents decision-making regarding health, social, and financial issues for the women being made by person other than themselves, their husbands, or jointly as a couple which may impact pregnancy.
'Another person' refers a third person other than the husband or wife.
Polygamous relationship represents women whose husbands have other wives.
Frequencies (n) and proportion (%) were rounded to the nearest whole number.
Population weighting was applied to the sample.
Asterix* represents missing observations.

Protestant and Pentecostal	1,536 (41)
Minor religion (combination of minor religions/sects)	316 (9)
Household wealth	
Poorest (Quintiles 1-2)	1,517 (40)
Middle (Quintile 3)	773 (21)
Highest (Quintiles 4-5)	1,439 (39)
Place of residence	
Urban	711 (19)
Rural	3,018 (81)
Mothers' age	
<20 years	220 (6)
20-34 years	2,644 (71)
35-49 years	865 (23)
Mothers' education	
Primary and lower	2,027 (54)
Secondary and higher	1,703 (46)
History of substance use	
None	558 (15)
Betel nut use	2,381 (63)
Kava use	23 (1)
Marijuana	23 (1)
Alcohol use	117 (3)
Tobacco and cigarette	626 (17)
Decision-making	
Husband, wife, or joint	3,163 (85)
Another person	143 (4)
Missing*	424 (11)
Women with polygamous husband	
No	3,142 (84)
Yes	186 (5)
Missing*	401 (11)
Sample 2: Maternal Health Characteristics	***(n=2,432)***
Number of antenatal care visits	
No	110 (4)
Yes	2,701 (96)
Received iron supplements during pregnancy	
No	220 (9)
Yes	2,209 (91)
Missing*	3 (0.1)
Malaria infection during pregnancy	
No	1,831 (75)
Yes	179 (8)
Missing*	422 (17)
Deworm during pregnancy	
No	1,166 (48)
Yes	1,266 (52)

Prevalence of LBW

Of all women and births in the last five years of the DHS survey (n=3,729), 10% (n=387) were estimated to be LBW. Furthermore, counterintuitively, a higher portion of LBW births was among those women from high wealth index status (38%, n=147) than women with low wealth index status (37%, n=144) (Table 3).

Risk Factors for LBW

After adjustment for confounders, the risk of LBW for women with a history of marijuana use [ARR 2.64 (0.64, 10.95)] was twice that of non-users. Our adjustment also showed the risk for LBW was 2.5 times with a history of kava [ARR 2.50 (0.63, 9.88)] than non-users. Women with polygamous husbands had an 84% higher risk of LBW [ARR 1.84 (1.15, 2.93)] than those in a monogamous relationship. Women who did not attend antenatal care during pregnancy had a 73% higher risk of having an LBW infant [ARR 1.73 (0.96, 3.13)] than those who attended antenatal care. Finally, our adjusted model further showed that women for whom another person made decisions for them (regarding health, social, and financial issues) had a 72% higher risk for LBW [ARR 1.72 (1.09, 2.72)] compared to those who did not. The magnitudes of associations between LBW and demographic and maternal health characteristics (age, education, wealth, malaria infection, anaemia, and worm infestation) were low (Table 3).

Table 3: Unadjusted and Adjusted Analysis of Social, Demographic, Behavioural, and Maternal Health Characteristics (n=3,729)[ix]

Risk Factors	Low Birth Weight		RR 95% CI	
	No	Yes	Unadjusted	Adjusted
Household members				
1-5 members	1276 (38.17)	127 (32.92)	**Reference**	**Reference**
>5 members	2,067 (61.83)	260 (67.08)	1.23 (0.97, 1.55)	1.17 (0.89, 1.53)
Parity (child ever born)				
1st child	536 (16.04**)**	77 (19.84)	1.22 (0.88, 1.68)	1.07 (0.70, 1.63)
2nd-4th child	1,976 (59.12)	228 (58.56)	**Reference**	**Reference**
>5th child and above	830 (24.84)	84 (21.60)	0.89 (0.65, 1.22)	0.75 (0.51, 1.09)
Sex of child				
Male	1,746 (52.24)	186 (48.10)	**Reference**	**Reference**
Female	1,596 (47.76)	201 (51.90)	1.16 (0.94, 1.43)	1.19 (0.94, 150)
Mothers' marital status				
Married/in union	3,040 (90.96)	349 (90.18)	**Reference**	
Not married	302 (9.04)	38 (9.82)	1.09 (0.78, 1.58)	
Religion/ denomination				
Anglican	1,003 (30.01)	123 (31.65)	1.17 (0.95, 1.95)	

[ix] ****** Information for antenatal and health services information was only available for that last birth in the survey. Adjusted analyses were made only for covariates with overall P-values less than 0.2.
CI: confidence interval, RR: relative risk

Roman Catholic	670 (20.06)	81 (20.89)	1.15 (0.89, 2.03)	
Protestant and Pentecostal	1,393 (41.67)	143 (37.05)	**Reference**	
Minor religion (combined)	276 (8.26)	40 (10.40)	1.36 (1.01, 2.50)	
Household wealth				
Poorest (Quintiles 1-2)	1,373 (41.07)	144 (37.27)	0.93 (0.71, 1.21)	1.07 (0.79, 1.45)
Middle (Quintile 3)	677 (20.26)	96 (24.82)	1.22 (0.91, 1.62)	1.33 (0.95, 1.85)
Highest (Quintiles 4-5)	1,292 (38.67)	147 (37.90)	**Reference**	**Reference**
Place of residence				
Urban	635 (19.01)	76 (19.62)	**Reference**	
Rural	2,707 (80.99)	311 (80.38)	0.97 (0.77, 1.21)	
Mothers' age (years)				
<20	188 (5.63)	32 (8.22)	1.46 (0.90, 2.11)	1.49 (0.93, 2.40)
20-34	2,381 (71.25)	263 (67.86)	**Reference**	**Reference**
35-49	773 (23.12)	93 (23.93)	1.08 (0.83, 1.40)	1.22 (0.89, 1.66)
Mothers' education status				
Primary and lower	1,819 (54.43)	208 (53.61)	0.97 (0.78, 1.22)	
Secondary and higher	1,523 (45.57)	180 (46.39)	**Reference**	
History of substance use				
None	508 (15.50)	51 (13.21)	**Reference**	**Reference**
Betel nut use	2,143 (76.58)	294 (75.86)	1.11 (0.80, 1.54)	1.05 (0.75, 1.49)
Kava use	18 (0.71)	5 (1.38)	2.52 (0.88, 7.19)	**2.50 (0.63, 9.88)**[x]
Marijuana use	17 (1.29)	11 (2.82)	2.92 (1.02, 8.32)	**2.64 (0.64, 10.95)**
Alcohol use	104 (5.92)	26 (6.73)	1.12 (0.53, 2.39)	1.28 (0.56, 2.96)
Tobacco and cigarette	552 (16.51)	75 (19.30)	1.32 (0.93, 1.87)	1.26 (0.85, 1.87)
Decision making				
Wife, husband or Joint	2,845 (85.11)	318 (82.20)	**Reference**	
Another person	119 (3.56)	24 (6.23)	1.66 (1.05, 2.68)	**1.72 (1.09, 2.72)**
Women with polygamous husband				
No	2,835 (84.83)	307 (79.27)	**Reference**	
Yes	152 (8.90)	46 (4.55)	1.89 (1.25, 2.87)	**1.84 (1.15, 2.93)**
No. of antenatal care visits (n=2,432)**				
No	51 (2.35)	11 (4.50)	1.78 (0.99, 3.22)	**1.73 (0.96, 3.13)**
Yes	2,134 (97.65)	235 (95.50)	**Reference**	
Received iron supplement (n=2,432)**				
No	197 (9.01)	23 (9.52)	1.06 (0.67, 1.67)	
Yes	1,986 (90.87)	223 (90.35)	**Reference**	
Malaria infection (n=2,432)**				
No	1650 (75.50)	181 (73.36)	**Reference**	
Yes	160 (7.32)	19 (7.83)	1.09 (0.70, 1.69)	
Deworm (n=2,432)**				
No	1045 (47.83)	121 (49.03)	1.04 (0.80, 1.37)	
Yes	1140 (52.17)	126 (50.97)	**Reference**	

[x] Bold figures under the adjusted column of Table 3 showed risk ratios of at least 2 or more between., although this may not be statistically significant, they showed some correlations between the dependent and the independent variable.

Population Attribution Fraction

A total of 10% of LBW was attributable to being in a household of greater than five members, 8% to a female child, 4% to tobacco and cigarette use history, 4% to women with polygamous husbands, 3% to marijuana use history, 3% to betel nut use history, 3% to no antenatal care visits, 3% to a decision made by another person, 1% to kava use history, and 1% to alcohol use history (Appendix L).

Discussion

Our study was the first to describe the risk factors and prevalence for LBW in the Solomon Islands using the latest available SIDHS 2015 data. Our results showed that the risks of LBW for women in the Solomon Islands were largely attributable to substance use, health, and social risk factors. A history of marijuana and kava use, women with polygamous husband, no antenatal care and decision making by another person was associated with LBW (Table 3).

Notably, a history of marijuana use among women was the most strongly associated risk factor for LBW among the risk factors investigated in this study. There is a paucity of literature on marijuana impacts on pregnancy in LMICs; however studies in high-income countries including the United States, Britain, and Canada on marijuana use during pregnancy have identified associations with Foetal Growth Restriction (FGR), preterm birth, lower mean birth weight, shorter mean length and head circumference[223-225]. The biological mechanisms by which *cannabinoids* or compounds found in marijuana impact these adverse birth outcomes were not yet well established in the literature. However, a study conducted in Ontario has suggested that *cannabinoid*s can cross the placental barriers and interfere with foetal development in the early stages, causing intrauterine growth restrictions to the developing foetus[226]. Furthermore, these studies also suggested that *cannabinoids* may have affect glucose and insulin regulation, thereby influencing foetal growth and development[225, 226]. Although the prevalence of maternal history of marijuana use in our study population was only 2% (n=23), a recent study in the Solomon Islands found a higher prevalence of 24%[133], suggesting that maternal use of marijuana before or during pregnancy is a probable risk for LBW in the Solomon Islands.

To date, there are limited studies on kava effects on the risk of adverse pregnancy and birth outcomes have been conducted. However, other studies elsewhere have found kava contained several constituent compounds, including *kavalactones*, the main active ingredients that can cause detrimental health effects on humans[227]. Furthermore, prolonged consumption of kava has been

reported that it can cause health impacts especially liver toxicity, raised cholesterol, and *dermatitis*[222]. While studies on kava in pregnancy are limited worldwide, some authors have suggested that kava consumption should be avoided entirely during pregnancy and lactation because of the uncertainty about its *hepatic* safety and the possible harm to the unborn baby[228, 229]. In our study, the prevalence of maternal history of kava use was only 1% (n=23). However, now being formally recognised as a local beverage and commodity export by the Solomon Island government, it is likely that kava use will increase[220]. Therefore, we hypothesise that kava is a potential perinatal risk factor of concern, and we suggest monitoring the prevalence of consumption and a future follow-up study on pregnancy effects.

Our study showed that women with husbands in polygamous relationships are strongly at risk of delivering a baby with LBW. Polygamy is unacceptable in many Solomon Islands cultures however the practice remains present. Our findings were supported by studies in Northern Africa that reported an association between polygamy and LBW[216]. The pathways by which polygamy leads to LBW are likely shared with the processes involving social disadvantage and cultural marginalisation[216]. Moreover, studies from Nepal show polygamous relationships can result in overwhelming stress in women, which can be a precursor to risk for LBW[230].

Decision-making related to health, social, and financial issues by another person other than the women or their spouses or jointly made as a couple was significantly associated with LBW. Our finding is comparable to a study in sub-Saharan African countries, which revealed that women who did not take part in the decision-making in relation to their health had an increased risk for LBW[231]. Furthermore, women with no antenatal care attendance had a risk for LBW that was similar to studies in PNG[98], and studies from other LMICs, including Brazil and Ethiopia[47, 212]. Our PAF analyses showed that LBW was mostly attributable to a household of greater than five members of 10% (Appendix L). Although there is minimal evidence in the literature on the relationship between household size and LBW, a study in Bangladesh reported that LBW tended to be more strongly associated with food-insecure households, which were impacted by inadequate maternal nutrition during pregnancy[33]. Food-insecure households were those with inadequate food supply and nutrition proportional to larger and poorer households[33]. Therefore, a household of more than five residents in the Solomon Islands can be a risk factor of concern where food and nutrition may be deficient, leading to LBW. Low Birth Weight was partially attributable to a history of tobacco and cigarette and betel nut use at 4% and 3%, respectively (Appendix L). Tobacco and cigarette use is a well-established risk factor for LBW and can be attributed to nicotine

interference with foetal development among other mechanisms[98, 232]. Furthermore, betel nut is a highly consumed substance in the Solomon Islands (64% in this study population) and several Asia Pacific countries, and our findings are consistent with two past studies in this region[181, 214].

Our overall estimated LBW prevalence was 10% (CI of 9%, 12%), a slight decline from the previous demographic and health survey in 2006, which estimated 12.5%[41]. This may indicate that LBW prevalence may be well accounted for, however, such interpretation has to made with caution due to recall bias which may also impacted these estimations. Other local hospital-based studies reported prevalence of 12.5% and 23.3%[40, 43]. These high prevalence rates can be explained by the increased referrals of high-risk pregnancies from rural health facilities with elevated LBW risk and may not reflect the actual LBW prevalence for the Solomon Islands' population.

Strength and Limitations

A strength of the study was that SIDHS 2015 used a nationally represented sample population of the Solomon Islands, that the findings can be inferred to. However, some of the limitations of this study are shared among all DHS studies. The recall of birthweights after more than five years may result in inaccurate information being supplied, given that 24% (n=892) of the women had to recall the birth weight. Also, given the length of time, some women may forget the number of antenatal visits, if they had received prophylaxis for malaria infection, worm infestation, or received iron tablets, or had taken those medications as required, or possibly report based on other pregnancies. Some women may not have known their age or year of birth due to the low literacy among women in the Solomon Islands[37]. Household members may also fluctuate as most Solomon Islanders live in extended families or clans. Some women may also fear revealing information on illegal substances use, especially marijuana and *kwaso*, or homemade distilled alcohol, which can lead to truth or information bias. Also, although betel nut and kava use are culturally acceptable, some women may deny using any of these substances. Furthermore, this study did not measure the intensity of substance use, and could be for that reason, betel nut did not show an association in the analysis. Our analysis on substance use was based on the assumption that women who had ever tried or had used any of them in the last 30 days or one year may represent women's behaviour, including during the last pregnancy. The survey questionnaire on substance use may therefore overestimate the prevalence of substance use during pregnancy. On the contrary, it remains possible that the prevalence of exposure to substance use could have been underestimated due to social desirability bias since not all women could disclose their substance use behaviour. Finally, another limitation of our study was the lack of certain variables known to

influence foetal growth which were not captured in the data set, for example, gestational diabetes and pre-pregnancy weight gain.

Conclusion

The prevalence of LBW in the Solomon Islands is approximately 10%. LBW was mostly attributable to residential overcrowding and was most strongly associated with the history of marijuana and kava use, polygamous relationships, and lack of antenatal care. The prevalence of kava use, and its effects on pregnancy, should be monitored in future studies given the high prevalence of exposure. Prospective studies are required to confirm these associations.

Acknowledgments

The authors thank the following people who have made it possible to obtain the SIDHS 2015 data: Stuart Clark and Nicole O'Connor of Research Office at Curtin, Curtin University; Douglas Kimi and Dr Willie Lahara of the Solomon Islands National Statistical Office, Solomon Islands; and Oliver Menaouer of the Secretariat of the Pacific Community, New Caledonia Headquarter.

Author Contributions

Kaforau, Tessema, Jancey, and Pereira conceived and conceptualised study design. Kaforau conducted data cleaning, merging, and analysis under the guidance of Tessema and Pereira. Kaforau also undertook the final selection of study variables under the guidance of Tessema and Pereira. Kaforau wrote the first draft which was then reviewed by Tessema, Jancey, Hugo Bugoro, and Pereira. All authors approved the final paper.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: this project did not receive funding. However, Pereira received funding from the National Health and Medical Research Council Project and Investigator (Grant #1099655 and #1173991), institutional funding for the WA Health and Artificial Intelligence Consortium, and supported by the Research Council of Norway through its Centres of Excellence funding scheme (Grant #262700). Tessema received funding from the National Health and Medical

Research Council Investigator (Grant #1195716). Kaforau is the recipient of an Australia Award scholarship, awarded in 2019 from the Department of Foreign Affairs, which covered her living stipend and tuition fee.

Chapter Seven: Descriptive Qualitative Study (Substudy Three)

Substudy Objective Addressed in This Chapter:

Objective 3: To gain an understanding of the behaviours and social and environmental context that mothers of LBW infants experience during their pregnancy.

This chapter is a pre-copyedited version of Publication 4, entitled "Lived experiences of women with LBW infants in the Solomon Islands: a descriptive qualitative study". This article was produced by the author and was accepted for publication in the *PLOS Global Public Health* following a robust peer review process. It should be noted that any disparities between this version presented in the thesis and the final published version of record is to the copyediting process. The version of record, Kaforau LS, Tessema GA, Bugoro H, Pereira G, Jancey J. Lived experiences of women with LBW infants in the Solomon Islands: a descriptive qualitative study. *PLOS Glob Public Health*. 2022;2(12):e0001008., is available at: doi.org/10.1371/journal.pgph.0001008

Abstract

Every year, around 20 million women worldwide give birth to LBW infants, with majority of these births occurring in low-and middle-income countries, including the Solomon Islands. Few studies have explored the pregnancy lived experience of women who deliver LBW infants. The aim of the study is to understand the lived experience of women in the Solomon Islands who gave birth to LBW infants by exploring their personal (sociodemographic and health), behavioural, social, and environmental contexts. We used a qualitative descriptive approach and purposely selected 18 postnatal women with LBW infants in the Solomon Islands for an in-depth interview. All data were analysed using thematic analysis in NVivo Version 20. We identified six themes reported as being related to LBW: health issues, diet and nutrition, substance use, domestic violence, environmental conditions, and antenatal care. Our findings suggest that women in the Solomon Islands are exposed to various personal, behavioural, social, and environmental risk factors during pregnancy that can impact birth outcomes, particularly LBW. We recommend further research should be redirected to look at the factors/themes identified in the interviews.

Introduction

It is estimated that 140 million women are pregnant worldwide every year, with most of these pregnancies occurring in LMICs[233]. Although pregnancy can be a rewarding experience and an exciting journey, this may not be the case for many women in LMICs due to their living conditions and exposure to risk factors that may adversely affect their pregnancies and birth outcomes[16, 212, 234-237]. Women's health during pregnancy in LMICs is largely influenced by sociodemographic, health, behavioural, and environmental factors. Sociodemographic factors include maternal age, household income, and education levels, and health factors include malaria infections and anaemia[215, 231]. Behavioural risk factors include substance use such as tobacco, alcohol, and betel nut[97, 99], and environmental risks include the lack of access to antenatal care and poor sanitation[98, 181].

The Solomon Islands is located in the South Pacific region, an island country with a fragile subsistence-based economy that relies on foreign aid for health services and socioeconomic development[238]. There are high rates of unemployment, illiteracy, and poverty[238], with more than 74% of the population living in rural areas as subsistence farmers[38]. Despite government efforts to ensure that health facility access is within an hour's reach, health service access and quality remain a problem, particularly for rural women[20]. Community health services and programs are

often lacking in many rural communities due to geographical isolation and dispersed communities across the 992 scattered islands[20]. The number of health workers per population density is lower than that of most countries in the Asia-Pacific region. Reports showed there were approximately 19 doctors and 145 nurses and midwives per 100,000 of the population[239, 240]. Clean water supplies and sanitation are non-existent in more than half of the rural communities[112, 149], and substance use, especially alcohol, marijuana, and *kwaso* (illegally distilled alcohol), are prevalent among the population[132, 134]. The Solomon Islands is also a patriarchal society comprising various indigenous cultures, where men, as head of the family, own the land and possess inherited wealth, predisposing women to oppression and violence[130].

LBW, defined as birth weight below 2,500 grams, is the most widely used perinatal benchmark for adverse birth outcomes globally[241]. LBW comprise 20% of global births (approximately 20 million per year), with 95% of these births occurring in LMICs[241]. The Solomon Islands has a prevalence for LBW of 10%, which places it within the minimal range compared to Southeast Asian countries and Melanesian countries of the Pacific such as PNG and Vanuatu (between 10–17% prevalence)[16, 37, 214, 242]. However, this rate is elevated compared to some countries in the Polynesia region, with Tonga, Samoa, and Tuvalu reporting LBW of well below 7%[16]. In addition, LBW in the Solomon Islands was predominantly found in preterm births, with a recent hospital-based study reporting LBW accounted for 77% of neonatal deaths[40, 43, 210].

LBW can result from women's exposure to the various risk factors experienced during pregnancy as quantified by numerous studies in LMICs[16, 199, 212, 214, 234-237, 242-245]; however, limited studies have quantified the associated risk factors for LBW locally. Furthermore, no studies have been conducted in the Solomon Islands on women's lived experiences during pregnancy. This study aimed to understand the lived experience during the most recent pregnancy of women in the Solomon Islands who gave birth to LBW infants by exploring and describing their personal (sociodemographic and health), behavioural, social, and environmental context during their pregnancy. The enquiry into the women's personal accounts illuminates their unique experiences in their respective communities.

Methods

Study Design and Sampling

We employed a descriptive qualitative study using purposive sampling to recruit women with LBW infants to participate in one-on-one in-depth interviews. This methodology was deemed

appropriate to explore women's personal stories and experiences during their recent pregnancies resulting in LBW babies[156, 246]. The consolidated criteria for reporting qualitative research (COREQ) checklist were used to ensure high-quality research reporting[246] (Appendix N).

Study Setting and Recruitment

Eighteen postnatal women aged 15 to 39 years were recruited from the special care nursery of the National Referral Hospital (NRH) in the Solomon Islands. NRH receives referral from all provinces. However, since it is located in Honiara on the Island of Guadalcanal, most of the women were either referred from Honiara or rural Guadalcanal. The women were required to have given birth to LBW infants weighing less than 2,500 grams, irrespective of gestational age, and within the last week before recruitment. It was also a requirement that the health of the mother and infant was stable. Women were required to be fluent in Pidgin English, the Solomon Islands *lingua franca*. The recruitment of participants was halted when data saturation was reflected in no new information emerging.

Data Collection

The PhD scholar (Lydia Sandrah Kaforau) conducted in-depth one-on-one semi-structured interviews with women within one week of delivery and before the infants were discharged from hospital. Although the original plan was to conduct face-to-face interviews, due to travel restrictions caused by the global COVID-19 pandemic, all interviews were conducted via international telephone calls. The processes were assisted by two local Research Assistants (RAs) trained in ethical research protocols. JT (RA1), a clinical nurse instructor in the paediatric and neonatal ward of the National Referral Hospital in the Solomon Islands, identified women who met the inclusion criteria. JT invited them to participate in the telephone interviews after explaining the aims of the study, participant information sheet (Appendix Z), and interview procedures, and ensured the provision of a secured private room for the women to sit during the interviews. LK (RA2), an academic at the University of South Pacific, Solomon Island Campus, supported the study by arranging and scheduling the telephone call processes and incentives for the women. The participants received a pair of infant booties in appreciation of their time.

The interview schedule was assessed for face and content validity by an expert panel who have PhDs and expertise in clinical and public health research. It was then trialled with four Solomon Island women living in Australia to ensure the content was understandable and the responses yielded would gather information that aligns well with the research aim. We asked the women

about their health, health behaviours, social and environmental conditions, access to antenatal care, and their understanding of risk factors during pregnancy that may have contributed to having an LBW infant. Demographic data (age, residence, ethnicity, education level) were also collected (Appendix M). Prior to the interviews, a further three interviews were conducted with women of LBW infants in the Solomon Islands to assess the interview schedule and the feasibility of the telephone interview method. Bracketing was undertaken through dialogue between the researchers to identify potential preconceived notions that might influence the data collection and analysis[157]. From this, a list of preconceived notions that might influence the data collection and analysis was written as a checklist guide to refer to during the data analysis.

The women who provided informed consent and permission for recording of the interview were placed in a secure private room for the interview. Confidentiality and privacy were strictly maintained for all participants throughout the interview process. RA1 (JT) escorted each participant into the room and assisted them in answering the telephone (if they were unfamiliar with the handset). Once the participant was comfortable, RA1 left and closed the door before the interview commenced. The interviews ranged from 30 to 70 minutes, with an average time of 54 minutes.

Data Management and Analysis

Data were de-identified by removing the participant names and replacing them with unique codes, which were uploaded to a password-protected database. All interviews were conducted in Pidgin English. Interviews were audio taped and field notes were taken. The PhD Scholar (Kaforau) transcribed all the interviews from Pidgin transcriptions directly into English, as she is fluent in both languages. Also, given that the Solomon Islands Pidgin creole is a derivative of the English language combined with local languages, direct transcribing and translation were considered optimal, as both languages are somewhat analogous in most terms. To ensure validity in the translation process, three colleagues fluent in Pidgin and English reviewed three translated transcripts. The translated and transcribed data were uploaded into NVivo Version 20 and then analysed using thematic analysis[159, 160]. This involved repeated close reading of each interview to become immersed and familiar with its content and annotating meanings arising from the data; generating succinct labels (codes) to identify essential features of the data; collating data to identify significant broader patterns of meaning and potential themes; reviewing themes against the dataset to ensure they told the story of the data; defining and naming themes; and weaving together the analytic narrative with quotes to illuminate themes[159, 160]. For validity and reliability,

co-authors (Jancey and Tessema), who are experienced in qualitative research, provided guidance, and reviewed the generated themes with the PhD scholar (Kaforau), leading to a consensus on the final themes.

Ethical Statement

Ethics approval was obtained from the Solomon Islands Health Research and Ethics Board of the Ministry of Health and Medical Services with ethics approval number HRE039/19. Reciprocal ethics was also granted by Curtin University Human Research Ethics Committee (HREC) with approval number HRE2020-0530. Informed consent was obtained from all participants involved in this study. Written consent was taken from parents and guardians of mothers of infants of 18 years and below.

Results

Demographic Characteristics of Participants

A total of 18 women aged 15 to 39 years were recruited, of which 80% (n=15) were in a union (permanent relationship), and 60% (n=11) were from rural areas (Appendix M).

Themes

Six major themes were identified: 1) health issues, 2) substance use, 3) diet and nutrition, 4) domestic violence, 5) environmental conditions, and 6) antenatal care.

Health Issues

Most women (n=11) reported experiencing a range of physical health issues during their pregnancies, which they believed impacted their pregnancy outcomes, such as early birth and LBW infant. For example, a woman stated: *"I was bleeding the entire pregnancy, and that was why I had a small baby." [P8, 23-year-old]* Illnesses experienced during pregnancy included malaria and non-specific infections, antepartum haemorrhage (APH), and chest pain, as attested by two of the women. *"At 4 months, I developed fever and shivering, got tested at the clinic and confirmed malaria positive. I believe I gave birth early due to the malaria infection." [P10, 18-year-old] "I had prolonged chest pain [chronic] the entire pregnancy without any diagnosis of my illness. I delivered my baby at seven months." [P2, 39-year-old]*

Women who experienced health problems during their pregnancy did not have the confidence to talk about these issues with the health staff, especially when it came to their sexual health. This was particularly so for young women aged less than 20 years who experienced symptoms

suggestive of sexually transmitted infections (STIs) or urinary tract infections (UTIs) during their pregnancy. These young women did not inform the health staff, thereby no screening or treatment was provided. This was reflected by two 19-year-old women as follows: *"I had experienced abnormal white foul pus coming out from my private parts with painful urination. I did not seek help from the clinic nurse." [P15],* and P14 stated *"I had yellow foul vaginal discharge during pregnancy. I did not tell the nurses. They [nurses] did not check me [via vaginal swab] and I did not receive any treatments."*

Women from both rural and urban areas tended to engage in hard physical work due to their subsistence lifestyle. Five women reported physical stress, falls, and accidents during their pregnancy, which they believed resulted in early labour and birth. For example, two of them described their experiences as follows: *"I fell twice at five months of pregnancy on my way to the garden and slipped over the slippery bush track while carrying a heavy load of garden produce to sell at the market. I barely had rest, from gardening and selling vegetable. From then on, I started to develop abdominal pains that led me to an early birth." [P17, 35-year-old, urban] "The nurse told me the bleeding was because of hard labour of carrying a heavy load without much rest." [P13, 25-year-old, rural]* Conversely, five other women claimed they did not experience any major health problems during their entire pregnancy as reflected by P14, a 19-year-old: *"I was well during pregnancy except the regular morning sickness."*

Substance Use

Substance use was widespread among this population, especially betel nut, tobacco, marijuana, and alcohol. Most women (n=11) reported chewing betel nut and smoking locally grown or manufactured tobacco during pregnancy, despite knowing that these substances could have adverse health consequences. Some women (n=4) even reported being heavy users, or not being able to stop using betel nut or tobacco during pregnancy: *"I am a heavy betel nut chewer; I chewed up to seven, six, five nuts per day before and during my last pregnancy. I also smoked tobacco and savusavu roll [homegrown dried tobacco leaves] of five to six rolls per day for three years. Savusavu is powerful, can cause dizziness and bad feeling[s]. I had to shower to feel better; then, I took one more roll. I think I had my baby very early because of this." [P13, 25-year-old]* Some women (n=3) denied or were unsure of the potential harm of betel nut use to their foetus, especially among the rural women as highlighted by two women as follows: *"I don't think betel nut will affect my baby." [P9, 25-year-old],* and P3 *[16-year-old] said "I am not sure if betel nut is harmful for my unborn baby."*

A few women (n=3) who were heavy chewers (three to six betel nuts per day) believed betel nut helped them during their pregnancy, as it reduced the bad taste and gave them a good feeling and more energy, as expressed by two women: *"I could not stop chewing betel nut because it improved my taste and made me feel better." [P6, 20-year-old],* and *"I could not stop because betel nut gives me good feelings, energy to do things, and keeps me awake." [P18, 18-year-old]* Some women (n=6) also reported witnessing pregnant women consuming other substances, including *kwaso* (homemade distilled alcohol), marijuana, and beer during pregnancy: *"I have heard and seen other women have taken kwaso, marijuana, and beer during pregnancy." [P11, 34-year-old]*

One participant expressed how women use the substances during pregnancy to cope with stress. *"I knew of a neighbour who took too much alcohol and smoked marijuana during pregnancy and gave birth to a sick baby. She said she took those due to stress." [P7, 30-year-old]* While substance use was quite prevalent among the women, several women (n=7) abstained from these substances during pregnancy due to religious beliefs and knowledge of their harmful effects*. "As Seventh-Day Adventists, we are not allowed to use betel nut and tobacco as it can cause problems with blood [anaemia]." [P12, 18-year-old]* These women demonstrated some level of knowledge of the impact of substance use during pregnancy. *"I don't take any of these during pregnancy, I am too scared of them. Betel nut, tobacco, and marijuana can lead to having a small baby." [P7, 30-year-old]*

Diet and Nutrition

Knowledge about a nutritious diet was at times limited, especially among the less educated women (primary school or less), and those from rural areas*. "I don't know what a healthy diet is like." [P13, 25-year-old]* Most participants (n=14) reported eating at least three meals a day. *"I ate a roasted green banana [plantain] for breakfast, tea for lunch, and sweet potatoes for dinner [three meals]. I did not like to eat sausage." [P12, 18-year-old]* However, their reported daily dietary intake during pregnancy tended to lack variety, often comprising starchy vegetables and carbohydrates (e.g., potatoes, rice) with limited quantities of protein. *"I usually eat potatoes, cassava, rice, cabbage like Amau [local cabbage], slippery cabbage [Ibika], and pakchoi [Chinese cabbage] and beans, tomato, and eggplant. I think chicken is not healthy to eat during pregnancy." [P13, 25-year-old]*

Although more than half of the participants (n=10) reported local homegrown food to be a healthier option, some also believed that some meat and fish were not healthy and so these food

types were not eaten during pregnancy. *"Sausage, chicken, and meat are not healthy." [P12, 18-year-old]* Many (n=12) of the participants reported cultural food taboos, food restrictions, or personal preference for certain foods which contributed to their limited protein intake as reflected by two women. *"We are not allowed to eat crab, pig meat [pork], and the fish with big mouths during pregnancy." [P15, 19-year-old] "Pregnant women are not allowed to eat ura [prawns], reef fish, shellfish, and megapod eggs; they will cause problems during labour." [P14, 19-year-old]*

For some women (n=6) food security was impacted by environmental calamities, such as heavy rains and floods, which destroyed crops. *"Heavy rains and flood destroyed our food garden, and all our banana plants died which affected our food supply." [P12, 18-year-old]* Also, limited finances reduced women's ability to purchase nutritious foods. *"The biggest challenge was to buy enough nutritious food and share with my household of extended family members." [P11, 34-year-old]* Conversely, five women reported that they experienced no food restrictions during their pregnancy and had an adequate food supply. *"I planted my own vegetables, so I have enough food with good nutrition." [P4, 24-year-old]*

Domestic Violence

Almost half of the participants (n=8) reported experiencing both physical and emotional violence during their pregnancy from their partners or significant others. Many of them (n=7) believed their exposure to violence had contributed to their child's early birth, as expressed by two women. *"Every weekend, he would return drunk and beat me up. He beat me and kicked me on my back twice during pregnancy, which led to the premature birth." [P15, 19-year-old] "During the last pregnancy of my twin babies, he [husband] bashed me. It was a terrifying experience. As a result of this, I delivered my twins prematurely." [P7, 30-year-old]* Although ten of the women did not experience domestic violence, most women understood the negative consequences of violence during pregnancy. *"Experiencing domestic violence during pregnancy can cause premature labour." [P15, 19-year-old]*

Environmental Conditions

Some rural women (n=5) described their dwellings and traditionally built homes as placing them at increased exposure to insects, particularly mosquitoes. *"We all lived in [a] thatched sago palm-built house with one big open space where my family of seven lives [overcrowded]. It is not safe from pests and insects like mosquitoes." [P13, 25-year-old]* Many of the women (n=7) reported living in large extended families and believed that overcrowding increased their risk of infection.

We lived in a two-bedroom house and built a small extension in the vicinity for 14 of us, including relatives. It is very crowded with a high risk for spreading infection." [P11, 34-year-old]

Half of the women, living in rural and urban areas (n=5), walked long distances to access water for drinking and domestic use. The water sources are often unsafe during rainy and drought seasons due to contamination. *"We used rainwater, [the] stream, and [the] river nearby for drinking, cooking, and domestic use. We must go downhill to reach the water sources. The stream and river get murky during rains or dries [sic] up during drought." [P14, 19-year-old]* Two women claimed they had premature births due to stress from carrying heavy water containers: *"I think I had premature labour because I worked so hard every day, carrying large containers of water for household use from the river." [P16, 32-year-old] "I carried water containers from the stream to the house uphill. One day I suddenly felt labour pains and gave birth early [24 weeks]." [P10, 18-year-old]*

Poor sanitation was pervasive, with a lack of proper toilet facilities throughout urban and rural areas. Some participants did not have toilet facilities and used bushes, creeks, and the seaside to defecate. *"We do not have a proper toilet; we use the nearby bushes[chuckled]. In Wagina, we would use the seaside. We have not received any information on good toilets and sanitation." [P17, 35-year-old] "We do not have a proper toilet like others in the community. We used a nearby creek as a toilet." [P15, 19-year-old]* However, a few participants (n=3) living in urban areas had inbuilt water and sanitary systems. *"I lived in a townhouse with an inbuilt modern toilet and water system." [P7, 30-year-old]*

Antenatal Care

Women described several challenges related to their antenatal care. These included limited access to health services, limited provision of health information by health professionals, and their own inability to seek out health information. The ability to obtain antenatal healthcare was frequently impeded by access issues, such as distances to antenatal services, which was more common in rural areas, as well as geographical barriers (e.g., mountainous areas), extreme weather conditions (e.g., tropical rain), and unaffordable transportation costs as expressed by three women. *"Our clinic is very far from the village without road access [where we live] and took two hours by foot. I walked to get there, climbing hills, and walking down the creek footpath which was very difficult." [P5, 38-year-old] "My antenatal attendance depends on the weather. I would not go when the*

weather was bad." [P4, 24-year-old] "The biggest challenge [to antenatal care] was the distance and travel costs. I would not go if I do not have the money for bus fare." [P12, 18-year-old]

Participants also nominated a range of barriers to obtaining optimal antenatal health care. These included the poor condition of health facilities, medicine shortages, no or inadequate health screening, long waiting times, and lack of professionalism among nursing staff. This was illustrated by participants who described the conditions women often experienced: *"Health clinic services [provision] should be improved; women should be checked properly and must be given malaria medicine [prophylaxis] during antenatal [care]." [P5, 38-year-old] "The clinic needs proper clean beds for pregnant women to lay on. Also, the nurses always scold us, are slow in their performance, resulting in long waiting hours and some mothers just left." [P7, 30-year-old]* Conversely, some participants (n=7) reported better access to health facilities and appreciation of the antenatal cares service provided. *"My closest clinic is 50 meters away. I am satisfied with the services provided, and the information was adequate. The nurse checked my baby's position, gave health advice, did a urine test, and supplied the red medicine for blood [ferrous sulphate tablets]." [P1, 20-year-old]*

Discussion

Summary of Findings

Our study is the first to explore women's lived experiences during pregnancy in the Solomon Islands, providing an understanding of the perceived risks these women are exposed to during pregnancy that led to an early birth and LBW. Risk factors identified stemmed from the women's knowledge and experiences, which were described as personal (sociodemographic and health issues), behavioural (diet and nutrition and substance use), social (domestic violence), and environmental conditions. Although some women were conscious of the potential impact of these risk factors on pregnancy outcomes, many were unaware.

Overview of Findings

Commonly reported personal health issues experienced by the women during pregnancy included malaria, APH, STIs, and UTIs, which are recognised as causes of early births and LBW[214, 247-249]. Malaria is endemic in the Solomon Islands[37], a known risk for LBW, affecting 125 million pregnant women globally[100, 193, 248, 250]. APH was another reported health issue, which can be triggered by infection, obstetric causes, or physical trauma[247]. Some women claimed that bleeding during pregnancy was due to strenuous physical work. Others reported experiences of falls and accidents

and perceived that these prompted the early onset of their labour, leading to early births. Similar findings have been reported in LMICs, where physical stress, falls, and trauma during pregnancy were recognised as causes of APH and early births[249]. The lack of screening and treatment for STIs or UTIs was also a nominated issue, with women being unaware of the risks to their pregnancies. STIs and UTIs are well-established risk factors for LBW[251, 252], with a previous local study confirming that UTIs affected 59% of pregnant women, and were linked to preterm births[40]. The women interviewed also reported not seeking help from healthcare providers for these STIs symptoms, a response linked to a pervasive negative attitude to sexual health problems in the Solomon Islands, which was also observed in a previous study[37]. Furthermore, STI screening, including vaginal swabbing, is out of the scope of the current Solomon Island antenatal protocol, which is a shortfall in antenatal care[141, 253].

Our findings indicate that the interviewed women had limited knowledge of nutrition, reporting a diet high in starchy vegetables and active avoidance of meat protein (e.g., chicken and sausage) during their pregnancy. Local food taboos led to the further avoidance of protein, as certain fish were viewed as causing illness in newborns, a sickness referred to as *'fis'*[254]. Although there is limited local research on food taboos, studies in other LMICs have found them to be associated with suboptimal nutrition during pregnancy and adverse birth outcomes[255-257]. In the Solomon Islands, 41% of women of reproductive age experience anaemia, a condition mostly affecting women of low educational status and those living in rural areas, which further increases their risk of having preterm and LBW infants[37].

The women's diet was also impacted by food availability due to environmental factors, such as heavy rains and floods causing the destruction of crops and contributing to food insecurity[254, 258-260]. This is despite the introduction of the National Food Security, Food Safety and Nutrition Policy 2019-23 by the Ministry of Health and Medical Services (MHMS)[261]. Priority policy areas included better nutrition for vulnerable populations (e.g., women and children), strengthening of the food supply chain, awareness of safe and healthy food choices, and promotion of health and nutrition. To date, it remains uncertain whether this has been well implemented at a consumer level.

Substance use (e.g., betel nut, tobacco, alcohol, and marijuana) during pregnancy was also reported by our participants, with betel nut use found to be particularly frequent. Although many of the women were aware of the impacts of these substances on pregnancy, there was a lack of knowledge and awareness, especially regarding betel nut use. There were also reports of betel nut

addiction among some women who claimed to use betel nuts to increase energy levels and reduce bad tastes during pregnancy, which has also been reported in a PNG study[99]. Betel nut has been found to be associated with adverse birth outcomes, especially LBW and preterm birth, in several studies in PNG and Southeast Asia[94, 97, 99, 181, 182, 214]. Conversely, the women's use of tobacco, alcohol, and marijuana during pregnancy was limited, with the women reporting some level of awareness of their harmful effects. The use of tobacco and alcohol during pregnancy, and their effect on pregnancy and birth, has been well documented[94, 262, 263]. Although evidence on marijuana use in pregnancy in LMICs is limited, studies in the United States have shown its use to be common among younger women, and a potential risk factor for LBW and other adverse birth outcomes[221, 263, 264]. There were also reports that women tended to use these drugs to relieve stress, which has been reported in a previous Solomon Islands study[130].

Domestic violence inflicted by an intimate partner or significant other was the social risk women reported. Almost half of the women in this study reported experiencing physical or emotional violence during their pregnancy. This is consistent with previous Solomon Islands studies, which have reported that up to 66% of women experience domestic violence from their intimate partner during pregnancy[130, 131]. Some of the women attested that being 'bashed', or kicked in the back, led to early births, a serious consequence of violence during pregnancy[130, 131, 265-267]. Despite the legislation of the Family Protection Act to protect families and promote safety and community education by the Solomon Islands government[131, 268], many of the women expressed a lack of social and community support, particularly in rural communities.

Environmental risks that women experienced included poor access to health facilities and lack of proper sanitation. The MHMS Role Delineation Policy[xi] underpins and safeguards affordable and accessible healthcare for its citizens, yet access to healthcare services remains a challenge[84]. It was evident that appropriate antenatal care was challenged by poor access, under-resourced health facilities, lack of staff professionalism, and limited health information. Antenatal access was hampered by distances, geographical isolation, and extreme weather conditions–all governmental challenges in servicing this dispersed population[37]. Poor access to antenatal care impacts attendance, as reflected by previous local studies, which showed 85% of women have late

[xi] The MHMS Role Delineation Policy plays a pivotal foundational role in directing the health sector transformation within the Solomon Islands. Executing this policy will support the MHMS to enhance the provision of comprehensive, individual-focused, primary healthcare services, with the aim being to attain Universal Health Coverage for the entire Solomon Islands population. Retrieved from: https://solomons.gov.sb/wp-content/uploads/2020/02/MHMS-Role-Delineation-Policy.pdf

antenatal bookings (trimesters 2 and 3), and 25% or less have only four antenatal visits[37, 42]. Poor access is a contextual risk for adverse pregnancy outcomes, which have been reported by other LMICs[98, 269]. Limiting health care, which is required during pregnancy[193, 250, 270], diminishes the ability to detect health risks and promote health services for better pregnancy outcomes. Women also expressed dissatisfaction with antenatal care due to not being treated with respect, and poor health facilities, also confirmed by one study from an LMIC[269].

Poor water and sanitation remain pervasive in rural and urban areas of the Solomon Islands, even though the National Water and Sanitation Policy 12-year implementation plan was introduced in 2017[271]. Poor water and sanitation poses a risk of vector and water-borne infections, as supported by a local study[37]. Although studies on sanitation and birth outcomes are limited, poor sanitation can threaten pregnancy due to infection[207, 272]. Furthermore, many of the women expressed that information on proper water and sanitation is limited in their community, which may contribute to the lack of awareness of these risks.

Study Limitations and Strength

This study provided an opportunity to talk with Solomon Island women from urban and rural areas, providing insights into their exposure to risk factors during their pregnancy. However, due to the COVID-19 travel restrictions, the interviews were conducted by telephone, which may have inhibited the discussion and reduced the opportunity for the researcher to observe the women's body language. The women were mainly from the Guadalcanal province and Honiara, and the findings were limited to these ethnic groups. Using a highly trained health professional as the interviewer can also be seen as a limitation, as they may presume a greater level of participant knowledge than non-health professionals. Health professionals may themselves be influenced by aspects of care based on their prior experience, which governs the dialogue and interpretation. Participants may be less inclined to open up to trained health professionals who maintain their professional identity throughout the interview process compared to non-health professionals who are perceived as peers, for example, an individual with a similar background or level of understanding. On the other hand, the strength of the study was that the primary investigator is a female health professional who is familiar with this type of participant, the clinical setting from which the women came, knowledgeable in the subject area, the local language of the participants (Pidgin English), and translation processes.

Conclusion

The study contributes to our understanding of the personal (sociodemographic and health), behavioural, social, and environmental risk factors women who gave birth to LBW infants in the Solomon Islands experienced during pregnancy. The study identified women's knowledge and experience of potential risk factors which included health issues, diet and nutrition, substance use, domestic violence, inadequate antenatal care, and environmental conditions. We recommend further research should be redirected to look at the factors/themes identified in the interviews.

Acknowledgement

We acknowledge all 18 women who have participated in the study. And we also acknowledge and thank our two research assistants, Registered Nurse Janet Tekatoha, Paediatric and Neonatal nurse instructor of the Special Care Nursery, National Referral Hospital, in the Solomon Islands, for recruiting and preparing participants for the interviews. We also acknowledge Lillian Kaforau, an academic at the University of South Pacific Solomon Island campus, for support with logistics.

Chapter Eight: Quantitative Analysis of the SIDHS 2015 Data on Births (Substudy Four)

Substudy Objective Addressed in This Chapter:

Objective 4:

To explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on under-five mortality in the Solomon Islands.

This chapter is a pre-copyedited version of Publication 5**,** entitled "Prevalence and risk factors associated with under-five mortality in the Solomon Islands: an investigation from the 2015 Solomon Islands demographic and health survey data". This article was produced by the author and was accepted for publication in the *Lancet Regional Health: Western Pacific* following a robust peer review process. It should be noted that any disparities between this version presented in the thesis and the final published version of record is due to the copyediting process. The version of record, Kaforau LS, Tessema GA, Jancey J, Bugoro H, Pereira G. Prevalence and risk factors associated with under-five mortality in the Solomon Islands: an investigation from the 2015 Solomon Islands demographic and health survey data. *Lancet Reg Health: West Pac*. 2023;33:100691., is available at doi.org/10.1016/j.lanwpc.2023.100691

Abstract

***Background*:** Annually, over five million children die before their fifth birthday worldwide, with 98% of these deaths occurring in low-and middle-income countries. The prevalence and risk factors for under-five mortality are not well-established for the Solomon Islands.

Methods: We used the Solomon Islands Demographic and Health Survey 2015 data to estimate the prevalence and risk factors associated with under-five mortality[xii].

Findings: Neonatal, infant, child and under-five mortality were 8/1,000, 17/1,000, 12/1,000 and 21/1,000 live births, respectively. After adjustment for potential confounders, neonatal mortality was associated with no breastfeeding [ARR 34.80 (13.60, 89.03)], no postnatal check [ARR 11.36 (1.22, 106.16)], and Roman Catholic [ARR 3.99 (1.34, 11.88)] and Anglican [ARR 2.78 (0.89, 8.65)] faiths; infant mortality to no breastfeeding [ARR 11.85 (6.15, 22.83)], Micronesian [ARR 5.54 (1.67, 18.35)], and higher birth order [ARR 2.00 (1.03, 3.88)]; child mortality to multiple gestation [ARR 6.15 (2.08, 18.18)], Polynesian [ARR 5.80 (2.48, 13.53)], and Micronesian [ARR 3.65 (1.46, 9.10)], cigarette and tobacco [ARR 1.77 (0.79, 3.96)] and marijuana use [ARR 1.94 (0.43, 8.73)], and rural residence [ARR 1.85 (0.88, 3.92)]; under-five mortality to no breastfeeding [ARR 8.65 (4.97, 15.05)], Polynesian [ARR 3.23 (1.09, 9.54)], Micronesian [ARR 5.60 (2.52, 12.46)], and multiple gestation [ARR 3.34 (1.26, 8.88)]. Proportions of 9% for neonatal and 8% of under-five mortality were attributable to no maternal tetanus vaccination.

***Interpretation*:** Under-five mortality in the Solomon Islands from the SIDHS 2015 data was attributable to maternal health, behavioural, and sociodemographic risk factors. We recommended future studies to confirm these associations.

Funding: No funding was declared to support this study directly.

Keywords

Under-five mortality; Neonatal mortality; Infant mortality; Child mortality; Risk factors

Research in Context

Evidence Before This Study

- Globally, over five million children under five years are dying annually, with over 98% of these deaths occurring in low and middle-income countries (LMICs).

[xii] Under-five mortality in the study, which is death before the age of five is a cumulative total, that includes neonatal, infant and child mortality markers.

- Most studies in LMICs from outside the Pacific regions and the Solomon Islands have reported that the relative risk of under-five mortality far exceeds those in high-income countries for many risk factors.

Added Value of This Study

- The prevalence of neonatal, infant, child and under-five mortality from the SIDHS 2015 were 8 per 1,000, 17 per 1,000, 12 per 1,000, and 21 per 1,000 live births, respectively.
- Neonatal mortality was associated with no breastfeeding, no postnatal check, and practising Roman Catholic and Anglican faiths.
- Infant mortality was associated with no breastfeeding, Micronesian race, and higher birth order.
- Child mortality was associated with multiple gestations, and Polynesian and Micronesian races.
- Under-five mortality was associated with no breastfeeding, Polynesian and Micronesian races, and multiple gestations.
- Approximately 41% of child mortality was attributable to being from a rural area.

Implications of all the Available Evidence

This study uses the latest DHS data to provide significant information on perinatal risk factors contributing to under-five mortality in the Solomon Islands. Our results serve as a benchmark for comparison to future studies, including future studies on the influence of the COVID-19 pandemic.

Introduction

Globally, approximately five million children die before their fifth birthday every year, with 98% of these deaths occurring in LMIC[55, 82]. Under-five mortality can also be sub-classified as neonatal mortality (death within 28 days of birth), infant mortality (death within one year of birth), and child mortality (death between one and five years)[55, 56, 82]. After 25 years of global efforts guided by the fourth Millennium Development Goals (MDG)–to reduce child mortality by two-thirds by 2015–most LMICs have still not accomplished this target. Although the global trend for under-five mortality indicates a 59% decline during this period[273], this reduction was trivial in LMICs[28, 83]. For instance, in 2019, more than five million children under the age of five years in LMICs died, with neonates accounting for 47% of these deaths, indicating that under-five deaths remain a significant global public health problem[28, 274]. The contribution of adverse birth outcomes to under-five mortality is high in LMICs. Notably, 90% of LBW and premature neonates die in the

neonatal period due to the lack of life-saving medical equipment[56, 87]. Furthermore, survivors are prone to an elevated risk of death before the age of five due to underlying preventable risks, including malnutrition and infection, increasing the child mortality total numbers[87].
Following the MDG, the SDG were launched to expand and continue the achievements of the MDGs. Through the SDGs, the United Nations and the WHO aimed to reduce global neonatal mortality to 12 deaths per 1,000 live births and under-five mortality to 25 deaths per 1,000 live births by 2030[84]. To achieve these goals and monitor progress, it is critical to first benchmark current prevalence at a national level and identify risk factors, as well as the relative contributions of these risk factors to mortality. While studies have addressed this in LMICs[14, 27, 83, 275-277], there remains a substantial knowledge gap for the Solomon Islands.

The Solomon Islands is a small developing state in the South Pacific, a double-chained archipelago with a population of 721,455 people dispersed over 992 islands[37, 38]. Most of the population (74%) live in rural areas and rely on subsistence farming and fisheries for survival[38]. The country's predominant race is Melanesian which makes up 95% of the population[37]. The remaining identify as Polynesian and Micronesian[37]. More than 90% of the Solomon Islands are Christians, with 33% identifying as Anglicans, 19% as Roman Catholics, 19% as South Seas Evangelicals, 12% as Seventh Day Adventists, and 10% as United Churches members.

The country is known for its political instability, fragile economy, and fragmented healthcare system[113]. It is geographically located in one of the most vulnerable regions of the globe, with ongoing threats of natural disasters and topographical isolation, which compounds the risks of poor pregnancy and perinatal outcomes[37, 113]. Social and economic instability has led to a high cost of living, widespread poverty, and poor health and social infrastructure[238, 278], which increases predisposition to neonatal, infant, child, and under-five mortality[113]. The National Health Strategic Plan 2016 to 2020 planned to reduce under-five mortalities to 15 per 1,000 live births[129], yet progress cannot be monitored because a thorough investigation of the current prevalence of under-five mortality has not yet been undertaken. Furthermore, the pertinent risk factors that contribute to neonatal, infant, child, and under-five mortality in the Solomon Islands have not been fully elucidated, partly due to the lack of high-quality research and health information systems in the region. Given the underprivileged social and health structures of the population, the prevalence of under-five mortality can be substantially high, and risk factors can be associated with poor socioeconomic status, poor access to health services, and widespread poverty. The objective of this study was to estimate prevalence, risk factors, and population attributable risk for

neonatal, infant, child, and under-five mortality using nationally representative data from the 2015 Solomon Islands Demographic and Health Survey (SIDHS 2015).

Methods

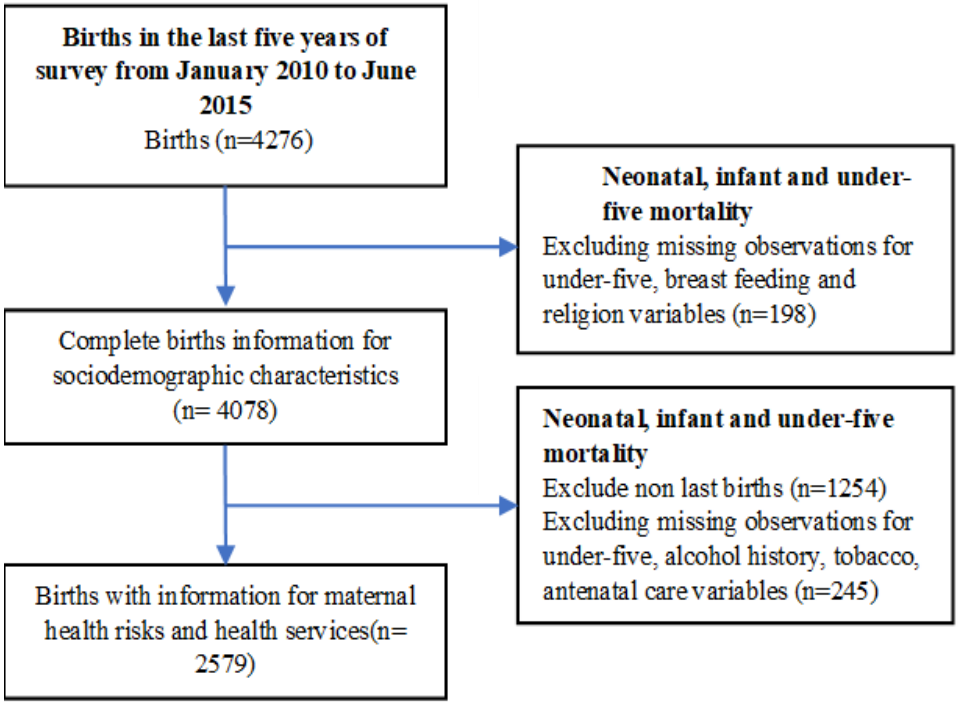
Study Design and Data Source

Our study used the latest available birth data from SIDHS 2015, a population-based, cross-sectional, nationally representative survey conducted between 6 April to 18 September 2015. The objectives of the survey were to provide current and reliable data on reproductive, maternal, and child health. The SIDHS 2015 used the demographic health survey (DHS) international standard questionnaire, which was adapted for the Solomon Islands by the Solomon Islands National Statistic Office in collaboration with the Health Ministry and the Secretariat of the Pacific Community.

Sampling and Sample Size

Study participants were selected from a two-stage stratified, nationally representative sample. In the first stage, EAs from the 2009 national census were selected from five domains (Honiara, Guadalcanal, Western and Malaita provinces) and a combination of smaller provinces (Choiseul, Santa Isabel, Central, Makira/Ulawa, Rennell/Bellona, and Temotu). The sampling frame consisted of 211 EAs (primary sampling units), and EAs were selected from each province using systematic random sampling with probability proportional to the estimated number of households[37]. In the second stage, within each EA 24 households were selected by the survey team supervisor using systematic random sampling, and participants were randomly invited from these selected households[37]. A total of 6,266 women aged 15–49 years from 5,042 households were interviewed. All women with children aged 0–5 years were included. Of these women, 4,272 women had births in the past five years at the time of completing the survey. We excluded missing observations for under-five mortality, breastfeeding, and religion (n=198), which resulted in a final unweighted sample of 4,078 women. We also defined a population for a separate analysis of women with antenatal information, which required exclusion of missing observations for under-five, alcohol history, tobacco, and antenatal care (n=245), and resulted in a final unweighted sample of 2,579 women (Figure 6).

Figure 6: Flow Chart Showing Samples Included in the Analysis of Under-Five Mortality



Outcome and Exposure Variables

The outcome variables of interest for this study were neonatal (death before one month), infant (death before one year), child (death between one year and five years), and under-five mortality (all deaths before five years)[27][xiii]. We included 25 exposure variables with measures relating to sociodemographic (marital status, religion, race, household wealth, place of residence, maternal age, maternal education, household member), maternal health risks and health services (birth order, antenatal care, malaria in pregnancy, postnatal check, place of delivery, mode of delivery, maternal tetanus vaccination, and birth attendant), child-related risk factors (sex of child, infant weighing less than 2.5 kilograms or LBW infant, plurality, breastfeeding), and behavioural factors (history of tobacco and cigarette, alcohol, kava, marijuana, and betel nut use) (Table 4). Variable selection was based on those relevant to the local context and hypothesised in the literature to be associated with neonatal, infant, child, and under-five mortality. The assessment of the impact of substance use (marijuana, betel nut, kava, and alcohol) assumed that women who have used any of these substances in the last 30 days or one year prior to the interview had an increased risk of exposure during the last pregnancy. A postnatal check variable refers to a postnatal check-up within two months of birth.

[xiii] In the study, under-five mortality, representing deaths occurring before the age of five, is an aggregate that encompasses neonatal, infant, and child mortality indicators.

Table 4: Sociodemographic, Behavioural, Health and Reproductive Characteristics for Women of the SIDHS 2015 Data [xiv]

Risk Factors	Frequency (%)
Sociodemographic and behavioural characteristics	*(n=4,334)*
Marital status	
In union	3,940 (90.96)
Not in union	392 (9.04)
Religion[1]	
Anglican	1,315 (30.36)
Roman Catholic	965 (22.28)
Protestant & Pentecostal churches	1,699 (39.20)
Minor religion	352 (8.15)
Ethnicity	
Melanesian	4,183 (96.55)
Polynesian	88 (2.03)
Micronesian	57 (1.31)
Missing*	5 (0.11)
Household wealth	
Poor (Quintiles 1-2)	1,956 (45.16)
Middle (Quintile 3)	844 (19.49)
High (Quintiles 4-5)	1,531 (35.35)
Place of residence	
Urban	761 (17.57)
Rural	3,571 (82.43)
Maternal age (years)	
<20	1,070 (6.04)
20-34	2,242 (70.53)
35-49	1,020 (23.43)
Maternal education	
Primary and lower	2,498 (57.67)
Secondary and higher	1,829 (42.23)
Missing*	5 (0.10)
Household member	
1-5	1,633 (37.70)
> 5	2,699 (62.30)

[xiv] Study population consists of all births of sociodemographic, behavioural characteristics (weighted population, n=4,334) and last births of health and reproductive characteristics (weighted population, n=2,706) born between 2010 and 2015 of the Solomon Islands demographic and health survey.
All frequencies are rounded to the nearest whole number and proportions are rounded to 2 decimal places.
*Asterix (*) means missing observations.
Abbreviations: SSEC (South Seas Evangelical Church), SDA (Seventh Day Adventist).
[1] Minor religion refers to the combination of all minor Christian and non-Christian denominations and religions. Protestant and Pentecostal churches represent South Seas Evangelical, Seventh Day Adventist, and United churches.
[2] Breastfeeding variable indicates if women had ever breastfed their babies.
[3] Tobacco and cigarette, alcohol use, kava, marijuana, and betel nut use history indicates that the women had ever tried or used any of these substances in the last 30 days or within one year of the interview.
[4] Postnatal check variable means the child had a postnatal check within two months since birth.
[5] High skilled health professionals represents: obstetricians, doctors, nurses and midwives. Low skilled professionals represent nurse aids and traditional birth attendants.
[6] Maternal tetanus vaccination during pregnancy.

Birth order	
1st child	675 (15.58)
2nd – 4th children	2,499 (57.69)
5th children and above	1,158 (26.74)
Sex of child	
Male	2,248 (51.89)
Female	2,084 (48.11)
Plurality	
Singleton	4,256 (98.25)
Multiple gestation	746 (1.75)
Breastfeeding[2]	
Yes	4,097 (94.58)
No	235 (5.42)
Tobacco/cigarette use history[3]	
Yes	732 (16.90)
No	3,592 (82.91)
Missing*	8 (0.19)
Alcohol use history[3]	
Yes	252 (5.81)
No	4,047 (93.41)
Missing*	34 (0.78)
Kava use history[3]	
Yes	113 (2.64)
No	4,156 (97.19)
Missing*	7 (0.16)
Marijuana use history[3]	
Yes	114 (2.67)
No	4,156 (97.19)
Missing*	6 (0.14)
Betel nut use history[3]	
Yes	3,630 (84.89)
No	643 (15.04)
Missing*	3 (0.07)
Maternal health risks and health services	*(n=2,706)*
Antenatal care	
Yes	2,582 (95.39)
No	125 (4.61)
Malaria in pregnancy	
Yes	201 (9.08)
No	2,008 (90.92)
Missing*	496 (18.34)
Postnatal check[4]	
Yes	1,716 (63.68)
No	979 (36.32)
Missing*	10 (0.36)
Place of delivery	
Health facility	2,338 (87.03)
Non health facility	348 (12.97)
Missing*	17 (0.66)
Birth weight (kilograms)	
<2.5 kilograms	233 (8.82)

≥2.5 kilograms	2,058 (76.09)
Missing*	414 (15.30)
Birth attendant[5]	
High skilled health professional	2,084 (78.19)
Low or no skilled attendant	581 (21.81)
Missing*	40 (1.47)
Mode of delivery	
C-section	182 (7.83)
Normal vaginal delivery	2,147 (92.17)
Missing*	376 (13.89)
Maternal tetanus vaccination[6]	
Yes	2,366 (87.48)
No	331 (12.24)
Missing*	8 (0.28)

Statistical Analysis

First, we summarised the distribution of background characteristics of the study population. Next, we conducted unadjusted analyses to estimate associations between these characteristics and neonatal, infant, child, and under-five mortality. We also applied post-estimation tests, and variables with *p*-values of less than 0.2 were included in the multivariate analysis. We applied a generalised linear model with log link functions for the final selected covariates to estimate relative risks at 95% confidence intervals for neonatal, infant, child, and under-five mortality. This was done for complete birth information (sociodemographic characteristics) and last births (maternal health risks and health services) in eight separate models. We also assessed for multicollinearity using regression and variance inflation factors prior to the final analysis. Probability weighting was also applied to account for the method of sample selection and non-response rate during the survey. We also calculated the PAF to estimate the proportion of mortality attributable to the risk factors[279]. All analyses were undertaken with Stata Version 17[155].

Ethical Approval

Informed consent was obtained from the participants involved in the SIDHS 2015. Ethics approval was also obtained from the Solomon Islands Health Research and Ethics Board of the Ministry of Health and Medical Services (HRE039/19). Reciprocal ethics approval was granted from Curtin University Human Research Ethics Committee (HREC) HRE2020-0530 to allow the data to be accessed and analysed.

Role of Funding Source

No funding source was involved in the study design, collection, analysis, or interpretation of the data, nor in the writing of the manuscript or in the decision to submit the manuscript for publication.

Results

Characteristics of Study Population

We included two weighted populations, 1) the total number of women who gave birth in the last five years (n=4,334), and 2) the women who had their last birth or antenatal information (n=2,706) included in the SIDHS 2015 data or were able to recall and provide this information during interviews (Figure 6). The mean age of the women was 29.8 years (SD=6.49), and 29% were aged below 21 and over 34 years, 82% (n=357) were from rural areas, and 45% (n=1,956) were from poor households (Table 1).

Neonate, Infant, Child, and Under-Five Mortality Prevalence

Using weighted samples, the five-year (2010 to 2015) prevalence estimated for neonatal mortality, infant, child, and under-five mortality was 8 per 1,000 live births, 17 per 1,000 live births, 12 per 1,000 live births, and 21 per 1,000 live births, respectively.

Factors Associated with Neonatal Mortality (Death Before 1 Month of Age)

After adjustment of the possible confounders, the risks for neonatal mortality from the strongest to the least associations are as follows. Neonates who were not breastfed had 35 times higher risk [ARR 34.80 (13.60, 89.03)] of neonatal mortality than those breastfed. Neonates with no postnatal check within two months of birth were 11 times higher risk [ARR 11.36 (1.22, 106.16)] of neonatal mortality than those who had a postnatal check. Neonates of women practicing the Roman Catholic and Anglican faith were almost four times [ARR 3.99 (1.34, 11.88)] and three times higher risks [ARR 2.78 (0.89, 8.65)] respectively for neonatal mortality than those from other denominations or religions. Neonates with birth weight less than 2,500 grams were almost three times higher risk [ARR 2.82 (0.61, 12.99)] of neonatal mortality than those with normal weight. Neonates of women with maternal age greater than 35 years were 1.54 times higher risk [ARR 1.54 (0.64, 3.71)] of neonatal mortality than those aged lower than 35 years. Neonates of women in a household with more than five members were 1.42 times less risk [ARR 0.58 (0.28, 1.21)] of neonatal mortality than those from a household of less than five members (Appendix P).

Factors Associated with Infant Mortality (Death Before 1 Year of Age)

Following the adjustment of confounding variables, the risks for infant mortality from the strongest to the least associations are as follows. Infants not breastfed were 12 times higher risk [ARR 11.85 (6.15, 22.83)] of infant mortality than those breastfed. Infants of the Micronesian ethnicity were six times higher risk [ARR 5.54 (1.67, 18.35)] of infant mortality than their counterpart ethnicity. Women with multiple gestation were two times higher risk [ARR 2.41 (0.77, 7.59)] of infant mortality than single births. Infants with the fifth or more birth order position were two times higher risk [ARR 2.00 (1.03, 3.88)] of infant mortality than those with a birth order of less than five. Infants of women practising the Roman Catholic and Anglican faith were 1.74 times higher risk [ARR 1.74 (0.87, 3.48)] and 1.71 times higher risk [ARR 1.71 (0.85, 3.45)] respectively for infant mortality than those from another sects or religion. Infants with no postnatal check-up within two months of birth were 1.58 times higher risk [ARR 1.58 (0.52, 4.95)] of infant mortality than those with a postnatal check (Appendix Q).

Factors Associated with Child Mortality (Death Between 1 and 5 Years of Age)

After adjustments for confounders, the risk for child mortality from the strongest to the least associations is as follows. Women with multiple gestation infants were six times higher risk [ARR 6.15 (2.08, 18.18)] of infant mortality than single births. Children of women of Polynesian and Micronesian ethnicities were six times [ARR 5.80 (2.48, 13.53)] and four times [ARR 3.65 (1.46, 9.10)] respectively higher risk of child mortality than their counterpart ethnicity. Children not breastfed were two times higher risk [ARR 2.04 (0.75, 5.57)] of child mortality than those breastfed. Children of women with a history of marijuana use were 1.94 times higher risk [ARR 1.94 (0.43, 8.73)] of child mortality than non-users. Children of women from rural residences had 1.85 times higher risk [ARR 1.85 (0.88, 3.92)] of child mortality than those from urban residences. Children of women with a history of tobacco and cigarette use had 1.77 times higher risk [ARR 1.77 (0.79, 3.96)] of child mortality than non-users (Appendix R).

Factors Associated with Under-Five Mortality (All Deaths Under Five-Years-Old)

Subsequent to the adjustment of potential confounding variables, the risk for under-five mortality from the strongest to the least associations is as follows. Children not breastfed during the first six months of birth were eight times higher risk [ARR 8.65 (4.97, 15.05)] of under-five mortality than those breastfed. Children of women of Micronesian and Polynesian ethnicities were six times [ARR 5.60 (2.52, 12.46)] and three times [ARR 3.23 (1.09, 9.54)] higher risk of under-five mortality than their counterpart ethnicity, respectively. Children of women with multiple gestation had three times higher risk [ARR 3.34 (1.26, 8.88)] of under-five mortality than those with singleton births.

Children of women practising the Roman Catholic faith were 1.62 times higher risk [ARR 1.62 (0.90, 2.94)] of under-five mortality compared to non-Roman Catholics. Children of women from a household with more than five members had a 1.45 less risk [ARR 0.55 (0.33, 0.93)] of under-five mortality than those from households of less than five members (Appendix S).

PAF for Neonatal, Infant, Child, and Under-Five Mortality

The proportion of neonatal mortality attributable to no postnatal check within two months of birth was 79%, no breastfeeding within the first six months of birth was 65%, LBW infant was 14%, no maternal tetanus vaccination during pregnancy was 9%. The proportion of infant mortality attributable to no breastfeeding was 37%, no postnatal check was 17%, history of tobacco and cigarette use was 7%, history of marijuana use was 2%, and multiple births was 2%. The proportion of child mortality attributable to being a rural resident was 41%, history of tobacco and cigarette use was 12%, multiple gestation was 8%, no breastfeeding was 5%, and history of marijuana use was 2%. The proportion of under-five mortality attributable to no breastfeeding for the first six months was 29%, no maternal tetanus vaccination during pregnancy was 8%, history of tobacco or cigarette use were 8%, and multiple gestation were 4% (Appendix T).

Discussion

Our study estimated under-five mortality which included neonatal, infant, and child mortality and the risk associated in the Solomon Islands from the SIDHS 2015 data. Risk factors identified were maternal health risk factors, including: no breastfeeding, no postnatal check, LBW infant, multiple gestation, higher birth order, maternal age greater than 35 years. Behavioural risk factors, including: a history of tobacco, cigarette, and marijuana use, and sociodemographic risk factors, including women of the Roman Catholic and Anglican faith, Polynesian and Micronesian ethnicity. Although undetected in the adjusted model, our PAF revealed that neonatal and under-five mortality were attributable to no maternal tetanus vaccination, while households with more than five members had a relatively lower risk of under-five mortality than smaller households.

We found that under-five and neonatal mortality in the Solomon Islands were 21 per 1,000 and 8 per 1,000 live births, respectively, which surpasses the SDG targets (25 per 1,000 live births for under-five and 12 per 1,000 live births for neonatal mortality). However, these findings will need to be confirmed through further analysis due to potential recall bias[84]. Compared to the previous SIDHS report from 2006, there was a slight decline in under-five mortality (28 to 21 per 1,000 live births), infant mortality (19 to 17 per 1,000 live births) and neonatal mortality (9 to 8 per 1,000 live

births)[37]. In light of other literature from national census data, under-five mortality trajectory in the Solomon Islands showed a decline from 38 to 21 per 1,000 live births between 1990 and 2015[38, 280, 281]. Our estimated under-five mortality is lower than sub-Saharan countries of Africa[11, 282] and PNG[30], however it was still higher than some countries of the Polynesia region[20], which signified that under-five mortality remains a public health problem for the Solomon Islands.

Lack of breastfeeding is a health risk which associated with the four mortality groups. Our findings were supported by studies in Nigeria, Ethiopia, and Indonesia that non-breastfed babies were at an elevated risk of under-five mortality due to sepsis and hypoglycaemia[14, 26, 283, 284]. A recent hospital-based study in the Solomon Islands showed that early initiation of breastfeeding can also be disrupted by separation of sick newborns from their mothers due to poor rooming-in facilities which increased the risk of neonatal mortality[210]. In addition, mortality relating to breastfeeding beyond infancy in the Solomon Islands may be related to early weaning, as 21% of the infants who were weaned before the recommended six months were found to have an elevated risk of malnutrition, infection, and death before the age of five years[37]. Recent studies showed that 20% of infants (aged six to 23 months) and 40% of children (aged two to five years) in the Solomon Islands are subjected to malnutrition and death from recurrent diarrhoeal diseases[259, 285]. Therefore, no breastfeeding, late breastfeeding initiation, and early weaning are the likely risk factors for neonatal and under-five mortality. Other health risks were related to maternal health and services. No postnatal check within two months of birth was strongly associated with neonatal and infant mortality, supported by studies in Indonesia, Burkina Faso, and Cambodia, as early postnatal check-ups allow the early detection and treatment of life threatening complications in infants[286, 287]. Higher birth order (fifth and more) was also a risk for death during the infancy period, which was also observed by an Indian study that proposed mothers be less cautious with high birth compared to low birth order infants[288]. Multiple gestation was also found to be a risk factor for infant and under-five mortality, confirmed by studies in Ghana and Ethiopia, and deaths were due to congenital anomalies, poor birth outcomes, and challenges with feeding[15, 18, 289-291].

Behavioural risk factors, such as history of tobacco and cigarette use, associated with child mortality was also confirmed by studies from Southeast Asia[292, 293]. It is widely established in the literature that nicotine has a role in vasoconstriction of the placenta and hypoperfusion resulting in Foetal Growth Restriction (FGR), placental abruption, and the risk of early infant deaths[263, 292, 293]. Further, studies on passive smoking showed that children of parent/s who smoked have an increased susceptibility to respiratory infections that may be responsible for child mortality[292, 293].

Given the high prevalence of smoking among women in the Solomon Islands (57%), tobacco smoking is a notable behavioural risk factor for child mortality in this population[133]. The history of marijuana use was also a behavioural risk factor associated with child mortality. Although studies on marijuana in LMICs were limited, studies in the United States showed that child mortality due to marijuana use can be due to intrauterine, breastmilk, and passive aerosolised exposure[294-297]. *Cannabinoids,* the main active compounds of marijuana, have been posited to interfere with foetal-placental circulation in pregnancy, provoking intrauterine growth restriction, or inflicting harm to young children via breastmilk and aerosol exposure[294-297].

Our study showed that sociodemographic factors, including race, religion, rural residences, and maternal age greater than 35 years were associated with under-five mortality. The Polynesian and Micronesian races of a social minority (3% of the study population) showed elevated risks of under-five mortality, specifically during infancy and childhood. Although there is a dearth of literature in the local context of the Solomon Islands studies on ethnic minorities, including women of the Pacific Islands living in the United States, showed that ethnic minority is a risk factor for under-five mortality and other adverse birth outcomes attributed to social disparities and cultural marginalisation[298-302]. Women practising the Roman Catholic or Anglican faiths had a higher risk of under-five mortality, especially during the neonatal and infancy period, than their counterpart sects and religions (Protestant and Pentecostal churches and minor religions). Although there is a paucity of literature on under-five mortality specific to these sects, studies in Mozambique also hypothesised that affiliation to a particular religion, for instance, those connected to the health sector and promote health, could be in a better position for child survival[303]. Children of women from rural residences were associated with child mortality, which was supported by a study of Burkina Faso, due to poor access to health facilities[304]. Advanced maternal age was also a risk for neonatal mortality, supported by a study of several African countries, as women of advanced age are vulnerable to obstetric and lifestyle diseases, which can complicate pregnancy[305-308]. Given the high incidence of non-communicable diseases in the Solomon Islands[37], advanced maternal age is a notable risk factor for neonatal mortality.

Interestingly, our results showed that larger households (>5 members) had a lower risk of neonatal and under-five mortality, which contradicts most studies in LMICs. For instance, studies in African countries showed that large families, most possibly of a high parity, are a risk factor for under-five and infant mortality[26, 309, 310]. Although living arrangements may be comparable to the Solomon Islands, larger households in the African context may result in competition for food, and

therefore inadequate nutrition, which has been linked to poor pregnancy outcomes and deaths[26]. Alternatively, larger households in the Solomon Islands may be advantageous, as they may enable social support and security, which is tied to the *wantok* system, a socioeconomic and political network commonly practiced in the Solomon Islands and Melanesia[121]. Therefore, living in a household of extended family size may be an indication of an advantage of support, protection, and impact, thereby reducing the risk of neonatal and under-five mortality[37]. We suggest further studies evaluate the role of the *wantok* system for maternal and child health.

The PAFs were estimated to range from 7% to 79% for neonatal, infant, child, or under-five mortality. High PAFs were estimated for no postnatal check, no exclusive breastfeeding, rural residence, LBW infant, history of tobacco and cigarette use, and multiple gestations, which were also confirmed by our adjusted analysis. Although maternal tetanus vaccination did not show an association in the adjusted analysis, proportions of 9% and 8% of neonatal and under-five mortality were attributable to no tetanus vaccinations, respectively. Although there is a dearth of studies on neonatal and under-five tetanus infection in the Solomon Islands, studies in LMICs of Nepal and PNG indicated that a lack of maternal tetanus vaccination was associated with neonatal and under-five mortality[27, 311].

Strengths and Limitations

The SIDHS 2015 study used a representative sample, which was the strength of the study. However, there were also limitations, as shared by all demographic and health surveys. Recall bias common to all retrospective studies can be a significant limitation to estimate the under-five mortality and the risk factors. Misreporting the date of birth and age at death due to shifting age or heaping to years before 2010 can distort the indices, deviating the estimation to the true value. Recall bias can affect variables such as maternal tetanus vaccination, malaria infection, and breastfeeding, as mothers may not give correct information. Social desirability bias can also potentially affect our study due to barriers such as low literacy and the lack of information on births. Women may provide incorrect information about their age and under-report or deny illegal substance use, including marijuana or *kwaso* (homebrewed distilled alcohol), and betel nut, beer, or kava. Also, as most Solomon Islanders live in extended families, the number of people living in a household fluctuates, and could either be under or overestimated. Another limitation is that the data in the SIDHS 2015 report is not current. However, population-level characteristics do not tend to vary over relatively short periods, and consequently, the Demographic and Health Surveys are

conducted at 5–10-year intervals. Nonetheless, our results will serve as a benchmark for comparison in future studies, including future studies on the influence of the pandemic.

Conclusion

The prevalence of neonatal, infant, child, and under-five mortality based on the SIDHS 2015 data were 8 per 1,000, 17 per 1,000, 12 per 1,000, and 21 per 1,000 live births, respectively. Furthermore, under-five mortality and its subgroups from the SIDHS 2015 data were associated with maternal health, behavioural, and sociodemographic risk factors. Given the high chance that under-five mortality is underestimated, further prospective studies with a nationally represented sample and robust methodology are required to confirm these findings. Future studies can now assess the direct and indirect impacts of the COVID-19 pandemic on perinatal and child health using these results as a benchmark.

Contributors

Lydia Sandrah Kaforau, Gizachew Tessema, Jonine Jancey, and Gavin Pereira conceived and conceptualised study design. Kaforau conducted data cleaning, merging, and analysis, and determined the final selection of study variables, under the guidance of Tessema and Pereira. Kaforau wrote the first draft, which was reviewed by Tessema, Jancey, Pereira, and Hugo Bugoro. All authors have approved the final paper.

Declaration of Conflicting Interests

No patient was directly involved in the study as data were taken from the SIDHS 2015 report.

Acknowledgements

We acknowledge the following who made it possible to obtain the SIDHS data: Stuart Clark and Nicole O'Connor of the Research Office at Curtin University, Douglas Kimi and Dr. Willie Lahara of the Solomon Islands National Statistic Office, Solomon Islands, and Oliver Menaouer of the Secretariat of the Pacific Community, New Caledonia Headquarter.

Funding

Pereira was supported with funding from the National Health and Medical Research Council Project and Investigator Grants #1099655 and #1173991, institutional funding for the WA Health and Artificial Intelligence Consortium, and the Research Council of Norway through its Centres of Excellence funding scheme #262700. Tessema was supported with funding from the National

Health and Medical Research Council Investigator Grant #1195716. Kaforau is the recipient of an Australia Award scholarship, awarded in 2019 from the Department of Foreign Affairs.

Supplemental Material

Supplemental material for this article is available online.

Patient and Public Involvement

No patient was directly involved in the study as data were taken from the SIDHS.

Data Sharing Statement

The Solomon Island Government, through the Solomon Island National Statistics Office (SINSO), kept all data that supports the findings of this study. Data can be obtained upon formal written request to the government statistician at SINSO.

Chapter Nine: Discussion

9.1 Reflection on Study Objectives

This chapter presents a discussion of the key findings of the thesis with consideration of the current literature, while also synthesising similar findings from the substudies. Through reflection on the overall aim of the study, the discussion explores estimates of the burden of the most critical birth outcomes, early life mortality and morbidity in the Solomon Islands, the contribution of risk factors to this burden, and develops an understanding of the context that influences these risks.

The overall aim is accomplished by four fundamental interlinked objectives of the thesis, which are informed by the four distinct substudies. The first objective of the thesis was to map the available literature on the prevalence of adverse birth outcomes and associated risk factors in the Pacific Island countries, which was achieved by Substudy One (Chapter Five). The second was to investigate the effects of sociodemographic, health, obstetric, and behavioural risk factors on LBW in the Solomon Islands, accomplished by Substudy Two (Chapter Six). The third objective of the thesis was to explore and gain an understanding of the personal (sociodemographic and health), behavioural, social, and environmental context that mothers of LBW infants experience during their pregnancy, which Substudy Three (Chapter Seven) achieved. The fourth aim sought to explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on under-five mortality in the Solomon Islands, which was accomplished by Substudy Four (Chapter Nine). Key findings of the research are discussed broadly as sociodemographic, health, obstetric, and behavioural risk factors. Furthermore, this discussion provides an overview of the prevalence and specific key findings of the risk factors associated with LBW and under-five mortality within the context of the literature.

9.2 Substudy One — Scoping Review

Objective 1: To map the available literature on the prevalence of adverse birth outcomes and associated risk factors in the Pacific Island countries.

The first study objective was successfully achieved through Substudy One (Chapter Five), which employed a scoping review that also included a consultation with health professionals (n=18) located in the Pacific Island regions of Fiji, PNG, the Solomon Islands, and Vanuatu. The review identified a significant shortage of peer-reviewed journals and grey literature investigating the risk

factors associated with adverse birth outcomes in the Pacific Island countries. Twenty studies were reviewed[37, 40, 91-100, 171, 192-198]; however, the studies only represented half of the 22 Pacific Island countries and territories. These studies mostly explored LBW, preterm birth, and SGA, and no studies have been conducted to measure the burden and identify the risk factors of stillbirth and miscarriage. This finding is consistent with views of health professionals from the region, who have also identified the lack of research on maternal and child health in most Pacific Island countries[174, 312]. Of the 20 studies analysed, the most studies focused on PNG[92, 93, 96-100, 192, 193], while the remaining Pacific Island countries, which include sub-regional countries of CNMI, Kiribati, Marshall Islands, Nauru, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu, were considered in up to two studies each[37, 40, 91, 94, 95, 171, 194-198]. Furthermore, among the 20 identified studies, half examined the association between adverse birth outcomes and risk factors, with a majority (n=8) of these studies originating from PNG[93, 96-100, 192, 193], and two from the CNMI[95] and Palau[94]. Notably, no studies that measured the risk factors of adverse birth outcomes were conducted in eleven other Pacific Island countries and territories, including the Solomon Islands.

The review revealed that LBW and preterm birth were the commonly investigated adverse birth outcomes in the region, with the prevalence of LBW and preterm birth determined as 12% and 13%, respectively. This also corresponded to the perspectives of health professionals from the region, who reported preterm birth, LBW, and SGA as commonly experienced adverse birth outcomes in their clinical settings[313]. These findings align with other regional estimates that indicate a prevalence of 12% for LBW[16], and 14% prevalence of preterm births[200] in the Asia-Pacific region. The review noted that the prevalence of LBW was highest in Nauru at 27%, while PNG and the Marshall Islands had LBW prevalence rates of up to 17% and 18%, respectively[91, 93, 100, 195]. In the Solomon Islands, the prevalence of LBW and preterm births was 12.7% and 24%, respectively[40, 210]. The review also identified that the Melanesia and Micronesia regions had the highest prevalence of adverse birth outcomes, which are likely due to poor maternal health services in these regions[174, 312]. Our findings for the region were consistent with existing literature, which indicates that preterm births are common in LMICs[314].

9.3 Adverse Birth Outcomes (Scoping Review and Health Professional Perspectives)

The scoping study conducted in the Pacific Island region identified several significant risk factors and adverse birth outcomes, though the identified studies do not represent the entire region.

Despite the limited number of studies, the review provided quantified measures of risk ratios of factors associated with one or more of the adverse birth outcomes. Additionally, the perspectives of 18 health professionals, derived from thematic and content analysis of narratives, provided supportive and detailed context regarding the risk factors. Overall, the health professionals interviewed acknowledged that persistent poverty in the Pacific Island region can be attributed to the social and health inequalities that increase the risks of adverse birth outcomes. Most Pacific Island countries are classified as LMICs with developing economies and poor social and health infrastructure. These conditions pose behavioural, social, environmental, and health risks that affect population outcomes[168, 174].

Substance use, specifically betel nut and tobacco, has been identified as a behavioural risk factor for LBW from studies in PNG[98] and Palau[94], where betel nut use is extremely high and widespread. The detrimental impact of betel nut and other harmful substances, including tobacco, kava, and marijuana use, during pregnancy on birth outcomes was also reported by the health professionals interviewed[313]. The risk associated with betel nut and tobacco use during pregnancy is consistent with studies from the Southeast Asia region, where betel nut is also consumed[181, 262, 315]. While studies on marijuana use during pregnancy have been conducted primarily in high-income countries and have shown significant adverse impacts on birth outcomes[223-226], no studies are available on the effects of maternal use of kava on birth outcomes.

The scoping review identified a range of health risk factors that were corroborated by health professionals. Malaria infection was found to be associated with LBW and preterm births from the review of studies from PNG[96, 100, 193]. Additionally, the health professionals interviewed confirmed malaria infection to be a significant risk factor for adverse birth outcomes in the region. Malaria is endemic and highly prevalent in the Pacific Island countries of PNG, the Solomon Islands, and Vanuatu[201-204]. The impact of malaria infection in relation to the risk of adverse birth outcomes is also relevant to Southeast Asia and Africa, where the disease is endemic[316, 317].

Maternal obesity is another risk factor for preterm birth, as was shown in a study in Palau[94]. Obesity affects 36% of the population in the Pacific Islands and increases the risk of preterm birth and pregnancy complications such as hypertension, gestational diabetes, and preeclampsia[168, 318-320]. This finding was further supported by the health professionals interviewed for this study[313]. In addition, maternal ages of less than 22 and greater than 35 years have also been identified in a PNG study[98] to increase the risk of LBW and preterm births. The risks for young mothers were also

supported by the health professional who nominated teenage pregnancy as a risk factor for an adverse birth outcome. The Pacific Island countries exhibit a heightened level of teenage pregnancy, attributed primarily to a combination of factors, including a sizable proportion of its populace comprising young individuals, a surfeit of early school discontinuation, and insufficient family planning coverage[321-323]. This has, in turn, led to the exacerbation of teenage marriage and pregnancy rates within the region[89, 322, 324]. Simultaneously, women of advanced maternal age from the PNG study[98] were at an elevated risk of experiencing adverse birth outcomes as a result of their heightened susceptibility to pregnancy-related conditions, such as hypertension, diabetes, and preeclampsia. This assertion was bolstered by the consensus of 17 health professionals and the literature[208]. Finally, iron deficiency anaemia was a factor that increased the risk of SGA. This was also supported by the acknowledgement from health professionals and the literature that identified iron deficiency anaemia to be a notable risk factor for adverse birth outcomes in LMICs[325, 326].

The lack of antenatal care, or insufficient antenatal care, was identified as an environmental risk factor for LBW and preterm births in the PNG study[98]. The health professionals explained the contextual background of the reasons for poor antenatal care, which stems from poor access to health facilities that contributes to insufficient care and monitoring of the pregnancy. Poor antenatal care and access in most of the Pacific Island region, akin to other LMICs[327], are mainly caused by underdeveloped health and social infrastructure, such as roads, transportation, and health facilities[174]. Access to healthcare facilities was also impeded by the isolation caused by the rugged geographical landscape of mountainous regions, terrains, and isolated islands that are found throughout the Pacific Island countries[168].

The health professionals interviewed also offered information regarding the contextual setting of social factors that were not identified in the literature review, emphasising that physical and emotional stress experienced during pregnancy also contribute to adverse birth outcomes. Physical and emotional stress were recognised as overexertion of the body and mind through arduous work and increased physical activity during pregnancy, for example, through domestic and household duties, or from the impact of domestic violence[328, 329]. While physical stress relating to hard labour during pregnancy has not been extensively studied in LMICs, research in high-income countries has suggested that increased strenuous activities during pregnancy can reduce maternal and foetal weight[330, 331]. In addition, the literature also indicates that emotional stress can pose a risk to pregnancy and contribute to adverse birth and pregnancy outcomes[331, 332]. The

emotional stress women experience during pregnancy may arise due to hormonal changes inherent to the gestation period. However, these stressors are also intricately interwoven with cultural and societal marginalisation, which in turn may give rise to stress-related anxiety and depression[333]. The broader impact of stress is often characterised by the elevation of stress hormones, including adrenaline and cortisol, thereby instigating pathophysiological mechanisms, such as gestational hypertension and diabetes. Ultimately, these cascading effects can culminate in adverse birth outcomes[334]. Physical and emotional stress encountered during pregnancy in LMICs are not only considerable but also unavoidable, challenges that most women in this region face due to the widespread poverty, cultural, and social marginalisation[168].

Domestic violence was also determined to be a social risk factor for adverse birth outcomes by interviewed health professionals. Intentional physical violence or emotional attacks perpetrated against pregnant women, commonly known as domestic violence or intimate partner violence, can also lead to physical and emotional stress and harm, as well as adverse birth and pregnancy outcomes[330]. Studies in LMICs and the region have confirmed that intimate partner or domestic violence contributes to adverse birth outcomes[131, 335, 336].

The health professionals nominated several health conditions, which they perceived to be linked to adverse birth outcomes that were not captured in the review of literature and primary studies. They affirmed that sexually transmitted and genitourinary infections, including HIV, AIDS, and UTIs, were risk factors for adverse birth outcomes, as supported by other studies in LMICs[166, 337, 338]. In addition, health professionals nominated rheumatic heart disease, which is widespread in the region[168], as a risk factor for adverse birth outcomes, also supported by the literature[339-341]. Furthermore, tuberculosis infection during pregnancy, which is also common in this region, was nominated by the health professionals as a risk factor for adverse birth outcomes, and was supported in the literature[342]. The interviewed health professionals also perceived the lack of good nutrition, a common problem in the region, as another risk factor for adverse birth outcomes, supported by the literature[343]. For example, approximately 80% of the population in the Highlands regions of PNG suffer from protein deficiency[168], while iron deficiency anaemia is also highly prevalent–41%– in the Solomon Islands[37].

Finally, the health professionals nominated unintended or unplanned pregnancy as a risk factor for adverse birth outcomes, further supported by the literature[344]. A recent study in the Solomon Islands showed that 57% of pregnancies were unintended, which was also associated with late

antenatal booking[42]. Unintended pregnancy can be associated with maternal depression, exposure to violence, low educational status, unmarried status, social marginalisation, and widespread poverty in the region[42, 345-349]. The literature also indicated that unintended pregnancy can lead to abortion[346], which the health professionals interviewed affirmed.

9.4 Prevalence of LBW and Under-Five Mortality in the Solomon Islands

The prevalence of LBW in the Solomon Islands was estimated to be 10%, based on the analysis conducted in Substudy Two, as presented in Chapter 7[350]. This estimated prevalence is lower than that observed in other LMICs globally. For instance, the highest LBW mean prevalence has been reported in Southern Asia and sub-Saharan Africa at 26% and 14%, respectively[66]. Given that there is a significant dearth of local population-based studies in the Solomon Islands that can be used for comparative analysis with the estimate of Substudy Two, the SIDHS 2006 study[41] was the only reliable population-based study available. The LBW prevalence in the Solomon Islands from the current estimate has decreased slightly from the 12.5% recorded in the SIDHS 2006[41]. Additionally, two hospital-based studies in the Solomon Islands, conducted in 2011 and 2013, also reported slightly higher LBW prevalence rates of 12.2% and 12.7%, respectively[40, 210]. However, these prevalence rates may be overestimated due to a high volume of referrals of high-risk pregnancies from rural health facilities with elevated LBW risk and may not represent the actual prevalence of LBW in the Solomon Islands[40, 210]. The minor differences in the trajectory of LBW prevalence may suggest that the estimation of LBW prevalence in the Solomon Islands was accurate. However, such an interpretation must be made with caution due to recall bias[351], which may impact these estimations. Nonetheless, LBW prevalence in the Solomon Islands remains a health challenge. It is also important to note that due to the possibility that recall bias may affect this estimation, future population-based studies with robust methodologies are required to provide more reliable estimates of LBW prevalence in the Solomon Islands, as discussed in the section on the implications for further research presented later in this chapter.

The prevalence of neonatal, infant, child, and under-five mortality for the Solomon Islands, based on the analysis from Substudy Four (Chapter 8), were 8 per 1,000, 17 per 1,000, 12 per 1,000, and 21 per 1,000 live births, respectively. When comparing these findings to the SIDHS 2006[41], there was a slight decrease in under-five mortality (from 28 to 21 per 1,000 live births), infant mortality (from 19 to 17 per 1,000 live births), and neonatal mortality (from 9 to 8 per 1,000 live births)[37]. Additionally, the national census data between 1990 and 2015 indicated a significant decline in the

overall trajectory of under-five mortality, from 38 to 21 per 1,000 live births[38, 280, 281]. Mortality estimates derived from the district health information data provided by MHMS reveal that neonatal mortality stands at 12.7 per 1,000, infant mortality at 15 per 1,000, and under-five mortality at 20.8 per 1,000 live births[109]. However, this data may only represent deaths in health facilities. The current analysis demonstrated that the neonatal and overall under-five mortality rates presently sit at 8 per 1,000 live births and 21 per 1,000 live births in the Solomon Islands, surpassing the 2030 SDG targets for neonatal mortality of 12 per 1,000 live births and under-five mortality of 25 per 1,000 live births, respectively[352]. These improvements are evidence of the progress of the enhanced Reproductive, Maternal, Newborn, Child, and Adolescent Health (RMCAH) programs implemented by the MHMS over the past two decades. Notable advancements encompass increased attendance of antenatal care, greater utilisation of skilled birth attendance, improved breastfeeding practices, enhanced child immunisation, and more effective integrated management of child health initiatives[37, 129, 149, 353]. The estimated under-five mortality for the Solomon Islands was lower than that of sub-Saharan African countries and the neighbouring country of PNG, which can reach up to 30 and 100 per 1,000 live births for under-five and neonatal mortality, respectively[11, 30, 282]. However, the prevalence in the Solomon Islands does remain higher than in some countries in the Polynesian region, such as the Cook Islands, which has 7.6 per 1,000 live births for under-five mortality[354]. Although the Solomon Islands may be ahead of the SDG 2030 targets for under-five and neonatal mortality, these findings suggest that under-five mortality remains a significant public health concern that requires more corroborated efforts by the MHMS and stakeholders in the Solomon Islands. Furthermore, considering the possibility of recall bias in the data, future studies are necessary to address this as discussed on study limitations and implications for further research section, later in this chapter.

9.5 Substudies Two and Three on LBW in the Solomon Islands

Objective 2: To explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on LBW in the Solomon Islands.

Objective 3: To gain an understanding of the behaviours and social and environmental context that mothers of LBW infants experience during their pregnancy.

The second and third objective of the study was successfully achieved through Substudies Two (Chapter 6) and Three (Chapter 7). This section presents a synthesis and discussion of key findings

from existing literature related to Objectives Two and Three. The measures of association between risk factors and LBW in the Solomon Islands were examined from two perspectives: the analysis of quantitative data on risk factors (Substudy Two), and the lived experiences of women with LBW infants during their most recent pregnancy (Substudy Three). Substudy Two used Adjusted Relative Risk (ARR) ratios to quantify the level of risk and estimate the PAF to determine the proportion of the population at risk when exposed to a certain risk factor. In contrast, Substudy Three was a qualitative study that explained the context and the social environment the women lived in, and their exposure to the risk factors based on their lived experiences.

9.6 Risk Factors Associated with LBW From Substudies Two and Three

Substudy Two showed that the history of kava and marijuana use was a behavioural risk factor that increased the risk of LBW. These findings were consistent with those reported in Substudy Three, in which women provided detailed descriptions of the contextual background of substance use during pregnancy. Women reported using marijuana, alcohol (especially *kwaso*, a homemade distilled alcohol), and tobacco (whether manufactured or homegrown) during pregnancy, which they believed contributed to LBW or premature birth. As previously discussed in Substudy One (Chapter Five), substance use including kava and other substances, such as betel nut and tobacco, are widely used in the Pacific Island region, and are known risk factors for adverse birth outcomes and LBW[214]. The finding in Substudy Two that linked the history of kava use to an impact on infant birth weight is a novel discovery; however, further studies are needed to confirm this outcome as discussed in the implications for further research section of this chapter.

Although kava is widely used in the Pacific Island region, maternal kava consumption in the Solomon Islands was only 1%, far lower usage compared to other countries in the region, such as Vanuatu, where maternal kava use prevalence was 15%[355]. However, the use of kava in the Solomon Islands is likely to increase as it has been accepted by the government as a commodity for export internationally[220]. Kava use is unique to Pacific Island populations, and while there have been several studies on the harmful effects of kava on human health, there has been a noticeable scarcity of research examining the maternal use of kava and its impact on pregnancy and birth outcomes. The main ingredient in kava is *kavalactone*, which has *anxiolytic, anticonvulsant*, and

analgesic[xv] properties, yet this substance has been found to have negative effects on human health, such as liver toxicity, raised cholesterol, and dermatitis[356, 357].

The history of marijuana use is a behavioural risk factor that increases the risk of LBW in the Solomon Islands, as revealed in Substudy Two, and is also supported by Substudy Three. The women interviewed confirmed that marijuana consumption during pregnancy was prevalent in the Solomon Islands and it is believed to increase the risk of LBW. While there is a lack of studies on perinatal marijuana use in LMICs, research conducted in high-income countries has found an association between marijuana use and LBW, as well as other adverse birth outcomes. Akin to the effect of nicotine from tobacco, *cannabinoids*, the main chemical substance in marijuana, may interfere with placental function, leading to intrauterine growth restriction, premature birth, and LBW[223-226].

The lack of attendance at antenatal care is a significant health risk factor for LBW, as indicated by Substudy Two, and substantiated by Substudy Three. Various factors, including poor access, long distances, severe weather patterns, and unaffordable costs, hindered women's access to antenatal care. Poor access to antenatal care is concerning and prevalent in the wider Pacific region, as found in Substudy One and identified in literature from the region[168, 174]. Geographical barriers, such as those encountered in the Solomon Islands and many other countries in the region, can significantly impact access to healthcare for women and the general population[168, 174, 312]. Inadequate health infrastructure, services, supplies, and unprofessional nursing staff behaviour were also identified as barriers to adequate antenatal care, as experienced and described by the women interviewed. Problematic behaviour among nursing staff and suboptimal patient treatment in the Solomon Islands may also stem from various other contributing factors. These factors encompass nursing staff burnout resulting from excessive workloads, inadequate nurse-patient ratios, insufficient government support for nurse's well-being and remuneration, unfavourable working conditions, and a deficiency in training opportunities[358]. These findings are consistent with those reported in other LMICs[359, 360].

Substudy Three revealed several critical health risks that were not identified in Substudy Two, particularly regarding women's experiences. Women reported being exposed to several health issues during pregnancy, including malaria infection, STIs, UTIs, APH, falls, and accidents, which

[xv] *Anxiolytic, anticonvulsant*, and *analgesic* are chemical properties of kava which reduce anxiety, convulsion, and pain, respectively.

they believed led to LBW or early births. These findings were also confirmed by Substudy One and were well established in the literature focused on LMICs[214].

Malaria infection is a notable risk factor for LBW and adverse pregnancy and birth outcomes, a risk well established in the literature on LMICs where the disease is endemic[100, 193, 361], which is also substantiated by Substudy One[214]. In Substudy Three, the women also reported having symptoms of STIs and UTIs during their pregnancy preceding to having an LBW infant[362]. This was supported by studies from LMICs, which confirmed that STIs and UTIs are risk factors for LBW and other birth outcomes[251, 252], and was also validated by the views of health professionals in Substudy One[313]. The women also reported experiencing APH during pregnancy, which was likely to be caused by infections, falls, and accidents from regular domestic activities, as well as domestic violence. There is a pronounced prevalence of domestic violence incidents during pregnancy in the Solomon Islands, as indicated by reports of up to 66% of expectant women encounter some form of violence [131]. In Substudy Three, women reported falls and accidents while walking on bush tracks to the food garden or fetching water, which they believe led to early labour and LBW infants[362]. As previously noted, such incidents reflect the marginalisation of women in the country, where they are frequently exposed to numerous health risks during pregnancy.

Sociodemographic factors, which include the lack of women's autonomy in decision-making, and being in polygamous relationships, have been found to be associated with LBW, as evidenced in Substudy Two. Substudy Three revealed that women are exposed to domestic violence during pregnancy, illustrated by those interviewed. Furthermore, in Substudy Three, eight women reported experiencing domestic violence, primarily from their intimate partners or significant others, which they believed directly contributed to the early delivery of an LBW infant. Domestic violence was also identified as a risk factor in Substudy One, as supported by local and international literature[130, 131, 266]. The prevalence of domestic or intimate partner violence is widespread in the Solomon Islands, with up to 66% of women experiencing violence[130]. The lack of decision-making pertains to situations where women are not involved in making health, social, and financial decisions for themselves or as a couple with their significant other. This phenomenon is also evident in sub-Saharan Africa[231]. Polygamous relationships, as identified by Substudy Two, increase the risk of LBW, which is also consistent in a study conducted in Africa[216]. Although it is not clear in the literature how polygamy correlates to LBW, stress and violence may be present in some polygamous relationships, which could lead to this increase in LBW. The Solomon Islands, being a patriarchal society, also reported that a high prevalence of violence stems from social

problems, including disputes over marital and polygamous issues, or male control (emotional, financial, and/or physical) over women, which is also supported by literature[130, 131].

In Substudy Three, women reported poor diet and nutrition during pregnancy as a contextual health risk, with their diets found to be high in carbohydrates and low in protein. Poor diet and nutrition were influenced by various factors, including a lack of knowledge of good nutrition, particularly among low-literate women, food taboos, and environmental factors such as heavy rain, floods, and cyclones, which destroy food gardens. These findings are also supported by local and regional studies[258-260].

Substudy Three identified several contextual and environmental factors that women interviewed believed to contribute to LBW but were not captured by Substudy Two. Women reported living in substandard housing where they were exposed to mosquitoes, and this put them at risk of transmission of malaria and other vector-borne diseases. They also reported limited access to water supplies and sanitation facilities. These conditions are often associated with marginalised populations and poverty in LMICs, as the interviewed health professionals from the wider Pacific region confirmed in Substudy One. In the Solomon Islands, poor water and sanitation are critical issues, with approximately half of the rural population lacking access to clean water and adequate sanitation facilities[37].

9.7 Substudy Four Under-five Mortality in the Solomon Islands

Objective 4: To explore the effects of sociodemographic, health, obstetric, and behavioural risk factors on under-five mortality in the Solomon Islands.

The fourth objective of the study was successfully achieved through Substudy Four (Chapter 8). This section discusses the results of Substudy Four and synthesises the outcomes in relation to the existing literature. The primary objective of Substudy Four was to ascertain the behavioural, sociodemographic, and health risk factors linked to mortality in children under the age of five in the Solomon Islands.

Substudy Four demonstrated that a maternal history of substance use, including marijuana, constituted a behavioural risk factor that increased the likelihood of child mortality between the ages of one and five. The impact of maternal marijuana use on children under the age of five may be attributed to exposure during pregnancy through breast milk or aerosol exposure, as supported by literature reviewed[294-297]. Although studies examining *cannabinoids*, the principal compounds

present in marijuana, and their impact on perinatal mortality are scarce in LMIC literature, research in high-income countries has shown that exposure to *cannabinoids* during the intrauterine period, and passive or aerosolised exposure post-birth can impact on child mortality[294-297]. Substudy Two, which also utilised the same population of women (the SIDHS 2015 dataset), also predicted LBW to be associated with a maternal history of marijuana, with relevant literature supporting these claims[225, 226]. This finding was further supported by Substudy Three, as the women interviewed could recall maternal use of marijuana as a contributing factor to LBW. These findings collectively suggest that exposure to marijuana during the perinatal period significantly contributes to LBW, which, in turn, contributes to the mortality of children under the age of five in the Solomon Islands.

Tobacco and cigarette use has been found to increase the risk of mortality in children aged between one and five years. This was also supported by our PAF estimation, which indicates that 7% of neonatal deaths, 12% of child deaths, and 8% of deaths in children under the age of five are also attributed to a history of tobacco and cigarette use. The impact of nicotine exposure on mortality has been extensively studied globally[263, 292, 293]. Exposure among children aged between one and five years may be due to intrauterine exposure to tobacco, which can lead to morbidity during early life, such as intrauterine growth restriction, preterm births, or LBW. Additionally, passive smoking has been found to increase childhood morbidities such as respiratory infections, as confirmed by previous studies[263, 292, 293].

Maternal tobacco use has far-reaching consequences that can lead to LBW and, ultimately, to early life mortality. Substudy One, which examined maternal tobacco use in the wider Pacific Islands region, shows maternal tobacco use is associated with LBW[313]. Moreover, Substudy Three, which involved interviews with women in the Solomon Islands, revealed that women's exposure to tobacco and cigarettes (whether homemade or manufactured) during pregnancy led to an early birth or the delivery of an infant with LBW. It is well-established that LBW is a precursor to early life mortality[8, 363]. Furthermore, Substudy Two estimated that 14% of neonatal deaths were attributable to LBW, although LBW may also result from other factors. These findings suggest that maternal use of tobacco may have long-lasting negative consequences for offspring, a risk that persists until the child reaches the age of five.

Substudy Four considered sociodemographic risk factors, such as advanced maternal age (maternal age greater than 35 years), certain religious affiliations, being in an ethnic minority, and

having a rural residence, which increased the risk of under-five mortality in the Solomon Islands. Advanced maternal age tended to associate with mortality in the neonatal period, which was also supported by studies in the African region[305-307]. Additionally, infants born to mothers belonging to Catholic and Anglican churches were found to be at a higher risk of mortality during the neonatal and infant period. Despite a lack of literature on the association between religious affiliation and child mortality globally, one theory suggests that certain cultural practices within these religions may jeopardise child survival, however further research is needed to develop a more extensive understanding of this specific risk factor[303]. Similarly, studies have shown that children belonging to Polynesian and Micronesian ethnic minorities in the Solomon Islands were at a greater risk of mortality before the age of five, a phenomena that has been observed in other social and ethnic marginalised populations worldwide[298, 300-302]. Furthermore, our study indicates that living in rural areas in the Solomon Islands is associated with a higher likelihood of mortality in young children, as is the case in Burkina Faso, where high rates of infants in rural areas were attributed to limited access to healthcare and social services[304].

Notably, the adjusted model suggests that households comprising more than five members are less likely to experience neonatal and under-five mortality. This finding contradicts the outcomes of most studies in LMICs, which have identified larger families, potentially with high parity, as a risk factor for infant and under-five mortality[26, 309, 310]. For instance, studies conducted across various African countries have reported that larger households may endure food competition, leading to inadequate nutrition that can result in unfavourable pregnancy outcomes and deaths[26]. Conversely, larger households in the Solomon Islands may provide social support and security, which are associated with the *wantok* system–a socio-economic and political network prevalent in the Solomon Islands and Melanesia[121]. Therefore, living in an extended family household in the Solomon Islands may have benefits in terms of support and protection that could reduce the risk of neonatal and under-five mortality.

Health risk factors that significantly increase under-five mortality, as found in Substudy Four, include the lack of breastfeeding, absence of postnatal check-ups, and lack of maternal tetanus vaccination. No breastfeeding increases the risk of death during the neonatal, infancy, and early childhood period. This has also been supported by the PAF estimation for this substudy, which shows that 65% of neonatal deaths, 37% of infant deaths, 5% of child deaths, and 29% of under-five deaths were attributed to the lack of breastfeeding. It is widely reported in the literature that a lack of breastfeeding increases the risk of early life mortality worldwide. Death in the early

neonatal period can be due to sepsis and hypoglycaemia, as reported by studies in Africa and Southeast Asia[14, 26, 283, 284]. On the other hand, mortality during infancy and childhood in the Solomon Islands may also result from early weaning and poor feeding[37]. Approximately 21% of children in the Solomon Islands were weaned early, before the age of six months, which places them at high risk of diarrhoeal diseases and malnutrition and increases their risk of death between the ages of one and five years[37, 285, 364].

The lack of postnatal checks also increases the risk of neonatal and child death. This was confirmed by the PAF estimation, which indicated that 79% of neonatal and 17% of infant mortality was linked to the absence of postnatal check-ups, which is consistent with studies conducted in Africa and Southeast Asia[286, 287]. Finally, the PAF estimate showed that 9% of infant mortality in the Solomon Islands could be attributed to the absence of maternal tetanus vaccination during pregnancy. Although early life mortality due to tetanus infection is rarely documented in the available literature, studies in PNG[311] and Nepal also reported this finding.

9.8 Study Significance

The advancement of healthcare and public health practice and policy hinges upon the acquisition of knowledge through health research. The findings yielded from this thesis carry far-reaching significance and implications for enhancing public health practice, policy, and future research in the Solomon Islands. The importance of this thesis lies in its contribution to knowledge, which can inform actions required to improve public health service and policy development. Moreover, the identification of research gaps can serve as a springboard for future studies in the Solomon Islands. After an extensive scoping review and analysis of the existing literature, to the author's knowledge, this study is the first to explore the risk factors associated with early life morbidity and mortality in the Solomon Islands. The study has addressed a significant knowledge gap by identifying important risk factors that contribute to LBW and under-five mortality, two pivotal indicators of maternal and child health in the Solomon Islands. The study identified multiple behavioural, health, sociodemographic, and environmental risk factors that significantly impact LBW and under-five mortality in the Solomon Islands. These findings provide robust evidence for the Solomon Islands MHMS and stakeholders to draw on to improve healthcare and public health practice by formulating targeted health policies and guidelines to enhance healthcare services in the region, tailored to the specific risks found in the Solomon Islands.

9.9 Strengths and Limitations

The study has several strengths, the first being the use of a concurrent mixed-methods study approach blending quantitative, qualitative, and review research methods. The quantitative approach used the data in the SIDHS 2015 report, while the qualitative approach encompassed a descriptive qualitative study of women with LBW lived experiences during their recent pregnancies, and a scoping review with consultation of health professionals from within the Pacific region. The use of mixed-methods research enables the triangulation of data and/or viewing the issues of interest from multiple perspectives. The quantitative data measured the relative risk ratios of risk factors for LBW and under-five mortality, while the qualitative data explains the retrospective context of the experience of the women with LBW infants. The second strength of the study is the use of a large dataset from a nationally representative survey, the SIDHS 2015 report. The sample population of the study was drawn from the 211 national census EAs in 2009, which represent the entire country and therefore the findings for this study can be inferenced to the Solomon Island population. The use of a scoping review is the third strength of the study. The scoping review identifies the burden of adverse birth outcomes, the associated risk factors, and the prevalence of such outcomes in the wider Pacific Island region. It also identifies the gaps in research on this theme in the region, specifically the Solomon Islands, the focus area of this thesis. The scoping review also included the perceptions of health professionals on the burden of adverse birth outcomes, potential risks, and recommendations on how both can be mitigated in the region.

Alongside these strengths, there remain limitations associated with the study. Firstly, the most recently available SIDHS dataset that was used in the study was from 2015 and may not reflect the contemporary situation in the Solomon Islands, particularly given the potential changes in maternal health and socioeconomic conditions following the global COVID-19 pandemic. However, demographic information, such as age and educational status, may remain relatively constant, even after 10 years, and may have a minimal impact on the study's findings[365], which is the reason DHS surveys are conducted at up to six-year intervals to observe changes in population characteristics[366]. Secondly, the SIDHS 2015 survey was prone to information and recall bias, which is a common challenge associated with retrospective surveys. This bias occurs because women interviewed for this survey were asked to recall experiences of at least five years' retrospectively, and there is a high probability that women may provide inaccurate information, which may affect the findings. These biases could affect the accuracy of the estimates, such as maternal tetanus

vaccination, malaria infection, and breastfeeding, as mothers may not recall correct information. Moreover, social desirability bias could potentially impact the results of the study due to factors such as low literacy and a lack of information on births, which may lead to women providing inaccurate information about their age and underreport or deny the use of illegal substances, such as marijuana, *kwaso* (homebrewed, distilled alcohol), betel nut, beer, or kava. The fluctuating number of people living in a household due to the extended family system prevalent in the Solomon Islands could lead to an under- or overestimation of household size. It can also be noted that there is a wide confidence level in the results for Substudies Two and Four, which is the analysis of the 2015 SIDHS data[350, 367]. The possible reason for this is the relatively small observations in the outcomes[368]. Despite the wide confidence intervals observed, we have nevertheless interpreted the relative risk ratio of at least two or more as being indicative of a discernible association between the risk factors and the outcomes. These limitations must be considered when interpreting the findings of the study, and future studies are recommended to address these limitations and utilise more contemporaneous data to provide more reliable estimates as stated in the implications for future research and health practice section.

9.10 Implication for Further Research and Health Practice

The study suggests five important implications are needed to mitigate the risks of early life morbidity and mortality, particularly LBW and under-five mortality observed in Substudies Two, Three and Four. These include the need for more robust research studies, enhancements to the health database system, further confirmatory investigations into kava usage and policy development on perinatal substance use, improvements in antenatal care, advancements in public health initiatives, and the strengthening of the IMCI program.

Firstly, the study highlights the necessity of conducting comprehensive population-based studies and analysing current data to accurately estimate population-based trends and statistics, such as the mortality rates associated with LBW and under-five mortality among children in the Solomon Islands. Achieving this objective may require the implementation of population-based studies employing rigorous methodologies. On the other hand, this can be a very difficult exercise, as large population-based studies can be very expensive for the government to implement and produce. In addition to the need for a current large population-based study to be conducted, there is a pressing need to enhance the existing healthcare system databases. This will be very effective in monitoring and maintaining effective and accurate records of births and deaths across various

healthcare settings, ranging from rural areas to national health facilities. Recently, MHMS has been employing a health information platform that utilises the District Health Information System. This open-source platform is utilised by over 70 countries globally for the purpose of collecting and analysing health-related data[109]. However, it is not clear if the system has effectively facilitated the proper documentation of births and deaths, as it may focus only on births and death within healthcare institutions. It is important to note that approximately 10% of births in the Solomon Islands occur outside of health facilities. Furthermore, as an LMIC, it is likely that a significant number of under-five deaths in the Solomon Islands [43, 116, 149] that occur outside of health facilities may go unaccounted for.

The second implication is the need for confirmatory studies to strengthen the evidence of substance use. This will enable health authorities to develop appropriate health policies regarding substance use. Substudy Two is the first of its kind regionally to establish a link between maternal kava consumption and LBW, and considering the increasing popularity of kava use in the Solomon Islands and the wider region it is imperative to conduct further research to confirm this finding. In addition to kava, the study also confirms the use of betel nut and marijuana, which is prevalent in the Solomon Islands and is also of concern, as both are associated with negative repercussions for LBW and under-five mortality. Consequently, it is necessary for the government to implement health policies addressing maternal use of betel nut and marijuana. By regulating and providing guidelines on perinatal use of these substances, the government can work towards mitigating the adverse effects they may have on foetal development, LBW, and under-five mortality.

Thirdly, the findings of this study highlight the urgent need to improve antenatal health care service. As recommended by the interviewed health professionals, proactive measures should be taken to mitigate risk factors during pregnancy. These measures are indispensable for ensuring healthy pregnancies and successful births. These include comprehensive health assessment and screening to rule out pregnancy comorbidities such as diabetes, hypertension, malaria, STI's, UTI's and health risks identified by substudy Two and Three. It is well established in the literature that early diagnosis and prompt treatment of any health conditions that may arise during pregnancy will improve pregnancy and birth outcomes. Despite many efforts being undertaken at the forefront of the clinical setting, regrettably, these initiatives have encountered impediments due to the geographical isolation, limited healthcare resources, and facilities that predominantly rely on directives and strategies formulated by the top-level bureaucracy of the healthcare system [116].

Consequently, addressing challenges related to the accessibility and quality of antenatal care presents a challenging undertaking.

Fourthly, the findings of this study underscore the necessity of redirecting greater attention toward public health initiatives. The current healthcare system in the Solomon Islands allocates a major portion of its budget to curative health services, with minimal emphasis on public health and health promotion. Other than improvement of antenatal care practice, another key area that needs public health attention is establishing preconception health in the health system. This initiative was suggested by the health professionals interviewed in Substudy One. Preconception health plays a pivotal role in overall health, which can result in healthier pregnancies, improve birth outcomes, and reduce under-five mortality[369]. It includes public awareness by targeting schools and communities, serving as an effective strategy to educate people planning a future pregnancy about abstaining from substance use, preventing STIs, and promoting good nutrition. Unfortunately, this aspect of health was not found to be given due emphasis within the healthcare system of the Solomon Islands. Considering its significance, preconception health should be developed and strengthened through public health initiatives and policy development. To develop and integrate the preventive health approach within the Solomon Islands healthcare system, it is recommended for health researchers to conduct assessments and investigative inquiries to examine the existing gaps and avenues to incorporate preconception healthcare.

The final implication is the need to prioritise the reinforcement of the IMCI program within all levels of the healthcare system. IMCI is a comprehensive approach to child health developed by the WHO and UNICEF[370, 371]. It aims to reduce childhood mortality and improve child health by providing an integrated strategy for managing the most common childhood illnesses. As noted from Substudy Four, the two significant risk factors for under-five mortality were the lack of breastfeeding and the lack of postnatal checks, which can be improved significantly with an optimal IMCI approach. To date, it has been reported that IMCI has made a modest contribution to the reduction of under-five mortality in the Solomon Islands.[147] However, given the persisting high trends in early life morbidity and mortality in the Solomon Islands, it is crucial to strengthen the IMCI programs throughout all levels of the healthcare system. This comprehensive approach is particularly valuable, as indicated by findings in Substudy Four, which implies that infants and children in rural areas face a heightened risk of dying before reaching the age of five. This suggests that the existing IMCI approach may not have been effectively implemented in rural settings.

Therefore, having the IMCI program strengthened in the rural setting would significantly reduce mortality among children under the age of five.

9.11 Conclusion

The study sheds light on the risk factors and prevalence of early life morbidity and mortality, particularly LBW and under-five mortality, an existing knowledge gap in the Solomon Islands. The identified risk factors associated with these outcomes stem from the population's sociodemographic, health, obstetric, and behavioural contexts, which are comparable to those found in other LMICs globally. Identifying these risk factors is critical for the country as it serves as a benchmark for the MHMS to improve public health approaches for maternal and child health and develop appropriate policy guidelines in the country. The findings from this study also support the need for reinforcement of the provision of the best quality antenatal care for women, the need to introduce pre-pregnancy care in the health system, and the need to reinforce IMCI for children under the age of five.

The findings of this study also define several important aspects that warrant attention and action. It underscores the necessity of strengthening the delivery of high-quality antenatal care for women, which entails ensuring that pregnant women receive comprehensive and evidence-based care throughout their pregnancy to promote optimal maternal and foetal health outcomes. The study highlights the imperative of introducing pre-pregnancy care within the healthcare system, a service which encompasses interventions and services aimed at optimising the health status of women before they conceive. By providing appropriate guidance, screenings, and interventions prior to pregnancy, potential risks and complications can be identified and addressed, thus enhancing the chances of a healthy pregnancy, birth, and child from birth to five years.

The findings also emphasise the need to reinforce the IMCI for children under the age of five. The IMCI approach encompasses a comprehensive set of interventions designed to address the major causes of morbidity and mortality in young children. Strengthening the implementation of IMCI in clinical and public health settings is crucial to ensure timely diagnosis, treatment, and management of illnesses in this vulnerable age group. Finally, these findings have opened new avenues for further health research to address the gaps identified. These gaps encompass prospective investigations employing rigorous methodologies to authenticate the accurate prevalence of LBW and under-five mortality, investigations into the perinatal use of kava and its

ramifications on LBW, analyses of religious practices alongside the influence of the *wantok* system within the Solomon Islands, and evaluations of the effects of both on child mortality.

Appendices

Appendix A: Scoping Review Protocol

Open access Protocol

BMJ Open

Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review protocol

Lydia Sandrah Kuman Kaforau ,[1,2] Gizachew Assefa Tessema,[2,3] Jonine Jancey ,[2] Gursimran Kaur Dhamrait ,[4,5] Hugo Bugoro,[1] G F Pereira[2,6]

To cite: Kaforau LSK, Tessema GA, Jancey J, *et al*. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review protocol. *BMJ Open* 2021;**11**:e042423. doi:10.1136/bmjopen-2020-042423

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-042423).

Received 04 July 2020
Revised 16 March 2021
Accepted 22 March 2021

For numbered affiliations see end of article.

Correspondence to
Lydia Sandrah Kuman Kaforau; l.kaforau@postgrad.curtin.edu.au

ABSTRACT

Introduction Fetal growth restriction, preterm birth, low birth weight and stillbirth are adverse birth outcomes that are prevalent in low-income and middle-income settings such as the Pacific Island region. It is widely accepted that the excess burden of adverse birth outcomes is attributable to socioeconomic and environmental factors that predispose families to excess risk. Our review seeks to determine the prevalence of adverse birth outcomes in the Pacific Island region and to identify the risk factors of adverse birth outcomes in the Pacific Island region.

Methods This scoping review will follow the five-staged Arksey and O'Malley's framework and consultation with Solomon Islands' health stakeholders. A preliminary literature review was undertaken to understand the scope of the review. We will use Medical Subject Heading and keyword terms for adverse birth outcomes to search CINAHL, Medline, Scopus, ProQuest and Springer Link databases for articles published from 1 January 2000. The subsequent searches will be undertaken via Google Scholar and the internet browser to world health organisation and regional health organisations for published and unpublished reports on non-indexed studies. All articles retrieved will be managed with EndNote software. Eligible studies will be screened using Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart for final selection. In the charting phase, we will extract the data into Excel spreadsheets. The results will be presented as numerical and thematic summaries that map risk factors and prevalence to the population and cultures of the Pacific Island region.

Ethics and dissemination Formal ethical approval is not required as primary or administrative data will not be collected. However, we will seek ethics approval for the stakeholder consultation from the Research Office of Curtin University and the Solomon Islands. The findings of this study will be published in peer-reviewed journals and presented in national and regional conferences and disseminated to stakeholders.

Ethics approval There will be no direct contact with human or patients in the case of the scoping review; therefore, no ethics will be required. However, we will seek ethical approval from the Research Ethics Office of Curtin University and the Health Research and Ethics Committee in the Solomon Islands for stakeholder consultation. Dissemination will be made through regional conferences and publication in peer-reviewed journals.

Strengths and limitations of this study

- The review will provide information to help identify knowledge gaps and focal points for further investigation to progress towards evidenced-based maternal healthcare in the region.
- A strength of this study will be consultation with stakeholders (health professionals working in maternal and child health services) as they will provide insights into adverse birth outcomes at a community level.
- We may not be able to access studies published in languages other than English.

INTRODUCTION

Despite improvements in medical care and technology, the incidence of adverse birth outcomes remains a significant public health issue, particularly in low-income and middle-income countries (LMICs).[1 2] Adverse birth outcomes include indicators for early gestation (preterm birth), fetal growth restriction and perinatal mortality. Preterm birth is the most well-accepted benchmark for morbidity attributable to early gestation and is defined as birth before 37 weeks of completed gestation.[2] In LMICs, fetal growth restriction is indicated by its proxies ascertained at birth.[3] These proxies include term low birth weight (LBW), defined as birth weight <2500 g from 37 weeks of completed gestation, and small for gestational age (SGA), defined as weight in the lowest 10th centile for gestational age and sex or as a multiple of SD from the sex-specific population mean weight. LBW is also historically used as a proxy for preterm birth given the lack of information on gestational length.[4 5] Fetal growth restriction is associated with infant mortality and morbidity.[1 2] Stillbirth is the most commonly investigated mortality-related outcome and is defined as birth without signs of life from 28 weeks of completed gestation in LMIC.[1] Both preterm birth and fetal growth restriction can

significantly impact longer term physiological complications and well-being of children[6 7] and are major risk factors for stillbirth.

The aetiologies of adverse birth outcomes are multifactorial and not entirely well understood.[1] Evidence from studies conducted elsewhere show that socioeconomic, health, obstetric and biological factors are linked with adverse birth outcomes in high-income countries as well as LMICs.[2 6 8–10] Moreover, evidence has also shown that environmental (non-genetic) risk factors are relatively more prevalent in LMICs resulting in higher infant mortality and morbidity in these countries.[6 7] More than 96% of the 32 million LBW infants born globally each year occur in LMICs.[8] Although adverse birth outcomes are reasonably well documented in some LMICs, such as India,[11] studies in the Pacific Island region remain sparse.

The Pacific Island region broadly refers to a group of countries and territories that border the Pacific Ocean.[12] The region, defined here as the LMICs and territories within the Melanesian, Polynesian and Micronesian subregions, are culturally and ethnically diverse, with varying degrees of economic development and living standards.[12] The indigenous populations of the region are typically over-represented in national and global scales for disease burden for both communicable and non-communicable diseases.[12] Health indicators also vary considerably across this region; for example, the infant mortality rate in Papua New Guinea is 50 per 1000 births compared with 20 per 1000 births in Fiji.[13] Similarly, LBW and SGA also vary within and between countries of the region with reported prevalence inconsistent and underreported.[14] A review in 2013 estimated a period prevalence of 8% for preterm birth, 10% for LBW and 19% for SGA in the broader region of Oceania,[15] but these prevalence are not well established for the Pacific Island region specifically. Moreover, although it is estimated that 98% of stillbirths occur in LMICs,[16] there are no high-quality estimates for stillbirth prevalence in the Pacific Island region. In the last two decades, there has been a substantial decline in infant and child mortality by approximately 50% in more than half of the Pacific Island countries and territories.[14] However, the extent of such improvements remains uncertain due to poor data quality and coverage and impacting cultural factors.

Deficiency in the provision of basic health services such as antenatal care and delivery services, infrastructure, telecommunication and transportation are pertinent contributors to the burden of adverse birth outcomes in the Pacific Island region.[17] Notably, more than 60% of the population in the region live in rural areas.[18] Factors such as access to healthcare, diet and substance use vary considerably. There is some indication that levels of alcohol consumption and tobacco and substance use (including betel or areca nut) may be among the highest globally.[19–23]

The aim of this scoping review is to synthesise available results from studies on the prevalence and risk factors of adverse birth outcomes in the Pacific Island region. Knowledge of the burden of adverse birth outcomes and key risk factors will provide policy makers and healthcare practitioners working in the region with evidence that can be used to inform strategies to achieve reductions in adverse birth outcomes and improve overall perinatal health. These research findings will help to design targeted interventions and better allocate resources to where they are needed. Additionally, findings of the review will inform future aetiological research on the effect of risk factors of adverse birth outcomes in the region.

METHODS

This scoping review will follow the Joanna Briggs Institute Reviewers Manual[24] derived from Arksey and O'Malley's five-staged methodological Framework[25] and further developed by Levac *et al*.[26] Briefly, this includes explicit specification of research questions, reproducible methods to identify relevant studies, transparent declarations of inclusion and exclusion criteria, documented collation of data and standardised summarisation and reporting of results. The scoping review will not involve patients and the public as data will be sourced from primary studies. However, we will also include an optional stage six of stakeholder consultation for additional insights. The stakeholder consultation exercise will only be involving doctors, midwives and nurses who work directly with pregnant women. Ethics and consent will be sought from respective authorities and clinicians. Our reporting will also be compliant with Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews checklist.[24] A preliminary literature review was undertaken to understand the extent of literature on exposures of risk factors of adverse birth outcomes in the Pacific Island region to determine an appropriate search timeframe. Thus, the scoping review will be conducted between December 2020 and February 2021.

Stage 1: specification of the research question

We will first identify the research question. A preliminary literature review was undertaken to understand the extent of literature on exposures of risk factors of adverse birth outcomes in the Pacific Island region to determine an appropriate search timeframe. This stage will allow the formulation of the research questions for the study. The broad research questions are: *what is the prevalence of the adverse birth outcomes in the Pacific Island region?,* and *what are the risk factors of adverse birth outcomes in the Pacific Island region?* The indigenous population of the region are broadly classified as Melanesian, Polynesian and Micronesians, each with their own diverse historical roots and cultures.[12] Such diversity is accompanied by differences in economic development and living standards, causing a wide variation in health outcomes between populations.[12] Consequently, this review will also describe the prevalence and risk factors by subpopulation group.

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
► All studies and articles irrespective of their designs. ► Primary and secondary studies. ► Population and inferential-based studies. ► Mother and infants' populations. ► 21 Pacific Island countries and territories. ► Articles published from the year 2000 to current.	► Studies on Pacific Islanders living in countries outside the region. ► Studies on Non-Pacific Islanders living in the Pacific Islands. ► Studies before the year 2000.

Stage 2: identifying relevant studies

The second stage of the review aims to identify the relevant studies through the eligibility criteria and search strategies involved. The Arksey and O'Malley's methodological framework[25] uses population–concept–context. For this review, the population is defined as all women of childbearing age (15–49 years old) who gave birth in the Pacific Island region and infants from these births; concept is the prevalence and risk factors for adverse birth outcomes (low birth weight, preterm birth, small for gestational age or fetal growth restriction, stillbirths and miscarriage); and context is defined geographically as all 21 countries and territories in the region.

Inclusion and exclusion criteria

We will include all studies and articles irrespective of their study design. We will incorporate all studies that report risk factors and their associations with one or more of the adverse birth outcomes in the Pacific Island region arising during pregnancy but observed at the separation of the fetus from the mother or shortly afterwards. We will include studies that will provide estimates of the prevalence rates and risk factors of adverse birth outcomes. That include inferential studies that aimed to estimate the prevalence and identify associated risk factors such as intervention and observational studies. Our review will also include descriptive population-based studies such as the Demographic Health Surveys and other surveys. We will include studies from the 21 sovereign island states and territories of the region, namely: American Samoa, Cook Islands, Easter Islands, Federated States of Micronesia, Fiji, Guam, Kiribati, Mariana Islands, Marshall Islands, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tahiti, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.[14] Both primary and secondary analytical studies published in peer-reviewed journals and grey literature as government reports will be included. Studies published in English from the year 2000 to February 2021 will be included. Table 1 illustrates a summary of the inclusion and exclusion criteria for the study.

Search strategy

The search strategy will follow the three-stage search process outlined by the Joanna Briggs Institute.[27] The first stage will include an initial search using key concept terms that will be undertaken in CINAHL and Medline to identify Medical Subject Heading (MeSH) or text terms contained within the titles and abstracts of articles. The key concept terms are adverse birth outcomes, pregnancy risk factors and Pacific Island region. Table 2 outlines the grid of key concepts and terms.

In the second stage of the search, all MeSH terms, key concept terms and their synonyms will be combined with Boolean operators, truncations and wildcards to generate search strings and will be applied across the selected databases. The following electronic databases will be searched: CINAHL, Medline, ProQuest, SpringerLink and Scopus. As all databases have different search protocols, we will ensure to follow each of their guidelines accordingly. In the second stage, we will carry out two levels of searches. The first level will use general key concept terms and their synonyms combined with MeSH terms identified. An example of general search string designed for CINAHL is as follows: ("adverse birth outcome*" OR "poor birth outcome*" OR "preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "small baby*" OR "very small baby*"OR "low birth weight" OR "low birthweight" OR "very low birth weight" OR "very low birthweight" OR "extremely low birth weight" OR "extremely low birthweight" OR "stillbirth" OR "still birth" OR MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND ("pregnancy risk factor*" OR "adverse pregnancy outcome*" OR "poor pregnancy outcome*" OR MH "risk factor*" OR MH "pregnancy risk*" OR MH "high risk*" OR MH "pregnancy in adolescence*" OR MH "pregnancy risk*") AND ("Pacific Island*" OR "Oceania" OR "South Pacific Island*" OR "Pacific Island country*" OR "MH Pacific Island*").

Table 2 Grid of key concepts and terms

Concept 1		Concept 2		Concept 3
Adverse birth outcomes	AND	Pregnancy risk factors	AND	Pacific Island region

CINAHL is as follows: ("preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "small baby*" OR "very small baby*" OR "low birth weight" OR "low birthweight" OR "very low birth weight" OR "very low birthweight" OR "extremely low birth weight" OR "extremely low birthweight" OR "stillbirth" OR "still birth"OR MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND ("malaria in pregnancy" OR "anaemia in pregnancy" OR "substance use" OR "alcohol use" OR "betel nut use" OR "areca nut use" OR "tobacco use" OR "cigarette use" OR "maternal obesity" OR "maternal malnutrition" OR "maternal undernutrition" OR "teenage pregnancy") AND ("American Samoa" OR "Cook Island*" OR "Easter Island*" OR "Federated States of Micronesia" OR "Fiji" OR "Guam" OR "Kiribati" OR "Mariana Island*" OR "Marshall Island*" OR "Nauru" OR "New Caledonia" OR "Niue" OR "Palau" OR "Papua New Guinea" OR "Samoa" OR "Solomon Island*" OR "Tahiti" OR "Tokelau" OR "Tonga" OR "Tuvalu" OR "Vanuatu" OR "Wallis and Futuna"). Table 3 illustrates a comprehensive search of general and specific search terms combined with MeSH that will be applied to CINAHL database.

In the third stage of the search, we will assess the reference lists of studies initially retrieved in order to identify any relevant studies that have not been identified by the electronic database searches. Additional searches will also be conducted to identify non-indexed studies and manually searching thesis repositories, Google Scholar and Google for regional health organisation websites. The online sources that we will search include the UNICEF, WHO, Pacific community and individual countries health websites.

Stage 3: study selection

At this stage, we will screen and select the studies. During the primary review, we will consolidate all studies retrieved, remove all duplicates and remove studies that do not correspond to the Population Concept Context criteria.[28] Next, we will screen the titles and abstracts of articles after importing all records retrieved from databases and web-based searches into EndNote. Two reviewers (LK and GT) will be conducting the study selection and data abstraction.[26] Any uncertainty with the title and abstract will go through full-text review. Any uncertainty reached on any article will be discussed with the broader research team. If consensus is not reached, articles will be excluded from the review. All remaining articles will go through full-text screening, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart,[29] and final articles will proceed to the final review.

Stage 4: charting data

Data charting will involve data extraction and documenting from the final articles selected. During the data extraction, all results will be entered into Excel spreadsheets alongside standard bibliographic information that includes author(s), year of publication, origin or country of origin, aims and purpose, study population, methodology, intervention type, intervention duration, outcomes and details and key findings. Box 1 outlines the standard bibliographic information.[27] For each article, reviewed key information to be retrieved will be risk factors matched to birth outcomes and prevalence to the specific context of the region. The framework will be pilot tested by the reviewers to ensure that it is consistent with data charting and the study aims and objectives. Charting of data will be an iterative process of screening and extracting data that will be done mostly by the principal investigator. Any arising questions and uncertainty during the process will be discussed with the research team to reach an agreement.

Box 1 Data extraction table

Main category

a. Author(s).
b. Year of publication.
c. Origin/country study was conducted.
d. Study design.
e. Aims/purpose.
f. Sampling strategy.
g. Study population.
h. Sample size.
i. Methodology.
j. Intervention/exposure type (if applicable) and comparison group (if applicable).
k. Duration of the exposure/intervention (if applicable).
l. Outcomes assessment and method to assess associations (if applicable).
m. Key findings that relate to the scoping review question/s.

Stage 5: collating, summarising and presenting the results

In stage five, tabular presentation of the findings will be mapped from data extracted from the selected articles, as outlined (see Box 1) and guided by Arskey and O'Malley.[25] Findings will be presented quantitatively in aggregated forms figure and qualitatively as thematic narrative summaries, all of which will reflect the study objectives.[25] The results of the studies will not be compared but presented as a body of evidence. We expect to map a wide range of risk factors, prevalence and the different adverse birth outcomes against the countries' ethnic and geographical diversity to provide the first such body of literature for the region.

Stage 6: stakeholder consultation

A consultation exercise will be conducted online with relevant health professionals in the Solomon Islands, including midwives, paediatric nurses, obstetricians and paediatricians identified through contacts and purposive and snowball sampling. This stage aims to validate findings from this study and to add additional insights and recommendations from their perspectives. Consultation will be undertaken at the completion of the article review. The exercise will involve the collection of quantitative and qualitative feedback from clinicians who work with pregnant mothers and infants to obtain their knowledge and experience of risk factors and birth

Table 3 CINAHL searches

Key concepts and terms				
The following key concepts were identified from the topic.				
Concept 1		**Concept 2**		**Concept 3**
Adverse birth outcomes	OR	Pregnancy risk factors	AND	Pacific Island region
MeSH and subject headings identified.				
Key concept terms		**CINAHL**		
Adverse birth outcomes		MH "Pregnancy outcome*" OR MH "Infant very Low birth weight" OR MH "Outcome* of prematurity"		
Pregnancy risk factors		MH "Risk factor*" OR MH "Pregnancy risk" OR MH "High risk*" OR MH "Pregnancy in adolescence" OR MH "Pregnancy risk*"		
Pacific Island region		MH "Pacific Island*"		
Search strings developed				
1. Key concept and general terms and synonyms search string				
("adverse birth outcome*" OR "poor birth outcome*" OR "preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "low birth weight" OR "low birthweight" OR "very low birth weight" OR "very low birthweight" OR "extremely low birth weight" OR "extremely low birthweight" OR "stillbirth" OR "still birth") AND ("pregnancy risk factor*" OR "adverse pregnancy outcome*" OR "poor pregnancy outcome*") AND ("Pacific Island*" OR "Oceania" OR "South Pacific Island*" OR "Pacific Island country*")				
2. MeSH terms search string				
(MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND (MH "risk factor*" OR MH "pregnancy risk*" OR MH "high risk*" OR MH "pregnancy in adolescence*" OR MH "pregnancy risk*") AND ("MH Pacific Island*")				
3. General and MeSH terms combined search string				
("adverse birth outcome*" OR "poor birth outcome*" OR "preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "small baby*" OR "very small baby*"OR "low birth weight" OR "low birthweight" OR "very low birth weight" OR "very low birthweight" OR "extremely low birth weight" OR "extremely low birthweight" OR "stillbirth" OR "still birth" OR MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND ("pregnancy risk factor*" OR "adverse pregnancy outcome*" OR "poor pregnancy outcome*" OR MH "risk factor*"OR MH "pregnancy risk*" OR MH "high risk*" OR MH "pregnancy in adolescence*" OR MH "pregnancy risk*") AND ("Pacific Island*" OR "Oceania" OR "South Pacific Island*" OR "Pacific Island country*" OR "MH Pacific Island*")				
4. Specific and MeSH terms combined search string				
("preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "small baby*" OR "very small baby*" OR "low birth weight" OR "low birthweight" OR "very low birth weight" OR "very low birthweight" OR "extremely low birth weight" OR "extremely low birthweight" OR "stillbirth" OR "still birth" OR MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND ("malaria in pregnancy" OR "anaemia in pregnancy" OR "substance use" OR "alcohol use" OR "betel nut use" OR "areca nut use" OR "tobacco use" OR "cigarette use" OR "maternal obesity" OR "maternal malnutrition" OR "maternal undernutrition" OR "teenage pregnancy") AND ("American Samoa" OR "Cook Island*" OR "Easter Island*" OR "Federated States of Micronesia" OR "Fiji" OR "Guam" OR "Kiribati" OR "Mariana Island*" OR "Marshall Island*" OR "Nauru" OR "New Caledonia" OR "Niue" OR "Palau" OR "Papua New Guinea" OR "Samoa" OR "Solomon Island*" OR "Tahiti" OR "Tokelau" OR "Tonga" OR "Tuvalu" OR "Vanuatu" OR "Wallis and Futuna")				
Filter/limiter used				
Year inclusion 2000 current				
Full-text articles				
English language				
MeSH				

MeSH, Medical Subject Headings.

Similarly, a specific search with more precise key terms or specific risk factors will narrow the search down for each country. Specific search terms will be identified through the initial literature review to understand the specific risk factors within the population. An example of specific key and MeSH terms and search strings also designed for

outcomes in the Solomon Islands from a clinical perspective. Ten health professionals working with pregnant woman and infants will be consulted. Selection will be made by purposeful and snowball sampling.

Stage 7: patient and public involvement

No patient involved.

Author affiliations
[1]Faculty of Nursing, Medicine and Health Sciences, Solomon Islands National University, Honiara, Solomon Islands
[2]School of Public Health, Curtin University Faculty of Health Sciences, Perth, Western Australia, Australia
[3]School of Public Health, University of Adelaide, The University of Adelaide Faculty of Health Sciences, Adelaide, South Australia, Australia
[4]Department of Public Health, Telethon Kids Institute, Nedlands, Western Australia, Australia
[5]School of Population and Global Health, The University of Western Australia Faculty of Health and Medical Sciences, Perth, Western Australia, Australia
[6]Norwegian Institute of Public Health, Centre for Fertility and Health (CeFH), Norwegian Institute of Public Health, Oslo, Norway

Twitter Lydia Sandrah Kuman Kaforau @MorningDew Kaforau and Jonine Jancey @joninejancey

Acknowledgements The authors would like to acknowledge the invaluable support and input from the librarian (Faculty of Health Science of Curtin University), the reviewers (*BMJ Open*) and our team of peer reviewers.

Contributors LSKK, GFP, GAT and JJ: study inception, conceptualisation and design, LSKK: drafted the first version and conducted the preliminary searches, collating all inputs reiteratively and revision of the manuscript; GAT, JJ, HB, GKD and GFP: critically reviewed the manuscript. All authors read and approved the final version.

Funding Article Processing Charge waiver claim 00164914. Full waiver grant number 00D0YaQIK. _5001v1P90VA. National Health and Medical Research Council Grants. #1099655 to GFP, #1173991 to GFP and #1195716 to GAT. Research Council of Norway Grants #262700 to GP.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iDs
Lydia Sandrah Kuman Kaforau http://orcid.org/0000-0002-7894-2896
Jonine Jancey http://orcid.org/0000-0002-7894-2896
Gursimran Kaur Dhamrait http://orcid.org/0000-0002-5191-211X

REFERENCES

1 Weng Y-H, Yang C-Y, Chiu Y-W. Risk assessment of adverse birth outcomes in relation to maternal age. *PLoS One* 2014;9:e114843.
2 Berhan T, Andargachew K. Prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions, South Ethiopia, in 2017. *Reproductive Health* 2018;15:1–10.
3 Sayers SM, Lancaster PAL, Whitehead CL. Fetal Growth Restriction: Causes and Outcomes. In: Quah SR, ed. *International encyclopedia of public health*. Second Edition. Oxford: Academic Press, 2017: 132–42.
4 Wachamo TM, Bililign Yimer N, Bizuneh AD, Tesfahun MW, Nigus BY, Asmamaw DB. Risk factors for low birth weight in hospitals of North Wello zone, Ethiopia: a case-control study. *PLoS One* 2019;14:e0213054.
5 Tampah-Naah A, Anzagra L, Yendaw E. Factors correlate with low birth weight in Ghana. *Br J Med Med Res* 2016;16:1–8.
6 Su D, Samson K, Garg A, *et al*. Birth history as a predictor of adverse birth outcomes: evidence from state vital statistics data. *Prev Med Rep* 2018;11:63–8.
7 Adane AA, Ayele TA, Ararsa LG, *et al*. Adverse birth outcomes among deliveries at Gondar university Hospital, Northwest Ethiopia. *BMC Pregnancy Childbirth* 2014;14:90.
8 Tsegaye B, Kassa A. Prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions, South Ethiopia, in 2017. *Reprod Health* 2018;15:193–93.
9 Chawanpaiboon S, Vogel JP, Moller A-B, *et al*. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. *Lancet Glob Health* 2019;7:e37–46.
10 Charlton KE, Russell J, Gorman E, *et al*. Fish, food security and health in Pacific island countries and territories: a systematic literature review. *BMC Public Health* 2016;16:285.
11 Dongarwar D, Salihu HM. Place of residence and inequities in adverse pregnancy and birth outcomes in India. *Int J MCH AIDS* 2020;9:53–63.
12 Horwood PF, Tarantola A, Goarant C, *et al*. Health challenges of the Pacific region: insights from history, geography, social determinants, genetics, and the microbiome. *Front Immunol* 2019;10:2184.
13 OECD, Organisation WH. Health at a glance: Asia/Pacific 2018: measuring progress towards universal health coverage. ParisOECD Publishing; 2018: 1–134. https://doi.org/10.1787/health_glance_ap-2018-en [Accessed 29.03.21].
14 Linhart C, Carter K, Sorchik R. Trends in neonatal and infant mortality for Pacific island states. Secretariat of the Pacific Community Cataloguing-in-publication data Secretariat of the Pacific Community; 2015: 1–90. https://sdd.spc.int/en/reports-manuals/101-pacific-infant-and-neonatal-mortality-trends-report
15 Lee ACC, Katz J, Blencowe H, *et al*. National and regional estimates of term and preterm babies born small for gestational age in 138 low-income and middle-income countries in 2010. *Lancet Glob Health* 2013;1:e26–36.
16 Yakoob MY, Lawn JE, Darmstadt GL, *et al*. Stillbirths: epidemiology, evidence, and priorities for action. *Semin Perinatol* 2010;34:387–94.
17 WHO. Country cooperation stratergy at a glance, Pacific island countries WHO country page; 2013: 1–2. http://www.who.int/countryfocus [Accessed 29 Mar 2021].
18 Andrew NL, Bright P, de la Rua L, *et al*. Coastal proximity of populations in 22 Pacific island countries and territories. *PLoS One* 2019;14:e0223249.
19 Quinn B, Peach E, Wright CJC, *et al*. Alcohol and other substance use among a sample of young people in the Solomon Islands. *Aust N Z J Public Health* 2017;41:358–64.
20 Pratt S. The challenge of betel nut consumption to economic development: a case of Honiara. *Solomon Islands* 2014;21:103.
21 Jarawan E, Carpio C. Health challenges in the small island developing countries of the Pacific and the Caribbean. OnlineWorld Bank; unknown: 1–37. https://www.worldbank.org/content/dam/Worldbank/Health
22 De Silva M, Panisi L, Brownfoot FC, *et al*. Systematic review of areca (betel nut) use and adverse pregnancy outcomes. *Int J Gynaecol Obstet* 2019;147:292–300.
23 Berger KE, Masterson J, Mascardo J, *et al*. The effects of chewing betel nut with tobacco and Pre-pregnancy obesity on adverse birth outcomes among Palauan women. *Matern Child Health J* 2016;20:1696–703.
24 Aromataris E, Munn Z. *JBI reviewer's manual*. 488. Adelaide, Australia: Joana Briggs Institute, 2020.
25 Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8:19–32.
26 Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci* 2010;5:69.
27 Peters M, Godfrey C, Khalil H. 2017 guidance for the conduct of JBI scoping reviews. *Joana Briggs Inst Rev Man* 2017;13:141–6.
28 Halas G, Schultz ASH, Rothney J, *et al*. A scoping review protocol to map the research foci trends in tobacco control over the last decade. *BMJ Open* 2015;5:e006643–e43.
29 Moher D, Liberati A, Tetzlaff J, *et al*. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;6:e1000097.

Appendix B: Search Strategy

Grid of key concepts and terms

Concept 1		**Concept 2**		**Concept 3**
Adverse birth outcomes	OR	Pregnancy risk factors	AND	Pacific Island countries

CINAHL searches for key concept terms and terms

Key concept terms	CINAHL Mesh and subject headings identified
Adverse birth outcomes	MH "Pregnancy outcome*" OR MH "Infant very Low birth weight" OR MH "Outcome* of prematurity"
Pregnancy risk factors	MH "Risk factor*" OR MH "Pregnancy risk" OR MH "High risk*" OR MH "Pregnancy in adolescence" OR MH "Pregnancy risk*"
Pacific Island region	MH "Pacific Island*"

Search strings developed

Key concept and general terms and synonyms search string ("adverse birth outcome*" OR "poor birth outcome*" OR "preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "low birth weight" OR "low birth weight " OR "very low birth weight" OR "very low birth weight " OR "extremely low birth weight" OR "extremely low birth weight " OR "stillbirth" OR "still birth") AND ("pregnancy risk factor*" OR "adverse pregnancy outcome*" OR "poor pregnancy outcome*") AND ("Pacific Island*" OR "Oceania" OR "South Pacific Island*" OR "Pacific Island country*")
MeSH terms search string (MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND (MH "risk factor*" OR MH "pregnancy risk*" OR MH "high risk*" OR MH "pregnancy in adolescence*" OR MH "pregnancy risk*") AND ("MH Pacific Island*")
General and MeSH terms combined search string ("adverse birth outcome*" OR "poor birth outcome*" OR "preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "small baby*" OR "very small baby*"OR "low birth weight" OR "low birth weight " OR "very low birth weight" OR "very low birth weight " OR "extremely low birth weight" OR "extremely low birth weight " OR "stillbirth" OR "still birth" OR MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND ("pregnancy risk factor*" OR "adverse pregnancy outcome*" OR "poor pregnancy outcome*" OR MH "risk factor*"OR MH "pregnancy risk*" OR MH "high risk*" OR MH "pregnancy in adolescence*" OR MH "pregnancy risk*") AND ("Pacific Island*" OR "Oceania" OR "South Pacific Island*" OR "Pacific Island country*" OR "MH Pacific Island*")
Specific and MeSH terms combined search string ("preterm birth*" OR "premature birth*" OR "Poor fetal growth*" OR "fetal growth restriction*" OR "intrauterine growth retardation" OR "growth retardation" OR "small baby*" OR "very small baby*" OR "low birth weight" OR "low birth weight " OR "very low birth weight" OR "very low birth weight " OR "extremely low birth weight" OR "extremely low birth weight " OR "stillbirth" OR "still birth" OR MH "pregnancy outcome*" OR MH "infant very low birth weight" OR MH "outcome* of prematurity") AND ("malaria in pregnancy" OR "anaemia in pregnancy" OR "substance use" OR "alcohol use" OR "betel nut use" OR "areca nut use" OR "tobacco use" OR "cigarette use" OR "maternal obesity" OR "maternal malnutrition" OR "maternal undernutrition" OR "teenage pregnancy") AND ("American Samoa" OR "Cook Island*" OR "Easter Island*" OR "Federated States of Micronesia" OR "Fiji" OR "Guam" OR "Kiribati" OR "Mariana Island*" OR "Marshall Island*" OR "Nauru" OR "New Caledonia" OR "Niue" OR "Palau" OR "Papua New Guinea" OR "Samoa" OR "Solomon Island*" OR "Tahiti" OR "Tokelau" OR "Tonga" OR "Tuvalu" OR "Vanuatu" OR "Wallis and Futuna") Filter/limiter used
Filter/Limiter used -Year inclusion 2000-1st January-28th 2021 -Full text articles -English Language

Appendix C: Data Extraction Table

Main Category
a. Author(s)
b. Year of publication
c. Origin/country study was conducted
d. Study design
e. Aims/purpose.
f. Sampling strategy
g. Study population
h. Sample size
i. Methodology
j. Intervention/exposure type (if applicable) and comparison group (if applicable)
k. Duration of the exposure/intervention (if applicable)
l. Outcome assessment and method to assess associations (if applicable)
m. Key findings that relate to the scoping review question(s)

Appendix D: Prevalence of Adverse Birth Outcome

Countries	Sources	Adverse Birth Outcome Prevalence	Effect Size 95% Confidence Interval (CI)
Low Birth Weight			
PNG	Peters, Vince and Friesen [98]	8%	(7%, 11%)
	Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	17%	(14%, 28%)
	Unger, Ome-Kaius, Karl, Singirok, Siba, Walker, Wangnapi, Mueller and Rogerson [192]	16%	(14%, 23%)
	Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	14%	(14%, 19%)
	Lufele, Umbers, Ordi, Ome-Kaius, Wangnapi, Unger, Tarongka, Siba, Mueller, Robinson and Rogerson [96]	14%	(14%, 19%)
	Fowkes, Davidson, Agius and Beeson [93]	17%	(14%, 29%)
	Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	15%	(16%, 20%)
	National Statistics Office [92]	14%	(15%, 18%)
Vanuatu	Ministry of Health [197]	11%	(10%, 15%)
Solomon Islands	Cafaro, Randle, Wyche, Higgins, Fink and Jones [40]	12%	(11%, 17%)
	SINSO [37]	10%	(10%, 13%)
Tonga	MHMS [172]	4%	(3%, 5%)
Samoa	Bureau of Statistics [171]	5%	(4%, 6%)
Tuvalu	Central Statistics Division [194]	6%	(4%, 10%)
CNMI	Dela Cruz[91,] Dela Cruz, Grant, Heck and Cash [95,93]	3%	(3%, 4%)
Palau	Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	8%	(7%, 11%)
Kiribati	National Statistic Office [198]	13%	(11%, 17%)
Marshall Is.	Economic Policy [195]	18%	(18%, 26%)
Nauru	Bureau of Statistics [91]	27%	(27%, 50%)
Preterm Birth			
PNG	Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	22%	(20%, 39%)
	Fowkes, Davidson, Agius and Beeson [93]	22%	(20%, 40%)
	Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	9 %	(8%, 13%)

Solomon Islands	Cafaro, Randle, Wyche, Higgins, Fink and Jones [40]	24%	(26%, 36%)
CNMI	Dela Cruz, Grant, Heck and Cash [95]	7 %	(6%, 8%)
Palau	Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	9%	(8%, 12%)
Preterm Low Birth Weight			
Palau	Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	5%	(4%, 5%)
Term Low Birth Weight			
	Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	4%	(3%, 5%)
Preterm Normal Weight			
Palau	Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	4%	(3%, 6%)
SGA			
PNG	Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	2%	(1%, 3%)
Smaller Than Average Babies			
PNG	National Statistics Office [92]	19%	(21%, 25%)
Solomon Islands	SINSO [37]	11%	(11%, 14%)
Samoa	Bureau of Statistics [171, 372]	11%	(11%, 14%)
Tuvalu	Central Statistics Division [194]	11%	(9%, 17%)
Kiribati	National Statistic Office [198]	5%	(4%, 7%)
Marshall Islands	Economic Policy [195]	18%	(18%, 26%)
Very Small Babies			
Solomon	SINSO [37]	3%	(3%, 4%)
Tonga	MHMS [172, 196]	5%	(4%, 7%)
Samoa	Bureau of Statistics [171, 372]	1%	(0%, 1%)
Tuvalu	Central Statistics Division [194]	3%	(2%, 5%)
Kiribati	National Statistic Office [198]	2%	(1%, 3%)
Marshall Islands	Economic Policy [195]	5%	(4%, 7%)
Nauru	Bureau of Statistics [91]	22%	(21%, 39%)

Appendix E: Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) Checklist

Section	Item	PRISMA-ScR Checklist Item	Reported on Page #
Title			
Title	1	Identify the report as a scoping review.	1
Abstract			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualise the review questions and/or objectives.	4
Methods			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	https://bmjopen.bmj.com/content/11/4/e042423
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4 Detailed in protocol inclusion and exclusion criteria"
Information sources	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Outlined in page 5 More detail in Supplementary file 1
Selection of sources of evidence	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6 Figure 1 PRISMA flow diagram
Data charting process	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Table 1 summary of studies
Critical appraisal of individual sources of evidence	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Not applicable
Synthesis of results	13	Describe the methods of handling and summarising the data that were charted.	5

Results			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	6, Figure 1 PRISMA flow diagram
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	6-7, supplementary 5 and 6 presenting effect estimates
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not applicable
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6-7, supplementary 5 and 6 presenting effect estimates
Synthesis of results	18	Summarise and/or present the charting results as they relate to the review questions and objectives.	6-7, supplementary 4 and 5 presenting effect estimates
Discussion			
Summary of evidence	19	Summarise the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	6-7
Limitations	20	Discuss the limitations of the scoping review process.	11
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	11
Funding			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	11

Retrieved from: Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169:467-473. doi: 10.7326/M18-0850

Appendix F: Health, Demographic, and Social Risk Factors Associated with LBW[xvi]

Authors	Exposures Comparison	Effect Estimate (95%, CI)
Lufele, Umbers, Ordi, Ome-Kaius, Wangnapi, Unger, Tarongka, Siba, Mueller, Robinson and Rogerson [96]	**Placenta malaria infection**	
	No	**Reference**
	Acute	AOR 2.0 (0.89, 3.95)
	Chronic	AOR 1.2 (0.59, 2.50)
	Past	AOR 1.0 (0.61, 1.63)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Placenta malaria infection**	
	No	**Reference**
	Chronic	AOR 3.3 (1.0, 10.60)
	Acute	AOR 0.7 (0.22, 2.0)
	Past	AOR 1.5 (0.37, 6.10)
	Sub-microscopic malaria infection	
	Negative	**Reference**
	Positive	AOR 2.4 (0.99, 5.89)
Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	**Plasmodium falciparum malaria infection**	
	No	**Reference**
	Sub-microscopic	AOR 1.0 (0.55, 1.84)
	Microscopic	AOR 1.0 (0.54, 1.75)
	Plasmodium falciparum malaria (peripheral blood)	
	No	**Reference**
	Sub-microscopic	AOR 1.0 (0.35, 2.83)
	Microscopic	AOR 2.8 (1.27, 5.94)
	P. falciparum malaria (placenta blood)	
	No	**Reference**
	Sub-microscopic	AOR 2.9 (0.82, 9.91)
	Microscopic	AOR 2.1 (0.87, 4.98)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Clinical history of infection**	
	No	**Reference**
	Yes	AOR 1.0 (0.42, 1.90)
	Maternal parasitaemia (enrolment)	
	No	**Reference**
	Yes	AOR 1.0 (0.50, 2.20)
Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	**Betel nut users with tobacco use**	
	No	**Reference**
	Yes	AOR 2.4 (1.0, 6.0)
	Betel nut users	
	No	**Reference**
	Yes	OR 1.9 (0.4, 17.0)

[xvi] AOR: adjusted odds ratio; cm: centimetre; g/dL: gram per decilitre; kgm3: kilogram per cubic metre; OR: odds ratio; SPAZ-IPTp: sulphadoxine-pyrimethamine and azithromycin.
Odds ratio rounded to the nearest one decimal place.

Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Betel nut users (term LBW)**	
	No	**Reference**
	Yes	OR 3.0 (0.4, 13.0)
Peters, Vince and Friesen [98]	**Maternal tobacco users**	
	No	**Reference**
	Yes	OR 2.9 (1.28, 6.32)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Maternal tobacco users**	
	No	**Reference**
	Yes	AOR 1.4 (0.62, 3.35)
Fowkes, Davidson, Agius and Beeson [93]	**Iron deficiency and gravidity**	
	Primigravida	AOR 0.3 (0.10, 0.66)
	Multigravida	**Reference**
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Southeast Asian ovalocytosis**	
	Normal	**Reference**
	Infected	AOR 2.3 (0.94, 5.75)
	Alpha thalassaemia infection	
	Wildtype	**Reference**
	Heterozygote	AOR 0.7 (0.27, 1.58)
	Homozygote	AOR 0.6 (0.22, 1.34)
	Maternal anaemia (Hb <8 g/dL)	
	No	**Reference**
	Yes	OR 1.0 (0.52, 1.80)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**Maternal height (<150cm)**	
	No	**Reference**
	Yes	AOR 1.7 (1.22, 2.41)
	Maternal MUAC (<23 cm)	
	No	**Reference**
	Yes	AOR 1.5 (1.10, 2.03)
Peters, Vince and Friesen [98]	**Maternal age (years)**	
	22-35	**Reference**
	< 22 years and >35	OR 1.9 (1.04, 3.56)
Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	**Body mass index (kgm3)**	
	<30 kgm3	**Reference**
	≥30 kgm3	AOR 0.6 (0.3, 1.4)
Peters, Vince and Friesen [98]	**Birth intervals (years)**	
	> 2 years	**Reference**
	<2 years	OR 3.6 (1.39, 9.30)
	Antenatal booking	
	Booked	**Reference**
	Unbooked	AOR 4.0 (2.12, 7.57)
	Antenatal visits	
	≥3 visits	**Reference**
	<3 visits	OR 2.9 (1.36, 6.14)
	Fever during pregnancy	
	No	**Reference**
	Yes	OR 2.8 (0.87, 8.83)
	Female infants	

Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	Yes	**Reference**
	No	OR 1.6 (1.22, 2.22)
	Primigravida	
	No	**Reference**
	Yes	AOR 2.9 (2.13, 3.96)
	Number of antenatal visits	
	≥3 visits	**Reference**
	1-2 visits	AOR 0.7 (0.46, 0.92)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Gravidity**	
	Primigravida	**Reference**
	Multigravida	AOR 0.3 (0.13, 0.57)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**Malaria prophylaxis (SPAZ-IPTp)**	
	Yes	**Reference**
	No	AOR 0.6 (0.48, 0.85)
	PNG highlands mothers	
	Yes	**Reference**
	No	AOR 0.3 (0.14, 0.80)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Maternal education status**	
	No	**Reference**
	Primary	AOR 0.5 (0.13, 1.70)
	Secondary	AOR 0.6 (0.16, 2.00)

Appendix G: Health, Demographic, and Social Risk Factors Associated with Preterm Births[xvii]

Authors	Exposures Comparison	Effect Estimate (95%, CI)
Lufele, Umbers, Ordi, Ome-Kaius, Wangnapi, Unger, Tarongka, Siba, Mueller, Robinson and Rogerson [96]	**Placenta malaria infection**	
	No	**Reference**
	Acute	AOR 2.3 (0.86, 6.35)
	Chronic	AOR 3.9 (1.64, 9.38)
	Past	AOR 1.5 (0.71, 3.03)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Placenta malaria infection**	
	No	**Reference**
	Acute	AOR 2.1 (0.75, 5.80)
	Chronic	AOR 4.2 (1.30, 13.40)
	Past	AOR 1.3 (0.30, 6.10)
Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	**Plasmodium falciparum malaria infection**	
	No	**Reference**
	Sub-microscopic	AOR 0.2 (0.02, 1.26)
	Microscopic	AOR 1.2 (0.49, 1.26)
	Plasmodium falciparum malaria (peripheral blood)	
	No	**Reference**
	Sub-microscopic	AOR 0.5 (0.07, 4.29)
	Microscopic	AOR 6.6 (2.46, 17.62)
	Plasmodium falciparum malaria (placenta blood)	
	No	**Reference**
	Sub-microscopic	AOR 3.3 (0.66, 16.83)
	Microscopic	AOR 3.0 (0.87, 10.30)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Tobacco smoke users**	
	No	**Reference**
	Yes	AOR 1.1 (0.50, 2.62)
Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	**Betel nut and tobacco smoke users**	
	No	**Reference**
	Yes	AOR 1.0 (0.6, 1.70)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Betel nut users**	
	No	**Reference**
	Yes	OR 0.6 (0.1, 5.4)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**Betel nut users**	
	No	**Reference**
	Yes	OR 0.9 (0.65, 1.38)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba,	**Southeast Asian ovalocytosis infection**	
	No	**Reference**
	Yes	AOR 1.1 (0.40, 2.99)
	Alpha thalassaemia infection	
	Wildtype	**Reference**

[xvii] AOR: adjusted odds ratio; kgm3: kilogram per cubic metre; OR: odds ratio.
Odds ratio rounded to the nearest one decimal place.

Beeson, Mueller, Fowkes and Rogerson [100]	Heterozygote	AOR 0.9 (0.38, 2.23)
	Homozygote	AOR 0.6 (0.25, 1.56)
Berger, Masterson, Mascardo, Grapa, Appanaitis, Temengil, Watson and Cash [94]	**Body mass index (kgm3)**	
	<30 kgm3	**Reference**
	≥30 kgm3	AOR 1.5 (1.0, 2.3)
Dela Cruz, Grant, Heck and Cash [95]	**Maternal age (years)**	
	20-34 years	**Reference**
	<20 years	AOR 1.3 (1.0, 1.80)
	≥35 years	AOR 1.5 (1.20, 1.9)
	Number of antenatal visits	
	≥9 visits	**Reference**
	0 visit	AOR 3.9 (2.90, 5.3)
	1-8 visits	AOR 2.8 (2.10, 3.7)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Gravidity**	
	Primigravida	**Reference**
	Multigravida	AOR 0.4 (0.19, 0.79)
	Used of bed nets during pregnancy	
	No	**Reference**
	Yes	AOR 0.8 (0.36, 1.7)
Dela Cruz, Grant, Heck and Cash [95]	**Maternal race/ethnicity**	
	Chinese women	**Reference**
	CNMI women	AOR 2.7 (2.0, 3.6)
	Pacific Island women	AOR 2.9 (2.1, 4.1)
	Filipino	AOR 2.3 (1.7, 3.1)
	Another non-Pacific Islander	AOR 1.1 (0.7, 1.7)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Maternal education status**	
	No	**Reference**
	Primary	AOR 0.2 (0.07, 0.66)
	Secondary	AOR 0.1 (0.04, 0.42)

Appendix H: Health, Demographic, and Social Risk Factors Associated with SGA[xviii]

Authors	Exposures Comparison	Effect Estimate (95%, CI)
Lufele, Umbers, Ordi, Ome-Kaius, Wangnapi, Unger, Tarongka, Siba, Mueller, Robinson and Rogerson [96]	**Placenta malaria infection**	
	No	**Reference**
	Acute	AOR -0.7 (-5.02, 3.71)
	Chronic	AOR -3.4 (-7.79, 1.02)
	Past	AOR -1.5 (-4.27, 1.23)
Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	**Plasmodium falciparum malaria**	
	No	**Reference**
	Sub-microscopic	AOR 1.7 (0.93, 2.92)
	Microscopic	AOR 0.7 (0.35, 1.43)
	Plasmodium falciparum malaria (peripheral blood)	
	No	**Reference**
	Sub-microscopic	AOR 1.3 (0.44, 3.96)
	Microscopic	AOR 1.7 (0.67, 4.39)
	Plasmodium Falciparum malaria (placenta blood)	
	No	**Reference**
	Sub-microscopic	AOR 2.6 (0.71, 9.56)
	Microscopic	AOR 1.6 (0.61, 4.34)
Unger, Ome-Kaius, Karl, Singirok, Siba, Walker, Wangnapi, Mueller and Rogerson [192]	**Malaria infection**	
	No	**Reference**
	Yes	ARR 1.1 (0.91, 1.36)
	Maternal recent infection (weeks)	
	>6	**Reference**
	<6	ARR 1.0 (0.81, 1.32)
	Maternal infection	
	1 infection	**Reference**
	≥2 infection	ARR 1.2 (0.85, 1.63)
	Betel nut chewing	
	No	**Reference**
	Yes	ARR 0.9 (0.72, 1.09
	Tobacco smoke	
	No	**Reference**
	Yes	ARR 1.0 (0.79, 1.22)
	Anaemia at enrolment (mg/L)	
	Hb<90	ARR 1.3 (1.06, 1.51)
	Hb>90	**Reference**
	Mid upper arm circumference (cm)	
	>22	**Reference**
	<22	ARR 1.5 (1.29, 1.76)
	Maternal height (cm)	
	>150	**Reference**
	<150	ARR 1.3 (1.04, 1.55)
	Maternal body mass index (kg/m3)	
	>18.5	**Reference**

[xviii] AOR: adjusted odds ratio; ARR: adjusted relative risks; cm: centimetre; Hb: haemoglobin; kg/m: kilogram per cubic metre; mg/L: milligram per litre; RR: relative risk.
*RR and CI recalculated.
Odds ratio rounded to the nearest one decimal place.

	<18.5	ARR 1.3 (0.95, 1.80)
	Gravidity	
	Multigravida	**Reference**
	Primigravida	RR 1.4 (1.13, 1.61)
	Recent IPTp malaria prophylaxis	
	No	**Reference**
	Yes	ARR 0.2 (0.04, 0.27)
	Maternal ethnicity	
	Madang/Morobe	**Reference**
	Other	RR 0.8 (0.70, 1.02)
	Literate mother	
	No	**Reference**
	Yes	RR 1.1 (0.81, 1.49)
	Mother generating income	
	No	**Reference**
	Yes	RR 1.0 (0.87, 1.24)
	Partner generating income	
	No	**Reference**
	Yes	RR 0.9 (0.73, 1.02)
	Maternal area of residence	
	Urban area	**Reference**
	Peri-urban area	RR 1.2 (0.87, 1.52)
	Rural area	RR 1.1 (0.83, 1.37)
Stillbirth and Miscarriage Risks		
Ome-Kaius, et al.[6]	**Betel nut chewing mothers**	
	Non-users	**Reference**
	Heavy users	RR 1.8 (0.63, 2.97)*
Unger, Rosanas-Urgell, Robinson, Ome-Kaius, Jally, Umbers, Pomat, Mueller, Kattenberg and Rogerson [193]	**Malaria Infection**	
	No infection	**Reference**
	Submicroscopic infection	AOR 0.8 (0.19, 3.41)
	Microscopic infection	AOR 2.0 (0.68, 5.66)

Appendix I: Health, Demographic, and Social Risk Factors Associated with Changes in Mean Birth Weight[xix]

Authors	Exposures Comparison	Effect Estimate (95%, CI)
Lufele, Umbers, Ordi, Ome-Kaius, Wangnapi, Unger, Tarongka, Siba, Mueller, Robinson and Rogerson [96]	**Placenta malaria infection**	
	No infection	**Reference**
	Acute infection	-189.0 (-323.3, -54.6)
	Chronic infection	-63.6 (-199.08, -71.7)
	Past infection	-76.1 (-159, -6.8)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Malaria infection**	
	Non-infected	**Reference**
	Infected	-42 (NR)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Submicroscopic Plasmodium falciparum malaria infection**	
	Negative	**Reference**
	Positive	-64 (-188, 59)
	Clinical history taken during antenatal care	
	No	**Reference**
	Yes	-104 (-230, 22)
	Parasitaemia	
	No	**Reference**
	Yes	-30 (-149, 89)
	Tobacco smoke users	
	No	**Reference**
	Yes	-197 (-333, -261)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Betel nut users**	
	Non-users	**Reference**
	Users	-238 (NR)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**Betel nut users**	
	Non-users	**Reference**
	Users	-1 (NR)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Haemoglobin test at enrolment**	
	No	**Reference**
	Yes	61 (19, 102)
	Anaemia	
	No	**Reference**
	Yes	-101 (-215, 13)
Fowkes, Davidson, Agius and Beeson [93]	**Gravidity and iron deficiency**	
	Primigravida	351 (188, 514)
	Multigravida	125 (-28, 277)

[xix] cm: centimetre; kgm3: kilogram per cubic metre; g/l: grams per litre; Hb: haemoglobin; NR: confidence interval not reported. Note: Effect estimate illustrated changes in mean birth weight in grams.

Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Anaemia (g/l)**	
	Hb >80	**Reference**
	Hb <80	-65 NR
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Southeast Asian ovalocytosis infection**	
	Yes	**Reference**
	Infected	-129 (-287, 29)
	Alpha thalassemia	
	Wildtype	**Reference**
	Heterozygote	-12 (-159, 135)
	Homozygote	47 (-100, 194)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Body mass index (kgm3)**	
	<20	**Reference**
	>20	-175 (NR)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**Mid upper arm circumference (cm)**	
	>23	**Reference**
	<23	-99 (NR)
	Short stature	
	>150cm	**Reference**
	<150 cm	-151 (NR)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Gravidity**	
	Multigravida	**Reference**
	Primigravida	-467 (NR)
	Hypertension	
	No	**Reference**
	Yes	-117 (NR)
	Haemoglobin (g/l)	
	>80	**Reference**
	<80	-65 (NR)
	Antenatal care	
	Yes	**Reference**
	No	-23 (NR)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**Gravidity**	
	Multigravida	**Reference**
	Primigravida	-214 (NR)
	Fewer antenatal visits	
	≥3 visits	**Reference**
	1-2 visits	-73 (NR)
	Infant sex	
	Male	**Reference**
	Female	-78 (NR)
	Malaria prophylaxis	
	Yes	**Reference**
	No	44 (NR)
	Use of bed net	
	Regular	**Reference**
	Irregular	16 (NR)
	Use of bed net	
	No	**Reference**

Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	Yes	-40 (-165, 84)
	Gravidity	
	Primigravida	**Reference**
	Multigravida	325 (211, 439)
Ome-Kaius, Unger, Singirok, Wangnapi, Hanieh, Umbers, Elizah, Siba, Mueller and Rogerson [97]	**PNG ethnicity**	
	Highlander	**Reference**
	Non-Highlander	-311 (NR)
	Received income	
	Yes	**Reference**
	No	-22 (NR)
Senn, Baiwog, Winmai, Mueller, Rogerson and Senn [99]	**Socioeconomic level**	
	High	**Reference**
	Low	-54 (NR)
	Education level	
	High	**Reference**
	Low	-33 (NR)
Stanisic, Moore, Baiwog, Ura, Clapham, King, Siba, Beeson, Mueller, Fowkes and Rogerson [100]	**Maternal education status**	
	No education	**Reference**
	Primary education	100 (-104, 305)
	Secondary education	79 (-127, 286)

Appendix J: Reported Adverse Birth Outcomes and Counts of Risk Factors Nominated by Health Professionals Interviewed (n=18)

Reported Adverse Birth Outcomes	Health Professionals (n=18)
Preterm birth	14
LBW	12
SGA	11
Stillbirth	8
Miscarriage or abortion	8
Reported risk factors for adverse birth outcomes	
Physical and emotional stress	13
Teenaged pregnancy	11
Malaria during pregnancy	11
Poverty	11
Poor antenatal care access	10
Pre-eclampsia	10
Anaemia and iron deficiency	9
Sexually transmitted infections including HIV	9
Hypertension or pregnancy-induced hypertension	7
Unplanned or unwanted pregnancies	6
Substance use (betel nut, tobacco, kava, and marijuana)	7
Type 2 diabetes or gestational diabetes	5
Abortion (spontaneous)	5
History of rheumatic heart disease	4
Domestic violence	5
Maternal illiteracy	5
Poor nutrition	4
Tuberculosis	4
Falls and accidents	3
Poor health seeking behaviour	3
Urinary tract infection and intrauterine infection	2
Food taboo	2

Appendix K: Unadjusted and Adjusted Analysis of Social, Demographic, Behavioural, and Maternal Health Characteristics Comparing All Births Including Self-Report of Birth Weight (n= 3729) and Births Excluding Self-Report of Birth Weight (n=2,879)[xx]

Risk Factors	RR 95% CI Including Self-Report (n=3,729)		RR 95% CI Excluding Self-Report (n=2,879)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Household members				
1-5 members	**Reference**	**Reference**	**Reference**	**Reference**
>5 members	1.23 (0.97, 1.55)	1.17 (0.89, 1.53)	1.23 (0.93, 1.64)	1.23 (0.89, 1.70)
Parity (child ever born)				
1st child	1.22 (0.88, 1.68)	1.07 (0.70, 1.63)	1.13 (0.79, 1.62)	1.07 (0.68, 1.68)
2nd-4th child	**Reference**	**Reference**	**Reference**	**Reference**
>5th child and above	0.89 (0.65, 1.22)	0.75 (0.51, 1.09)	0.81 (0.56, 1.17)	0.69 (0.45, 1.06)
Sex of child				
Male	**Reference**	**Reference**	**Reference**	**Reference**
Female	1.16 (0.94, 1.43)	1.19 (0.94, 150)	1.29 (1.01, 1.64)	1.29 (0.98, 1.68)
Mothers' marital status				
Married/ in union	**Reference**		**Reference**	
Not married	1.09 (0.78, 1.58)		1.02 (0.66, 1.57)	
Religion/ denomination				
Anglican	1.17 (0.95, 1.95)		1.24 (0.92, 1.67)	
Roman Catholic	1.15 (0.89, 2.03)		1.03 (0.68, 1.58)	
Protestant and Pentecostal	**Reference**		**Reference**	
Minor religion (combined)	1.36 (1.01, 2.50)		1.36 (0.91, 2.03)	
Household wealth				
Poorest (Quintiles 1-2)	0.93 (0.71, 1.21)	1.07 (0.79, 1.45)	0.82 (0.59, 1.13)	0.95 (0.65, 1.38)
Middle (Quintile 3)	1.22 (0.91, 1.62)	1.33 (0.95, 1.85)	1.11 (0.80, 1.53)	1.11 (0.76, 1.62)
Highest (Quintiles 4-5)	**Reference**	**Reference**	**Reference**	**Reference**
Place of residence				
Urban	**Reference**		**Reference**	

[xx]**Information for antenatal and health services information was only available for that last birth in the survey. Adjusted analyses were made only for covariates with overall P-values less than 0.2. CI; confidence interval, RR; relative risk.

Rural	0.97 (0.77, 1.21)		0.89 (0.71, 1.13)	
Mothers' age (years)				
<20	1.46 (0.90, 2.11)	1.49 (0.93, 2.40)	1.39 (0.89 2.16)	1.43 (0.87, 2.35)
20-34	**Reference**	**Reference**	**Reference**	**Reference**
35-49	1.08 (0.83, 1.40)	1.22 (0.89, 1.66)	1.04 (0.76, 1.43)	1.22 (0.84, 1.79)
Mothers' education status				
Primary and lower	0.97 (0.78, 1.22)		0.95 (0.73, 1.24)	
Secondary and higher	**Reference**		**Reference**	
History of substance use				
None	**Reference**	**Reference**	**Reference**	**Reference**
Betel nut use	1.11 (0.80, 1.54)	1.05 (0.75, 1.49)	1.02 (0.72, 1.45)	1.06 (0.72, 1.54)
Kava use	2.52 (0.88, 7.19)	2.50 (0.63, 9.88)	2.93 (1.04, 8.28)	3.16 (0.85, 11.83)
Marijuana use	2.92 (1.02, 8.32)	2.64 (0.64, 10.95)	3.23 (1.11, 9.42)	3.13 (0.88, 11.23)
Alcohol use	1.12 (0.53, 2.39)	1.28 (0.56, 2.96)	1.57 (0.71, 3.45)	1.71 (0.74, 3.97)
Tobacco and cigarette	1.32 (0.93, 1.87)	1.26 (0.85, 1.87)	1.15 (0.77, 1.73)	1.17 (0.72, 1.88)
Decision making				
Wife, husband, or Joint	**Reference**	**Reference**	**Reference**	**Reference**
Another person	1.66 (1.05, 2.68)	1.72 (1.09, 2.72)	1.66 (0.99, 3.05)	1.60 (0.87, 2.92)
Women with polygamous husband				
No	**Reference**	**Reference**	**Reference**	**Reference**
Yes	1.89 (1.25, 2.87)	1.84 (1.15, 2.93)	1.42 (1.01, 4.09)	1.30 (0.68, 2.51)
No. of antenatal care visits (n=1,959)**				
No	1.78 (0.99, 3.22)	1.73 (0.96, 3.13)	2.03 (1.01, 4.09)	2.12 (1.07, 4.18)
Yes	**Reference**		**Reference**	**Reference**
Received iron supplement (n=1,959)**				
No	1.06 (0.67, 1.67)		1.13 (0.66, 1.94)	
Yes	**Reference**		**Reference**	
Malaria infection (n=1,959)**				
No	**Reference**		**Reference**	
Yes	1.09 (0.70, 1.69)		1.05 (0.62, 1.77)	
Deworm (n=1,959)**				
No	1.04 (0.80, 1.37)		0.96 (0.71, 1.31)	
Yes	**Reference**		**Reference**	

Appendix L: PAFs of the Potential Risk Factors and LBW in the Solomon Islands[xxi]

Groups at Risk	Proportion Exposed	Adjusted Relative Risk	PAF (%)
Household with >5 members	0.62	1.17	10
Female child	0.48	1.19	8
Tobacco and cigarette use history	0.17	1.26	4
Polygamous relationship	0.05	1.84	4
Marijuana use history	0.02	2.64	3
Betel nut use history	0.64	1.05	3
No antenatal care visits	0.04	1.73	3
Another person made decision	0.04	1.72	3
Kava use history	0.01	2.5	1
Alcohol use history	0.03	1.28	1

[xxi] PAF was calculated by multiplying the proportion of the population exposed by relative risk, divided by the proportion of the population exposed, then multiplied by relative risk. MS Excel was used for calculations.

Appendix M: Women's Characteristics

Characteristics	Frequency (n=18)	%
Age (Years)		
<20	6	33
21-30	7	39
31-40	5	28
Area of residence		
Rural	11	61
Urban	7	39
Ethnicity		
Melanesian	16	88
Micronesian	1	6
Polynesian	1	6
Union (permanent relationship)		
In union	15	83
Not in union	3	17
Education Status		
Primary school and lower	5	28
Secondary and above	13	72
Employment status		
Unemployed	16	89
Employed	2	11
Gravidity		
Primigravida	8	44
Multigravida	10	66

Appendix N: Domains and Items Covered by the COREQ Checklist[xxii]

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research Team and Reflexivity			
Personal Characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	Page 5
Credentials	2	What were the researcher's credentials? E.g., PhD, MD	Page 6
Occupation	3	What was their occupation at the time of the study?	Page 6
Gender	4	Was the researcher male or female?	Page 5, 19, 20
Experience and training	5	What experience or training did the researcher have?	Page 20, 21
Relationship with Participants			
Relationship established	6	Was a relationship established prior to study commencement?	Page 4-6
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g., personal goals, reasons for doing the research	Page 4-6 Supplementary File 2
Interviewer characteristics	8	What characteristics were reported about the interviewer/facilitator? e.g., Bias, assumptions, reasons, and interests in the research topic	Page 19-20
Domain 2: Study Design			
Theoretical Framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g., grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Page 5
Participant Selection			
Sampling	10	How were participants selected? e.g., purposive, convenience, consecutive, snowball	Page 5
Method of approach	11	How were participants approached? e.g., face-to-face, telephone, mail, email	Page 5-6
Sample size	12	How many participants were in the study?	Page 5
Non-participation	13	How many people refused to participate or dropped out? Reasons?	–
Setting			
Setting of data collection	14	Where was the data collected? e.g., home, clinic, workplace	Page 5-6
Presence of nonparticipants	15	Was anyone else present besides the participants and researchers?	Page 5-6
Description of sample	16	What are the important characteristics of the sample? e.g., demographic data, date	Page 5-6 Table 1
Data Collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Page 5-6

[xxii] Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual in Health Care*. 2007; 19(6):349-357. doi:10.1093/intqhc/mzm042

			Supplementary file 2
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	No
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	Page 7 Audio and transcribed
Field notes	20	Were field notes made during and/or after the interview or focus group?	Page 7
Duration	21	What was the duration of the inter views or focus group?	Page 7
Data saturation	22	Was data saturation discussed?	Page 5
Transcripts returned	23	Were transcripts returned to participants for comment and/or correction?	N/A
Domain 3: Analysis and Findings			
Data Analysis			
Number of data coders	24	How many data coders coded the data?	Page 7
Description of the coding tree	25	Did the authors provide a description of the coding tree?	Page 7
Derivation of themes	26	Were themes identified in advance or derived from the data?	Page 8
Software	27	What software, if applicable, was used to manage the data?	Page 7
Participant checking	28	Did participants provide feedback on the findings?	N/A
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g., participant number	Page 8-15
Data and findings consistent	30	Was there consistency between the data presented and the findings?	Page 8-15
Clarity of major themes	31	Were major themes clearly presented in the findings?	Page 8
Clarity of minor themes	32	Is there a description of diverse cases or a discussion of minor themes?	Page 8-15

Appendix O: Table of Quotes not Included in the Results

Themes	Sub-Themes	Other Quotes on the Themes That Were not Included in the Results
Health issues	• Health problems women experienced during pregnancy • Women's understanding of the causes of having LBW infants	• *Yes, since the first month of my pregnancy, I was not well until I gave birth at six months. I had recurrent fevers, lethargy, and poor appetite. I could not see nurses or go to the clinic to check up because I was still at school. I was not sure what illness I had. I think I had malaria and had a preterm birth. I think malaria is a common health problem affecting many pregnant women. [P6, 20-year-old]* • *I was bleeding the entire pregnancy and that is the reason I have a small baby. I was referred from Kwaio in Malaita Provinces to NRH due to this. I delivered prematurely at eight months. [P8, 23-year-old]* • *I had severe malaria during the first trimester. I was very sick and could not eat well. I have seen other women with pneumonia and flu during pregnancy. I was sick at six months and delivered the baby early. [P7, 30-year-old]* • *I have been having irregular periods, so I didn't know that I was pregnant. I experienced no illness or dislike of food during pregnancy until 32 weeks I was sick with malaria. I saw Dr DB who gave me coartem first dose, second, and after dose third dose, but I went into labour. They tried to stop the labour, but they could not, so I delivered my baby early. [P11, 34-year-old]*
Substance use	• Substance use during pregnancy • Understanding the impact of substance use on pregnancy	• *I also chewed betel nut and stopped due to the illness I had when I was pregnant and stop chewing until now. I have seen a lot of pregnant women who smoke tobacco and chew betel nut in my community. Tobacco smoke causes craving and addiction that and even in the middle of the night men and women will still go out to look for it. [P2, 39-year-old]* • *I chewed throughout my pregnancy. My mother told me to stop chewing but I did not stop. Now I am still chewing betel nut. I am not sure if betel nut is harmful to unborn babies during pregnancy. [P3, 16-year-old]* • *I often ate three betel nuts during pregnancy. I feel like to betel nut after my meal. It made me feel better after food. [P10, 18-year-old]* • *I was a heavy betel nut chewer before pregnancy and reduced it during pregnancy. During pregnancy, I only chew when my mouth is sour. Betel nut helped reduce the bad taste. Yes, it will affect the baby because everything the mother consumes the baby will also receive. [P11, 34-year-old]*
Diet and nutrition	• Knowledge of diet and nutrition • Dietary intake and nutrition quality • Social, cultural, and environmental impact on food supply and nutrition	• *My diet is mostly comprised of rice, cassava, cabbage, beans, cucumber, and snake beans I normally had tea for breakfast, at lunch, I had rice and vegetable[s], and the same for dinner. Wind and rain destroy our vegetables. [P7, 30-year-old]* • *I normally ate kumara [sweet potatoes], green banana [plantain], rice, fish, and cassava. No, I did not receive information on diet and nutrition. Flood spoils our food garden causing a shortage of food. [P9, 25-year-old]* • *Our food supply was affected by strong wind, cyclones, and floods, which spoil our banana plants [plantains] and food garden. During heavy rains, [there] are usually very big floods which destroy our entire garden and we run out of food. Banana [plantain/green banana] is our staple food. [P5, 38-year-old]* • *In my culture [tribe] pregnant women should not eat eggs. It will cause sickness to babies e.g., boils on the head. [P1, 20-year-old]* • *We are not allowed to eat clam shells and some types of fish, which I forgot their names. Bonito [tuna] and salt fish are forbidden during pregnancy. [P10, 18-year-old]*

Domestic violence	• Presence of domestic violence in pregnancy • Understanding the impact of domestic violence on pregnancy and birth	• *I personally experience so much domestic violence in my marriage, especially with my husband who often returns home drunk and start[s] throwing plates and spoons at me and all over the house. [P11, 34-year-old]* • *My husband beat me on my legs with a stick while I was two months pregnant. He knew I was pregnant and did this only one time. Domestic violence can cause the baby to be born early or die before birth. [e.g., prematurity or stillbirth] [P12, 18-year-old]* • *My husband beat me countless times and cause[d] me injury and bleeding. It was a terrifying experience. I sustained major and minor injuries. Sometimes he pushes me off and fell onto the concrete floor. He stopped a while ago before the last pregnancy domestic violence can cause stillbirth. Some men can be uncontrollably angry ended up beating up on their wives' backs or tammy which can lead to death in the unborn child (stillbirth). [P13, 25-year-old, rural]* • *He slapped me in my last pregnancy. He did not kick me. I was affected emotionally. He apologised to me before delivery. I believe this affected my pregnancy. [P17, 35-year-old]*
Environmental conditions	• Dwellings and overcrowding • Quality of water supply and toilet facilities	• *I lived in a sago palm-built two-bedroom house with six people living there. I shared a room with my sister. [P9, 25-year-old]* • *We lived in a thatched sago palm three-bedroom house. There are three of us there our couple and his younger sister who still goes to school. There are plenty of rats and dogs around. [P14,19-year-old]* • *We do not have a proper toilet. We just use the bush as a toilet. If it were in Wagina, we would use the seaside but here in Guadalcanal inland, we just use the bush [chuckled]. This is not right. I always complain to my husband about this. The water supply pipes were destroyed. During sunny days the borehole dries up, so we have to go a long distance to get water. [P18, 18-year-old]* • *We do not have a proper water supply. We usually go down the hill to the main road to a stream few metres down. We live on Marble Street near the public phone. The water spring is close to the drain on the side of the road. [P10,18-year-old]*
Antenatal care	• Access to antenatal healthcare service • Quality of antenatal care and services	• *My local nearby clinic is Fox Bay Clinic of west Guadalcanal. We must paddle in a dugout canoe for 30 minutes to get there. [P16, 32-year-old]* • *Nurses must give treatment to mothers; accordingly, I think nurses should improve their service. [The] government should provide proper instruments and medicine for nurses to use in antenatal clinics. [P6, 20-year-old]* • *It's a long way to go to the clinic. It is very tiring. I started my trip at 8am and reached the clinic at 11am. I would wait for hours before the nurse sees me. The nurse work[s] very slow[ly] and there were piles of antenatal cards from the many mothers waiting. There are so many pregnant women. I would finally see the nurse at 3pm. I retired back and would arrive back home at dusk [6pm] This was really a big challenge for me. [P18, 18-year-old]* • *My home village is far from the clinic. We have to walk up and down the hill for two-and-a-half-hours to get to the clinic. I was only supplied with tonic [ferrous sulphite tablets] which I took daily. The malaria medicine and the medicine for worms were out of stock. I am satisfied with the nurses' advice and counselling. [P17, 35-year-old]*

Appendix P: Unadjusted and Adjusted Analysis of Sociodemographic, Maternal Health, and Behavioural Risks for Neonatal Mortality of the SIDHS 2015[xxiii]

Covariate and Group	Neonatal Mortality			
Sociodemographic, behavioural, health characteristics, weighted population (n=4,334)				
	Number (%)		OR 95% CI	
	No (%)	Yes (%)	CRR	ARR
Marital status				
In union	3,910 (90.94)	30 (93.10)	**Reference**	
Not in union	390 (9.06)	2 (6.90)	0.74 (0.16, 3.47)	
Religion[1]				
Anglican	1,302 (30.27)	14 (42.93)	3.12 (0.99, 9.89)	2.78 (0.89, 8.65)
Roman Catholic	954 (22.19)	11 (33.97)	3.36 (1.17, 9.70)	3.99 (1.34, 11.88)
Protestant & Pentecostal churches	1,693 (39.36)	6 (17.75)	**Reference**	**Reference**
Minor religion	351 (8.17)	2 (5.35)	1.45 (0.29, 7.36)	1.62 (0.34, 7.66)
Ethnicity				
Melanesian	4,152 (96.57)	30 (94.69)	**Reference**	
Polynesian	87 (2.02)	1 (2.98)	1.51 (0.16, 13.93)	
Micronesian	56 (1.31)	1 (2.33)	1.81 (0.22, 15.09)	
Wealth quintile				
Poor (Quintiles 1-2)	1,939 (45.11)	17 (52.63)	1.00 (0.41, 2.48)	0.85 (0.34, 2.16)
Middle (Quintile 3)	842 (19.59)	2 (6.37)	0.28 (0.06, 1.32)	0.22 (0.05, 0.94)
High (Quintiles 4-5)	1,518 (35.31)	13 (41.01)	**Reference**	**Reference**
Place of residence				
Urban	755 (17.55)	7 (20.24)	**Reference**	
Rural	3,545 (82.45)	26 (79.76)	0.84 (0.38, 1.87)	
Maternal age (years)				
≤20	1,064 (24.75)	6 (17.71)	0.57 (0.07, 4.41)	0.37 (0.04, 3.18)
21-34	2,227 (51.80)	15 (46.76)	**Reference**	**Reference**
35-49	1,008 (23.45)	11 (35.52)	1.73 (0.82, 3.64)	1.54 (0.64, 3.71)
Maternal education				
Primary & lower	2,481 (57.70)	17 (53.59)	0.84 (0.40, 1.80)	
Secondary & above	1,814 (42.20)	15 (46.41)	**Reference**	
Household member				
1-5	1,617 (37.61)	16 (49.41)	**Reference**	**Reference**
> 5	2,683 (62.39)	16 (50.59)	0.61 (0.38, 0.97)	0.58 (0.28, 1.21)
Birth order				
1st children	670 (15.57)	5 (16.56)	1.32 (0.48, 3.61)	
2nd - 4th children	2,484 (57.77)	15 (46.52)	**Reference**	
5th children and above	1,146 (26.66)	12 (36.92)	1.71 (0.78, 3.75)	
Sex of child				
Male	2,233 (51.92)	15 (47.45)	**Reference**	
Female	2,067 (48.08)	17 (52.55)	1.20 (0.50,2.85)	
Plurality				
Single	4,227 (98.26)	31 (97.52)		
Multiple gestation	75 (1.74)	1 (2.48)	1.43 (0.35, 5.78)	
Breastfeeding				
Yes	4,086 (95.04)	11 (34.16)	**Reference**	**Reference**

[xxiii] Population consists of all births (weighted n=4,334) and last births (weighted n=2,706) born between 2010 and 2015 drawn from 2015 the Solomon Islands demographic health survey.
Adjusted analyses were made for all covariates with p-values less than 0.2. Frequencies (n) were rounded to the nearest whole number.
CRR; crude relative risk; ARR; adjusted relative risk.

No	213(4.96)	21(65.84)	33.68 (13.92, 81.51)	34.80 (13.60, 89.03)
Tobacco/cigarette history				
Yes	728 (16.94)	4(11.05)	0.61 (0.18, 2.02)	
No	3,563(82.87)	29(88.95)	**Reference**	
Alcohol use history				
Yes	247(5.76)	4(12.73)	2.35 (0.69, 7.98)	0.58 (0.28, 1.21)
No	4,019(93.46)	28(87.27)	**Reference**	**Reference**
Kava use history				
Yes	8(1.89)	1(2.56)	1.36 (0.19, 9.98)	
No	4,210(97.93)	31(97.44)	**Reference**	
Marijuana use history				
Yes	92(2.10)	1(2.56)	1.20 (0.16, 8.92)	
No	4,200(97.70)	31(97.44)	**Reference**	
Betel nut use history				
Yes	3,619(85.20)	76(90.55)	1.27 (0.40, 4.01)	
No	626(14.2)	8(9.45)	**Reference**	
Health and reproductive characteristics, weighted population (n=2,706)				
Antenatal care				
Yes	2,323(87.11)	37 (91.64)	2.99 (0.39, 23.05)	
No	344(12.89)	3(8.36)	**Reference**	
Malaria infection				
Yes	200(7.45)	1(3.29)	0.48 (0.06, 3.74)	
No	1,992(74.29)	16(68.28)	**Reference**	
Postnatal check				
Yes	1,714(63.91)	2(9.91)	**Reference**	**Reference**
No	959(35.77)	19(84.45)	14.95 (3.12, 71.65)	11.36 (1.22, 106.16)
Place of delivery				
Health facility	1,714(63.91)	2(9.91)	**Reference**	
Non health facility	959(35.77)	19(84.45)	0.46 (0.07, 2.89)	
Birth attendant				
High skilled	2,063(76.92)	21(90.34)	**Reference**	
Low or no skilled	579(21.60)	2(9.66)	2.61 (0.65, 10.44)	
Birth weight (kilograms)				
<2.5 kilograms	230(8.59)	3(11.86)	2.86 (0.64, 12.78)	2.82 (0.61, 12.99)
≥2.5 kilograms	2,050(76.42)	8(36.65)	**Reference**	**Reference**
Mode of delivery				
C-section	178(6.64)	4(18.30)	2.86 (0.81, 10.06)	1.06 (0.13, 8.83)
Normal vaginal delivery	2,130(79.41)	17(75.32)	**Reference**	**Reference**
Tetanus vaccination				
Yes	2,348(87.57)	18(76.76)	**Reference**	**Reference**
No	326(12.15)	5(23.24)	2.15 (0.77, 6.05)	1.79 (0.19, 16.53)

Appendix Q: Unadjusted and Adjusted Analysis of Sociodemographic, Maternal Health, and Behavioural Risks for Infant Mortality of the SIDHS 2015[xxiv]

Covariate and Group	Infant Mortality			
Sociodemographic, behavioural, health characteristics, weighted population (n=4,334)				
	Number (%)		**ARR 95% CI**	
	No (%)	**Yes (%)**	**CRR**	**ARR**
Marital status				
In union	3,881(90.92)	62(91.35)	**Reference**	
Not in union	388(9.08)	6(8.65)	0.95 (0.39, 2.33)	
Religion				
Anglican	1,290(30.22)	25(37.74)	1.76 (0.80, 3.83)	1.71 (0.85, 3.45)
Roman Catholic	948(22.20)	19(28.40)	1.80 (0.88, 3.66)	1.74 (0.87, 3.48)
Protestant & Pentecostal churches			**Reference**	**Reference**
Minor religion[1]	349(8.17)	4(6.09)	1.06 (0.32, 3.44)	1.19 (0.41, 3.43)
Ethnicity				
Melanesian	4,125(96.63)	62(91.75)	**Reference**	**Reference**
Polynesian	86(2.02)	2(2.55)	1.32 (0.24, 7.29)	1.32 (0.17, 10.28)
Micronesian	53(1.24)	4(5.71)	4.57 (1.75, 11.94)	5.54 (1.67, 18.35)
Household wealth				
Poor (Quintiles 1-2)	1,921(45.00)	37(55.30)	1.13 (0.60, 2.14)	1.11 (0.54, 2.30)
Middle (Quintile 3)	841(19.70)	4(6.59)	0.31 (0.10, 0.96)	0.27 (0.09, 0.82)
High (Quintiles 4-5)	1,507(35.30)	26(38.11)	**Reference**	**Reference**
Place of residence				
Urban	752(17.61)	10(15.30)	**Reference**	
Rural	3,517(82.39)	57(84.70)	1.18 (0.64, 2.18)	
Maternal age (years)				
≤20	257(6.02)	3(3.68)	0.59 (0.17, 2.09)	
21-34	3,006(70.42)	50(73.66)	**Reference**	
35-49	1,006(23.57)	15(22.66)	0.92 (0.53, 1.60)	
Maternal education				
Primary & lower	2,460(57.63)	40(60.06)	1.10 (0.62, 1.94)	0.49 (0.27, 0.87)
Secondary & above	1,804(42.26)	27(39.94)	**Reference**	**Reference**
Household member				
1-5	1,601(37.51)	32(48.27)	**Reference**	
> 5	2,667(62.49)	35(51.73)	0.65 (0.40, 1.06)	
Birth order				
1st children	665(15.59)	9(14.13)	1.09 (0.53, 2.25)	1.48 (0.69, 3.19)
2nd - 4th children	2,469(57.85)	32(47.94)	**Reference**	**Reference**
5th children and above	1,334(26.56)	25(37.93)	1.71 (0.93, 3.15)	2.00 (1.03, 3.88)
Sex of child				
Male	2,217(51.95)	34(50.80)	**Reference**	
Female	2,051(48.05)	33(49.20)	1.05 (0.54, 2.03)	
Plurality				
Single	4,196(98.31)	64(94.80)	**Reference**	**Reference**
Multiple gestation	72(1.69)	3(5.20)	3.08 (1.13, 8.40)	2.41 (0.77, 7.59)
Breastfeeding				
Yes	4,059(95.10)	42(62.14)	**Reference**	**Reference**

[xxiv] Population consists of all births (weighted n=4334) and last births (weighted n=2706) born between 2010 and 2015 of the Solomon Islands demographic health survey.
Adjusted analyses were made for all covariates with p-values less than 0.2.
Frequencies (n) were rounded to the nearest whole number.
CRR; crude relative risk, AARR; adjusted relative risk.

No	209(4.90)	25(37.86)	10.64 (5.65, 20.04)	11.85 (6.15, 22.83)
Tobacco/cigarette use history				
Yes	718(16.82)	16(23.43)	1.50 (0.74, 3.01)	1.42 (0.66, 3.08)
No	3,542(82.99)	51(76.57)	**Reference**	**Reference**
Alcohol use history				
Yes	245(5.74)	7(9.72)	1.73 (0.74, 4.08)	1.22 (0.43, 3.45)
No	3,988(93.46)	61(90.28)	**Reference**	**Reference**
Kava use history				
Yes	81(1.89)	2(2.35)	1.24 (0.30, 5.16)	
No	4,178(97.93)	66(97.65)	**Reference**	
Marijuana use history				
Yes	90(2.11)	3(4.06)	1.93 (0.60, 6.20)	1.60 (0.31, 8.25)
No	4,169(97.72)	64(95.94)	**Reference**	**Reference**
Betel nut use history				
Yes	3,638(85.26)	59(88.19)	1.28 (0.50, 3.30)	
No	626(14.66)	8(11.81)	**Reference**	
Health and reproductive characteristics, weighted population (n=2706)				
Antenatal care				
Yes	2,545(95.43)	37(92.56)	**Reference**	
No	122(4.57)	3(7.44)	1.66 (0.52, 5.29)	
Malaria in pregnancy				
Yes	199(7.47)	2(4.06)	0.53 (0.13, 2.23)	
No	1,977(74.20)	31(76.93)	**Reference**	
Postnatal check				
Yes	1,702(63.84)	16(39.68)	**Reference**	**Reference**
No	956(35.86)	23(56.33)	2.49 (1.14, 5.43)	1.58 (0.52, 4.95)
Place of delivery				
Health facility	2,303(86.37)	37(92.68)	**Reference**	
Non health facility	346(12.96)	3(7.32)	0.53 (0.15, 1.83)	
Birth attendant				
High skilled	2,049(76.83)	37(91.76)	**Reference**	
Low or no skilled	578(21.68)	3(8.24)	0.32 (0.10, 1.04)	
Birth weight (kilograms)				
<2.5 kilograms	228(8.55)	5(13.18)	2.31 (0.78, 6.89)	1.18 (0.18, 7.97)
≥2.5 kilograms	2,037(76.47)	20(50.37)	**Reference**	**Reference**
Mode of delivery				
C-section	177(6.65)	5(12.40)	1.82 (0.59, 5.63)	0.30 (0.02, 3.74)
Normal vaginal delivery	2,116(79.37)	32(80.28	**Reference**	**Reference**
Maternal tetanus vaccination				
Yes	2,330(87.58)	36(81.17)	**Reference**	**Reference**
No	323(12.13)	8(18.83)	1.59 (0.63, 4.05)	1.45 (0.31, 6.75)

Appendix R: Unadjusted and Adjusted Analysis of Sociodemographic, Maternal Health, and Behavioural Risks for Child Mortality of SIDHS 2015[xxv]

Covariate and Group	Child Mortality			
Sociodemographic, behavioural, health characteristics, weighted population (n=4334)				
	Number (%)		RR 95% CI	
	No (%)	Yes (%)	CRR	ARR
Marital status				
In union	3,865(90.95)	45(88.56)	**Reference**	
Not in union	385(9.05)	6(11.44)	1.29 (0.52, 3.22)	
Religion				
Anglican	1,286(30.26)	15(30.12)	1.01 (0.46, 2.24)	
Roman Catholic	942(22.17)	14(26.53)	1.21 (0.61, 2.43)	
Protestant & Pentecostal churches	1,673(39.36)	20(38.71)	**Reference**	
Minor religion[1]	349(8.21)	2(4.64)	0.58 (0.12, 2.76)	
Ethnicity				
Melanesian	4,109(96.69)	44(85.94)	**Reference**	**Reference**
Polynesian	84(1.97)	3(6.34)	3.53 (1.65, 7.56)	3.65 (1.46, 9.10)
Micronesian	52(1.23)	4(7.72)	6.64 (2.86, 15.39)	5.80 (2.48, 13.53)
Household wealth				
Poor (Quintiles 1-2)	1,913(45.02)	28(54.72)	1.25 (0.62, 2.49)	
Middle (Quintile 3)	837(19.69)	6(10.93)	0.57 (0.18, 1.82)	
High (Quintiles 4-5)	1,500(35.29)	18(34.35)	**Referenc**e	
Place of residence				
Urban	748(17.61)	6(10.88)	**Reference**	**Reference**
Rural	3,501(82.39)	46(89.12)	1.74 (0.79, 3.86)	1.85 (0.88, 3.92)
Maternal age (years)				
≤20	255(6.00)	3(6.48)	0.92 (0.31, 2.71)	0.97 (0.33, 2.86)
21-34	2,993(70.42)	42(83.11)	**Reference**	**Reference**
35-49	1,002(23.58)	5(10.41)	0.38 (0.13, 1.06)	0.43 (0.16, 1.16)
Maternal education				
Primary & lower	2,453(57.71)	29(57.09)	0.97 (0.51, 1.87)	
Secondary & above	1,973(42.18)	22(42.91)	**Reference**	
Household member				
1-5	1,592(37.45)	25(49.21)	**Reference**	**Reference**
> 5	2,658(62.55)	26(50.79)	0.62 (0.34, 1.13)	0.62 (0.33, 1.17)
Birth order				
1st children	664(15.62)	6(11.31)	0.73 (0.25, 2.10)	
2nd - 4th children	2,456(57.80)	29(57.39)	**Reference**	
5th children and above	1,130(26.58)	16(31.30)	1.18 (0.53, 2.64)	
Sex of child				
Male	2,205(51.88)	58(57.84)	**Reference**	
Female	2,045(48.12)	22(42.16)	0.79 (0.39, 1.59)	
Plurality				
Single	4,179(98.34)	47(91.74)	**Reference**	**Reference**
Multiple gestation	71(1.66)	4(8.26)	5.08 (1.71, 15.06)	6.15 (2.08, 18.18)
Breastfeeding				
Yes	4,042(95.10)	46(91.00)	**Reference**	**Reference**

[xxv] Population comprised of all births (weighted n=4,334) and last births (weighted n=2,706) born between 2010 and 2015 as per the 2015 SIDHS.
Adjusted analyses were made for all covariates with p-values less than 0.2.
Frequencies (n) were rounded to the nearest whole number.
CRR; crude relative risk, ARR; adjusted relative risk.

No	208(4.90)	5(9.00)	1.90 (0.69, 5.22)	2.04 (0.75, 5.57)
Tobacco/cigarette use history				
Yes	713(16.79)	16(31.49)	2.24 (1.11, 4.54)	1.77 (0.79, 3.96)
No	3,528(83.02)	35(68.51)	**Reference**	**Reference**
Alcohol use history				
Yes	244(5.73)	4(7.58)	1.33 (0.49, 3.62)	
No	3,972(93.47)	47(92.42)	**Reference**	
Kava use history				
Yes	80(1.89)	1(2.15)	1.14 (0.24, 5.46)	
No	4,162(97.93)	50(97.85)	**Reference**	
Marijuana use history				
Yes	89(2.10)	3(5.66)	2.74 (0.75, 10.05)	1.94 (0.43, 8.73)
No	4,154(97.74)	48(94.34)	**Reference**	**Reference**
Betel nut use history				
Yes	3,621(85.20)	47(91.98)	1.97 (0.64, 6.10)	1.44 (0.46, 4.57)
No	626(14.72)	4(8.02)	**Reference**	**Reference**
Health and reproductive characteristics, weighted population (n=2,706)				
Antenatal care				
Yes	2,540(95.42)	21(100.0)		
No	122(4.58)	0(0.00)		
Malaria in pregnancy				
Yes	198(7.44)	1(5.83)	0.66 (0.13, 3.34)	0.52 (0.17, 1.66)
No	1,976(74.22)	19(89.00)	**Reference**	**Reference**
Postnatal check				
Yes	1,699(63.83)	17(79.69)	**Reference**	
No	955(35.87)	4(18.86)	0.42 (0.14, 1.24)	
Place of delivery				
Health Facility	2,298(86.34)	19(92.99)		
Non health facility	355(12.98)	1(7.01)	0.50 (0.10, 2.61)	
Birth attendant				
High skilled	228(8.56)	3(12.22)	**Reference**	
Low or no skilled	2,035(76.45)	16(74.57)	0.19 (0.03, 1.50)	
Birth weight (kilograms)				
<2.5 kilograms	2,044(76.79)	20(94.83)	1.46 (0.31, 6.79)	
≥2.5 kilograms	578(21.72)	1(5.17)	**Reference**	
Mode of delivery				
C-section	175(6.58)	5(11.36)	1.67 (0.33, 8.38)	
Normal vaginal delivery	2,114(79.42)	17(81.63)	**Reference**	
Maternal tetanus vaccination				
Yes	2,330(87.53)	36(81.1)	**Reference**	
No	324(12.19)	8(18.83)	1.23 (0.29, 5.17)	

Appendix S: Unadjusted and Adjusted Analysis of Sociodemographic, Maternal Health, and Behavioural Risks for Under-Five Mortality of SIDHS 2015[xxvi]

Covariate and Group	Under-Five Mortality			
Sociodemographic, behavioural, health characteristics, weighted population (n=4,334)				
	Number (%)		RR 95% CI	
	No (%)	Yes (%)	CRR	ARR
Marital status				
In union	3,865(90.98)	75(89.57)	**Referenc**e	
Not in union	383(9.02)	9(10.43)	1.17 (0.55, 2.47)	
Religion				
Anglican	1,286(30.28)	29(34.78)	1.44 (0.76, 2.72)	1.34 (0.74, 2.42)
Roman Catholic	941(22.14)	24(29.16)	1.64 (0.92, 2.95)	1.62 (0.90, 2.94)
Protestant & Pentecostal churches			**Reference**	**Reference**
Minor religion[1]	349(8.21)	4(4.87)	0.75 (0.25, 2.27)	0.83 (0.31, 2.25)
Ethnicity				
Melanesian	4,107(96.69)	75(89.41)	**Reference**	**Reference**
Polynesian	84(1.97)	4(5.00)	2.66 (1.26, 5.61)	3.23 (1.09, 9.54)
Micronesian	52(1.23)	5(5.59)	4.59 (2.46, 8.58)	5.60 (2.52, 12.46)
Household wealth				
Poor (Quintiles 1-2)	1,912(45.00)	45(53.46)	1.12 (0.64, 1.96)	1.14 (0.61, 2.13)
Middle (Quintile 3)	837(19.69)	8(9.09	0.44 (0.18, 1.11)	0.41 (0.17, 1.00)
High (Quintiles 4-5)	1,500(35.31)	31(37.45	**Reference**	**Reference**
Place of residence				
Urban	748(17.62)	13(15.21)	**Reference**	
Rural	3,500(82.38)	71(84.79)	1.19 (0.70, 2.03)	
Maternal age (years)				
≤20	1,053(24.80)	17(20.00)	0.81 (0.32, 2.02)	
21-34	2,192(51.61)	50(59.21)	**Reference**	
35-49	1,002(23.59)	17(20.79)	0.84 (0.50, 1.41)	
Maternal education				
Primary & lower	2,451(57.70)	47(56.10)	0.94 (0.58, 1.52)	
Secondary & above	1,792(42.20)	37(43.90)	**Reference**	
Household member				
1-5	1,592(37.46)	42(49.71)	**Reference**	**Reference**
> 5	2,657(62.54)	42(50.29)	0.61 (0.38, 0.97)	0.55 (0.33, 0.93)
Birth order				
1st children	664(15.62)	11(13.23)	1.08 (0.53, 2.18)	
2nd - 4th children	2,455(57.78)	44(52.74)	**Reference**	
5th children and above	1,130(26.59)	29(34.03)	1.50 (0.71, 3.18)	
Sex of child				
Male	2,203(51.86)	45(53.37)	**Reference**	
Female	2,045(48.14)	39(46.63)	0.94 (0.53, 1.68)	
Plurality				
Single	4,177(98.34)	79(94.03)	**Reference**	**Reference**
Multiple gestation	71(1.66)	5(5.97)	3.57 (1.41, 9.03)	3.34 (1.26, 8.88)
Breastfeeding				
Yes	4,040(95.10)	57(68.45)	**Reference**	**Reference**

[xxvi] Population comprised of all births (weighted n=4,334) and last births (weighted n=2,706) born between 2010 and 2015 as per the 2015 SIDHS.
Adjusted analyses were made for all covariates with p-values less than 0.2.
Frequencies (n) were rounded to the nearest whole number.
CRR; crude relative risk, AARR; adjusted relative risk.

No	208(4.90)	26(31.55)	8.05 (4.57, 14.17)	8.65 (4.97, 15.05)
Tobacco/cigarette use history				
Yes	712(16.75)	20(24.22)	1.56 (0.88, 2.77)	1.48 (0.81, 2.72)
No	3,528(83.05)	64(75.78)	**Reference**	**Reference**
Alcohol use history				
Yes	244(5.73)	8(9.49)	1.69 (0.79, 3.60	1.24 (0.52, 2.97)
No	3,971(93.47)	76(90.51)	**Reference**	**Reference**
Kava use history				
Yes	80(1.89)	2(2.29)	1.21 (0.35, 4.16)	
No	4,160(97.93)	82(97.71)	**Reference**	
Marijuana use history				
Yes	89(2.10)	4(4.42)	2.11 (0.71, 6.26)	1.35 (0.34, 5.35)
No	4,152(97.74)	80(95.58)	**Reference**	**Reference**
Betel nut use history				
Yes	3,619(85.20)	76(90.55)	1.64 (0.64, 4.21)	1.03 (0.39, 2.70)
No	626(14.72)	8(9.45)	**Reference**	**Reference**
Health and reproductive characteristics, weighted population (n=2,706)				
Antenatal care				
Yes	2,540(95.42)	42(93.32)	**Reference**	
No	122(4.58)	3(6.68)	1.48 (0.47, 4.70)	
Malaria infection				
Yes	198(7.44)	3(5.99)	0.78 (0.27, 2.30)	
No	1,974(74.20)	34(76.92)	**Reference**	
Postnatal check				
Yes	1,697(63.81)	19(42.44)	**Reference**	**Reference**
No	595(35.89)	24(53.98)	2.23 (1.09, 4.56)	1.38 (0.58, 3.26)
Place of delivery				
Health facility	2,297(86.33)	42(93.42)	**Reference**	
Non health facility	346(12.99)	3(6.58)	0.47(0.14, 1.62)	
Birth attendant				
High skilled	2,042(76.77)	41(92.60)	**Reference**	
Low or no skilled	578(21.73)	3(7.40)	0.29 (0.09, 0.93)	
Birth weight (kilograms)				
<2.5 kilograms	228(8.56)	5(11.84)	1.89 (0.66, 5.45)	1.07 (0.16, 7.03)
≥2.5 kilograms	2,033(76.43)	25(55.40)	**Reference**	**Reference**
Mode of delivery				
C-section	175(6.58)	7(16.33)	2.50 (0.97, 6.42)	1.13 (0.22, 5.76)
Normal vaginal delivery	2,112(79.41)	34(77.09)	**Reference**	**Reference**
Maternal tetanus vaccination				
Yes	2,330(87.58)	36(81.17)	**Reference**	**Reference**
No	323(12.13)	8(18.83)	1.65 (0.69, 3.93)	1.67 (0.45, 6.14)

Appendix T: PAFs of Sociodemographic, Maternal Health, and Behavioural Risks for Neonatal, Infant, Child, and Under-Five Mortality in the Solomon Islands

Groups at Risk	Proportion Exposed to Risks (%)	Adjusted Relative Risk (ARR)	PAF (%)
Neonatal mortality			
No postnatal check	36.32	11.36	79
No breastfeeding	5.42	34.8	65
LBW infant	8.82	2.82	14
No tetanus vaccination	12.24	1.79	9
Infant mortality			
No breastfeeding	5.42	11.85	37
Postnatal check	36.32	1.58	17
Tobacco/cigarette use history	16.9	1.42	7
Marijuana use history	2.67	1.6	2
Multiple births	1.75	2.41	2
Child mortality			
Rural Residence	82.43	1.85	41
Tobacco/cigarette use history	16.9	1.77	12
Multiple gestation	1.75	6.15	8
No breastfeeding	5.42	2.04	5
Marijuana use history	2.67	1.94	2
Under-five mortality			
No breastfeeding	5.42	8.65	29
No tetanus vaccination	12.24	1.67	8
Tobacco/cigarette use history	16.9	1.48	8
Multiple births	1.75	3.34	4

Appendix U: Ethics Approval Documentation

i. Solomon Island Health Research and Ethics Review Board (Certificates)

No: HRE039/19

Solomon Islands Health Research and Ethics Review Board
Ministry of Health & Medical Services

Research Certificate

Associate Professor. Gavin Pereira
School of Public Health
Building 400, Curtin University
Kent Street Bentley Campus,
WA 6102. Australia

The Solomon Islands Health Research and Ethics Review Board (SIHRERB) of the Ministry of Health & Medical Services has received amendments and additional documents following recommendations made on 12th August 2020 and has approved your application to do research titled: "Risk factors of adverse birth outcomes and lived experiences of mothers with low birth weight infants in the Solomon Islands."

You are hereby granted permission to conduct the research in Solomon Islands for the proposed duration in 12th August 2020 to 22 November 2022 only. This approval is for the one-time conduction of your research and any amendments, repetition and/or extension of this research will need further SIHRERB approval. Refer to the SIHRERB report for terms and conditions of your permit. Failure to abide to the terms will result in suspension or discontinuation of approval.

Dr. Nemia Bainivalu
Chairman, SIHRERB

MINISTRY OF HEALTH AND MEDICAL SERVICES
SOLOMON ISLAND GOVERNMENT

14/08/2020
Date

Solomon Islands Health Research and Ethics Review Board
Ministry of Health and Medical Services

HRE Form 5

Project Title	*Risk factors of adverse birth outcomes and lived experiences of mothers with low birth weight infants in the Solomon Islands*
HRE No.	039/19
Re	Study protocol received with amendments from Mrs. Lydia Sandrah Kuman Kaforau dated 18th May 2020.

Reviewed by: SIHRERB **Date:** 12th August 2020

For (Principal Investigator): Associate Professor. Gavin Pereira

SIHRERB Remarks

The Solomon Islands Health Research and Ethics Review Board (SIHRERB) considered the above protocol with amendments following its review on **12th August 2020** and is pleased to advise it is satisfied that this protocol meets the requirements as set out in the Solomon Islands ethical guideline. Having taken into account the advice of the committee, the chairman of the SIHRERB has approved the project to proceed.

Would you please note:-

- Approval is valid from **12th August 2020 to 22nd November 2022**
- You are required to provide a final report of your study to SIHRERB and upon the request of SIHRERB.
- You are required to immediately report to the SI Ethics Secretariat anything which might warrant review of ethical approval of the protocol including:
  - Serious or unexpected Adverse Effect (SAE) experienced by the participants,
  - Proposed changes in the protocol,
  - Unforeseen events or new information (e.g. from other studies) that might affect continued acceptability of the project or may indicate the need for amendments to the protocol.
- Any modifications must have prior written approval by the SIHRERB
- If the research project is discontinued before the expected date of completion, the Principal Investigator is required to inform SIHRERB and relevant institutions.

The SIHRERB executive wishes you every continued success in your research.

Chairman (Name) Dr. Nemia Bawidamo **Signature** **Date** 19/08/2020

MINISTRY OF HEALTH AND MEDICAL SERVICES SOLOMON ISLAND GOVERNMENT

ii. Reciprocal Ethics Approval: Curtin University

Research Office at Curtin
GPO Box U1987
Perth Western Australia 6845
Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
aWeb research.curtin.edu.au

23-Sep-2020

Name: Gavin Pereira
Department/School: School of Public Health
Email: Gavin.F.Pereira@curtin.edu.au

Dear Gavin Pereira

RE: Reciprocal ethics approval
Approval number: HRE2020-0530

Thank you for your application submitted to the Human Research Ethics Office for the project Risk factors of adverse birth outcomes and lived experiences of mothers with low birth weight infants in the Solomon Islands.

Your application has been approved by the Curtin University Human Research Ethics Committee (HREC) through a reciprocal approval process with the lead HREC.

The lead HREC for this project has been identified as Solomon Islands Health Ethics Review Board.

Approval number from the lead HREC is noted as HRE039/19.

The Curtin University Human Research Ethics Office approval number for this project is **HRE2020-0530**. Please use this number in all correspondence with the Curtin University Ethics Office regarding this project.

Approval is granted for a period of one year from to **22-Nov-2022**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Kaforau, Lydia Sandrah Kuman	Student
Pereira, Gavin	CI

You must comply with the lead HREC's reporting requirements and conditions of approval. You must also:

- Keep the Curtin University Ethics Office informed of submissions to the lead HREC, and of the review outcomes for those submissions
- Conduct your research according to the approved proposal
- Report to the lead HREC anything that might warrant review of the ethics approval for the project
- Submit an annual progress report to the Curtin University Ethics Office on or before the anniversary of approval, and a completion report on completion of the project. These can be the same reports submitted to the lead HREC.
- Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
  Data and primary materials must be managed in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the
- Curtin University Research Data and Primary Materials policy
- Where practicable, results of the research should be made available to the research participants in a timely and clear manner The
- Curtin University Ethics Office may conduct audits on a portion of approved projects.

This letter constitutes ethical approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.
Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Amy Bowater
Ethics, Team Lead

iii. Health Professionals' Consultation Ethics Approval

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

12-May-2021

Name: Jonine Jancey
Department/School: Curtin University
Email: J.Jancey@curtin.edu.au

Dear Jonine Jancey

RE: Ethics Office approval
Approval number: HRE2021-0250

Thank you for submitting your application to the Human Research Ethics Office for the project **Risk Factors and Prevalence of adverse birth outcomes in the Pacific Islands countries - health professionals perspective**.

Your application was reviewed through the Curtin University Low risk review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007).*

Approval is granted for a period of one year from **12-May-2021** to **11-May-2022**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Jancey, Jonine	CI
Pereira, Gavin	Co-Inv
Tessema, Gizachew	Co-Inv
Kaforau, Lydia	Student

Approved documents:

Document

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
   - proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an

amendment is undertaken to eliminate an immediate risk to participants)

4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

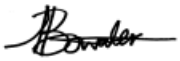
Special Conditions of Approval

It is the responsibility of the Chief Investigator to ensure that any activity undertaken under this project adheres to the latest available advice from the Government or the University regarding COVID-19.

This letter constitutes low risk/negligible risk approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely



Amy Bowater
Ethics, Team Lead

Appendix V: Memorandum of Understanding with Solomon Islands National Statistics Office

i. MOU to Use the SIDHS 2015 Data in 2021

Memorandum of Understanding

Between

CURTIN UNIVERSITY

(ABN 99 143 842 569) a body corporate established under the Curtin University Act 1966

of Kent Street, Bentley, Western Australia 6102 ('Curtin')

And

Solomon Islands National Statistics Office

Access to the Demographic Health Survey DHS 2015 Unit Record Data

November 21, 2017

As the legal Owner and custodian of the copyright of Solomon Islands national Demographic Health Survey DHS 2015 unit record data ['the dataset'], the Solomon Islands Government through the Government Statistician of the National Statistics Office ['SINSO'] mandated by the Statistics Act 1970 including the successive 2007 amendment, grants Curtin permission to use the dataset (required variables) for the purpose of investigating the household and maternal characteristics associated with adverse perinatal and child outcomes in the Solomon Islands, subject to the following conditions:

1. The period of agreement shall be from the date the last Party signs and must not exceed one year.

2. Access to the restricted data will be limited to the Principal Investigator and Data User from the Curtin named below:

	Name	Employing organisation	Address of organisation	Position in organisation	Email	Telephone	Role
1.	Principal Investigator: Associate Professor Jonine Jancey	Curtin University	Kent Street, Bentley WA 6102	Associate Professor	J.Jancey@curtin.edu.au	+61 08 9266 3807	PhD Primary Supervisor and will have input in study design and interpreting results.
2.	Data User: Lydia Sandrah Kuman Kaforau			Higher Degree by Research (HDR) Student			PhD student and will lead the analysis and draft key results of the studies to publish in peer-reviewed journals.

CTR-15069

3.	Data User: Associate Professor Gavin Pereira	Curtin University	Kent Street, Bentley WA 6102	Associate Professor	Gavin.f.pereira@curtin.edu.au	+61 435056461	PhD co-supervisor and will have input in study design, assist in analysis and interpreting results.
4.	Data User: Dr Gizachew Tessema	Curtin University	Kent Street, Bentley WA 6102	Research Fellow	Gizachew.tessema@curtin.edu.au	+61 08 9266 2120	PhD co-supervisor and will have input in study design, assist in analysis and interpreting results.*

*Dr Tessema is a trained and certified in DHS data analysis and has published over four papers directly using DHS data from Ethiopia.

3. Copies of the restricted data or any data created on the basis of the original data will not be copied or made available to anyone other than those mentioned in paragraph 2 in this MOU, unless formally authorized by the Solomon Islands Government (SIG) through the Government Statistician.

4. Data will be used for statistical and scientific research specific to purposes of analysis stated above. The data will be employed solely for reporting aggregated information, including modeling, and not for investigating specific individuals or organizations. Data will not in any way be used for any administrative, proprietary or law enforcement purposes.

5. Microdata (including subsets of the datasets) and copyrighted materials provided by the SINSO will not be redistributed or sold to other individuals, institutions or organizations without the SINSO's written agreement. Non-copyrighted materials which do not contain microdata (such as survey questionnaires, manuals, codebooks, or data dictionaries) may be distributed without further authorization. The ownership of all materials provided by the SINSO remains with the SINSO.

6. The Principal Investigator and Data User in paragraph 2 above undertakes that no attempt will be made to identify any individual person, family, business, enterprise or organization. If such a unique disclosure is made inadvertently, no use will be made of the identity of any person or establishment discovered and full details will be reported to the SIG. The identification will not be revealed to any other person not included in the MOU and that such confidentiality be upheld at all times.

7. The Principal Investigator and Data User (s) in paragraph 2 above will implement security measures to prevent unauthorized access to licensed microdata acquired from the SIG.

8. The microdata must be destroyed immediately upon the completion of this research and analysis. Destruction of the microdata must be confirmed in writing by the Principal Investigator to the SIG. All related hard and soft copies containing confidential data must also be destroyed.

9. The sole purpose of the use of the dataset is for the purpose stated above. Any data or analysis or investigation for any purpose other than the derivation of the indicators requested from the SIG, unless formally authorized by the SIG, will be considered to be a breach of this agreement.

10. This agreement will come into force on the date that approval is given for access to the restricted dataset and remain in force until the end date of the project or an earlier date if the project is completed ahead of time as stated in paragraph 1 above.

11. Any breach of any of the provisions of this Memorandum of Understanding will be taken seriously and will result in the immediate termination of the access to the data, the termination of the agreement and the prohibition of any further access to data.

12. If there are any changes to the period of data use, specification, security arrangements, or personnel detailed in this agreement, it is the responsibility of the Principal Investigator to seek the agreement of the SIG to these changes.

13. Analysis of the findings or key outputs of the data specific to the purpose stated, will involve collaborative and joint-work between Curtin and SINSO, Ministry of Health and Medical Services, and other relevant SIG Ministries, and potential co-authorship with designated officers of the SINSO and SIG. For the avoidance of doubt this excludes Lydia Sandrah Kuman Kaforau's (**'the Student'**) thesis and all copyright in the Student's thesis vests in the Student.

14. No attempt will be made to re-identify respondents, and there will be no use of the identity of any person or establishment discovered inadvertently. Any such discovery will be reported immediately to the SINSO.

15. No attempt will be made to produce links between datasets provided by the SINSO or between SINSO data and other datasets that could identify individuals or organizations.

16. Subject to confidentiality an electronic copy of all analysis and publications based on the requested data will be sent to the SINSO.

17. The SINSO and the relevant funding agencies bear no responsibility for the data's use or for interpretation or inferences based upon it.

18. Data will be stored in a secure environment at the site or address of the Principal Investigator and Data User as stated in paragraph 2 above, with adequate access restrictions. The SINSO may at any time request information on the storage and dissemination facilities in place.

19. Disputes arising during the period of use of the data will initially be resolved by the SINSO Management/Government Statistician and the Principal Investigator.

Appendix-1 (Provided by Douglas KIMI, Solomon Islands Government Statistician)

Access to the Solomon Islands national Demographic Health Survey DHS 2015, unit records is granted, to allow the Principal Investigator and Data User(s) to undertake the purpose of investigating the household and maternal characteristics associated with adverse perinatal and child outcomes in the Solomon Islands, within the meaning of this Memorandum of Understanding.

Honiara: .....

GOVERNMENT STATISTICIAN
15 JAN 2021
SOLOMON ISLANDS
NATIONAL STATISTICS OFFICE

Douglas Kimi
Government Statistician
Solomon Islands National Statistics Office

Nicole O'Connor
Director, Research Services and Systems
Curtin University
(ABN 99 143 842 569)

ii. MOU to Use the SIDHS 2015 Data in 2022

Curtin University

Our ref: CTR-15069

Research Office at Curtin

Building 100 Level 1 West
Beazley Avenue
GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Web research.curtin.edu.au

Mr Douglas Kimi
Government Statistician
National Statistics Office
Ministry of Finance & Treasury
P.O. Box G6
Honiara
Solomon Islands

By email: dkimie@mof.gov.sb
Copy to: Professor Jonine Jancey

19 November 2021

Dear Douglas,

RE: Access to the Demographic Health Survey DHS 2015 Unit Record Data November 21, 2017 ("Project")

We refer Memorandum of Understanding between Curtin University ("**Curtin**") and Solomon Islands National Statistics Office ("**SIG**") executed on 15 January 2021 ("**Agreement**") in relation to the above Project.

Further to correspondence between yourself and Ms Lydia Sandrah Kuman Kaforau we wish to vary the Agreement to provide an additional 12 months for Ms Kaforau to review the data and present it to her supervisors before writing the report.

SCOPE OF VARIATION

In accordance with clause 12 of the Agreement, Curtin and SIG agree to vary the Agreement as follows:

1. Replace Clause 1 with "The period of agreement shall be from the date the last party signs and must not exceed two years".

This variation will take effect from the date both Parties sign this variation. All other terms, conditions and provisions of the Agreement remain in full force and effect and the parties reaffirm that the Agreement (as varied) is valid and binding on them.

Unless otherwise specified, capitalised terms used in this variation have the meanings given to those terms in the Agreement. This variation shall be construed and governed in accordance with the laws and jurisdiction as set out in the Agreement.

To signify your acceptance of this variation, please sign below and return a copy to us at ROCContracts@curtin.edu.au.

Yours sincerely

Ms Nicole O'Connor
Director of Research Services & Systems

Signed for and on behalf of
National Statistics Office
by its duly authorised signatory:

Authorised signatory: _____

Name: Douglas Kimi

Date: 19 November 2021

GOVERNMENT STATISTICIAN
22 NOV 2021
SOLOMON ISLANDS
NATIONAL STATISTICS OFFICE

iii. MOU to Use the SIDHS 2015 Data in 2023

Curtin University

Hannah Allan
Director, Research Services and Systems

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Email director.research@curtin.edu.au
Web curtin.edu.au

CTR-15069

4 November 2022

Mr Douglas Kimi
Government Statistician
National Statistics Office
Ministry of Finance & Treasury
P.O. Box G6
Honiara
Solomon Islands

By email: dkimie@mof.gov.sb

Dear Douglas,

RE: Access to the Demographic Health Survey DHS 2015 Unit Record Data November 21, 2017 ("Project")

We refer Memorandum of Understanding between Curtin University ("**Curtin**") and Solomon Islands National Statistics Office ("**SIG**") executed on 15 January 2021 ("**Agreement**") in relation to the above Project and amended by variation dated 19 November 2021.

Further to correspondence between yourself and Ms Lydia Sandrah Kuman Kaforau we wish to vary the Agreement to provide an additional 12 months for Ms Kaforau to review the data and present it to her supervisors before writing the report. We do not anticipate the need for a further extension as the additional 12 months will allow Ms Kaforau to complete and present the report to her supervisors.

SCOPE OF VARIATION

In accordance with clause 12 of the Agreement, Curtin and SIG agree to vary the Agreement as follows:

1. Replace Clause 1 with "The period of agreement shall be from the date the last party signs and must not exceed three years".

This variation will take effect from the date both Parties sign this variation. All other terms, conditions and provisions of the Agreement remain in full force and effect and the parties reaffirm that the Agreement (as varied) is valid and binding on them.

Unless otherwise specified, capitalised terms used in this variation have the meanings given to those terms in the Agreement. This variation shall be construed and governed in accordance with the laws and jurisdiction as set out in the Agreement.

To signify your acceptance of this variation, please sign below and return a copy to us at ROCContracts@curtin.edu.au.

Yours sincerely

Mrs Hannah Allan
Director of Research Services & Systems

Copy to: Professor Jonine Jancey. J.Jancey@curtin.edu.au

Signed for and on behalf of
National Statistics Office
by its duly authorised signatory:

21 NOV 2022

Authorised signatory: _____

Name: Dayan Kimi

Date: 21/11/22

Appendix W: Interview Schedule with Health Professionals (Stakeholder Holder Exercise)

Introduction

Hello, I am Lydia Kaforau, a Solomon Islander nurse and PhD student, currently undertaking research with my supervisory team from the school of Public Health, Curtin University into adverse birth outcomes in the Pacific islands. Adverse birth outcome is a generic term referring to undesirable birth outcome. Examples of adverse birth outcomes are low birth weight, preterm birth, SGA or fetal growth restriction, stillbirth, and miscarriage. I am wanting to talk with health professionals (nurse, midwives, and obstetrician) working in prenatal care, births and neonatal units to find out about their knowledge and experiences with adverse birth outcomes and possible risk factors for these adverse birth outcomes. I am consulting with Health professionals located in the Pacific Islands region, which includes the Solomon Islands, Vanuatu, Fiji, PNG (PNG) and Samoa.
Prior to commencing I would like to you to review the information sheet and if you are happy to participate in this research. Please indicate you agree to participate.

Interviewee Demographics information

Name Initial	
Designation	
Age	
Qualification	
Years of Experience	
Department	
Pacific Islands country of practice	

Firstly, I would like to ask you about your experience with adverse birth outcomes. Remembering that an adverse birth outcome is an undesirable birth outcome.

Types of adverse birth outcome common in your context

1. In your experience/practice what do you think are the most frequent/common adverse birth outcomes in babies born to mothers in your context?

Secondly, I would like to ask about risk factors for adverse birth outcomes. I would like you to think about what you consider to be the main risk factors for adverse birth outcomes in your context.
Risk factors and exposes of adverse birth outcomes in your context.

2. In your opinion, briefly describe what you consider to be the main risk factors that are associated with adverse birth outcome (Low birth weight or PTB or FGR) in your context. You can refer to the specific adverse birth outcome you see frequently in your setting OR select a few adverse birth outcomes and infer the specific risk factors you think are the main cause (risk factors also mean causes)

I would now like to ask you about women and their awareness/knowledge of risk factors for adverse birth outcomes.

3. **Do you think women understand or know about risk factors for adverse birth outcomes?**

☒Yes (Go To question 4)
☐No
☐Not sure

4. **What risk factors are women aware of? (list)**

I would now like to ask you about the role of health professionals.

Role of Health Professionals

5. Do you think health professionals can assist in reducing the risk of adverse birth outcomes prior to women becoming **pre-pregnancy**?

☐Yes (go to question 7)

☐No (Go to question 9)

☐Not sure (go to question 9)

6. Do you think health professionals can assist in reducing the risk of adverse birth outcomes **during prenatal care?**

☐Yes (Go to question 8)

☐No (go to question 10)

☐Not sure (go to question 10)

7. What actions do you think health practitioners (nurse, midwives, and obstetrician) who work with women during the **pre-pregnancy** period can do to reduce the risk of adverse birth outcomes in your context.

8. What actions do you think health professionals (nurse, midwives, and obstetrician) who work with women during **antenatal/prenatal care period** can do to reduce the risk of adverse birth outcomes in your context.

9. Why are you unsure or do not think health professionals (nurse, midwives, and obstetrician) who work with women during the **pre-pregnancy period** cannot reduce the risk of adverse birth outcomes in your context.

10. Why are you unsure or do not think health professionals (nurse, midwives, and obstetrician) who work with women during the **antenatal/prenatal care period** cannot reduce the risk of adverse birth outcomes in your context.

Appendix X: In-depth Interview Schedule for Postnatal Mothers in the Solomon Islands (with Pidgin Translation)

Aim

To gain an understanding of the behaviours and social and environmental context that mothers of LBW infants experience during their pregnancy.

Objective 1: To explore mothers' experiences of exposures to behavioural, social, and environmental risk factors such as poor diet, substance use, domestic violence and poverty that may contribute to having an LBW infant.

Objective 2: To explore mothers' understanding of behavioural, social, and environmental risk factors that may contribute to have an LBW infant.

Introduction

Hello, *Name of the participant.*

It's my pleasure to talk to you today. My name is Lydia; I am a registered nurse and researcher. I am very pleased to meet you today. Thank you for your time. Now, I formally welcome you to the interview. Please feel relaxed as this is just going to be like a normal conversation you have, like seeing a nurse at your clinic. I want us to discuss some issues/ problems you have experienced in your pregnancy. I will be asking you some questions, and I would be grateful if you could tell your stories from your experiences and knowledge based on these questions that I shall be asking you. There are no right or wrong answers. If you do not know the answers or refuse to answer, we can skip the questions and move to the next one. I will use my phone to record our conversation to help me accurately record all the information we talk about. As I mentioned, all information we discuss here will be kept strictly confidential. First, I would like us to complete your personal details.

Halo _____. Mi barava hapi tumas for tok wetem yu tode. Nem blog mi Lydia. Mi wan fala regista nes long hia an mi duim resech long dis fala hospital. Mi hapi tumas long mitimyu tude fo taem blong yu fo u mi tufala lelebit stori. Dis taem mi laek welkam yu long stori blong yu mi tufala. Mi laekem yu feel fri an relax nomoa taem yu mi tufala stori. Jus fil olsem nomoa tae yu tok wetem nes blong yu long klinic. Mi laek fo u mi tufala stori abaot na sam fala problem u experensim taem yu babule. Bae mi askem yu sam fala kwesten mi laek for stori kam folom wat yu save and oloketa experens blong yu. Long stori blong yu mi tufala, everi ansa u talem kam folom tru experens blong yu hem impotent. No ani ansa hem korect an no ani ansa hem wrong. Bae mi usim fon blong mi fo rekodim oloketa tok tok blong yu mi tufala. Fo everi stori blong u mi tula mi rekodim gud fo usim long fucha. Olsem mi talem finis everi stori blong yu mi tufala hem bitwin yu an mi nomoa. Bae nem blog yu bae mi tekwm aot taem mi analaesim data. Dis wan hem folom na rul blong mi fala olketa nes an resecha.

Mother and infant details

Name		Age (mother)	
Date of birth (child)		Province	
Birthweight (infants)		Marital status	
Current place of residence		Occupation	
Usual place of residence		Employment status	
Ethnicity		Education level	
Parity		Gestational age (at birth)	
Religion/ Denomination			

QUESTIONS ON HEALTH DURING PREGNANCY

Questions and probing questions
First, I want us to talk about some major issues and problems that might affect you during pregnancy, I would like you to tell me what your opinions and your experiences are. Recall your last pregnancy. Can you tell me some of the problems and challenges you have experienced affecting your last pregnancy?
Distaem mi laek yu mi tufala tok abaoutim nao oloketa bik samting wea hem kasim yu time yu babule wea hem afecktim helt blog yu. Mi laekem fo yu stori kam abaot last babule blong yu. Wat nao samfala samting wea afectim helt blong yu.

What are the problems? You tell me as many as you can. Or what common issues and problems do you think other women in your community have experienced? Can you tell me the specific issues other women face during pregnancy?
Yu talem kam wat nao oloketa problem ya. Mi laekem fo yu stori gud kam folom. Mi laekem askem tu lo ting ting blo yu wat nao oloketa yu thinkim oloketa woman long komuniti blong yu faesim time oloketa babule. Mi laekem fo yu talem kam oloketa wat kaem problems ya, klia kam lo experiens blong yu or ting ting blong yu.

QUESTIONS ON DIET AND NUTRITION

Questions and probing questions
Now, let us talk about your food and diet during your last pregnancy. I want to assure you that there is no right or wrong answer. Please respond to the questions that I will be asking accordingly. Describe your diet and nutrition during your last pregnancy?
Dis team bae yu mitufala bae storin a abaut kakai and helti kakai. Mi laek talem olowe dat efri stori yu talem kam hem gud, no eni ansa hem gud or no gud. Mi laek yu stori kam wat kaen kakai na yu savvy kakai taim yu babule?

Describe what a typical meal you had in a day during pregnancy was like? Describe what a healthy diet is. Describe what you think is an unhealthy diet is? Where and how did you get food during pregnancy?
Mi laek yu stori kam lo mi, taim yu babule wat kaen kakai na yu savvy kakaim olowe? Long ting ting blo yu wat kae kakai na hem helti an wat kain kakai nahem no helti? Yu stori kam lo wea an hao na yu tekem oloketa kakai ya from?

Describe some challenges in acquiring adequate food and nutrition during pregnancy. What are the challenges to getting adequate food? What are the challenges to getting healthy food?
Mi laik yu stori kam gud lo me, wat na oloketa samting wea hem stopim yu for no tekem or garem gud an helti kakai taim yu babule

Is there any food you are not allowed to eat during pregnancy? Describe the specific food taboos for women during pregnancy in your tribe/culture. (If no) Do you know a culture in Solomon Islands which certain food restrictions during pregnancy?
Stori kam lo me if yu fala garem eni kakai, wea yu mas no kakaim taim yu babule. Stori kam lo me if lo lotu or kastom blo yu, eni kakai bae yu no savvy kaikaim team yu babule.

QUESTIONS ON ANTENATAL SERVICES, AND HEALTH CARE PROVIDERS

Questions and probing questions
Let us discuss the antenatal care you received during your last pregnancy. Can you please describe your main healthcare provider during pregnancy?
Mi laek, yu stori kam, long wea na yu go mak taim yu babule. Yu savvy story kam abaut clinic blo yu.

When during your last pregnancy did you start your antenatal and why? How many antenatal appointments did you miss and why? How many times did you ANC clinics during pregnancy? What were the challenges to access antenatal care? How satisfied were you with the health information provided by the clinic?

Wat taim na yu stat mak an why yu stat lo disfala manis? yu missim any taim for mak an why na yu misim? hao meni taims na yu go mak? Mi laik yu stori kam oloketa wat kain samting na mekem go mak lo clinic had for yu? yu hapi tu wetem oloketa infomesin from olketa nes or dokta lo klinic?

How far do you walk to get there? Can you describe the challenges about getting to an antenatal clinic? Tell me if you are satisfied with the services provided. Do you think the services are adequate or not, explain? What are some reasons that made you feel hesitant to go for a visit?
Dis taem mi laekim you stori gud abaot klinik bolong yu. Hao fa nao yu stap kolsap klinik? Yu savvy storim kam eini problem yu garem fo stopim yu go long klinik blong yu? Waswe yu hapi tu long waka blong olketa nes lo dea? Long ting ting blong yu sevis long klinik hem enaf an yu satisfae long hem tu? Mi laek u stori wae u ting sevis hem not gud. Sam taems yu no laek visit, mi laekem yu stori kam wae yu no save visit.

Why is antenatal important? What are the reasons pregnant women should attend antenatal clinic? What kind of antenatal services do you want? (Your clinics/nurses to provide to you with) What kind of services do you want? Explain what you think of the services, if they are adequate or not, explain why.
Mi laek yu stori kam lo me, wae na go mak hem impotent? Yu stori kam wat na rison, mak lo klinik taim babule hem impotent? Mi laek yu stori kam wat kaen sevis na yu laekem for ota nes an dokta givim lo yu taim yu babule? Stori kam wat kain sevis na yu laekem an wae na yu laekim disfala sevis?

Describe all the treatments you were given during the antenatal. What medications did you receive during antenatal? What injections did you receive? Describe how often did you take those medications.
Mi laek yu stori kam lo me, wat kaen meresin na ota nes and dokta givim lo yu taim yu babaule. Yu savvy talem kam ota meresin ya? Yu talem kam tu eni nila yu tekem tu. Mi laek yu stori kam lo me, hao meni taems yu tekem ota meresin ya

Tell me of any blood test you had during antenatal. What were the results?
Mi laek yu stori kam, if ota nes or dokta tekem blood lo han blo yu. Wat na ota talem yu abaut resalt blo dis fala test?

I will ask you a sensitive but important question. You can decline to answer it if you feel uncomfortable giving me an answer. Tell me if you have any foul smell vaginal discharge or sores during pregnancy. Describe any test taken for that. Describe the medications you receive.
Mi laek askem yu one fala sensitive but one fala impotent kwesten. If yu no laekim ansam if yu fil dis fale kwesten hem tabu yu savvy no ostori kam. Waswe taim yu babule yu karem eni nana kam aot lo praevet pat blo yu. Storim kam if disfala nana hem smel no gut? Waswe, ota nes or dokta givim eni meresin fo yu an wat kaen meresin na ota givin yu?

Where did you obtain your health information regarding healthy pregnancy? Describe the health information you received during pregnancy. What information would you really want to know? Who provided you with this information?
Waswe, ota nes or dokta givim yu oloketa helt information? Wat kaen infomesin na yu barava laekem tumas fo herem from ota nes an dokta time yu babule.

QUESTIONS ON INCOME AND LIVELIHOOD

Questions and probing questions
Let's talk about your everyday living for income and livelihood during pregnancy. Recall back to when you were pregnant (Recent) and tell me your experiences and your daily routine at home or work during pregnancy. Can you describe how you survive every day?
Mi laek fo yu ting go baek long taem yu babaule just finis go ya, mi laek yu storim kam long me Hao na yu savaev evri dei. Oloketa wat kaen samting nao yu duim fo yu stap laef evri dei?

Describe the work you do. What do you do to earn income? Do you think this burden you, and if so, how? Is money earned enough? What are other means of survival? Can you describe them apart from your wages? Describe other social and financial support you received?
Mi laekem yu stori kam tu abaut wat kaen waka na yu duim. Mi laekem yu stori kam abaot laef blong yu evride taem yu babaule. Hao nao yu savve faedim selen. Wat nao olokata bik problem long laef blon yu long deili waka blong yu long haos blong yu or ples yu waka? Stori abaot wat na yu duim evride. Wat nao yu savvy duim fo mekem selen for famili blong yu. Hao nao eksperiens blong yu, yu storim kam. Waswe oloketa selen yu save waka fo hem hem inaf fo famili nids blong yu an family. Wat moa samfala samting yu savvy duim for savave long everi de apat from selen blong salari u enim? Eni wan savvy sapotim yu lo selen or oloketa nid blong yu?

QUESTIONS ON DOMESTIC VIOLENCE

Questions and probing questions
Now I want us to talk about something very important and maybe very sensitive to you. It is called domestic violence, which is violent or aggressive behaviour women experienced by a husband or a significant other during pregnancy. You may decline to answer this question now if you feel this topic is very sensitive for you. Domestic violence is common in the Solomon Islands. Now, I would like us to discuss your knowledge and experiences on domestic violence. Let me assure you again that all information regarding our discussion will be strictly kept confidential. Can you tell me what you know about domestic violence?
Disteam bae yu mi tufala stori about wan fala veri impotent samting dat yu maet no laek tok abaut. Disfala samting ota kolem domestik vaelens, wea hem minim, ota olo or eni wan lo famli savvy faetim woman taim hem babule. Sapos yu no laek intala stori abaut, bae intala savvy stop lo hia. Bat domestik vaelens hem wanfala bik problem lo kantri blo yu mi, so mi laek fo yu stori kam lo wat na yu savvy or eksperensim. Oloketa stori ya, hem stori blo yu mi tufala nomoa ya. Mi fala ota nes an waka man blo helt garem rul dat bae mi fala no storim go moa lo eni wan ota stori ya. Mi laek yu stori kam abaut wat na yu savvy abaut demetik vaelens.

Tell me what you know about domestic violence during pregnancy? Do you know of a person who was beaten by her intimate partner while pregnant? How does it happen? (don't tell me her name) Why do you think this has happened to her? Tell me if you have experienced this? Does it affect your pregnancy? Do you think this can affect the unborn baby and how? What do you think are the health consequences of domestic violence during pregnancy? Can you tell me your feelings and how this has affected that person or you?
Mi laekem yu mi tufala tok aboaot domestik vaelens oloketa babule mami save eksperensim taem babule. Mi laekem yu stori kam if yu savvy long any mami, olo blo hem save kilim taem hem babule. Bae yu no nid talem kam nem blong hem. Long ting ting blong yu, wae nao yu think husband blong hem savvy kilim wife blong hem? Waswe u eksperensim tu this kaen problem tu taem yu babule. Yu stori kam if disfafa problem hem afektim hellt blong yu taem yu babule. Long ting ting blong yu dis kaen problem savvy afektim tu smol beibi long bele blong yu? Lo ting ting blong yu wat nao oloketa problem savvy hapen long beibi long domestik vaelens? Yu savvy stori kam how na yu fil taem yu eksperensim diswan.

QUESTIONS ON WATER AND SANITATION

Questions and probing questions
Tell me about the kind of water sources and toilet facilities you use at your home/ community? Describe the kind of water source to your home? Can you describe if water is safe for human consumption? If not, why do you think your water sources are not safe? Can you tell me how to ensure your water is safe for use? What do you do?
Mi laekem yu mi tufala stori kam about wata an toilet fasilitis yu fala yusim long hom. Yu storim kam wat kaen wata nao yu fala yusim long hom? Yu lelebet story kam if wata ya hem sif fo yu fala and helt blong yu fala. Storim kam wae nao yu ting hem no seif. Mi laekem yu storim kam wat nao yu fala save duim fo mek sua hem seif.

Can you tell me about your toilet facilities? Describe the toilet facilities of your home and community. Describe the kind of facilities. Can you tell me how you would ensure your toilet facilities are safe from the spread of infection? Can you tell me if the facility is safe or not and explain why?
Dis taem mi laekem yu storim gud kam wat kaen toilet fasiliti nao yu fala lo komuniti and famili savvy yusim. Mi laek yu talem mi wat nao ting ting blong yu sapos toilet ya hem seif or nomoa an eksplenim kam wae nao yu ting hem no seif. Yu stori kam too wat nao yu fala save duim fo mekem hem seif?

QUESTIONS ON BEHAVIOURAL RISK FACTORS/SUBSTANCE USE

Questions and probing questions
Now I want us to talk about something very important and maybe very sensitive to you. It is called substance use. You may decline to give an answer if you feel this question is too sensitive for you. Tell me of any harmful substance you know people in your home/community use?
Disteam bae yu mi tufala stori about wan fala veri impotent samting dat yu maet no laek tok abaut. Disfala samting ota kolem sabstans use, or oloketa drags or no gud samting ota pipol savvy usim.
Distaem mi laekem, yu stori kam lo mi, oloketa wat kaen taep drags or no gud samting nao ota pipol lo hom blong yu savvy usim.

Can you tell me some of them you know? What harmful substances do you think woman should not use during pregnancy? (alcohol/Kwaso, are betel nut, tobacco, marijuana) Do you know of someone (don't mention her name) who is using any of the substances in your home or community? what harmful substance?
Mi laek yu stori kam wat nao some fala drag wea yu savvy people save tekem? Long ting ting blong yu, wat nao oloketa nogut samting olsem drag wea babule mami mast no tekem? Mi laekem yu storim kam if yu save long eni wan long vilig blong wea tekem dis fala kae no gud drags (bae u no talem nem blong hem) an wat kaen taep drag na hem tekem and any rison u save wae hem tekem.

Do you know of any pregnant woman using it and why they are using it? Tell me if you use substance should not be taken during pregnancy? How long and often have you been using it? And why? Tell me how any of these substances affect you. Tell me if this affects your health and the unborn fetus. Mi laekem yu storim kam if yu save long eni babule mami wea tekem dis fala kaen no gud drags (bae yu no talem nem blong hem). Wat kaen taep drag na hem tekem an eni rison yu save wae hem tekem. Nao mi laek askem if yu tu savvy tekem eni drag olsem. Hao long na yu tekem and wae yu tekem dis fala drag. Mi laek yu stori kam how nao yu ting drag ya hem afektim yu. Yu storim kam gud if drag ya hem afektim helt blong yu an beibi blo yu and hao?

Appendix Y: Participation Information Sheet for Health Professionals

Stakeholder Consultation, Participant Information Sheet, and Consent Form

What is this project about?
I am Lydia Kaforau, a Solomon Islander Registered nurse and PhD candidate, currently undertaking research into adverse birth outcomes in the Pacific islands with my supervisory team from the school of Public Health, Curtin University. Adverse birth outcome is a generic term referring to undesirable birth outcome. Examples of adverse birth outcomes are low birth weight, preterm birth, small for gestational age or fetal growth restriction, stillbirth, and miscarriage. I am wanting to talk with health professionals (nurse, midwives, and obstetrician) working in prenatal care, births, and neonatal units to find out about their knowledge and experiences with adverse birth outcomes and possible risk factors for these adverse birth outcomes. I am consulting with Health professionals located in the Pacific Islands region, which includes the Solomon Islands, Vanuatu, Fiji, Papua New Guinea (PNG) and Samoa.

Are there any benefits to being in the research project?
This research seeks to understands what risk factors are affecting the lives and health of our women in the Pacific Islands countries during pregnancy. The consultation will provide information to help identify knowledge gaps and focal points for further investigation to progress towards evidenced based maternal health care in the region.

What do I have to do?
If you agree to participate, I will ask you some personal details, such as your age, experience, and qualifications. I will then ask you about your opinion of adverse birth outcomes and risk factors for adverse birth outcomes in your context. The interview should take about 10 to 15 minutes.

Do I have to take part?
However, it is your choice to take part or not. If you decide to take part and then change your mind, you can withdraw at any time from the study. There are no penalties if you choose to withdraw.

Confidentiality
All information collected during the interview will be de-identified and treated as confidential. The data will be stored in secure password protected files at Curtin University. Only the Curtin University research team will have access to the stored data. The information will be kept at Curtin University for 7 years after the research has ended and then it will be destroyed.
The aggregated results of this research will be included in a final report and may be presented at conferences or published in professional journals. Your personal details will not be identified in any results that are published or presented.

Contacts and Concerns or complaints
If you have any concerns or further questions about the interview or research project, please contact:
Associate Professor Jonine Jancey at +61 8 9266 3807 or at J.Jancey@curtin.edu.au or Lydia Kaforau at l.kaforau@postgrad.curtin.edu.au Curtin University's Human Research Ethics Committee (HREC) has approved this study (HRE2017-0862). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

✂----------

Please screen shot this page and send it to the principal investigator

Participant Consent

HREC Project Number:	HRE2017-0862
Project Title:	Risk factors and Prevalence of adverse birth outcomes in the Pacific Islands countries; A scoping Review
Chief Investigator:	Associate Professor Jonine Jancey (PhD)
Student researcher:	Lydia Kaforau (PhD Candidate)

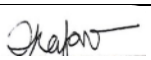
Tick a box

☐I was explained clearly in my first language, the information statement version listed above, and I understand its contents.

☐I understand the purpose and importance of the study.

☐I voluntarily consent to take part in this research project

☐I voluntarily consent to be audio recorded as taking part in this study

Pseudonym (Initial only)		Researcher name	Lydia Kaforau
Participant Signature		**Researcher Signature**	
Date		**Date**	26 March 2021

Appendix Z: Qualitative Study, Participants Information Sheet.

Curtin University

Qualitative study, Participant Information Sheet, and Consent Form

What is this project about?
I am Lydia Kaforau, a Solomon Islander Registered nurse and PhD candidate at Curtin University, Western Australia. This study will investigate the Lived experience of women in the Solomon Islands during pregnancy. This study is conducted under the guidance of my supervisors from the School of Public Health, Curtin University. As a keen researcher, I am interested to know the lived experience of women in the Solomon Islands during pregnancy and the potential impact on their babies. I believe that understanding this will help us health providers improve women's health and our practices to care for women during pregnancy.

Are there any benefits to being in the research project?

This research seeks to understand the lived experience of women in the Solomon Islands during pregnancy and the potential risk factors affecting their lives and health. This interview will generate information to fill knowledge gaps and focal points for further investigation to progress toward improving maternal and child health care in the Solomon Islands.

What do I have to do?
If you agree to participate, I will ask you for some personal details, such as your age, marital status, and education level. Then I will ask you some questions about your experience during your last pregnancy. The interview should take about 30 to 50 minutes.

Do I have to take part?
However, it is your choice to take part or not. If you decide to take part and then change your mind, you can withdraw at any time from the study. There are no penalties if you choose to withdraw.

Confidentiality
All information collected during the interview will be de-identified and treated as confidential. The data will be stored in secure password protected files at Curtin University. Only the Curtin University research team will have access to the stored data. The information will be kept at Curtin University for 7 years after the research has ended and then it will be destroyed. The aggregated results of this research will be included in a final report and may be presented at conferences or published in professional journals. Your personal details will not be identified in any results that are published or presented.

Contacts and Concerns or complaints
If you have any concerns or further questions about the interview or research project, please contact: Associate Professor Jonine Jancey at +61 8 9266 3807 or at J.Jancey@curtin.edu.au or Lydia Kaforau at l.kaforau@postgrad.curtin.edu.au Curtin University's Human Research Ethics Committee (HREC) has approved this study (HRE2017-0862). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au.

✂----------

Please screen shot this page and send it to the principal investigator
Participant Consent

HREC Project Number:	HRE2017-0862
Project Title:	Lived experiences of women with LBW infants in the Solomon Islands: a descriptive qualitative study
Chief Investigator:	Associate Professor Jonine Jancey (PhD)
Student researcher:	Lydia Kaforau (PhD student)

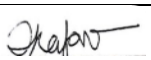
Tick a box

☐I was explained clearly in my first language, the information statement version listed above, and I understand its contents.

☐I understand the purpose and importance of the study.

☐I voluntarily consent to take part in this research project

☐I voluntarily consent to be audio recorded as taking part in this study

Pseudonym (Initial only)		Researcher name	Lydia Kaforau
Participant Signature		**Researcher Signature**	
Date		**Date**	20 December 2021

Bibliography

1. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implementation Science*. 2010;5(1):69. doi:10.1186/1748-5908-5-69
2. Besnier E TK, Stonkute D, Mohammad T, Akhter N, Todd A, Jensen MR, Kilvik A, Bambra C. Which public health interventions are effective in reducing morbidity, mortality and health inequalities from infectious diseases amongst children in low-income and middle-income countries (LMICs): protocol for an umbrella review. *BMJ Open*. 2019 9(12)doi:10.1136/bmjopen-2019-032981
3. C Reiner R. Mapping geographical inequalities in childhood diarrhoeal morbidity and mortality in low-income and middle-income countries, 2000–17: analysis for the Global Burden of Disease Study 2017. *The Lancet*. 2020;395(10239):1779-1801. doi:https://doi.org/10.1016/S0140-6736(20)30114-8
4. Rom Jensen M, Kilvik A, Bambra C, et al. Which public health interventions are effective in reducing morbidity, mortality and health inequalities from infectious diseases amongst children in low- and middle-income countries. *PloS one*. 2021;16(6):e0251905. doi:10.1371/journal.pone.0251905
5. Mokuolu OA, Adesiyun OO, Ibrahim OR, et al. Appraising Neonatal Morbidity and Mortality in a Developing Country Categorized by Gestational Age Grouping and Implications for Targeted Interventions. *Frontiers in pediatrics*. 2022;10:899645-899645. doi:10.3389/fped.2022.899645
6. McIntire DD, Leveno KJ. Neonatal mortality and morbidity rates in late preterm births compared with births at term. *Obstetrics and gynecology (New York 1953)*. 2008;111(1):35-41. doi:10.1097/01.AOG.0000297311.33046.73
7. Simovic A, Kuc A, Jevtic E, et al. Can early hyperglycemia affect the morbidity/mortality of very low birth weight premature infants? *The Turkish Journal of Pediatrics*. 2021;63(3):482-489. doi:https://doi.org/10.24953/turkjped.2021.03.015
8. Islam MM, Ababneh F, Akter T, Khan HR. Prevalence and risk factors for low birth weight in Jordan and its association with under-five mortality: a population-based analysis. *East Mediterr Health J*. 2020;26(10):1273-1284.
9. Sayers SM, Lancaster PA, Whitehead CL. Fetal growth restriction: causes and outcomes. *International encyclopedia of public health*. Elsevier; 2017:132-142.
10. Anil KC, Basel PL, Singh S. Low birth weight and its associated risk factors: Health facility-based case-control study. *PLOS ONE*. 2020;15(6):e0234907. doi:10.1371/journal.pone.0234907
11. Sharrow D, Hug L, You D, et al. Global, regional, and national trends in under-5 mortality between 1990 and 2019 with scenario-based projections until 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *The Lancet Global Health*. 2022;10(2):e195-e206.
12. Cloke B, Pasupathy D. Understanding perinatal mortality. *Obstetrics, Gynaecology & Reproductive Medicine*. 2013;23(11):323-330. doi:https://doi.org/10.1016/j.ogrm.2013.08.001
13. Choudhary TS, Kumar M, Sinha B, et al. Anthropometric Indicators as Predictors of Mortality in Early Life Among Low Birthweight Indian Infants. *Frontiers in nutrition (Lausanne)*. 2022;9:884207-884207. doi:10.3389/fnut.2022.884207
14. Kayode GA, Adekanmbi VT, Uthman OA. Risk factors and a predictive model for under-five mortality in Nigeria: evidence from Nigeria demographic and health survey. *BMC Pregnancy and Childbirth*. 2012;12(1):10. doi:10.1186/1471-2393-12-10
15. Fikru C, Getnet M, Shaweno T. Proximate determinants of under-five mortality in Ethiopia: using 2016 nationwide survey data. *Pediatric health, medicine and therapeutics*. 2019;10:169.
16. Blencowe H, Krasevec J, de Onis M, et al. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. *The Lancet Global Health*. 2019;7(7):e849-e860. doi:10.1016/S2214-109X(18)30565-5
17. Li Z, Karlsson O, Kim R, Subramanian SV. Distribution of under-5 deaths in the neonatal, postneonatal, and childhood periods: a multicountry analysis in 64 low- and middle-income countries. *International Journal for Equity in Health*. 2021;20(1):109. doi:10.1186/s12939-021-01449-8
18. Yaya S, Bishwajit G, Okonofua F, Uthman OA. Under five mortality patterns and associated maternal risk factors in sub-Saharan Africa: A multi-country analysis. *PLOS ONE*. 2018;13(10):e0205977. doi:10.1371/journal.pone.0205977

19. Verhulst A, Prieto JR, Alam N, et al. Divergent age patterns of under-5 mortality in south Asia and sub-Saharan Africa: a modelling study. *The Lancet Global Health*. 2022;10(11):e1566-e1574. doi:10.1016/S2214-109X(22)00337-0
20. UNFPA. *Reproductive, Maternal, Newborn, Child, and Adolescent health Workforce*. 2019 148. https://pacific.unfpa.org/en/publications/state-pacifics-rmncah-workforce-2019-report
21. Macharia PM, Beňová L. Double burden of under-5 mortality in LMICs. *The Lancet Global Health*. 2022;10(11):e1535-e1536. doi:10.1016/S2214-109X(22)00357-6
22. Lomazzi M, Borisch B, Laaser U. The Millennium Development Goals: experiences, achievements and what's next. *Global Health Action*. 2014;7(1):23695. doi:10.3402/gha.v7.23695
23. Feeny S, Clarke M. Achieving the Millennium Development Goals in the Asia-Pacific region: The role of international assistance. *Asia Pacific Viewpoint*. 2008;49(2):198-212. doi:https://doi.org/10.1111/j.1467-8373.2008.00370.x
24. Kikuchi K, Okawa S, Zamawe CO, et al. Effectiveness of continuum of care—linking pre-pregnancy care and pregnancy care to improve neonatal and perinatal mortality: a systematic review and meta-analysis. *PloS one*. 2016;11(10):e0164965.
25. Chao F, You D, Pedersen J, Hug L, Alkema L. National and regional under-5 mortality rate by economic status for low-income and middle-income countries: a systematic assessment. *The Lancet Global health*. 2018;6(5):e535-e547. doi:10.1016/S2214-109X(18)30059-7
26. Gebretsadik S, Gabreyohannes E. Determinants of under-five mortality in high mortality regions of Ethiopia: an analysis of the 2011 Ethiopia Demographic and Health Survey data. *International Journal of Population Research*. 2016;2016,
27. Ghimire PR, Agho KE, Ezeh OK, Renzaho A, Dibley M, Raynes-Greenow C. Under-five mortality and associated factors: evidence from the Nepal demographic and health survey (2001–2016). *International journal of environmental research and public health*. 2019;16(7):1241.
28. Kitila FL, Petros RM, Jima GH, et al. Under-five mortality and associated factors in southeastern Ethiopia. *PLOS ONE*. 2021;16(9):e0257045. doi:10.1371/journal.pone.0257045
29. Pawar S. Global, regional, and national progress towards Sustainable Development Goal 3.2 for neonatal and child health: all-cause and cause-specific mortality findings from the Global Burden of Disease Study 2019. *Available at SSRN 3939245*. 2021,
30. Pham BN, Emori RB, Ha T, Parrish A-M, Okely AD. Estimating Child Mortality at the Sub-national Level in Papua New Guinea: Evidence From the Integrated Health and Demographic Surveillance System. *Frontiers in Public Health*. 2022;9doi:10.3389/fpubh.2021.723252
31. Van Malderen C, Amouzou A, Barros AJD, Masquelier B, Van Oyen H, Speybroeck N. Socioeconomic factors contributing to under-five mortality in sub-Saharan Africa: a decomposition analysis. *BMC Public Health*. 2019;19(1):760. doi:10.1186/s12889-019-7111-8
32. Bater J, Lauer JM, Ghosh S, et al. Predictors of low birth weight and preterm birth in rural Uganda: Findings from a birth cohort study. *PloS one*. 2020;15(7):e0235626-e0235626. doi:10.1371/journal.pone.0235626
33. Chowdhury M, Dibley MJ, Alam A, Huda TM, Raynes-Greenow C. Household Food Security and Birth Size of Infants: Analysis of the Bangladesh Demographic and Health Survey 2011. *Current developments in nutrition*. 2018;2(3):nzy003-nzy003. doi:10.1093/cdn/nzy003
34. Gebremedhin M, Ambaw F, Admassu E, Berhane H. Maternal associated factors of low birth weight: a hospital based cross-sectional mixed study in Tigray, Northern Ethiopia. *BMC Pregnancy and Childbirth*. 2015;15(1):222. doi:10.1186/s12884-015-0658-1
35. Kader M, Perera NKPP. Socio-economic and nutritional determinants of low birth weight in India. *North American journal of medical sciences*. 2014;6(7):302-308. doi:10.4103/1947-2714.136902
36. Jańczewska I, Wierzba J, Jańczewska A, Szczurek-Gierczak M, Domżalska-Popadiuk I. Prematurity and Low Birth Weight and Their Impact on Childhood Growth Patterns and the Risk of Long-Term Cardiovascular Sequelae. *Children*. 2023;10(10):1599. https://www.mdpi.com/2227-9067/10/10/1599
37. Solomon Islands Demographic and Health Survey 2015 (SPC's Noumea HeadquartersB.P. D5,) rends in neo (2017).
38. SINSO. *2019 National National Housing and Census Project* Solomon Islands National Statistic Office 2020:9 https://www.statistics.gov.sb/census-2019

39. Jones PD, Balasundaram N, D'Costa L, Kacker K, Kaludewa A, Fink J. High perinatal mortality rates persist in Kirakira: The sustainable development goals for health remain out of reach in the provinces of Solomon Islands. *Journal od paeditrics and child Health* 2018;54(8):895-899. https://doi-org.dbgw.lis.curtin.edu.au/10.1111/jpc.13919
40. Cafaro J, Randle E, Wyche P, Higgins M, Fink J, Jones PD. An assessment of current antenatal care practices and identification of modifiable risk factors for prematurity and low birth weight infants in pregnancy in Solomon Islands. *The international journal of rural and remote health research, education practice and policy* 2015 15(3):3230. James cook University http://www.rrh.org.au
41. Solomon Islands Demographic and Health Survey 2006-2007 (Secretariate of the Pacific Community) (2009).
42. Kluckow H, Panisi L, Larui J, et al. Socio-demographic predictors of unintended pregnancy and late antenatal booking in Honiara, Solomon Islands. *Aust N Z J Obstet Gynaecol*. 2018;58(3):349-357. doi:10.1111/ajo.12782
43. Tosif S, Jatobatu A, Maepioh A, Subhi R, Francis KL, Duke T. Cause-specific neonatal morbidity and mortality in the Solomon Islands: An assessment of data from four hospitals over a three-year period. *J Paediatr Child Health*. 2020;56(4):607-614. doi:10.1111/jpc.14699
44. Degno S, Lencha B, Aman R, et al. Adverse birth outcomes and associated factors among mothers who delivered in Bale zone hospitals, Oromia Region, Southeast Ethiopia. *Journal of International Medical Research*. 2021;49(5):03000605211013209. doi:10.1177/03000605211013209
45. Berhan T, Andargachew K. Prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions, south Ethiopia, in 2017. *Reproductive Health*. 2018;15(1):1-10. https://reproductive-health-journal.biomedcentral.com/track/pdf/10.1186/s12978-018-0631-3
46. Hailu LD, Kebede DL. Determinants of Low Birth Weight among Deliveries at a Referral Hospital in Northern Ethiopia. *Biomed Res Int*. 2018;2018:8169615. doi:10.1155/2018/8169615
47. Tsegaye B, Kassa A. Prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions, south Ethiopia, in 2017. *Reprod Health*. 2018;15(1):193. doi:10.1186/s12978-018-0631-3
48. Dashe JS, McIntire DD, Lucas MJ, Leveno KJ. Effects of symmetric and asymmetric fetal growth on pregnancy outcomes. *Obstetrics & Gynecology*. 2000;96(3):321-327. doi:https://doi.org/10.1016/S0029-7844(00)00943-1
49. Weng Y-H, Yang C-Y, Chiu Y-W. Risk Assessment of Adverse Birth Outcomes in Relation to Maternal Age. *PLOS ONE*. 2014;9(12):e114843. doi:10.1371/journal.pone.0114843
50. Chang HY, Sung YH, Wang SM, et al. Short- and Long-Term Outcomes in Very Low Birth Weight Infants with Admission Hypothermia. *PLoS One*. 2015;10(7):e0131976. doi:10.1371/journal.pone.0131976
51. Robbers G, Vogel JP, Mola G, Bolgna J, Homer CSE. Maternal and newborn health indicators in Papua New Guinea - 2008-2018. *Sex Reprod Health Matters*. 2019;27(1):1686199. doi:10.1080/26410397.2019.1686199
52. Vogel JP, Chawanpaiboon S, Watananirun K, et al. Global, regional and national levels and trends of preterm birth rates for 1990 to 2014: protocol for development of World Health Organization estimates. *Reprod Health*. 2016;13(1):76. doi:10.1186/s12978-016-0193-1
53. Wachamo TM, Bililign Yimer N, Bizuneh AD. Risk factors for low birth weight in hospitals of North Wello zone, Ethiopia: A case-control study. *PLoS One*. 2019;14(3):e0213054. doi:10.1371/journal.pone.0213054
54. Sinha S, Aggarwal AR, Osmond C, Fall CHD, Bhargava SK, Sachdev HS. Maternal age at childbirth and perinatal and under-five mortality in a prospective birth cohort from Delhi. *Indian Pediatrics*. 2016;53(10):871-877. doi:10.1007/s13312-016-0950-9
55. Buck T, Chapman K, Ebel B, et al. *Infant Mortality Reduction Report*. Division of Prevention and Community Health; 2017 https://www.doh.wa.gov/Portals/1/Documents/Pubs/140-157-InfantMortalityReductionReport.pdf
56. Ogbo FA, Ezeh OK, Awosemo AO, et al. Determinants of trends in neonatal, post-neonatal, infant, child and under-five mortalities in Tanzania from 2004 to 2016. *BMC Public Health*. 2019;19(1):1243. doi:10.1186/s12889-019-7547-x

57. van Dijk IK. Early-life mortality clustering in families: A literature review. *Population Studies*. 2019;73(1):79-99. doi:10.1080/00324728.2018.1448434
58. Giabicani E, Pham A, Brioude F, Mitanchez D, Netchine I. Diagnosis and management of postnatal fetal growth restriction. *Best Practice & Research Clinical Endocrinology & Metabolism*. 2018;32(4):523-534.
59. Malhotra A, Allison BJ, Castillo-Melendez M, Jenkin G, Polglase GR, Miller SL. Neonatal Morbidities of Fetal Growth Restriction: Pathophysiology and Impact. *Front Endocrinol (Lausanne)*. 2019;10:55. doi:10.3389/fendo.2019.00055
60. Ranzil S, Walker DW, Borg AJ, Wallace EM, Ebeling PR, Murthi P. The relationship between the placental serotonin pathway and fetal growth restriction. *Biochimie*. 2019;161:80-87. doi:https://doi.org/10.1016/j.biochi.2018.12.016
61. Bocca-Tjeertes I, Bos A, Kerstjens J, de Winter A, Reijneveld S. Symmetrical and asymmetrical growth restriction in preterm-born children. *Pediatrics*. 2014;133(3):e650-656. doi:10.1542/peds.2013-1739
62. Heng S, O'Meara WP, Simmons RA, Small DS. Relationship between changing malaria burden and low birth weight in sub-Saharan Africa: A difference-in-differences study via a pair-of-pairs approach. *eLife*. 2021;10:e65133. doi:10.7554/eLife.65133
63. Sharma D, Shastri S, Sharma P. Intrauterine Growth Restriction: Antenatal and Postnatal Aspects. *Clinical medicine insights Pediatrics*. 2016;10:67-83. doi:10.4137/CMPed.S40070
64. Figueras F, Gratacos E. An integrated approach to fetal growth restriction. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2017;38:48-58. doi:https://doi.org/10.1016/j.bpobgyn.2016.10.006
65. Vogel JP, Chawanpaiboon S, Moller A-B, Watananirun K, Bonet M, Lumbiganon P. The global epidemiology of preterm birth. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2018;52:3-12. doi:https://doi.org/10.1016/j.bpobgyn.2018.04.003
66. Blencowe H, Cousens S, Jassir FB, et al. National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis. *The Lancet Global Health*. 2016;4(2):e98-e108.
67. Pereira G, Blair E, Lawrence D. Validation of a model for optimal birth weight: a prospective study using serial ultrasounds. *BMC Pediatrics*. 2012;12(1):73. doi:10.1186/1471-2431-12-73
68. Walani SR. Global burden of preterm birth. *International Journal of Gynecology & Obstetrics*. 2020;150(1):31-33. doi:https://doi.org/10.1002/ijgo.13195
69. Harrison MS, Goldenberg RL. Global burden of prematurity. Elsevier; 2016:74-79.
70. Di Renzo GC, Tosto V, Giardina I. The biological basis and prevention of preterm birth. *Best Pract Res Clin Obstet Gynaecol*. 2018;52:13-22. doi:10.1016/j.bpobgyn.2018.01.022
71. Blencowe H, Cousens S, Chou D, et al. Born Too Soon: The global epidemiology of 15 million preterm births. *Reproductive Health*. 2013;10(1):S2. doi:10.1186/1742-4755-10-s1-s2
72. Moutquin JM. Classification and heterogeneity of preterm birth. *BJOG*. 2003;110 Suppl 20:30-33. doi:10.1016/s1470-0328(03)00021-1
73. White LJ, Lee SJ, Stepniewska K, et al. Estimation of gestational age from fundal height: a solution for resource-poor settings. *Journal of the Royal Society Interface*. 2012;9(68):503-510.
74. Singhal R, Jain S, Chawla D, Guglani V. Accuracy of New Ballard Score in Small-for-gestational Age Neonates. *Journal of Tropical Pediatrics*. 2017;63(6):489-494. doi:10.1093/tropej/fmx055
75. Feresu SA, Harlow SD, Woelk GB. Risk Factors for Low Birthweight in Zimbabwean Women: A Secondary Data Analysis. *PLoS One*. 2015;10(6):e0129705. doi:10.1371/journal.pone.0129705
76. Wardlaw T, Blanc A, Zupan J, Åhman E. *United Nations Children's Fund and World Health Organization, Low Birthweight: Country, regional and global estimates. UNICEF*. UNICEF,; 2004. https://www.unicef.org/publications/index_24840.html
77. Ohmi HK, Hirooka A, Hata Y, Mochizuki. *Low birth weight OECD Health at a Glance 2017;*. OECD Publishing; 2017:1269-1271. doi:https://doi.org/10.1787/ae3016b9-en.
78. Development OfEC-oa. *Health at a Glance 2017*. OECD Publishing; 2017. doi:doi:https://doi.org/10.1787/health_glance-2017-en
79. TeKolste K, Bragg J, Wendel S. Extremely Low Birth Weight NICU Graduate Supplement to the Critical Elements of Care for the Low Birth Weight Neonatal Intensive Care Graduate (CEC-LBW). Washington State Department of Health, Children with Special Health Care Needs Program; 2004.

80. Katz J, Lee AC, Kozuki N, et al. Mortality risk in preterm and small-for-gestational-age infants in low-income and middle-income countries: a pooled country analysis. *Lancet*. 2013;382(9890):417-425. doi:10.1016/S0140-6736(13)60993-9
81. Lee AC, Katz J, Blencowe H, et al. National and regional estimates of term and preterm babies born small for gestational age in 138 low-income and middle-income countries in 2010. *Lancet Glob Health*. 2013;1(1):e26-36. doi:10.1016/S2214-109X(13)70006-8
82. Saleem S, Naqvi F, McClure EM, et al. Neonatal deaths in infants born weighing ≥ 2500 g in low and middle-income countries. *Reproductive Health*. 2020;17(2):158. doi:10.1186/s12978-020-01013-7
83. Aheto JMK. Predictive model and determinants of under-five child mortality: evidence from the 2014 Ghana demographic and health survey. *BMC Public Health*. 2019;19(1):64. doi:10.1186/s12889-019-6390-4
84. Abate MG, Angaw DA, Shaweno T. Proximate determinants of infant mortality in Ethiopia, 2016 Ethiopian demographic and health surveys: results from a survival analysis. *Arch Public Health*. 2020;78(1):4. doi:10.1186/s13690-019-0387-4
85. Reiner Jr RC, Wiens KE, Deshpande A, et al. Mapping geographical inequalities in childhood diarrhoeal morbidity and mortality in low-income and middle-income countries, 2000–17: analysis for the Global Burden of Disease Study 2017. *The Lancet*. 2020;395(10239):1779-1801.
86. Delnord M, Zeitlin J. Epidemiology of late preterm and early term births - An international perspective. *Semin Fetal Neonatal Med*. 2019;24(1):3-10. doi:10.1016/j.siny.2018.09.001
87. Purisch SE, Gyamfi-Bannerman C. Epidemiology of preterm birth. *Semin Perinatol*. 2017;41(7):387-391. doi:10.1053/j.semperi.2017.07.009
88. Agorinya IA, Kanmiki EW, Nonterah EA, et al. Socio-demographic determinants of low birth weight: Evidence from the Kassena-Nankana districts of the Upper East Region of Ghana. *PLoS One*. 2018;13(11):e0206207. doi:10.1371/journal.pone.0206207
89. Sorchik R, Than J, Carter K, Linhart C, Haberkorn G, Taylor R. *Fertility Trends in Pacific Island Countries and Territories*. Secretariat of the Pacific Community 2019:105. https://sdd.spc.int/news/2019/07/19/fertility-trends-pacific-island-countries-and-territories
90. UNICEF. *Situation Analysis of Children in Solomon Islands*. United Nations Children's Fund; 2017:132. https://www.unicef.org/pacificislands/media/1221/file/Situation-Analysis-of-Children-Solomon-Islands.pdf
91. Bureau of Statistics NatSotPC. *Republic of Nauru Demographic and Health Survey 2007*. Secretariat of the Pacific Community; 2007 1-344. http://www.spc.int/prism/country/nr/stats/
92. National Statistics Office PNG. *Papua Nue Guinea Demographic Health Survey 2016-2018* National Statistical Office Port Moresby, Papua New Guinea; 2018
93. Fowkes FJI, Davidson E, Agius PA, Beeson JG. Understanding the interactions between iron supplementation, infectious disease and adverse birth outcomes is essential to guide public health recommendations. *BMC Med*. 2019;17(1):153. doi:10.1186/s12916-019-1376-8
94. Berger KE, Masterson J, Mascardo J, et al. The Effects of Chewing Betel Nut with Tobacco and Pre-pregnancy Obesity on Adverse Birth Outcomes Among Palauan Women. *Matern Child Health J*. 2016;20(8):1696-1703. doi:10.1007/s10995-016-1972-6
95. Dela Cruz R, Grant J, Heck JE, Cash HL. Disparities in Adverse Perinatal Outcomes Among Pacific Islanders in the Commonwealth of the Northern Mariana Islands. *Prev Chronic Dis*. 2018;15(3):E29. doi:10.5888/pcd15.170385
96. Lufele E, Umbers A, Ordi J, et al. Risk factors and pregnancy outcomes associated with placental malaria in a prospective cohort of Papua New Guinean women. *Malar J*. 2017;16(1):427. doi:10.1186/s12936-017-2077-4
97. Ome-Kaius M, Unger HW, Singirok D, et al. Determining effects of areca (betel) nut chewing in a prospective cohort of pregnant women in Madang Province, Papua New Guinea. *BMC Pregnancy Childbirth*. 2015;15(1):177. doi:10.1186/s12884-015-0615-z
98. Peters H, Vince J, Friesen H. Low birthweight at a Papua New Guinea highlands hospital. *Journal of Tropical Pediatrics*. 2001;47(1):17-23. doi:10.1093/tropej/47.1.17
99. Senn M, Baiwog F, Winmai J, Mueller I, Rogerson S, Senn N. Betel nut chewing during pregnancy, Madang province, Papua New Guinea. *Drug and Alcohol Dependence*. 2009;105(1):126-131. doi:https://doi.org/10.1016/j.drugalcdep.2009.06.021

100. Stanisic DI, Moore KA, Baiwog F, et al. Risk factors for malaria and adverse birth outcomes in a prospective cohort of pregnant women resident in a high malaria transmission area of Papua New Guinea. *Trans R Soc Trop Med Hyg*. 2015;109(5):313-324. doi:10.1093/trstmh/trv019
101. Chawanpaiboon S, Vogel JP, Moller A-B, et al. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. *The Lancet Global Health*. 2019;7(1):e37-e46. doi:https://doi.org/10.1016/S2214-109X(18)30451-0
102. Diamond JM. New Zealand as an archipelago: an international perspective. *Ecological restoration of New Zealand islands*. 1990;2:3-8.
103. Shaw BJ, Summerhayes GR, Buckley HR, Baker JA. The use of strontium isotopes as an indicator of migration in human and pig Lapita populations in the Bismarck Archipelago, Papua New Guinea. *Journal of Archaeological Science*. 2009;36(4):1079-1091.
104. World Bank. *Systematic Country Diagnostic Priorities for Supporting Poverty Reduction & Promoting Shared Prosperity*. World Bank Group 2017:128. https://documents1.worldbank.org/curated/en/416501528199593828/pdf/Solomon-Islands
105. Frazer I. The Struggle for Control of Solomon Island Forests. *The Contemporary Pacific*. 1997;9(1):39-72. http://www.jstor.org/stable/23706782
106. SINSO. *2009 Population & Housing Census Report on Gender*. Solomon Islands National Statistical Office Ministry of Finance and Treasury PO Box G6, Honiara, Solomon Islands; 2014 198. https://www.statistics.gov.sb/sinso-documents
107. McMurray C. Population growth in Solomon Islands: signs of slowing? 2019,
108. Fund UNP. *Population and development profiles: Pacific Island countries*. United Nations Population Fund, Pacific Sub-Regional Office Suva, Fiji; 2014.
109. Ministry of Health & Medical Services. *Solomon Islands National Health Strategic Plan 2022–2031 "A Healthy Future for All" NHSP*. Published by the Ministry of Health and Medical Services of the Solomon Islands; 2022:80.
110. Foukona J. Urban Land in Honiara: Strategies and Rights to the City. *The Journal of Pacific History*. 2015;50(4):504-518. doi:10.1080/00223344.2015.1110328
111. Maebuta HE. *Livelihood strategies of people in Solomon Islands squatter settlements*. Suva: The University of the South Pacific; 2007. https://openresearch-repository.anu.edu.au/bitstream/1885/157948/1/243_generating
112. Water Aid, Water Sector Analysis, Solomon Islands Ausaid 2016 https://sirwash.weebly.com/uploads/4/2/7/6/42764129/solomon_islands_wash_sector_analysis_
113. Organization WH. Solomon Islands health system review. Regional Office for the Western, Pacific: Manila : WHO Regional Office for the Western Pacific; 2015.
114. Theresa M. The impacts of natural disasters, epidemics and pandemics on women's health in the Pacific: a narrative synthesis. *Pacific Journal of Reproductive Health*. 2020;12(1):638-643. doi:DOI: 10.18313/pjrh.2020.011
115. McIver L, Kim R, Woodward A, et al. Health impacts of climate change in pacific island countries: A regional assessment of vulnerabilities and adaptation priorities. *Environ Health Perspective*. 2016;124(11):1707-1714. doi:10.1289/ehp.1509756
116. Hodge N, Slatyer B, Skiller L. *Solomon Islands Health System Review*. World Health Organization, Regional Office for the Western Pacific; 2015:145. https://apps.who.int/iris/bitstream/handle/10665/208212/9789290616931
117. Leal Filho W, Otoara Ha'apio M, Lütz JM, Li C. Climate change adaptation as a development challenge to small Island states: A case study from the Solomon Islands. *Environmental science & policy*. 2020;107:179-187. doi:10.1016/j.envsci.2020.03.008
118. Haque TA. The influence of culture on economic development in Solomon Islands: a political-economy perspective. 2012, https://openresearch-repository.anu.edu.au/bitstream/1885/9857/1/Haque_InfluenceCulture2012.pdf
119. WorldBank. *World Bank list of economies (June 2020)*. World Bank 2019 2. https://databank.worldbank.org/data/download/site-content/CLASS.xls
120. Zhang D, Pendeverana L, Diamana W. What Do China and Solomon Islands Get From Their Security Pact?A look at China's goals and the domestic politics of the deal in the Solomons. The Diplomat The Diplomat The Diplomat 2022. p. 5.

121. Nanau GL. The wantok system as a socio-economic and political network in Melanesia. *OMNES: The Journal of Multicultural Society*. 2011;2(1):31-55.
122. Brigg M. Wantokism and state building in Solomon Islands: a response to Fukuyama. *School of Political Science and International Studies*. 2019;24 https://openresearch-repository.anu.edu.au/bitstream/1885/157946/1/243_
123. Bobongie-Harris F. Girls' education in the Solomon Islands: stories, research, and wantoks. *Ethnography and Education*. 2021;16(4):373-383. doi:10.1080/17457823.2021.1938166
124. Arua RA, Eka DJ. Wantok system. *Melanesian Journal of Theology*. 2002 7. https://docplayer.net/173833784-Wantok-system-revd-ako-arua-and-daniel-john-eka.html
125. Foukona JD. Solomon Islands. *The Contemporary Pacific*. 2022;34(2):490-498.
126. Watson G, Karen A. English in the Solomon Islands. *World Englishes*. 1987;6(1):21-32. doi:https://doi.org/10.1111/j.1467-971X.1987.tb00174.x
127. Media C. *Unemployment in the Solomon Islands*. Central Bank of the Solomon Islands; 2021 3. http://www.cbsi.com.sb/wp-content/uploads/2021/05/Article-03.21-Unemployment-in-Solomon-Islands
128. Alley M. *Solomon Islands poverty profile based on the 2012/13 household income and expenditure survey*. SINSO 2015. https://sdd.spc.int/digital_library/solomon-islands-poverty-profile-based-201213-household-income-and-expenditure
129. MHMS. *National Health Strategic Plan 2016 - 2020*. Ministry of Health and Medical Service; 2020 https://daisi.com.au/wp-content/uploads/2016/09/Strategic-Plan-for-Solomon-Islands-2016-2010.pdf
130. SPC. *Solomon Islands Family Health and Safety Study: A study on violence against women and children*. Secretariat of the Pacific Community; 2009:252. https://pacificwomen.org/wpcontent/uploads/2017/09/SolomonIslandsFamilyHealthandSafetyStudy1.pdf
131. Koete B, Nusair P, Mohammadnezhad M, Khan S. Prevalence and Characteristics of Intimate Partner Violence (IPV) Among Pregnant Women Seeking Antenatal Care, Solomon Islands (2016). *Journal of Community Medicine & Health Education*. 2017;7:1000558. doi:10.4172/2161-0711.1000558
132. Pratt S. The Challenge of Betel Nut Consumption to Economic Development: a Case of Honiara, Solomon Islands. *Asia-Pacific Development Journal*. 2014;21:103. doi:10.18356/b368d584-en
133. Quinn B, Peach E, Wright CJC, Lim MSC, Davidson L, Dietze P. Alcohol and other substance use among a sample of young people in the Solomon Islands. *Aust N Z J Public Health*. 2017;41(4):358-364. doi:10.1111/1753-6405.12669
134. Tovosia S, Chen P-H, Ko AM-J, Tu H-P, Tsai P-C, Ko Y-C. Prevalence and Associated Factors of Betel Quid Use in the Solomon Islands: A Hyperendemic Area for Oral and Pharyngeal Cancer. *The American Journal of Tropical Medicine and Hygiene*. 2007;77(3):586-590. doi:https://doi.org/10.4269/ajtmh.2007.77.586
135. Brown AM. Auditing Solomon Islands' health and medical governance. *Clinical Governance: An International Journal*. 2013,
136. Amosa-Lei Sam F, Akinremi A, Mery L, Sarfati D, Stanley J, Gurney J. Cancer Incidence in Samoa: A 10-Year Retrospective Survey (2007-2016). *Asia Pacific Journal of Public Health*. 2020;33(6-7):700-706. doi:10.1177/1010539520975261
137. Whiting S, Dalipanda T, Postma S, Jamshaid de Lorenzo A, Aumua A. Moving towards Universal Health Coverage through the Development of Integrated Service Delivery Packages for Primary Health Care in the Solomon Islands. *International journal of integrated care*. 2016;16(1):3-3. doi:10.5334/ijic.2447
138. Multi-Sectoral National Non-Communicable Disease Strategic Plan 2019–2023. A long and healthy life for all (Ministry of Health and Medical services) 55 (2019).
139. Kinley W, Sarma H, Leaburi J, McBryde E, Clements ACA. Evaluation of the malaria reporting system supported by the District Health Information System 2 in Solomon Islands. *Malaria Journal*. 2020;19:1-14. doi:http://dx.doi.org/10.1186/s12936-020-03442-y
140. Russell TL, Grignard L, Apairamo A, et al. Getting to zero: micro-foci of malaria in the Solomon Islands requires stratified control. *Malaria Journal*. 2021;20(1):248. doi:10.1186/s12936-021-03779-y
141. Marks M, Kako H, Butcher R, et al. Prevalence of sexually transmitted infections in female clinic attendees in Honiara, Solomon Islands. *BMJ Open*. 2015;5(4):e007276. doi:10.1136/bmjopen-2014-007276
142. Lifigao M, Nasi T, Titiulu C, Lumasa S, Duke T. Congenital Syphilis in Honiara, Solomon Islands. *Journal of Tropical Pediatrics*. 2020;66(6):583-588. doi:10.1093/tropej/fmaa017

143. Furusyo N, Hayashi J, Kakuda K, et al. Markedly high seroprevalence of hepatitis B virus infection in comparison to hepatitis C virus and human T lymphotropic virus type-1 infections in selected Solomon Islands populations. *The American journal of tropical medicine and hygiene*. 1999;61(1):85-91. https://www.ajtmh.org/view/journals/tpmd/61/1/article-p85.xml
144. Getahun A, Baekalia M, Panda N, et al. Seroprevalence of hepatitis B surface antigen in pregnant women attending antenatal clinic in Honiara Solomon Islands, 2015. *World journal of hepatology*. 2016;8(34):1521. doi:10.4254/wjh.v8.i34.1521
145. Hiatt T, Nishikiori N. Epidemiology and control of tuberculosis in the Western Pacific Region: analysis of 2012 case notification data. *Western Pacific surveillance and response journal: WPSAR*. 2014;5(1):25. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3984966/pdf/WPSAR.2014.5.1-025.pdf
146. Role Delineation Policy for Solomon Islands (Ministry of Health and Medical Service) 1-54 (n.d).
147. National Health Strategic Plan The Ministry of Health & Medical Services (Ministry of Health and Medical Service) 1-60 (2011).
148. Solomon Islands National Health Strategic Plan 2016 - 2020 (Ministry of Health and Medical Services) 52 (2016).
149. MHMS. *Descriptive Health Report, Solomon Islands* 2018 1-46
150. Liamputtong P. Handbook of Research Methods in Health Social Sciences. Singapore: Springer Singapore Pte. Limited; 2019. doi:10.1007/978-981-10-5251-4
151. Creswell JW, Clark VLP. *Designing and conducting mixed methods research*. Sage publications; 2017.
152. Kaforau LSK, Tessema GA, Jancey J, Dhamrait GK, Bugoro H, Pereira GF. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review protocol. *BMJ Open*. 2021;11(4):e042423. doi:10.1136/bmjopen-2020-042423
153. Institute JB. Collaborating Entity The Western Australian Group for Evidence Informed Healthcare Practice: a JBI Centre of Excellence. 2020. 2020. https://jbi.global/node/2258
154. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*. 2005;8(1):19-32. doi:10.1080/1364557032000119616
155. STATACorp. *Stata User's Guide Release 17*. Stata Press, 4905 Lakeway Drive, College Station, Texas 77845; 2021:399. https://www.stata.com/manuals/u.pdf
156. Jacobsen KH. *Introduction to health research methods: A practical guide*. Jones & Bartlett Publishers; 2020.
157. Tufford L, Newman P. Bracketing in Qualitative Research. *Sage Publication*. 2010;11:80-96. doi:10.1177/1473325010368316
158. Jourdan C. Bilingualism and creolization in Solomon Islands. 2009:245-256. doi:10.1075/cll.34.18jou
159. Attard DJ, Ross DL, Weeks KW. Developing a spiritual care competency framework for pre-registration nurses and midwives. *Nurse Education in Practice*. 2019;40:102604. doi:https://doi.org/10.1016/j.nepr.2019.07.010
160. Maguire M, Delahunt B. Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars.*. *AISHE-J*. 2017;3:3351-33514. http://ojs.aishe.org/index.php/aishe-j/article/view/335
161. Booth A, Hannes K, Harden A, Noyes J, Harris J, Tong A. COREQ (Consolidated Criteria for Reporting Qualitative Studies). *Guidelines for Reporting Health Research: A User's Manual*. 2014:214-226. Accessed 2023/06/14. doi:https://doi.org/10.1002/9781118715598.ch21
162. Blumenshine P, Egerter S, Barclay CJ, Cubbin C, Braveman PA. Socioeconomic Disparities in Adverse Birth Outcomes: A Systematic Review. *American Journal of Preventive Medicine*. 2010;39(3):263-272. doi:https://doi.org/10.1016/j.amepre.2010.05.012
163. Gedefaw G, Alemnew B, Demis A. Adverse fetal outcomes and its associated factors in Ethiopia: a systematic review and meta-analysis. *BMC pediatrics*. 2020;20:1-12.
164. Campbell EE, Seabrook JA. The influence of socioeconomic status on adverse birth outcomes. *Can J Midwifery Res Pract*. 2016;15(2):11-20.
165. Kandasamy Y, Tanchi PPD, Edmonds LK. Small for Gestational Age and Low Birth Weight Term Admissions to a Tertiary Perinatal Centre in Northern Queensland, Australia. *Journal of Immigrant and Minority Health*. 2015;17(1):227-231. doi:10.1007/s10903-013-9891-8

166. Joseph Davey DL, Shull HI, Billings JD, Wang D, Adachi K, Klausner JD. Prevalence of Curable Sexually Transmitted Infections in Pregnant Women in Low- and Middle-Income Countries From 2010 to 2015: A Systematic Review. *Sexually Transmitted Diseases*. 2016;43(7), https://journals.lww.com/stdjournal/Fulltext/2016/07000/Prevalence_of_Curable_Sexually_Transmitted.11.aspx
167. Magnusson RS, Patterson D. How Can We Strengthen Governance of Non-communicable Diseases in Pacific Island Countries and Territories? *Asia & the Pacific policy studies*. 2015;2(2):293-309. doi:10.1002/app5.84
168. Horwood PF, Tarantola A, Goarant C, et al. Health Challenges of the Pacific Region: Insights From History, Geography, Social Determinants, Genetics, and the Microbiome. *Frontiers in Immunology*. 2019;10(2184), https://www.frontiersin.org/article/10.3389/fimmu.2019.02184
169. Organization WH. *Country Coping Stratergy at a Glance, Pacific Island Countries* World Health Organization 2013 2. http://www.who.int/countryfocus
170. Linhart C, Karen Carter, Renee Sorchik, Haberkorn G, Taylor R. *Trends in Neonatal and Infant Mortality for Pacific Island States*. 2015. https://sdd.spc.int/en/reports-manuals/101-pacific-infant-and-neonatal-mortality-trends-report
171. Bureau of Statistics S. *Samoa Demographic and Health Survey 2014 by Census-Surveys and Demography Division*. Samoa demographic and health survey 2014 / Census-Surveys and Demography Division. - Apia, Samoa : Samoa Bureau of Statistics, Government of Samoa, 2014; 2014 1-345. www.sbs.gov.ws
172. MHMS W. *Health Service Delivery Profile, Solomon Islands, 2012* WHO and the Ministry of Health; 2012 http://www.wpro.who.int/health_services/service_delivery_profile_solomon_islands
173. WHO Western Pacific. *Western Pacific Country Health Information Profile 2011 REVISION* WHO Western Pacific Region 2011:556. https://spccfpstore1.blob.core.windows.net/digitallibrary-

df%22
174. Wilson AN, Spotswood N, Hayman GS, et al. Improving the quality of maternal and newborn care in the Pacific region: A scoping review. *The Lancet Regional Health – Western Pacific*. 2020;3doi:10.1016/j.lanwpc.2020.100028
175. Gani A. Some Aspects of Communicable and Non-communicable Diseases in Pacific Island Countries. *Social Indicators Research*. 2009;91(2):171-187. doi:10.1007/s11205-008-9276-x
176. Charlton KE, Russell J, Gorman E, et al. Fish, food security and health in Pacific Island countries and territories: a systematic literature review. *BMC Public Health*. 2016;16(1):285. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-2953-9
177. Barnett J. Dangerous climate change in the Pacific Islands: food production and food security. *Regional Environmental Change*. 2011;11(1):229-237. doi:10.1007/s10113-010-0160-2
178. Kumar L, Jayasinghe S, Gopalakrishnan T, Nunn PD. *Climate Change and the Pacific Islands*. Climate Change and Impacts in the Pacific. Springer International Publishing; 2020. doi:10.1007/978-3-030-32878-8_1
179. Smith J, Lloyd T, Bobogare A, et al. Malaria early warning tool: linking inter-annual climate and malaria variability in northern Guadalcanal, Solomon Islands. *Malaria Journal*. 2017;16:1. doi:http://dx.doi.org/10.1186/s12936-017-2120-5
180. Chan CW, Iata H, Yaviong J, et al. Surveillance for malaria outbreak on malaria-eliminating islands in Tafea Province, Vanuatu after Tropical Cyclone Pam in 2015. *Epidemiol Infect*. 2017;145(1):41-45. doi:10.1017/s0950268816002041
181. De Silva M, Panisi L, Brownfoot FC, et al. Systematic review of areca (betel nut) use and adverse pregnancy outcomes. *Int J Gynaecol Obstet*. 2019;147(3):292-300. doi:10.1002/ijgo.12971
182. Hossain MF, Anwar M, Akhtar S, Numan SM. Adverse effects on health posed by consumption of Areca nut (Areca catechu L., family: Palmaceae). *Int J Community Med Public Health*. 2015;2(4):357-360.
183. Community SotP. *Fiji Kava Quality Manual* Secretariate of the Pacific Community ?:1-79. https://phama.com.au/wp-content/uploads/2017/03/Fiji-Kava-Quality-Manual-1.pdf
184. Shimoda LMN, Park C, Stokes AJ, Gomes HH, Turner H. Pacific Island 'Awa (Kava) Extracts, but not Isolated Kavalactones, Promote Proinflammatory Responses in Model Mast Cells. *Phytotherapy Research*. 2012;26(12):1934-1941. doi:https://doi.org/10.1002/ptr.4652

185. Aromataris E, Munn Z. *JBI Reviewer's Manual*. Joana Briggs Institute; 2020:488. https://reviewersmanual.joannabriggs.org/.https://doi.org/10.46658/JBIRM-19-01
186. Andrew NL, Bright P, de la Rua L, Teoh SJ, Vickers M. Coastal proximity of populations in 22 Pacific Island Countries and Territories. *PLOS ONE*. 2019;14(9):e0223249. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0223249
187. Peters M, Godfrey C, Khalil H, Mcinerney P, Soares C, Parker D. 2017 guidance for the conduct of JBI scoping reviews. *Joana Briggs Inst Rev Man*. 2017;13:141-146.
188. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*. 2018;169(7):467-473.
189. Erlingsson C, Brysiewicz P. A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*. 2017;7(3):93-99. doi:https://doi.org/10.1016/j.afjem.2017.08.001
190. Liamputtong P. Making sense of qualitative data : analysis process *Qualitative Research Method*. 2013 pp 241-263. Oxford University Press.
191. White M, Marsh E. Content Analysis: A Flexible Methodology. *Library Trends*. 2006;55doi:10.1353/lib.2006.0053
192. Unger HW, Ome-Kaius M, Karl S, et al. Factors associated with ultrasound-aided detection of suboptimal fetal growth in a malaria-endemic area in Papua New Guinea. *BMC Pregnancy Childbirth*. 2015;15(1):83. doi:10.1186/s12884-015-0511-6
193. Unger HW, Rosanas-Urgell A, Robinson LJ, et al. Microscopic and submicroscopic Plasmodium falciparum infection, maternal anaemia and adverse pregnancy outcomes in Papua New Guinea: a cohort study. *Malaria Journal*. 2019;18(1):302. doi:10.1186/s12936-019-2931-7
194. Central Statistics Division tSotPC, and Macro International Inc. *Tuvalu Demographic and Health Survey 2007*. Secretariat of the Pacific Community Noumea, New Caledonia October 2009; 2007
195. Economic Policy PaSOM, Marshall Islands. *Marshall Islands Demographic and Health Survey 2007*. Secretariat of the Pacific Community; 2007 421
196. Ministry of Health TDoS, the Secretariat of the Pacific Community, and United Nations Population Fund. *Tonga Demographic and Health Survey 2012*. Secretariat of the Pacific Community; 2012
197. Ministry of Health VNSO, the Secretariat of the Pacific Community. *Vanuatu Demographic and Health Survey 2013*. Secretariat of the Pacific Community Noumea; 2013
198. National Statistic Office KaSotPC. *Kiribati Demographic and Health Survey 2009*. Secretariat of the Pacific Community; 2009
199. World Health Organization. *Global Nutrition Targets 2025 Low Birth Weight Policy Brief*. World Health Organization 2014 1-8 https://apps.who.int/iris/bitstream/handle/10665/149020/WHO_NMH_NHD_14.5_eng.pdf?ua=1
200. Howsen CP, Kinney MV, Lawn JE. *The global action report on preterm*. 2012. https://www.who.int/pmnch/media/news/2012/201204_borntoosoon-report.pdf
201. Donald W, Pasay C, Guintran JO, et al. The Utility of Malaria Rapid Diagnostic Tests as a Tool in Enhanced Surveillance for Malaria Elimination in Vanuatu. *PLoS One*. 2016;11(11):e0167136. doi:10.1371/journal.pone.0167136
202. Hetzel MW, Saweri OPM, Kuadima JJ, et al. *Papua New Guinea malaria indicator survey 2016-2017: malaria prevention, infection, and treatment*. Papua New Guinea Institute of Medical Research, Goroka; 2018 1-70. https://www.malariasurveys.org/documents/PNGIMR%202018%20-%20PNG
203. Wangdi K, Sarma H, Leaburi J, McBryde E, Clements ACA. Evaluation of the malaria reporting system supported by the District Health Information System 2 in Solomon Islands. *Malaria Journal*. 2020;19(1):372. doi:10.1186/s12936-020-03442-y
204. Opeskin B. Malaria in Pacific populations: seen but not heard? *Journal of Population Research*. 2009;26(2):175-199. doi:10.1007/s12546-009-9011-8
205. World Health Organization. *World malaria report 2020: 20 years of global progress and challenges*. World Health Organization 2020:151. https://reliefweb.int/report/world/world-malaria-report-2020
206. Organization WH. Countries and territories certified malaria-free by WHO. WHO 2019. https://www.who.int/malaria/areas/elimination/malaria-free-countries/en/
207. Bradbury R, Hii S, Harrington H, Speare R, Traub R. Ancylostoma ceylanicum Hookworm in the Solomon Islands. *Emerging Infectious Diseases*. 2017;23doi:10.3201/eid2302.160822

208. Uzan J, Carbonnel M, Piconne O, Asmar R, Ayoubi J. Pre-eclampsia: Pathophysiology, diagnosis, and management. *Vascular health and risk management*. 2011;7:467-474. doi:10.2147/VHRM.S20181
209. Kessaram T, McKenzie J, Girin N, et al. Overweight, obesity, physical activity and sugar-sweetened beverage consumption in adolescents of Pacific islands: results from the Global School-Based Student Health Survey and the Youth Risk Behavior Surveillance System. *BMC Obesity*. 2015;2(1):34. doi:10.1186/s40608-015-0062-4
210. Tosif S, Nasi T, Gray A, Sadr-Azodi N, Ogaoga D, Duke T. Assessment of the quality of neonatal care in the Solomon Islands. *Journal of paediatrics and child health*. 2017;54doi:10.1111/jpc.13686
211. Redman-MacLaren M, MacLaren D, Asugeni R, et al. "We can move forward": Challenging historical inequity in public health research in Solomon Islands. *International journal for equity in health*. 2010;9:25. doi:10.1186/1475-9276-9-25
212. Falcão IR, Ribeiro-Silva RdC, de Almeida MF, et al. Factors associated with low birth weight at term: a population-based linkage study of the 100 million Brazilian cohort. *BMC Pregnancy and Childbirth*. 2020;20(1):536. doi:10.1186/s12884-020-03226-x
213. Lema Desalegn H, Kebede DL. Determinants of Low Birth Weight among Deliveries at a Referral Hospital in Northern Ethiopia. *BioMed Research International*. 2018;2018:8. doi:http://dx.doi.org/10.1155/2018/8169615
214. Kaforau LSK, Tessema GA, Jancey J, Dhamrait G, Bugoro H, Pereira G. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: A scoping review. *Lancet Reg Health West Pac*. 2022;21:100402. doi:10.1016/j.lanwpc.2022.100402
215. Kassaw MW, Abebe AM, Kassie AM, Abate BB, Masresha SA. Trends of proximate low birth weight and associations among children under-five years of age: Evidence from the 2016 Ethiopian demographic and health survey data. *PLOS ONE*. 2021;16(2):e0246587. doi:10.1371/journal.pone.0246587
216. Oladeinde HB, Oladeinde OB, Omoregie R, Onifade AA. Prevalence and determinants of low birth weight: the situation in a traditional birth home in Benin City, Nigeria. *African Health Sciences*. 2015 15(4):7. doi:10.4314/ahs.v15i4.10
217. Keen M, Kiddle L. *State, society and Govanance in Melanesia* Australia National University 2016:2. https://openresearch-repository.anu.edu.au/bitstream/1885/142754/1/ib-2016-28-keenkiddle.pdf
218. Chand S. Conflict to crisis in Solomon Islands. *Pacific Economic Bulletin*. 2002;17:1-7. https://www.researchgate.net/publication/268273185Conflict_to_crisis_in_Solomon_Islands
219. PSRO U. *Solomon Islands Family Health and Safety Study:A study on violence against women and children*. Secretariat of the Pacific Community; 2009 254 https://pacific.unfpa.org/en/publications/solomon-islands-family-health-and-safety-study
220. Kekea G. Kava Formally Recognized as a Beverage. 2020:2. https://www.solomontimes.com/news/kava-formally-recognized-as-a-beverage/10289
221. Warshak CR, Regan J, Moore B, Magner K, Kritzer S, Van Hook J. Association between marijuana use and adverse obstetrical and neonatal outcomes. *Journal of Perinatology*. 2015;35(12):991-995. doi:10.1038/jp.2015.120
222. Butt J. *Review of kava use among Aboriginal and Torres Strait Islander people.* . 2019 28. file:///C:/Users/61433/Desktop/Journal%20download%2021st%20July/kava-bulletin-web.pdf
223. Fergusson DM, Horwood LJ, Northstone K, Team AS. Maternal use of cannabis and pregnancy outcome. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2002;109(1):21-27. doi:https://doi.org/10.1111/j.1471-0528.2002.01020.x
224. Koto P, Allen VM, Fahey J, Kuhle S. Maternal Cannabis Use During Pregnancy and Maternal and Neonatal Outcomes: A Retrospective Cohort Study. *BJOG*. 2022;doi:10.1111/1471-0528.17114
225. Nashed MG, Hardy DB, Laviolette SR. Prenatal Cannabinoid Exposure: Emerging Evidence of Physiological and Neuropsychiatric Abnormalities. *Frontiers in Psychiatry*. 2021;11doi:10.3389/fpsyt.2020.624275
226. Michalski CA, Hung RJ, Seeto RA, et al. Association between maternal cannabis use and birth outcomes: an observational study. *BMC Pregnancy and Childbirth*. 2020;20(1):771. doi:10.1186/s12884-020-03371-3
227. Food Standards Australia New Zealand. *Kava, a Human Health Risk Assessment*. Food Standards Australia New Zealand; 2004 26. 30 file:///C:/Users/61433/Desktop/My%20EndNote%20Librarybackup070521.Data/PDF/2749025683/30_Kava

228. Romm A, Hardy ML, Mills S. Kava kava-Piper methysticum. In: Romm A, Hardy ML, Mills S, eds. *Botanical Medicine for Women's Health*. Churchill Livingstone; 2010:539-541. doi:https://doi.org/10.1016/B978-0-443-07277-2.00028-3
229. Ulbricht C, Basch E, Boon H, et al. Safety review of kava (Piper methysticum) by the Natural Standard Research Collaboration. *Expert Opinion on Drug Safety*. 2005;4(4):779-794. doi:10.1517/14740338.4.4.779
230. DØRheim Ho-Yen S, Tschudi Bondevik G, Eberhard-Gran M, Bjorvatn B. Factors associated with depressive symptoms among postnatal women in Nepal. *Acta Obstetricia et Gynecologica Scandinavica*. 2007;86(3):291-297. doi:https://doi.org/10.1080/00016340601110812
231. Tessema ZT, Tamirat KS, Teshale AB, Tesema GA. Prevalence of low birth weight and its associated factor at birth in Sub-Saharan Africa: A generalized linear mixed model. *PloS one*. 2021;16(3):e0248417-e0248417. doi:10.1371/journal.pone.0248417
232. Salihu HM, Wilson RE. Epidemiology of prenatal smoking and perinatal outcomes. *Early Human Development*. 2007;83(11):713-720. doi:https://doi.org/10.1016/j.earlhumdev.2007.08.002
233. Lassi ZS, Kedzior SG, Tariq W, Jadoon Y, Das JK, Bhutta ZA. Effects of Preconception Care and Periconception Interventions on Maternal Nutritional Status and Birth Outcomes in Low- and Middle-Income Countries: A Systematic Review. *Nutrients*. 2020;12(3):606. doi:10.3390/nu12030606
234. Das Gupta R, Swasey K, Burrowes V, Hashan MR, Al Kibria GM. Factors associated with low birth weight in Afghanistan: a cross-sectional analysis of the demographic and health survey 2015. *BMJ Open*. 2019;9(5):e025715. doi:10.1136/bmjopen-2018-025715
235. Endalamaw A, Engeda EH, Ekubagewargies DT, Belay GM, Tefera MA. Low birth weight and its associated factors in Ethiopia: a systematic review and meta-analysis. *Italian Journal of Pediatrics*. 2018;44(1):141. doi:10.1186/s13052-018-0586-6
236. Khan N, Mozumdar A, Kaur S. Determinants of low birth weight in India: An investigation from the National Family Health Survey. *American Journal of Human Biology*. 2020;32(3):e23355. doi:https://doi.org/10.1002/ajhb.23355
237. Singh U, Ueranantasun A, Kuning M. Factors associated with low birth weight in Nepal using multiple imputation. *BMC Pregnancy and Childbirth*. 2017;17(1):67. doi:10.1186/s12884-017-1252-5
238. Gibson J, Simler K, Carnahan M. *Solomon Islands Poverty Profile Based on the 2012/13 Household Income And Expenditure Survey*. Solomon Islands National Statistic Office 2015 56. https://www.statistics.gov.sb/images/SolomonFiles/Social-and-Demography-Statistics/SI_Report_on_Poverty_
239. Westcott M, Martiniuk AL, Fowler RA, Adhikari NK, Dalipanda T. Critical care resources in the Solomon Islands: a cross-sectional survey. *BMC Int Health Hum Rights*. 2012;12:1. doi:10.1186/1472-698x-12-1
240. Oecd, Organization WH. *Health at a Glance*. Health at a Glance: Asia/Pacific. OECD Publishing; 2020.
241. Cutland CL, Lackritz EM, Mallett-Moore T, et al. Low birth weight: Case definition & guidelines for data collection, analysis, and presentation of maternal immunization safety data. *Vaccine*. 2017;35(48 Pt A):6492-6500. doi:10.1016/j.vaccine.2017.01.049
242. Dahlui M, Azahar N, Oche OM, Aziz NA. Risk factors for low birth weight in Nigeria: evidence from the 2013 Nigeria Demographic and Health Survey. *Global Health Action*. 2016;9(1):28822. doi:10.3402/gha.v9.28822
243. Gebregzabiherher Y, Haftu A, Weldemariam S, Gebrehiwet H. The Prevalence and Risk Factors for Low Birth Weight among Term Newborns in Adwa General Hospital, Northern Ethiopia. *Obstetrics and Gynecology International*. 2017;2017:2149156. doi:10.1155/2017/2149156
244. Girma S, Fikadu T, Agdew E, et al. Factors associated with low birthweight among newborns delivered at public health facilities of Nekemte town, West Ethiopia: a case control study. *BMC Pregnancy and Childbirth*. 2019;19(1):220. doi:10.1186/s12884-019-2372-x
245. Chhea C, Ir P, Sopheab H. Low birth weight of institutional births in Cambodia: Analysis of the Demographic and Health Surveys 2010-2014. *PLOS ONE*. 2018;13(11):e0207021. doi:10.1371/journal.pone.0207021

246. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care*. 2007;19(6):349-357. doi:10.1093/intqhc/mzm042
247. Battula SP, Mohammed NHA, Datta S. Antepartum haemorrhage. *Obstetrics, Gynaecology & Reproductive Medicine*. 2021;31(4):117-123. doi:https://doi.org/10.1016/j.ogrm.2021.02.001
248. Bauserman M, Conroy AL, North K, Patterson J, Bose C, Meshnick S. An overview of malaria in pregnancy. *Semin Perinatol*. 2019;43(5):282-290. doi:10.1053/j.semperi.2019.03.018
249. Gupta N. Antepartum Hemorrhage. In: Gandhi A, Malhotra N, Malhotra J, Gupta N, Bora NM, eds. *Principles of Critical Care in Obstetrics: Volume I*. Springer India; 2016:281-301. doi:10.1007/978-81-322-2692-5_27
250. Guyatt Helen L, Snow Robert W. Impact of Malaria during Pregnancy on Low Birth Weight in Sub-Saharan Africa. *Clinical Microbiology Reviews*. 2004;17(4):760-769. doi:10.1128/CMR.17.4.760-769.2004
251. Johnson HL, Ghanem KG, Zenilman JM, Erbelding EJ. Sexually Transmitted Infections and Adverse Pregnancy Outcomes Among Women Attending Inner City Public Sexually Transmitted Diseases Clinics. *Sexually Transmitted Diseases*. 2011;38(3):167-171. http://www.jstor.org/stable/44981396
252. Kalinderi K, Delkos D, Kalinderis M, Athanasiadis A, Kalogiannidis I. Urinary tract infection during pregnancy: current concepts on a common multifaceted problem. *Journal of Obstetrics and Gynaecology*. 2018;38(4):448-453. doi:10.1080/01443615.2017.1370579
253. MHMS SI. Standard Treatment Manual Obstetrics & Gynaecology. Honiara Ministry of Health and Medical Service, Solomon Islands 2018 p. 220
254. Jones C, Schwarz AM, Sulu R, Tikai P. *Foods and diets of communities involved in inland aquaculture in Malaita Province, Solomon Islands. Penang, Malaysia:CGIAR Research Program on Aquatic Agricultural Systems. Program Report: AAS-2014-30.* WorldFish, P.O. Box 438, Honiara, Solomon Islands; 2014 36. http://hdl.handle.net/1834/31423
255. Iradukunda F. Food taboos during pregnancy. *Health Care Women Int*. 2020;41(2):159-168. doi:10.1080/07399332.2019.1574799
256. Tsegaye D, Tamiru D, Belachew T. Food-related taboos and misconceptions during pregnancy among rural communities of Illu Aba Bor zone, Southwest Ethiopia. A community based qualitative cross-sectional study. *BMC Pregnancy and Childbirth*. 2021;21(1):309. doi:10.1186/s12884-021-03778-6
257. Jerzy K, Paofa D, Kaugla N, Totona C, Samiak S, Kumei E. Food taboos and traditional customs among pregnant women in Papua New Guinea: Missed opportunity for education in antenatal clinics. *Contemporary PNG Studies*.1-11. doi:10.3316/informit.846982897061954
258. Horsey B, Swanepoel L, Underhill S, Aliakbari J, Burkhart S. Dietary Diversity of an Adult Solomon Islands Population. *Nutrients*. 2019;11(7):1622. https://www.mdpi.com/2072-6643/11/7/1622
259. Albert J, Bogard J, Siota F, et al. Malnutrition in rural Solomon Islands: An analysis of the problem and its drivers. *Wiley-Maternal and Child Nutrition* 2020:12. doi: 10.1111/mcn.12921
260. Vogliano C, Raneri JE, Maelaua J, Coad J, Wham C, Burlingame B. Assessing Diet Quality of Indigenous Food Systems in Three Geographically Distinct Solomon Islands Sites (Melanesia, Pacific Islands). *Nutrients*. 2021;13(1)doi:10.3390/nu13010030
261. Mapping child growth failure across low- and middle-income countries. *Nature*. 2020;577(7789):231-234. doi:10.1038/s41586-019-1878-8
262. Yang MJ, Chung TC, Yang MJ, Hsu TY, Ko YC. Betel quid chewing and risk of adverse birth outcomes among aborigines in eastern Taiwan. *J Toxicol Environ Health A*. 2001;64(6):465-472. doi:10.1080/152873901753215920
263. Brown HL, Graves CR. Smoking and Marijuana Use in Pregnancy. *Clinical Obstetrics and Gynecology*. 2013;56(1), https://journals.lww.com/clinicalobgyn/Fulltext/2013/03000/Smoking_and_Marijuana_Use_in_Pregnancy.17.aspx
264. Thompson R, DeJong K, Lo J. Marijuana Use in Pregnancy: A Review. *Obstetrical & gynecological survey*. 2019;74(7):415-428. doi:10.1097/OGX.0000000000000685
265. Nongrum R, Thomas E, Lionel J, Jacob KS. Domestic violence as a risk factor for maternal depression and neonatal outcomes: a hospital-based cohort study. *Indian J Psychol Med*. 2014;36(2):179-181. doi:10.4103/0253-7176.130989

266. WHO. *Violence against women prevalence estimates, 2018: global, regional and national prevalence estimates for intimate partner violence against women and global and regional prevalence estimates for non-partner sexual violence against women*. World Health Organization; 2021:1-112 9240022252. https://iris.who.int/bitstream/handle/10665/341337/9789240022256-eng.pdf?sequence=1&isAllowed=y
267. Sigalla GN, Mushi D, Meyrowitsch DW, et al. Intimate partner violence during pregnancy and its association with preterm birth and low birth weight in Tanzania: A prospective cohort study. *PLOS ONE*. 2017;12(2):e0172540. doi:10.1371/journal.pone.0172540
268. Family protection bill 2014, 132014, Solomon Islands Government (Government SI 2014). http://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=98705&p_count=96182&p_classification=01&p_classcount=12516
269. Finlayson K, Downe S. Why Do Women Not Use Antenatal Services in Low- and Middle-Income Countries? A Meta-Synthesis of Qualitative Studies. *PLOS Medicine*. 2013;10(1):e1001373. doi:10.1371/journal.pmed.1001373
270. Aderoba AK, Iribhogbe OI, Olagbuji BN, Olokor OE, Ojide CK, Ande AB. Prevalence of helminth infestation during pregnancy and its association with maternal anemia and low birth weight. *International Journal of Gynecology & Obstetrics*. 2015;129(3):199-202.
271. Solomon Islands National Water and Sanitation Implementation Plan 2017 - 2033 An integrated national water resource and sanitation management plan to implement the goals and objectives of the National Water and Sanitation Policy (National Intersectoral Water Coordination Committee Ministry of Mines, Energy and Rural Electrification) 40 (2017).
272. Campbell OMR, Benova L, Gon G, Afsana K, Cumming O. Getting the basic rights – the role of water, sanitation and hygiene in maternal and reproductive health: a conceptual framework. *Tropical Medicine & International Health*. 2015;20(3):252-267. doi:https://doi.org/10.1111/tmi.12439
273. Koini SM. Evaluation of Millennium Development Goals in Reduction of Maternal and Child Mortality in Narok County, Kenya. *Journal of Education and Practice*. 2017;8(9):31-42.
274. Hamid W, Jahangir MS, Khan TA. Lived experiences of women suffering from breast cancer in Kashmir: a phenomenological study. *Health Promot Int*. 2021;36(3):680-692. doi:10.1093/heapro/daaa091
275. Abir T, Agho KE, Page AN, Milton AH, Dibley MJ. Risk factors for under-5 mortality: evidence from Bangladesh Demographic and Health Survey, 2004–2011. *BMJ Open*. 2015;5(8):e006722. doi:10.1136/bmjopen-2014-006722
276. Dejene T, Girma E. Social determinants of under-five mortality in Ethiopia: Event history analysis using evidence from Ethiopian Demographic and Health Survey (EDHS). *Health*. 2013;Vol.05No.05:6. doi:10.4236/health.2013.55115
277. Moon J, Choi JW, Oh J, Kim K. Risk factors of diarrhea of children under five in Malawi: based on Malawi Demographic and Health Survey 2015–2016. *J Glob Health Sci*. 2019;1(2), https://doi.org/10.35500/jghs.2019.1.e45
278. NHSP. *National Health Strategic Plan 2016 - 2020*. Ministry of Health and Medical Services; 2016:52 https://daisi.com.au/wp-content/uploads/2016/09/Strategic-Plan-for-Solomon-Islands-2016-2010.pdf
279. Lin C-K, Chen S-T. Estimation and application of population attributable fraction in ecological studies. *Environmental Health*. 2019;18(1):52. doi:10.1186/s12940-019-0492-4
280. Solomon Islands Child Health Situational Analysis May 2011 (WHO solomon Islands) 1-132 (2012).
281. ICPD. *Solomon Islands Country Implementation Profile:Population Dynamics and Household Structure*. International Conference on Population and Development Beyond 2014; 2014. https://www.unfpa.org/sites/default/files/resource-pdf/FINAL_Solomon_Islands.pdf
282. Hug L, Alexander M, You D, Alkema L, for Child UI-aG. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. *The Lancet Global Health*. 2019;7(6):e710-e720.
283. Khan J, Vesel L, Bahl R, Martines JC. Timing of breastfeeding initiation and exclusivity of breastfeeding during the first month of life: effects on neonatal mortality and morbidity—a systematic review and meta-analysis. *Maternal and child health journal*. 2015;19(3):468-479.
284. Lee MK, Binns C. Breastfeeding and the Risk of Infant Illness in Asia: A Review. *International Journal of Environmental Research and Public Health*. 2020;17(1)doi:10.3390/ijerph17010186

285. Gali A, Krishna K, Lowry J, Mohammadnezhad M. Environmental factors associated with diarrhoea prevalence among under-five children in the Mataniko settlements in Honiara, Solomon Islands. *Rural Remote Health*. 2020;20(1):5308. doi:10.22605/rrh5308
286. Kikuchi K, Yasuoka J, Nanishi K, et al. Postnatal care could be the key to improving the continuum of care in maternal and child health in Ratanakiri, Cambodia. *PloS one*. 2018;13(6):e0198829-e0198829. doi:10.1371/journal.pone.0198829
287. Millogo O, Doamba JEO, Sié A, Utzinger J, Vounatsou P. Geographical variation in the association of child, maternal and household health interventions with under-five mortality in Burkina Faso. *PLOS ONE*. 2019;14(7):e0218163. doi:10.1371/journal.pone.0218163
288. Mishra S, Ram B, Singh A, Yadav A. Birth order, stage of infancy and infant mortality in India. *Journal of Biosocial Science*. 2018;50(5):604-625.
289. Wolde HF, Gonete KA, Akalu TY, Baraki AG, Lakew AM. Factors affecting neonatal mortality in the general population: evidence from the 2016 Ethiopian Demographic and Health Survey (EDHS)—multilevel analysis. *BMC research notes*. 2019;12(1):1-6.
290. Dwomoh D, Amuasi S, Agyabeng K, Incoom G, Alhassan Y, Yawson AE. Understanding the determinants of infant and under-five mortality rates: a multivariate decomposition analysis of Demographic and Health Surveys in Ghana, 2003, 2008 and 2014. *BMJ Global Health*. 2019;4(4):e001658. doi:10.1136/bmjgh-2019-001658
291. Uthman OA, Uthman MB, Yahaya I. A population-based study of effect of multiple birth on infant mortality in Nigeria. *BMC Pregnancy and Childbirth*. 2008;8(1):41. doi:10.1186/1471-2393-8-41
292. Andriani H, Putri S, Kosasih RI, Kuo H-W. Parental Smoking and Under-Five Child Mortality in Southeast Asia: Evidence from Demographic and Health Surveys. *International journal of environmental research and public health*. 2019;16(23):4756. doi:10.3390/ijerph16234756
293. Wu H, Sun J, Xi B. Parental tobacco and indoor secondhand smoking exposure and the risk of offspring under-five mortality in low- and middle-income countries. *Indoor Air*. 2021;31(6):2188-2199. doi:https://doi.org/10.1111/ina.12897
294. Metz TD, Allshouse AA, Hogue CJ, et al. Maternal marijuana use, adverse pregnancy outcomes, and neonatal morbidity. *Am J Obstet Gynecol*. 2017;217(4):478.e471-478.e478. doi:10.1016/j.ajog.2017.05.050
295. Metz TD, Borgelt LM. Marijuana Use in Pregnancy and While Breastfeeding. *Obstet Gynecol*. 2018;132(5):1198-1210. doi:10.1097/aog.0000000000002878
296. Joseph P, Vettraino IM. Cannabis in Pregnancy and Lactation - A Review. *Missouri medicine*. 2020;117(5):400-405. https://pubmed.ncbi.nlm.nih.gov/33311738

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7723128/
297. Wilson KM, Torok MR, Wei B, Wang L, Lowary M, Blount BC. Marijuana and Tobacco Coexposure in Hospitalized Children. *Pediatrics*. 2018;142(6):e20180820. doi:10.1542/peds.2018-0820
298. Ciciolla L, Armans M, Addante S, Huffer A. *Racial Disparities in Pregnancy and Birth Outcomes*. Handbook of Children and Prejudice: Integrating Research, Practice, and Policy. Springer International Publishing; 2019. doi:10.1007/978-3-030-12228-7_4
299. Gao W, Paterson J, Carter S, Percival T. Risk factors for preterm and small-for-gestational-age babies: A cohort from the Pacific Islands Families Study. *J Paediatr Child Health*. 2006;42(12):785-792. doi:10.1111/j.1440-1754.2006.00978.x
300. Nembhard WN, Ayers BL, Collins RT, et al. Adverse Pregnancy and Neonatal Outcomes Among Marshallese Women Living in the United States. *Maternal and Child Health Journal*. 2019;23(11):1525-1535. doi:10.1007/s10995-019-02775-8
301. Jang CJ, Lee HC. A Review of Racial Disparities in Infant Mortality in the US. *Children*. 2022;9(2):257.
302. Malin M, Gissler M. Maternal care and birth outcomes among ethnic minority women in Finland. *BMC Public Health*. 2009;9(1):84. doi:10.1186/1471-2458-9-84
303. Cau BM, Sevoyan A, Agadjanian V. Religious Affiliation and Under-Five Mortality In Mozambique. *Journal of Biosocial Science*. 2013;45(3):415-429. doi:10.1017/S0021932012000454
304. Diallo AH, Meda N, Sommerfelt H, Traore GS, Cousens S, Tylleskar T. The high burden of infant deaths in rural Burkina Faso: a prospective community-based cohort study. *BMC Public Health*. 2012;12(1):1-15.

305. Laopaiboon M, Lumbiganon P, Intarut N, et al. Advanced maternal age and pregnancy outcomes: a multicountry assessment. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2014;121(s1):49-56. doi:https://doi.org/10.1111/1471-0528.12659
306. Kahveci B, Melekoglu R, Evruke IC, Cetin C. The effect of advanced maternal age on perinatal outcomes in nulliparous singleton pregnancies. *BMC Pregnancy and Childbirth*. 2018;18(1):343. doi:10.1186/s12884-018-1984-x
307. Lean SC, Derricott H, Jones RL, Heazell AEP. Advanced maternal age and adverse pregnancy outcomes: A systematic review and meta-analysis. *PLOS ONE*. 2017;12(10):e0186287. doi:10.1371/journal.pone.0186287
308. Lisonkova S, Potts J, Muraca GM, et al. Maternal age and severe maternal morbidity: A population-based retrospective cohort study. *PLOS Medicine*. 2017;14(5):e1002307. doi:10.1371/journal.pmed.1002307
309. Ekholuenetale M, Wegbom A, Tudeme G, Onikan A. Household factors associated with infant and under-five mortality in sub-Saharan Africa countries. *International Journal of Child Care and Education Policy*. 2020;14doi:10.1186/s40723-020-00075-1
310. Edeme RK, Innocent AI, Okereke OS. Relationship between household income and child mortality in Nigeria. *Am J Life Sci*. 2014;2:1-2.
311. Datta SS, Barnabas R, Sitther A, et al. Three cases of neonatal tetanus in Papua New Guinea lead to development of national action plan for maternal and neonatal tetanus elimination. *Western Pacific surveillance and response journal : WPSAR*. 2013;4(2):40-43. doi:10.5365/WPSAR.2013.4.1.008
312. Vallely LM, Calvert B, De Silva M, et al. Improving maternal and newborn health and reducing stillbirths in the Western Pacific Region – current situation and the way forward. *The Lancet Regional Health – Western Pacific*. 2023;32doi:10.1016/j.lanwpc.2022.100653
313. Kaforau LSK, Tessema GA, Jancey J, Dhamrait G, Bugoro H, Pereira G. Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: A scoping review. *The Lancet Regional Health - Western Pacific*. 2022;21:100402. doi:https://doi.org/10.1016/j.lanwpc.2022.100402
314. Vogel JP, Lee ACC, Souza JP. Maternal morbidity and preterm birth in 22 low- and middle-income countries: a secondary analysis of the WHO Global Survey dataset. *BMC Pregnancy and Childbirth*. 2014;14(1):56. doi:10.1186/1471-2393-14-56
315. Yang M-S, Lee C-H, Chang S-J, et al. *The effect of maternal betel quid exposure during pregnancy on adverse birth outcomes among aborigines in Taiwan*. vol 95. 2008. doi:10.1016/j.drugalcdep.2008.01.003
316. Bakken L, Iversen PO. The impact of malaria during pregnancy on low birth weight in East-Africa: a topical review. *Malaria Journal*. 2021;20(1):348. doi:10.1186/s12936-021-03883-z
317. Rijken MJ, McGready R, Boel ME, et al. Malaria in pregnancy in the Asia-Pacific region. *The Lancet Infectious Diseases*. 2012;12(1):75-88. doi:https://doi.org/10.1016/S1473-3099(11)70315-2
318. Secretariate of the Pacific Community. *Obesity in the Pacific: too big to ignore*. 2002:1-18. 9822039255.
https://iris.who.int/bitstream/handle/10665/207524/9822039255_eng.pdf?sequence=1&isAllowed=y
319. Alfadhli EM. Maternal obesity influences birth weight more than gestational diabetes. *BMC Pregnancy and Childbirth*. 2021;21(1):111. doi:10.1186/s12884-021-03571-5
320. Ovesen P, Rasmussen S, Kesmodel U. Effect of Prepregnancy Maternal Overweight and Obesity on Pregnancy Outcome. *Obstetrics & Gynecology*. 2011;118(2 Part 1), https://journals.lww.com/greenjournal/Fulltext/2011/08000/Effect_of_Prepregnancy_Maternal_Overweight_and.15.aspx
321. Kennedy E, Gray N, Azzopardi P, Creati M. Adolescent fertility and family planning in East Asia and the Pacific: a review of DHS reports. *Reproductive Health*. 2011;8(1):11. doi:10.1186/1742-4755-8-11
322. Harrington RB, Harvey N, Larkins S, Redman-MacLaren M. Family planning in Pacific Island Countries and Territories (PICTs): A scoping review. *PLOS ONE*. 2021;16(8):e0255080. doi:10.1371/journal.pone.0255080
323. UNFPA. *Adolescent Sexual and Reproductive Health Situation Analysis for Solomon Islands* UNFPA 2006:1-63. https://www.hivpolicy.org/Library/HPP001132.pdf
324. UNFPA. *Young Women's Empowerment and Teenage Pregnancy in the Pacific*. United Nation Population Fund 2013 24 https://pacific.unfpa.org/sites/default/files/pub-pdf/UNFPASWOPPacificSupplementIamNotaLostCauseLR5final.pdf

325. Vishnu Khanal1, Yun Zhao2 and Kay Sauer2. Role of antenatal care and iron supplementation during pregnancy in preventing low birth weight in Nepal: comparison of national surveys 2006 and 2011. *Archives of Public Health*. 2014, https://espace.curtin.edu.au/handle/20.500.11937/43086
326. Rahman MA, Khan MN, Rahman MM. Maternal anaemia and risk of adverse obstetric and neonatal outcomes in South Asian countries: A systematic review and meta-analysis. *Public Health in Practice*. 2020;1:100021. doi:https://doi.org/10.1016/j.puhip.2020.100021
327. Dahab R, Sakellariou D. Barriers to Accessing Maternal Care in Low Income Countries in Africa: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2020;17(12):4292. https://www.mdpi.com/1660-4601/17/12/4292
328. Mulder EJH, Robles de Medina PG, Huizink AC, Van den Bergh BRH, Buitelaar JK, Visser GHA. Prenatal maternal stress: effects on pregnancy and the (unborn) child. *Early Human Development*. 2002;70(1):3-14. doi:https://doi.org/10.1016/S0378-3782(02)00075-0
329. Traylor CS, Johnson JD, Kimmel MC, Manuck TA. Effects of psychological stress on adverse pregnancy outcomes and nonpharmacologic approaches for reduction: an expert review. *American Journal of Obstetrics & Gynecology MFM*. 2020;2(4):100229. doi:https://doi.org/10.1016/j.ajogmf.2020.100229
330. Stadtlander L. Pregnancy and Intimate Partner Violence. *International Journal of Childbirth Education*. 2018;33(4):28-31. https://search.ebscohost.com/login.aspx?direct=true&AuthType=sso&db=cul&AN=133869697&site=ehost-live&custid=s8423239
331. Weck RL, Paulose T, Flaws JA. Impact of Environmental Factors and Poverty on Pregnancy Outcomes. *Clinical Obstetrics and Gynecology*. 2008;51(2), https://journals.lww.com/clinicalobgyn/Fulltext/2008/06000/Impact_of_Environmental_Factors_and_Poverty_on.18.aspx
332. Leeners B, Neumaier-Wagner P, Kuse S, Stiller R, Rath W. Emotional Stress and the Risk to Develop Hypertensive Diseases in Pregnancy. *Hypertension in Pregnancy*. 2007;26(2):211-226. doi:10.1080/10641950701274870
333. Staneva AA, Morawska A, Bogossian F, Wittkowski A. Maternal psychological distress during pregnancy does not increase the risk for adverse birth outcomes. *Women & Health*. 2018;58(1):92-111. doi:10.1080/03630242.2017.1282395
334. Hayase M, Shimada M, Seki H. Sleep quality and stress in women with pregnancy-induced hypertension and gestational diabetes mellitus. *Women and Birth*. 2014;27(3):190-195.
335. McKelvie S, Stocker R, Manwo M-M, et al. Intimate partner violence and health outcomes experienced by women who are pregnant: a cross-sectional survey in Sanma Province, Vanuatu. *The Lancet Regional Health – Western Pacific*. 2021;16doi:10.1016/j.lanwpc.2021.100272
336. Hill A, Pallitto C, McCleary-Sills J, Garcia-Moreno C. A systematic review and meta-analysis of intimate partner violence during pregnancy and selected birth outcomes. *International Journal of Gynecology & Obstetrics*. 2016;133(3):269-276. doi:https://doi.org/10.1016/j.ijgo.2015.10.023
337. Baer RJ, Nidey N, Bandoli G, et al. Risk of early birth among women with a urinary tract infection: a retrospective cohort study. *American Journal of Perinatology Reports*. 2021;11(01):e5-e14. doi:https://doi.org/10.1055/s-0040-1721668.
338. Schnarr J, Smaill F. Asymptomatic bacteriuria and symptomatic urinary tract infections in pregnancy. *European Journal of Clinical Investigation*. 2008;38(s2):50-57. doi:https://doi.org/10.1111/j.1365-2362.2008.02009.x
339. Sawhney H, Aggarwal N, Suri V, Vasishta K, Sharma Y, Grover A. Maternal and perinatal outcome in rheumatic heart disease. *International Journal of Gynecology & Obstetrics*. 2003;80(1):9-14.
340. Sullivan E, Vaughan G, Li Z, et al. The high prevalence and impact of rheumatic heart disease in pregnancy in First Nations populations in a high-income setting: a prospective cohort study. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2020;127(1):47-56.
341. Liaw J, Walker B, Hall L, Gorton S, White AV, Heal C. Rheumatic heart disease in pregnancy and neonatal outcomes: A systematic review and meta-analysis. *Plos one*. 2021;16(6):e0253581.
342. Alene KA, Jegnie A, Adane AA. Multidrug-resistant tuberculosis during pregnancy and adverse birth outcomes: a systematic review and meta-analysis. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2021;128(7):1125-1133. doi:https://doi.org/10.1111/1471-0528.16573

343. Abu-Saad K, Fraser D. Maternal Nutrition and Birth Outcomes. *Epidemiologic Reviews*. 2010;32(1):5-25. doi:10.1093/epirev/mxq001
344. Sedgh G, Singh S, Hussain R. Intended and Unintended Pregnancies Worldwide in 2012 and Recent Trends. *Studies in Family Planning*. 2014;45(3):301-314. doi:https://doi.org/10.1111/j.1728-4465.2014.00393.x
345. Abajobir AA, Maravilla JC, Alati R, Najman JM. A systematic review and meta-analysis of the association between unintended pregnancy and perinatal depression. *Journal of affective disorders*. 2016;192:56-63. http://dx.doi.org/10.1016/j.jad.2015.12.008
346. Goossens J, Van Den Branden Y, Van der Sluys L, et al. The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. *Human Reproduction*. 2016;31(12):2821-2833. doi:10.1093/humrep/dew266
347. Hall JA, Barrett G, Copas A, Phiri T, Malata A, Stephenson J. Reassessing pregnancy intention and its relation to maternal, perinatal and neonatal outcomes in a low-income setting: A cohort study. *PLOS ONE*. 2018;13(10):e0205487. doi:10.1371/journal.pone.0205487
348. Ranatunga IDJC, Jayaratne K. Proportion of unplanned pregnancies, their determinants and health outcomes of women delivering at a teaching hospital in Sri Lanka. *BMC Pregnancy and Childbirth*. 2020;20(1):667. doi:10.1186/s12884-020-03259-2
349. Tebekaw Y, Aemro B, Teller C. Prevalence and determinants of unintended childbirth in Ethiopia. *BMC Pregnancy and Childbirth*. 2014;14(1):326. doi:10.1186/1471-2393-14-326
350. Kaforau LS, Tessema GA, Jancey J, Bugoro H, Pereira G. Prevalence and Factors Associated With Low Birth Weight in the Solomon Islands: Evidence From the 2015 Solomon Islands Demographic and Health Survey data. *Asia Pacific Journal of Public Health*. 2023:10105395231158868. doi:10.1177/10105395231158868
351. Ties Boerma J, Sommerfelt AE. Demographic and health surveys (DHS: contributions and limitations. *World health statistics quarterly 1993; 46 (4): 222-226*. 1993,
352. Organization FaA. *Sustainable Development Goals: 17 goals to transform our world*. Food and Agriculture Organisation, Regional Office for Asia and the Pacific 2015 70 https://www.fao.org/3/CA3121EN/ca3121en.pdf
353. MHMS SI. *Statistical Health Core Indicator Report*. MHMS 2017
354. UNFPA. *Reproductive, Maternal, Newborn, Child, and Adolescent health Workforce*. 2019 https://pacific.unfpa.org/en/publications/state-pacifics-rmncah-workforce-2019-report
355. Grace R. Kava drinking in Vanuatu--a hospital based survey. *Pacific health dialog*. 2003;10:41-44.
356. Celentano A, Tran A, Testa C, et al. The protective effects of Kava (Piper Methysticum) constituents in cancers: A systematic review. *Journal of Oral Pathology & Medicine*. 2019;48(7):510-529. doi:https://doi.org/10.1111/jop.12900
357. Pont-Fernandez S, Kheyfets M, Rogers JM, Smith KE, Epstein DH. Kava (Piper methysticum) in the United States: the quiet rise of a substance with often subtle effects. *The American journal of drug and alcohol abuse*. 2023;49(1):85-96. doi:10.1080/00952990.2022.2140292
358. Colquhoun S, Ogaoga D, Tamou M, Nasi T, Subhi R, Duke T. Child health nurses in the Solomon Islands: Lessons for the Pacific and other developing countries. *Human resources for health*. 2012;10:45. doi:10.1186/1478-4491-10-45
359. Kyei-Nimakoh M, Carolan-Olah M, McCann TV. Access barriers to obstetric care at health facilities in sub-Saharan Africa—a systematic review. *Systematic reviews*. 2017;6:1-16.
360. Mohseni M, Isfahani HM, Moosavi A, et al. Health system-related barriers to prenatal care management in low-and middle-income countries: a systematic review of the qualitative literature. *Primary Health Care Research & Development*. 2023;24:e15.
361. Ngai M, Weckman AM, Erice C, et al. Malaria in Pregnancy and Adverse Birth Outcomes: New Mechanisms and Therapeutic Opportunities. *Trends in Parasitology*. 2020;36(2):127-137. doi:https://doi.org/10.1016/j.pt.2019.12.005
362. Kaforau LS, Tessema GA, Bugoro H, Pereira G, Jancey J. Lived experiences of women with low birth weight infants in the Solomon Islands: A descriptive qualitative study. *PLOS Global Public Health*. 2022;2(12):e0001008.
363. Suparmi S, Belinda C, Julianty P. Low Birth Weights and Risk of Neonatal Mortality in Indonesia. *Health Science Journal of Indonesia*. 2016;7(2):113-117.

364. Albert J, Bogard J, Siota F, et al. Malnutrition in rural Solomon Islands: An analysis of the problem and its drivers. *Maternal & Child Nutrition*. 2020;16(2):e12921. doi:https://doi.org/10.1111/mcn.12921
365. Du P, Coles FB, O'Campo P, McNutt L-A. Changes in population characteristics and their implication on public health research. *Epidemiologic Perspectives & Innovations*. 2007;4(1):6. doi:10.1186/1742-5573-4-6
366. Corsi DJ, Neuman M, Finlay JE, Subramanian S. Demographic and health surveys: a profile. *International Journal of Epidemiology*. 2012;41(6):1602-1613. doi:10.1093/ije/dys184
367. Kaforau LS, Tessema GA, Jancey J, Bugoro H, Pereira G. Prevalence and risk factors associated with under-five mortality in the Solomon Islands: an investigation from the 2015 Solomon Islands demographic and health survey data. *The Lancet Regional Health - Western Pacific*. 2023:100691. doi:https://doi.org/10.1016/j.lanwpc.2023.100691
368. Hespanhol L, Vallio CS, Costa LM, Saragiotto BT. Understanding and interpreting confidence and credible intervals around effect estimates. *Brazilian Journal of Physical Therapy*. 2019;23(4):290-301. doi:https://doi.org/10.1016/j.bjpt.2018.12.006
369. Alie MS, Alemu T, Alemayehu D, Negesse Y, Abebe G. Preconception care utilization and associated factors among reproductive age women in Mizan-Aman town, Bench Sheko zone, Southwest Ethiopia, 2020. A content analysis. *PLoS One*. 2022;17(8)doi:https://doi.org/10.1371/journal.pone.0273297
370. Organization WH. *Handbook: IMCI integrated management of childhood illness*. World Health Organization; 2000.
371. Organization WH. *WHO recommendations on the management of diarrhoea and pneumonia in HIV-infected infants and children: integrated management of childhood illness (IMCI)*. World Health Organization; 2010.
372. Sugiyama MS, Cash HL, Roseveare C, Reklai R, Basilius K, Madraisau S. Assessment of Gestational Diabetes and Associated Risk Factors and Outcomes in the Pacific Island Nation of Palau. *Matern Child Health J*. 2017;21(10):1961-1966. doi:10.1007/s10995-017-2313-0