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Examining Health Impacts of the Cambodian Genocide and Generational Trauma on Cambodian Nationals, Cambodian American Immigrant Mothers, U.S.-born Cambodian Mothers and Infants

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Public Health

by

Erika Mey

Dissertation Committee:
Professor Dylan H. Roby, Chair
Associate Professor In-Residence Sean Arayasirikul
Associate Professor Rachel E. Goldberg
Associate Professor Denise D. Payán

2025

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DEDICATION

For Mom, Dad, and Brother

For my family members (past, present, and future)

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Thank you for stumbling across this dissertation. May you learn a little more about our story and community. May you be inspired.

VITA
Erika Mey

EDUCATION

University of California, Irvine

2025	Doctor of Philosophy in Public Health
2020	Master of Arts in Demographic and Social Analysis
2018	Bachelor of Arts in Public Health Policy
	Bachelor of Arts in Sociology

FELLOWSHIPS

2021-2025	Health Policy Research Scholars (HPRS) Fellowship, Robert Wood Johnson Foundation (RWJF)
2020-2024	Doctoral Training Fellowship, University of California (UC), Irvine
2023	Dr. James A. Ferguson Emerging Infectious Diseases Research Initiatives for Student Enhancement (RISE) Graduate Fellowship, affiliated with Kennedy Krieger Institute and Johns Hopkins University and funded by the Centers for Disease Control and Prevention (CDC)
2021	Dream Summer Fellowship, Dream Resource Center, University of California, Los Angeles Labor Center
2019	Summer Public Health Scholars Program, Mailman School of Public Health, Columbia University funded by the CDC

HONORS AND AWARDS

2024	Travel Award, School of Population and Public Health, UC Irvine
	Dissertation Award, HPRS, RWJF
	Travel Conference Award, HPRS, RWJF to APHA
	Travel Conference Award, HPRS, RWJF to PAA
2022	Travel Conference Award, HPRS, RWJF to IAPHS

PROFESSIONAL EXPERIENCE

2022-2025	Research Assistant, Department of Psychology, DePaul University
2023-2024	Research Fellow, Rapid Research Evaluation
2022	Research and Evaluation Intern, Roots Community Health Center, Oakland
2020-2022	Research Assistant, School of Population and Public Health, UC Irvine
2019	Research and Evaluation Intern, New York City Department of Health and Mental Hygiene, New York

PUBLICATIONS

2022	Avalos Padilla, A., Mey, E., & Sandoval Contreras, A. (2022). Resource Accessibility Across the University of California Campuses Through Undocumented Students' Experiences. *UCLA: Institute for Research on Labor and Employment*. Retrieved from https://escholarship.org/uc/item/3xb1v2dn

CONFERENCE PRESENTATIONS (*Presenter)

***Mey, E.,** Goldberg, R.E. Analyzing the Long-term Health Impacts of the Cambodian Genocide on Cambodia's Population. American Public Health Association (APHA) Conference, Minneapolis, MN, October 2024. [Poster]

***Mey, E.,** Goldberg, R.E. Long-term Demographic and Health Impacts of the Cambodian Genocide. Population Association of American (PAA) Conference, Columbus, OH, April 2024. [Poster]

***Mey, E.** Quality of Self-swabbing for COVID-19 Polymerase Chain Reaction (PCR) Tests among Children and Adults in the U.S. by Demographic Subgroups. CDC John R. Lewis Undergraduate Public Health Scholars and Dr. James A. Ferguson Emerging Infectious Diseases Graduate Fellowship 2023 Student Showcase and Exposition: Centers for Disease Control and Prevention, Atlanta, GA, July 2023. [Poster]

***Mey, E.** & *Toch, L. Situating Cambodian Americans Within the Historical Trauma Framework. Asian American Studies Association Conference, Long Beach, CA, April 2023. [Panel]

*Dhatt, S., *Huynh, M.P., & ***Mey, E.** Resilience Impacts between Pandemic Stressors and Mental Health Outcomes in Asian Americans. Asian American Psychological Association Conference, Virtual, September 2022. [Poster]

***Mey, E.** & *Huynh, M.P. Type 2 Diabetes and Psychological Distress among Asian American Ethnic Groups in California. Interdisciplinary Association for Population Health Sciences (IAPHS) Annual Conference, Minneapolis, MN, September 2022. [Poster]

TEACHING EXPERIENCE

Teaching Assistant, University of California, Irvine

- Principles in Public Health
- Global Health Ethics
- Nutrition and Global Health
- Case Studies in Public Health Practice
- Introduction to Global Health
- Drug Abuse and Its Prevention
- Health Behavior Theory

SERVICE AND ELECTED POSITIONS

School Service

2022-2024	Workshop Committee Chair, Health Justice Advocates at UC Irvine Speaker Coordinator for Inaugural Health Justice Symposium, Health Justice Advocates at UC Irvine
2020-2021	Committee Member, Public Health Diverse Educational Community and Doctoral Experience, UC Irvine

National Service

2021-2023	Secretary, Board of Directors, Asian Pacific Islander Caucus in affiliation with the American Public Health Association

Community Service

2021 Research Evaluation Data Analyst, The Cambodian Family, Santa Ana
Doctoral Student Program Evaluator, Southeast Asian Community Alliance, Los Angeles

PROFESSIONAL MEMBERSHIPS

2024-2025 American Public Health Association
2024-2025 Population Association of America
2022-2024 Asian American Psychology Association
2023 AcademyHealth
2023 Asian American Studies Association
2022-2023 Interdisciplinary Association for Population Health Sciences

ABSTRACT OF DISSERTATION

Examining Health Impacts of the Cambodian Genocide and Generational Trauma on Cambodian Nationals, Cambodian American Immigrant Mothers, U.S-born Cambodian Mothers and Infants

by

Erika Mey

Doctor of Philosophy in Public Health

University of California, Irvine, 2025

Professor Dylan H. Roby, Chair

The overall goal for this dissertation is to inform policy, programs, and/or services for the Khmer communities by better understanding their past experiences and how they contribute to their present-day experiences and overall health. The Cambodian genocide occurred between April 1975 and January 1979. The first study (Chapter 2) examines how the genocide impacted Cambodia's mortality, fertility, and morbidity, particularly highlighting two birth cohorts (1) those born shortly before and during the genocide (1972-1979), and (2) those born after the genocide (1980-1987). The first part of the study focuses on fertility and mortality patterns sourced from population pyramids from the Population Division of the United Nations' Department of Economic and Social Affairs. The second part of the study sourced data from the two most recent waves of the Cambodia Demographic and Health Surveys (2014 and 2021-2022) to examine differences in morbidities (disability, smoking behavior, and stunted growth) based on exposure or non-exposure to the genocide during early childhood. Logistic regressions were conducted and revealed that individuals born shortly before or during the genocide were more likely to report having any disability, to smoke, and to have experienced stunted growth compared to individuals who were not exposed to genocide during early childhood. The second study (Chapter 3) analyzes potential risk factors for low birth weight among Cambodian mothers

by age group, as age is a telling indicator of childhood exposure to the Cambodian genocide. Comparisons are made between mothers born before or during the genocide and shortly after the genocide. The data was sourced from Cambodia 2000, 2005, and 2010 Demographic and Health Surveys data. Logistic regressions were conducted and revealed that mothers born after the genocide were more likely to deliver a low-birth-weight baby compared to individuals who were born during the genocide, when considering 21-25 years old across the three waves of data. However, when examining low birth weight and small at birth within survey data, the 2000 outputs revealed that mothers born before the genocide were least likely to deliver a baby low birth weight and slightly more likely to deliver a baby small at birth compared to those born during the genocide, whereas mothers who were born after the genocide were slightly more likely to deliver a low-birth-weight baby and slightly less likely to deliver a small for birth size baby compared to mothers born during the genocide. Compared to mothers born during the genocide, in 2005 mothers born before the genocide were not as likely to deliver a baby low birth weight or a baby small at birth, yet mothers who were born after the genocide were slightly at greater odds to give birth to a low-birthweight or small for birth size baby. Compared to mothers born during the genocide, the 2010 results revealed that mothers born before the genocide were more likely to deliver a low-birth-weight baby and mothers who were born after the genocide were slightly less likely to deliver a low-birth-weight baby; however, mothers born before or after the genocide were slightly more likely to deliver a baby small at birth compared to mothers who were born during the genocide. The last study (Chapter 4) explores risk factors for adverse birth outcomes, small-for-gestational age and low birth weight, among Cambodian women by nativity status in California. The data is sourced from the California Birth Cohort File, containing birth record data from the years 2005-2019. Logistic regression models (with and without

interaction between race and nativity) revealed that Cambodian mothers were more likely to deliver babies with small for gestational age or low birth weight compared to their White counterparts. Among Cambodian mothers in California, U.S.-born mothers were more likely to give birth to a small for gestational age or low birth weight baby compared to foreign-born mothers. The overall results from the dissertation will inform readers and stakeholders about the health disparities that exist among Cambodian genocide survivors and their children in Cambodia, as well as among Cambodian mothers residing in the U.S. of America, particularly California. The findings may encourage collaboration between the Cambodian government and health care facilities to invest in programs that have professionally trained practitioners to address health concerns of genocide survivors and subsequent generations. Such collaborations may also result in the continued curation and distribution of low-cost or cost-free educational resources for expecting/new mothers, so they can stay informed about maternal and child health concerns. This knowledge may help mitigate or prevent adverse health outcomes for the mother-child relationship. The implementation of resources and services should be affordable and accessible for all. It would also be critical for healthcare professionals to be properly educated and aware about the Cambodian genocide and its health implications for the Cambodian community, regardless of their nativity status. Researchers should continue to support and advocate for data disaggregation, particularly among and within the Asian American community in relation to health. This recommendation has the potential to shed light on the stark health inequities that exist within the Asian American community, and specifically that of the Cambodian population in California. Next steps may be taken to improve overall wellbeing of the Cambodian community through actionable solutions: policy, programs, services, resources, and public health interventions.

CHAPTER 1: INTRODUCTION

The Cambodian Genocide

Three years, eight months, and twenty days. The Cambodian genocide occurred between April 1975 and January 1979 (Islam et al., 2017), under the rule of communist leader Pol Pot (Kiernan, 2002). This atrocious period was the time of the Khmer Rouge Regime, also referred to as the Khmer Rouge Era (Kiernan, 2002). During this time, Cambodia and its people were brought to the brink of extinction (Etcheson, 2005). Mass destruction plagued the country, resulting in the obliteration of education, culture, currency, jobs, religion, and tradition to recreate Cambodia anew (Islam et al., 2017). Pol Pot's intention to create an agricultural Cambodia formulated a radical revolution known as "Year Zero" (Clayton, 1998). Approximately 1.2 to 3.3 million people died during this inhumane episode of history (Heuveline, 2015). These deaths were tallied through physical evidence such as bone remnants of deceased individuals and mass grave pits yet may fail to account for individuals who perished along the way of their escape from Cambodia; therefore, true casualty counts are potentially underestimated (Heuveline, 2015).

In addition to violent and non-violent deaths, the genocide had a variety of physical and mental health impacts on survivors, their offspring, and subsequent generations (Wyatt, 2023). Documented physical impacts include injuries and accidents, as well as mental health conditions such as post-traumatic stress disorder and depression, in addition to traumas on its victims which resulted in physical disabilities, pervasive toxic stress, and increased malnutrition during early childhood (Berthold et al., 2014; Greene, 2015; Nou, 2024; Tyner & Rice, 2016). Consequently, it is likely that some of these impacts span across the life course and across multiple generations; this is known as intergenerational trauma (Wyatt, 2023).

Prior to the genocide, Cambodia had been undergoing socio-political turmoil. These events included French colonization for nearly 100 years, brief Japanese occupation, and the Secret War which stemmed from the Vietnam War (Kiernan, 2004). Prince Sihanouk, who ruled Cambodia once French colonization came to an end, was not well received by the people of his country nor by those in other countries (Gruspier & Pollanen, 2017). As a result, Prince Sihanouk was overthrown from his position in 1970, and General Lon Nol took over as president (Gruspier & Pollanen, 2017). However, because Lon Nol gave the United States (U.S.) permission to bomb Cambodia during the Vietnam War (which resulted in the Secret War), he lost trust from many Cambodians (Gruspier & Pollanen, 2017; Kiernan, 2004). This political act gave Pol Pot the opportunity to gain many supporters of the ideologies on which he founded the Democratic Kampuchea (Gruspier & Pollanen, 2017; Kiernan, 2004). Pol Pot and his supporters eventually drove out the Vietnamese communists from Cambodia (Gruspier & Pollanen, 2017). Shortly after, Pol Pot and his group intentionally misinformed the Cambodian population that the U.S. would bomb the country once more, so they must all evacuate their homes and return in a few days (Tyner et al., 2014). It was at this time that the Cambodian genocide began.

Cambodian Community in the United States of America

Between the 1950's and the 1960's, the U.S. of America received its first set of Cambodian individuals, international exchange students who came to obtain a college education at California State University of Los Angeles and Long Beach (Chan, 2015). After the genocide ended, an estimated 200,000 Cambodian survivors sought refuge in other countries such as France, Australia, and the U.S. (Heuveline, 2001). Broadly, the beginning of the influx of Indo-Chinese refugees in the U.S., 1975 and 1980, reinforces that their arrival was a result of genocide and war in their home countries (Vietnam, Laos, and Cambodia) (Rumbaut, 2006). Thus,

Vietnamese, Laotian, and Cambodian refugees are not comparable to East Asian immigrants as they were the newest group of refugees in the U.S. (Rumbaut, 2006).

In the U.S., the Cambodian American community makes up one of the largest refugee groups (Marshall et al., 2005; Sharif et al., 2019). Between 1975 and 1994, about 158,000 Cambodian refugees had the opportunity to resettle in the U.S. (Sharif et al., 2019). Upon arrival, about 40% to 50% of Cambodian refugees found employment in laborious occupations (Sharif et al., 2019). Cambodians who immigrated to the U.S. after 1994 were considered immigrants (Chan, 2015). To date, Long Beach, California is home to the largest Cambodian diaspora outside of Cambodia (Chan, 2015).

Connection to the Dissertation

The Cambodian genocide caused detrimental health impacts (long-term and generational) on Cambodia's population, influencing fertility, mortality, and morbidities (Heuveline, 2001). The adverse mental health impacts deriving from genocide exposure are well-documented among the Cambodian population (Berthold et al., 2014). As a result of the Cambodian genocide, Cambodian Americans are one of the most traumatized communities residing in the U.S. (Berthold et al., 2014). In comparison to the general U.S. population and other Asian American subgroups, Cambodian Americans have disproportionately high rates of physical, mental, and chronic health outcomes (Than, 2020). Cambodian Americans experience heightened rates of post-traumatic stress disorder and depression and are therefore at greater risk for chronic diseases such as diabetes and cardiovascular diseases (Sharif et al., 2019).

According to Yang & Dinh (2018), research is scant on intergenerational trauma among Southeast Asians in relation to war and genocide. Therefore, this dissertation explores the long-term impacts of the Cambodian genocide on Cambodia's population (fertility, mortality,

smoking, stunted growth, disability), and the intergenerational impacts of the Cambodian genocide on perinatal health outcomes among Cambodian mothers in Cambodia (low birth weight and small birth size) and in the U.S. (low birth weight and small for gestational age). In short, the three studies explore different adverse health outcomes among different Cambodian populations at different points in the life course. Overall, this dissertation may be the first of its kind to closely examine the life course and intergenerational consequences of exposures to the Cambodian genocide for Cambodians in Cambodia and the United States.

Study 1

The first study utilizes the two most recent waves of the Cambodia Demographic and Health Surveys (2014 and 2021-2022) to analyze the long-term health impacts of the Cambodian genocide on Cambodia's population: fertility, mortality, smoking behaviors, stunted growth, and disabilities. Population pyramids depicted the demographic impacts of the genocide on Cambodia's fertility and mortality patterns. Logistic regression models were utilized to examine the relationship between age and adverse health outcomes (smoking, stunted growth, and disabilities) while adjusting for maternal educational level, marital status, wealth index, and sex. The objective of this study is to understand the long-term impacts of the Cambodian genocide on its population, especially those who survived the genocide during early childhood or were born shortly after the tragic event. The findings from this study may highlight the importance of health disparities linked to the genocide that persist decades after the catastrophe ended.

Study 2

The second study explores potential risk factors for low birth weight and small for birth size among Cambodian mothers by exposure to the genocide, utilizing 2000, 2005, and 2010 survey data from the Cambodia Demographic and Health Survey data sets to conduct logistic

regression models while controlling for the following covariates: sex of the baby, educational attainment of the mother, prenatal care visits, and type of place of residence. This study aims to understand the potential impacts of mother's exposure to the genocide on the child's birth outcome, namely low birth weight and small for birth size. Given that the Cambodian community is still impacted by the aftermath of the genocide decades after the horrific event, the findings from this study may shed light on the atrocities that the Cambodian community survived while helping to reinforce the importance of improving maternal and child health outcomes to reduce adverse perinatal health conditions in present-day Cambodia.

Study 3

The third study examines risk factors for low birth weight and small for gestational age among Cambodian mothers in California (2005-2019), by nativity status and race. The study includes multiple combinations of comparisons between Cambodian mothers, White mothers, and all other Asian mothers. This study is ultimately examining whether there are health disparities among the babies' health outcomes in relation to the mother's race and nativity status. The logistic regression models adjust for covariates including maternal age, maternal education, sex of the baby, prenatal care visits, principal payment type, smoking behavior during pregnancy, and mother's body mass index.

Although the health outcomes are similar to the second study, this study differs from the other two studies in that it includes mothers who were born in Cambodia and mothers who were born in the United States. Some of the mothers in this study who were born in Cambodia may be refugees or survivors of the genocide who had their children in the U.S., and specifically California. Given that California has the largest Cambodian population in the U.S., the findings

from this study can help inform how to better serve the Cambodian population and mitigate any health disparities within the community.

Dissertation Overview

The dissertation is comprised of three complete studies which are nestled between an introduction chapter (including a brief overview of the Cambodian genocide, some research contributions, and a dissertation overview) and a conclusion chapter (which outlines the main results and discusses their implications). In Chapter 2, I analyze the health impacts of the Cambodian genocide on the Cambodian population via birth cohort comparisons for smoking, stunted growth, and disabilities. In Chapter 3, I explore risk factors for low birth weight and small birth size among mothers in Cambodia, centering maternal age as a proxy for exposure to the genocide. In Chapter 4, I examine the contribution of nativity status to differences in adverse birth health outcomes among Cambodian mothers in California, with comparisons to White and other Asian counterparts. In Chapter 5, I present a summary of the findings from each study, highlight their importance, provide their conclusions, and include their implications. Below, I present descriptions of each of the three studies.

Study 1/Chapter 2: Utilizing Population Pyramids and Cambodia Demographic and Health Surveys Data (2014 and 2021-2022) to Analyze the Health Impacts of the Cambodian Genocide on Fertility, Mortality, and Comorbidities

The genocide may have various health impacts on its survivors and subsequent generations. Research analyzing the demographic and health impacts of the Cambodian genocide are limited. This study highlights consequences of the genocide for fertility and mortality through population pyramid comparisons, and health impacts on survivors through use of Cambodia Demographic and Health Survey (DHS) data. Although previous research studies

utilized DHS data for Cambodia, this is the first study of its kind to utilize the two most recent waves of data to explore the long-term health impacts of the genocide on the Cambodian population. This study compares comorbidities (smoking, stunted growth, and disabilities) among individuals born shortly before and during the genocide (ages 35-42 in 2014, born between 1972-1979) and after the genocide (35-42 in 2022, born between 1980-1987). The purpose in selecting the same age group (35-42) at two different time points (2014 and 2021-2022) is to understand how childhood exposure to genocide may influence differences in health outcomes between individuals who have and have not experienced this historical event.

This two-part study aims to answer the following questions: 1) Does age structure illustrate evidence of mortality and fertility patterns deriving from the Cambodian genocide? 2) Does comparison of those born shortly before and during the genocide reveal evidence of long-term health consequences (toxic stress, stunted growth, and disability) from early childhood exposures to the Cambodian genocide?

For the first part of the study, I utilized population pyramid data from the Population Division of the United Nations' Department of Economic and Social Affairs to compare the population structures of Cambodia and Thailand in different time frames: 1975, 1985, 2014, and 2022. Thailand was selected as the country of comparison because it is a Southeast Asian country located in the same region as Cambodia but that did not experience genocide. The rationale for the selected years is as follows: 1975 was the first year of the Cambodian genocide, 1985 was 10 years since the start of the Cambodian genocide, and 2014 and 2022 coincide with the two most recent waves of Demographic and Health Surveys data for Cambodia.

For the second part of the study, I utilized 2014 and 2021-2022 Demographic and Health Survey (DHS) data for Cambodia to compare health behaviors and health outcomes among

individuals born shortly before, during, and after the genocide. These comparisons were made to learn about the long-term health impacts of the Cambodian genocide on Cambodia's population, namely in relation to smoking, disability, and stunted growth. Depending on the models, age and survey data were the two main independent variables, both proxying genocide exposure. The control variables across all models included marital status, educational attainment, and the wealth index.

I utilized multivariate logistic regression models to predict the health impacts of the Cambodian genocide on the Cambodian population. The data were weighted using DHS sample weights. The first set of models examine whether genocide exposure (proxied by both age and survey wave) was predictive of smoking among Cambodian women, while controlling for marital status, educational attainment, and the wealth index. The different age groups include ages 27-34, 35-42, and 43-50. The second set of models examine stunted growth among Cambodian women ages 35-42, using survey wave as a proxy for genocide exposure. The last set of models examine whether age (as a proxy for genocide exposure) was predictive of disability among Cambodian men and women in each survey year, while controlling for marital status, educational attainment, and the wealth index.

Study 2/Chapter 3: Utilizing Cambodia Demographic and Health Surveys Data (2000, 2005, and 2010) to Explore Possible Risk Factors for Low Birth Weight and Small Birth Size among Cambodian Mothers of Reproductive Age (15-49)

The consequences of the genocide may contribute to adverse health outcomes among generations who did not directly experience the tragic event. Research exploring the generational health impacts of the children of survivors of the Cambodian genocide in Cambodia is scant. Existing research studies on perinatal health outcomes and children's health in Cambodia have

utilized Demographic and Health Surveys data for Cambodia to analyze various topics such as anemia among pregnant mothers, patterns of childhood mortality, stunted growth among children under 5 years of age, and the prevalence of low birth weight across provinces. However, at the time this study was conducted, this is the first study of its kind to utilize three consecutive waves of Cambodia DHS data (2000, 2005, 2010) to explore the links between early childhood genocide exposure and subsequent low birth weight births among Cambodian women. More specifically, the study in this chapter compares low birth weight and small birth size among mothers born shortly before, during, and after the genocide, containing within survey year comparisons by age and across survey year comparisons among the same age group. The rationale is to learn about the potential intergenerational impacts of childhood exposure to genocide in relation to possible differences in perinatal health outcomes between mothers who have and have not experienced the Cambodian genocide.

The study in this chapter aims to address the question of whether maternal early life exposure to the Cambodian genocide is associated with adverse birth outcomes (low birth weight and small birth size) during their reproductive years.

Similar to the first study, this study also uses a quantitative retrospective cohort design conducted through secondary data analysis. I utilized the 2000, 2005, and 2010 DHS data for Cambodia to explore potential risk factors for low birth weight and small birth size among Cambodian mothers who either experienced the Cambodian genocide during early childhood or did not. The dependent (binary) variables are low birth weight and small birth size. Depending on the models, age or survey year were the main independent variables. The control variables across all models include sex of baby (male or female), mother's educational attainment (none, primary, secondary or higher), engagement in prenatal care visit (no or yes), and type of

residence (rural or urban). I weighted the data and utilized multivariate logistic regression models to examine whether age or survey year (as proxies for genocide exposure) along with the aforementioned covariates were predictive of low birth weight or small birth size.

Study 3/ Chapter 4: Utilizing 2005-2019 California Birth Record Data to Examine Associations between Nativity Status and Adverse Birth Outcomes (Low Birth Weight and Small for Gestational Age) among Cambodian Mothers

Research exploring perinatal health outcomes among the Asian American population is scant, and existing work is particularly limited with a lack of disaggregated data for Asian American sub-populations. Existing research studies on perinatal health outcomes among the Asian American community usually aggregate the Cambodian subgroup, which masks health vulnerabilities within this marginalized population. At the time this study was conducted, this is the first study of its kind to utilize 2005-2019 California Birth Certificate data to examine the potential risk factors of small for gestational age and low birth weight among native-born and foreign-born Cambodian mothers, while making comparisons to other racial and ethnic groups such as White and other Asian mothers. The study in this chapter makes various comparisons among Cambodian, White, and Asian mothers (including disaggregated and disaggregated Asian ethnic groups) in relation to adverse birth health outcomes. The rationale is to learn about the predictors of small for gestational age and low birth weight among Cambodian mothers by nativity status and making comparisons with other mothers (White and other Asian subgroups).

This study aims to address two questions: 1) How do perinatal outcomes of Cambodian mothers in California compare to those of other Asian and non-Hispanic White mothers? 2) Does Cambodian foreign-born status predict the risk of small for gestational age and low birth weight?

I utilized the 2005-2019 California Birth Record Data to explore possible risk factors for adverse perinatal health outcomes among Cambodian mothers by nativity status, in comparison to White and Asian counterparts. The two (binary) dependent variables were small for gestational age and low birth weight. Across most of the models, the main independent variables are race/ethnicity of mother (Cambodian, White, and all other Asian subgroups) and mother's nativity status (native-born, foreign-born). Additionally, some models disaggregate Asian subgroups (East Asian, South Asian, Southeast Asian, Native Hawaiian/Pacific Islander, and Other Asian). The models that contain interaction terms have similar independent variables while also accounting for the interaction between race and nativity status. The control variables across all models include sex of baby, maternal age, marital status, mother's educational attainment, engagement in prenatal care visits, smoking during pregnancy, and mother's body mass index.

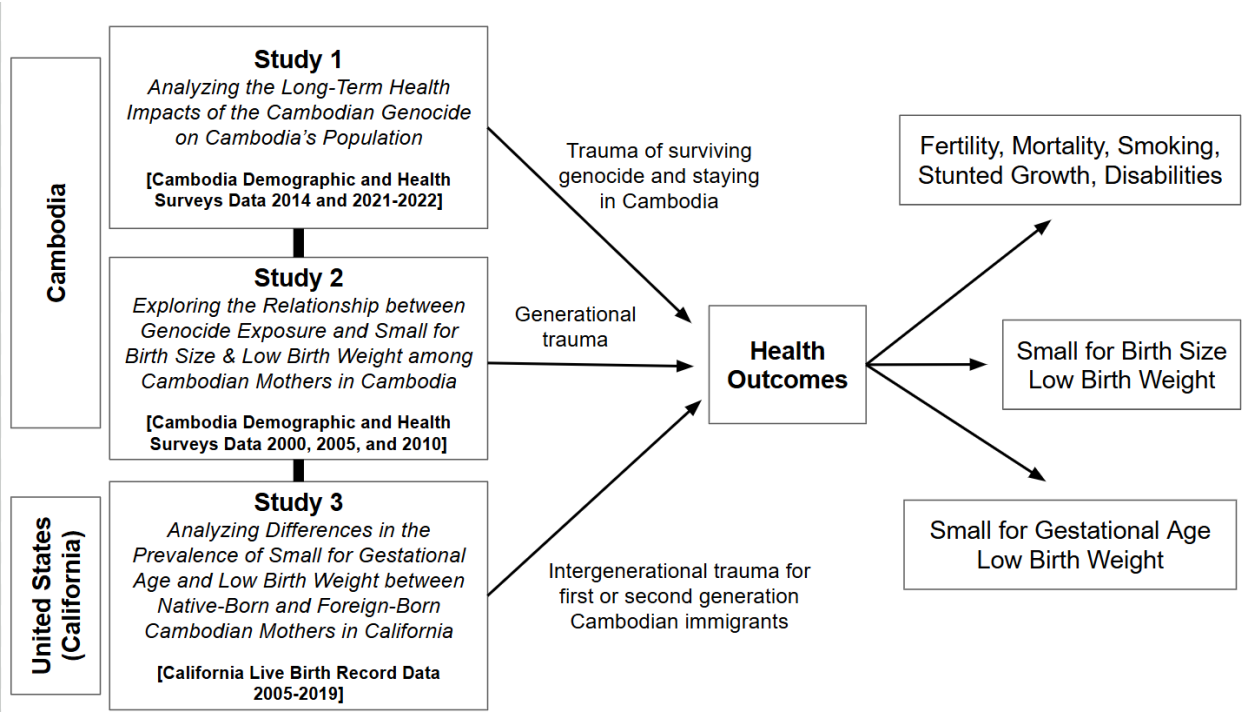
I utilized multivariate logistic regression models to analyze potential risk factors for low birth weight and small for gestational age. The first set of models examine whether race (White, Cambodian, all other Asian) and nativity status (native-born, foreign-born) were predictive of low birth weight and small for gestational age while controlling for sex of the baby (male, female), maternal age group (19 and under, 20-24, 25-29, 30-34, 35 and over), educational attainment level of the mother (less than high school, high school, any college or graduate school), engagement in prenatal care visit (no, yes), type of principal payment source (Medi-Cal, private, other), smoking during pregnancy (no, yes, missing or unknown), mother's body mass index (normal, underweight, overweight, obese). The second set of models examines whether race/ethnicity (White, Cambodian, East Asian, South Asian, Southeast Asian, Native Hawaiian/Pacific Islander, other Asian) and nativity status (native-born, foreign-born) are predictive of small for gestational age and low birth weight while controlling for the

aforementioned covariates. The third and fifth sets of models are similar to the first and second models yet include interaction terms between race/ethnicity and nativity status. The fourth set of models is similar to the third, yet it disaggregates race and nativity status rather than using an interaction term; categories are White and native-born (reference group), White and foreign-born, Cambodian and native-born, Cambodian and foreign-born, all other Asian and native-born, and all other Asian and foreign-born.

Cumulatively, these three studies aim to advance the understanding of health disparities that may exist within the Cambodian community in Cambodia and the United States, while supporting the notion of data disaggregation regarding Asian American health. Consequently, the findings may highlight differences in long-term health impacts from the genocide between Cambodian genocide survivors and the birth cohort born shortly after the genocide, and possibly reveal any adverse perinatal health outcomes between Cambodian infants to Cambodian-born and U.S.-born mothers in comparison to their White and Asian American counterparts.

Figure 1.1 illustrates the dissertation's three studies and its relation to one another. The figure contains a brief overview for each study while depicting the possible relationship between the primary exposures of interest and health outcomes.

Figure 1.1. Visual Representation of the Three Studies



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CHAPTER 2: ANALYZING THE LONG-TERM HEALTH IMPACTS OF THE CAMBODIAN GENOCIDE ON CAMBODIA'S POPULATION

Limited research has been conducted on the long-term health consequences of the genocide on survivors (Milazzo & Cuesta, 2021). Therefore, this study broadly analyzes the long-term demographic and health impacts of the Cambodian genocide on individuals in Cambodia, specifically examining differences between birth cohorts born shortly before or during the genocide and those born shortly after. Population pyramids spanning four decades illustrate the mortality, and fertility impacts of Cambodia's genocide on the country's population structure. Multivariate analyses using data from the two most recent waves (2014 and 2021-2022) of the nationally representative Cambodia Demographic and Health Surveys explore the enduring health sequelae of the Cambodian genocide, comparing the smoking behaviors, disability status, and stunted growth of Cambodian adults with early-life exposure to the genocide (born 1972-1979) to individuals born shortly after the genocide (1980-1987).

Previous Research

Impacts of the Cambodian Genocide on Demographic Composition

Previously, studies have identified that extreme conflicts often result in an age-sex deficit in the population (Guha-Sapir & D'Aoust, 2012). This may be evident due to a shortage of male and female children and adults, which can be attributed to high mortality and low fertility rates during the time of conflict. These impacts deriving from changes in both mortality and fertility alter the population structure.

The Cambodian genocide resulted in increased mortality rates, decreased fertility rates, and a host of morbidities (Berthold et al., 2014; De Walque, 2006; Heuveline, 2001). The following sections describe what is known to date about the mortality and fertility rates during

the Cambodian genocide, and about morbidities associated with the genocide such as toxic stress, stunted growth, and disability.

Mortality

Mortality crisis was the most direct consequence of the Cambodian genocide. Mortality crisis refers to when mortality suddenly increases in a population (Heuveline, 2001). In the span of the genocide between 1975-1979, an estimated 2 million people lost their lives (Heuveline & Poch, 2007; Neupert & Prum, 2005). These deaths were a result of the direct and indirect consequences of the genocide. However, given that the death tolls are only estimates, the count may be higher.

The increase in mortality is attributed to, but not limited to, consequences of war, ethnic cleansing, and disease in addition to starvation, exploitation, population displacement, forced labor and mass execution (Heuveline, 2001). Therefore, during the Khmer Rouge regime, excess mortality heavily affected Cambodia's population composition (De Walque, 2006).

The deadly consequences of the genocide impacted all age groups ranging from unborn children, teenagers, young adults, and the middle-aged to the elderly. Prior to the genocide, in 1974, the crude death rate was 22 deaths per 1,000 population; as a result of the genocide, by 1975 the crude death rate had more than quadrupled to 86 deaths per 1,000 population (World Bank, 2024). Shortly after the genocide, in 1980, the crude death rate decreased to 17 deaths per 1,000, with further decline over time (World Bank, 2024).

Fertility

Circumstances during times of turmoil also often lead to decreased births (Heuveline, 2001), and thus may alter fertility patterns (Frankenberg et al., 2014). Consistent with this, during the Khmer Rouge Era, fertility and marriage rates steeply declined (De Walque, 2006).

Stress from toxic environments and ongoing violent events may have contributed to the hindrance of conceiving a child or of carrying the pregnancy to term (Frankenberg et al., 2014). Conflict-related insecurity such as general increase in violence and psychological stress were also known to decrease fertility rates and in turn, reduce the number of children per woman (Guha-Sapir & D'Aoust, 2012).

Cambodian birth rates were markedly lower during the genocide (De Walque, 2006), rebounding rapidly after the genocide ended. The crude birth rate decreased from 35 births per 1,000 population in 1974 (pre-genocide) to 31 births per 1,000 population in 1975 (World Bank, 2024). Shortly after the genocide, in 1980, the crude birth rate increased to 49 births per 1,000, with further growth over time (World Bank, 2024).

As another measure of fertility change, total fertility rates were significantly lower during the Khmer Rouge Era. There was an average of 4.6 births per woman during the genocide whereas prior to the genocide, the average was 6.5 births per woman (U.S. Census, 2010). Moreover, the total fertility rate increased to 7.6 births per woman immediately after the genocide came to an end (U.S. Census, 2010). Therefore, in addition to its mortality impacts, the Cambodian genocide influenced the fertility rates of the Cambodian population.

Impacts of the Cambodian Genocide on Morbidity

The life course perspective is a useful theoretical framing for understanding the morbidity impacts of the genocide. The life course perspective facilitates understanding of the ways childhood experiences can impact an individual's health throughout their life and possibly in subsequent generations (Braveman & Barclay, 2009). Adult health reflects experiences throughout an individual's life (Montez & Hayward, 2013). Specifically, chronic illnesses and health behaviors observed in adulthood derive in part from detrimental exposures in childhood, such as poverty, familial distress, and food insecurity (Hayward & Gorman, 2004; Shonkoff et

al., 2009). This suggests that early-life exposures to the physical and emotional traumas associated with the Cambodian genocide may be reflected in morbidities in adulthood. In this study, these morbidities are conceptualized as stemming from three genocide-linked factors: (1) toxic stress, (2) malnutrition, and (3) disability.

Toxic Stress and Smoking

Many detrimental health outcomes in adulthood derive from exposures to toxic stress in early childhood (Shonkoff et al., 2012). Toxic stress from early childhood adversities is linked to life-long developmental and behavioral consequences (McEwen & McEwen, 2017) and many adverse mental and physical health outcomes, as it alters the functioning of the brain, immune system, and other body systems (Shonkoff et al., 2012). Similarly, chronic stress stemming from constant exposure to traumatic surroundings can result in poor health and poor health behaviors (Messer et al., 2006).

Smoking is a health behavior linked to stress (Shadel & Mermelstein, 1993). More specifically, smoking serves as a problem-focused and emotion-focused coping mechanism to combat stress (Baqutayan, 2015). Past research has identified a positive correlation between stress and smoking, with higher levels of stress associated with higher risk of smoking cigarettes (Bindu et al., 2011; Siqueira et al., 2000). Additionally, smoking is a common form of coping with pain, especially chronic pain (Patterson et al., 2012). Furthermore, those who smoke cigarettes are more likely to have mental health conditions such as depression and anxiety (Patterson et al., 2012). Consequently, toxic stress in early childhood, such as exposure to traumas linked to genocide, may translate to risk behaviors in adulthood such as smoking. In other words, individuals exposed to the Cambodian genocide during early childhood may have

experienced high levels of toxic stress and, in adulthood, may rely on smoking as one of the ways to cope.

Malnutrition and Stunted Growth

The violence that ensued from the Cambodian genocide produced mass starvation throughout the country; during these brutal circumstances, food rations were distributed unevenly, which contributed to famine, malnourishment and even death (Tyner & Rice, 2016). Given that the critical period for growth is between ages 0 and 2, a lack of nutritional intake from early childhood is associated with stunted growth (Reinhardt & Fanzo, 2014). Height is linked to childhood nutritional consumption and early environment exposures (Perkins et al., 2016). Cambodians who suffered from inadequate nutritional intake during early childhood thus likely faced increased risk of long-term stunted growth (De Walque, 2006). Research findings on Cambodia and Germany conclude that malnourishment resulted in numerous adverse health outcomes, including stunting, especially among individuals exposed to war during early childhood (Moyano, 2017).

Therefore, exposure to the genocide in early childhood may have influenced height during adulthood through stunting as a result of malnourishment. Maternal exposure to genocide-linked malnutrition while in utero may also have contributed to stunted growth. Because of its long-term imprinting, stunting provides an important lens through which to understand the long-term impacts of early childhood exposure to the genocide.

Disability

Disabilities can be a byproduct of the violence and mass destruction of war. The Cambodian genocide inflicted physical trauma on the population through exposures to combat, bombings, and executions, in addition to starvation and slave labor (Berthold et al., 2014). Such

disabilities are associated with a host of poor physical and emotional health outcomes such as chronic pain, diabetes and post-traumatic stress, which can result in additional disabilities such as impairment of vision, mobility, and memory (Berthold et al., 2014; Schnurr et al., 2007; Sonis et al., 2009). Additionally, experiencing malnourishment in early childhood during the time of the genocide impacted some children brain development, which also may result in disabilities (Blaser, 2002). Therefore, exposure to the Cambodian genocide was associated with a myriad of poor health outcomes, including disability, with sometimes life-long consequences.

Research Contribution

Overall, this study focuses broadly on the demographic and health impacts of the Cambodian genocide. The first part of the study uses population pyramids to understand long-term changes to Cambodia's demographic composition, influenced by genocide-linked changes in fertility and mortality rates. The second part of the study explores to what extent adverse health outcomes in adulthood are a byproduct of genocide exposure in early childhood.

Although previous research studies utilized Demographic and Health Surveys (DHS) data for Cambodia, this is the first study of its kind to utilize the two most recent study waves (2014 and 2021-2022) to examine the impacts of the genocide on long-term health outcomes. One previous study utilized the 2000 Cambodia DHS to examine the short-term impacts of the genocide, particularly focusing on those adolescent aged and above at the time of the genocide (De Walque, 2006). Another study utilized older waves of the Cambodia DHS data to explore selective mortality during the time of the Cambodian genocide; results revealed that those more likely to die included adult males, those who were educated or were children from educated families, those living in urban areas, and those who were religious (De Walque, 2005). Other previous studies have utilized Cambodia DHS data between 2000 and 2014 to explore topics not related to the genocide, including healthcare utilization among mothers, children, and those who

had disabilities as well as exploring reproductive health/obesity among women and anemia among children (Chham et al., 2021; World Health Organization, 2017; Zhou et al., 2020).

Given that research examining the long-term impacts of the Cambodian genocide on survivors is scant, this current study utilizes recent data from the 2014 and 2021-2022 Cambodia DHS to compare the adult health outcomes of individuals born shortly before and during the genocide. Specifically, it compares the health of those who were ages 35-42 in 2014 (born shortly before and during the genocide in 1972-1979) and those who were ages 35-42 in 2022 (born shortly after the genocide in 1980-1987). The aim in selecting the same age group (35-42) at two different time points (2014 and 2021-2022) is to understand how exposure to genocide may influence differences in health outcomes between two groups who grew up during similar historical times but differed in their exposure to the genocide at an early age. Additionally, some of the analyses examine differences across proximal ages within the same survey wave to similarly compare individuals born shortly before/during and after the genocide. All these comparisons allow for examination of the consequences of exposure to genocide during early childhood. Overall, this is the first known study to explore the long-term impacts of the Cambodian genocide on the population using recent data.

Research Questions and Hypotheses

Research Question 1. Does age structure illustrate evidence of mortality and fertility patterns deriving from the Cambodian genocide?

> **Hypothesis 1.** Cambodia's population pyramids will show an absence of individuals in the age cohorts most impacted by increased mortality and decreased fertility during the genocide.

Research Question 2. Does comparison of those born shortly before and during the genocide

reveal evidence of long-term health consequences (toxic stress, stunted growth, and disability) from early childhood exposures to the Cambodian genocide?

Hypothesis 2. This study hypothesizes that if an individual was born in Cambodia between 1972-1979 (shortly before or during the time of the genocide), then they will be more likely to smoke, be of lower height, and have greater prevalence of disabilities in adulthood compared to their counterparts born after the genocide (born between 1980-1987).

Methodology and Data

Part 1

Study Design

The first part of the study provides a visual representation of the impacts of the genocide on the country's population structure over time. Population pyramids from 1975, 1985, 2014, and 2021-2022 are used. Comparisons between Cambodia and Thailand are made, given that Thailand is a neighboring country in the Southeast Asian region that did not experience genocide. This approach allows for better isolation of impacts of the genocide on Cambodia's population composition.

Dataset: Population Pyramids from PopulationPyramid.net

Population pyramids were retrieved from PopulationPyramid.net, whose primary data source was the Population Division of the United Nations' Department of Economic and Social Affairs. Population pyramids were utilized to illustrate the fertility and mortality patterns in Cambodia and Thailand during the aforementioned specific time frames.

Methodology

Defining Population Pyramids.

Population pyramids, also known as age-sex pyramids, are demographic visuals that capture the age and sex composition of a given population at a point in time (Bao, 2022). The x-axis of a population pyramid represents the percentage of individuals in the population by age group, and the y-axis represents the age groups broken down in 5-year intervals starting with ages 0-4 at bottom of the pyramid (Bao, 2022). Therefore, beyond showing the population composition of a country, population pyramids tell a story about shifts in the respective country's population over time. Because age is a proxy for birth cohort, historical patterns of change in mortality and fertility are revealed through the demographic breakdown of the population of each country by age and gender.

Comparison of Cambodia and Thailand.

Population pyramids were retrieved from PopulationPyramid.net for both Cambodia and Thailand. Thailand was selected for comparison because it is a Southeast Asian country in the same region as Cambodia that did not experience a genocide or war during the same time period. The specific years were selected for the following reasons: 1975 marks the initial year of the Cambodian genocide, 1985 marks 10 years since the start of the Cambodian genocide, and 2014 and 2022 align with the two most recent waves of DHS data available for Cambodia.

Part 2

Study Design

The second part of the study uses a quantitative retrospective cohort design conducted through secondary data analysis. The analysis compares the smoking status, disability status, and height of individuals born shortly before and during the genocide (1972-1979) with those born shortly after the genocide (1980-1987). In analyses of smoking and height, the study compares the same age group (ages 35-42) in different survey years (2014 and 2021-2022). In analyses of

smoking and disability, the study compares individuals in the same survey wave (e.g., 2014) who were born in different years (e.g., 1972-1979 vs. 1980-1987). The expectation across all analyses is that health outcomes may vary based on genocide exposure. Therefore, age and survey year serve as proxies for exposure to genocide.

Dataset: Cambodia Demographic and Health Surveys

The Cambodia Demographic and Health Surveys (DHS) is a nationally representative survey consisting of face-to-face interviews with women of reproductive age (primarily ages 15-49), face-to-face interviews with a sub-sample of men (ages 15-49), and household surveys capturing data on all household members. Data was retrieved from the individual and household surveys of the 2014 and 2021-22 Cambodia DHS. The cross-sectional data for this analysis focuses on 2014 and 2021-2022 survey years, as they are the most recent publicly available DHS data on Cambodia. Although previous years of data (such as 1998, 2000, 2005, and 2010) were available, they were not utilized for this study due to their lack of recency and the different sets of questions in these surveys.

The health outcomes analyzed are limited to particular genders because the DHS lacked data on each outcome for all male and female respondents. The analysis for smoking included only Cambodian women aged 27-50 (N=24,902), by survey year. The analysis for stunted growth included Cambodian women aged 35-42 (N=8,403) in 2014 and 2021-2022. The analysis for disability included Cambodian men and women aged 27-50 (N=48,672), by survey year. All survey respondents were residing in Cambodia at the time of survey.

Methodology

Data were derived from the DHS individual and household surveys in relation to health and health behaviors, specifically smoking, height, and disability. The smoking variable

(categorical) includes data collected from females, aged 27-50. The height variable (continuous) includes data collected from females, aged 35-42. The disability variable (categorical) includes data collected from males and females, between ages 27-50. The analytic sample size differs depending on the health outcome, the survey wave(s), and the comparisons being made.

The strategy used to compare individuals born shortly before and during the genocide with those born shortly after the genocide varies by outcome. Across analyses, age was used as a proxy for birth before and during the genocide or shortly after the genocide ended (see summary in Table 2.1). Because smoking prevalence may vary for all ages between 2014 and 2021-2022 given declines in smoking globally in this period, within (between proximal age groups) as well as between-wave (35-42-year-olds in 2014 and 2021-2022) comparisons were made. For stunting, comparisons were only made between those aged 35-42 in 2014 and 2021-2022. Because stunting is set in childhood, its prevalence is not expected to change for these two birth cohorts between the two survey waves. For the analysis of men's and women's disability status, within- and between-wave comparisons were made given variation in the way disability questions were asked in the two survey waves (discussed below).

Smoking.

For the measures of smoking status, data was only available for female respondents. The analytic sample size (N=11,277) for 2014 Cambodia DHS data and the analytic sample size (N=13,625) for 2021-2022 Cambodia DHS data include females who were between the ages of 27-50. Three age groups were analyzed for this specific dependent variable: 27-34, 35-42, and 43-50. The breakdown of the analytic sample sizes by age group for 2014 survey data were N=4,998 for women aged 27-34, N=3,142 for women aged 35-42, and N=3,137 for those aged

43-50. The analytic sample sizes by age group for 2021-2022 survey data were N=5,380 for women aged 27-34, N=5,352 for those aged 35-42, and N=2,893 for those aged 43-50.

Stunted Growth.

Stunted growth data were also available only for female respondents. The analysis for this specific dependent variable focuses on women ages 35-42. The analytic sample (N=3,091) for 2014 Cambodia DHS data includes women who were between the ages of 35-42, born between 1972-1979, either a little before the genocide began or during the time of the genocide. The analytic sample (N=5,312) for 2021-2022 Cambodia DHS data includes women who were between the ages of 35-42 born between 1980-1987, after the genocide ended. Across both survey waves, the total analytic sample for stunted growth was N=8,403.

Disability.

Regarding disability status, data were available for both female and male respondents. The analytic sample (N=21,957) for 2014 Cambodia DHS data includes 10,684 males and 11,273 females, and the analytic sample (N=26,715) for 2021-2022 Cambodia DHS data includes 13,050 males and 13,665 females. Both analytic samples include males and females between the ages of 27-50. Three age groups were analyzed for this specific dependent variable: 27-34, 35-42, and 43-50. The breakdown of the analytic sample size by age group for 2014 survey data was N=9,799 for those 27-34, N=6,146 for those aged 35-42, and N=6,012 for those aged 43-50. The breakdown for the analytic sample size by age group for 2021-2022 survey data N=10,579 for individuals aged 27-34, N=10,515 for individuals aged 35-42, and N=5,621 for individuals aged 43-50.

All statistical analysis was performed utilizing StataSE 17 (64-bit) statistical software. Robustness checks were performed for validity and reliability purposes in relation to the results for two outcome variables, smoking and disability.

Measures

The DHS contains individual-level information such as age, sex, smoking habits, height, and prevalence of disabilities. Although household-level information is also available, individuals are the unit of analysis for this study.

The dependent variables are smoking habits (currently smoking cigarettes or not), height (measurement of female recorded in centimeters), and disability (difficulty with vision, hearing, walking/climbing, remembering/concentrating, self-care, and/or communication versus none). Disability and smoking are binary dependent variables, whereas height is a continuous dependent variable which is turned into a binary variable for the purpose of this study.

The main independent variable in some of the analyses is the survey year, whether 2014 or 2021-2022. In some analyses, age is used as a proxy for exposure to the genocide in early childhood, distinguishing those born before or during the genocide and those born after. Covariates consistent across models include sex (male or female), marital status (never, married, widowed/divorced), level of educational attainment (no education/pre-kindergarten, primary, secondary or higher), and wealth index (poor, middle, rich). The DHS constructed the wealth index based on household assets.

The sociodemographic controls were selected based on previous literature. For example, studies have found that unmarried individuals tend to have worse health outcomes compared to their counterparts who are married (Robard et al., 2012). Moreover, an individual's overall well-

being has been attributed to their educational status and marital status in addition to their income (Ndayambaje et al., 2020).

Dependent Variables.

There are three dependent variables in this section of the study: smoking, stunted growth, and disability. The initial purpose of the DHS was to collect data on women of reproductive age. Given that the DHS primarily focuses on women, and specifically on women's reproductive histories, a shorter questionnaire was administered to a subset of men. These abbreviated surveys did not collect information on smoking and stunted growth from the male population. Given that smoking and stunted growth data were only available for female respondents, the analyses of smoking and stunting were limited to Cambodian women. For the analyses of disability, the study population included both Cambodian women and men.

Smoking.

Smoking was measured with a question asking, "Do you currently smoke cigarettes?" in 2014, and with a question asking, "Do you currently smoke cigarettes every day, some days, or not at all?" in 2021-2022. For each wave, smoking was coded as 0 if a female did not currently smoke and coded as 1 if a female did currently smoke at all at the time the survey was taken.

Stunted Growth.

The interviewers measured the height of female respondents in centimeters. Height is a proxy for stunting stemming from malnutrition in early childhood. Stunted growth was coded as 0 if a female did not experience stunted growth and coded as 1 if a female did experience stunted growth. Stunted growth in this study was defined as being under 150 centimeters at the time of survey; this definition follows the cut-off mark from scholarship on the impacts of genocide on

population health, particularly among Cambodian women in relation to nutritional risk (De Walque, 2004). Being under 150 centimeters is equivalent to being shorter than 4 feet 11 inches.

Disability.

The DHS survey measured six disabilities: hearing, seeing, walking/climbing, remembering/concentrating, self-care, and communication. The 2014 questions differed slightly from the 2021-2022 questions. For hearing, 2014 respondents were asked, "Does [name] have difficulty hearing, even if using a hearing aid?" For sight, they were asked, "Does [name] have difficulty seeing, even if wearing glasses?" For walking/climbing, the question was, "Does [name] have difficulty walking or climbing steps?" For remembering/concentrating, respondents were asked, "Does [name] have difficulty remembering or concentrating?" For self-care, they were asked, "Does [name] have difficulty with self-care such as washing all over or dressing?" For communication, the question was, "Because of physical, mental or emotional health conditions, does [name] have difficulty communicating?"

In 2021-2022, for vision, participants were told and asked, "I would like to know if [name] has difficulty seeing. Would you say that [name] has no difficulty seeing, some difficulty, a lot of difficulty, or cannot see at all?" For hearing, the respondents were asked, "I would like to know if [name] has difficulty hearing. Would you say that [name] has no difficulty hearing, some difficulty, a lot of difficulty, or cannot hear at all?" For communication, they were asked, "I would like to know if [name] has difficulty communicating when using his/her usual language. Would you say that [name] has no difficulty understanding or being understood, some difficulty, a lot of difficulty, or cannot communicate at all?" For remembering/concentrating, they were told and asked, "I would like to know if [name] has difficulty remembering or concentrating. Would you say that [name] has no difficulty remembering or concentrating, some

difficulty, a lot of difficulty, or cannot remember or concentrate at all?" For walking or climbing, they were asked, "I would like to know if [name] has difficulty walking or climbing steps. Would you say that [name] has no difficulty walking or climbing steps, some difficulty, a lot of difficulty, or cannot walk or climb steps at all?" For self-care such as washing or dressing, the respondents were asked, "I would like to know if [name] has difficulty washing all over or dressing. Would you say that [name] has no difficulty washing all over or dressing, some difficulty, a lot of difficulty, or cannot wash all over or dress at all?"

There were several differences in how the questions were asked about difficulties between survey years. One example is in relation to hearing and seeing. In 2014, respondents were specifically asked if there were any difficulties *despite* wearing glasses or hearing aids. However, in 2021-2022, respondents may have reported difficulties that could be corrected with glasses or hearing aids. Moreover, in the 2021-2022 survey, respondents were directly prompted in the questions to report on less serious disabilities (such as "some difficulty"), whereas in the 2014 survey, severity was left open. This is important to note because it may be possible that some of the respondents from the 2014 survey may not have reported on less serious disabilities.

Given the relatively low prevalence of each disability, all six disabilities were combined into one measure to represent the presence of any disabilities. This method follows a recommendation from the Washington Group on Disability Statistics, a group formed under the United Nations Statistical Division that works on defining and measuring disability in an equitable matter (Madans et al., 2011). If an individual did not have difficulty with any of the aforementioned actions, the disability status measure was coded as 0. However, if an individual did report any of the six difficulties, it was coded as 1.

Age, Gender, Educational Attainment, Marital Status, and Wealth.

Age (in 2014 and 2021-2022) was determined through a question asking, "In what month and year were you born?" For stunted growth, age was measured in years and coded as 0 if the individual was not between the ages of 35-42 and 1 if the individual was between the ages of 35-42. For smoking and disability, three age groups were distinguished: 27-34, 35-42, and 43-50. Survey year is a binary independent variable coded as 0 if the survey was conducted in 2014 and 1 if the survey was conducted in 2021-2022. Sex was determined by asking, "Is [name] male or female?" and coded as 0 if the individual was male and 1 if the individual was female. Marital status was determined by asking, "What is [name]'s current marital status?" Marital status is recoded as follows: never married as 1, married as 2, and widowed/divorced as 3. Educational attainment was determined by asking, "Have you ever attended school?" If the response was "Yes," the follow up question was, "What is the highest level of school you attended: primary, secondary, or higher?" Educational attainment was coded as 1 for no education/preschool, 2 for primary school, and 3 for secondary school or higher. The wealth index was generated by the DHS through a principal components analysis information on household characteristics, consumer goods and assets. A few examples include ownership of transportation, property such as farmland, livestock, and household products such as refrigerator, radio, and other electronic devices. The wealth index was coded as 1 for poor, 2 for middle, and 3 for rich.

Weighted Logistic Regression Models

Multivariable logistic regression was used to examine the health impacts of early exposure to the genocide. Sampling weights provided by the DHS were utilized to adjust for the sample design and survey non-response. Logistic regression models were used because the

dependent variables were all operationalized dichotomously. Control variables in all of the logistic regression analyses included marital status, educational attainment, and the wealth index.

Results

Demographic Composition: Comparisons Between Cambodia and Thailand

Figure 2.1 includes population pyramids of Cambodia and Thailand for the following years: 1975, 1985, 2014, and 2022. In 1975, the population pyramid structure was the same between Cambodia and Thailand. However, in 1985, deficits were forming in Cambodia's population pyramid which illustrated the decrease in girls and boys who would have been born shortly before or during the genocide (aged 5-9 in 1985), in addition to the increase of babies born after the genocide ended (aged 0-4 in 1985). In Thailand in 1985, there was no such deficit in the 5-9 age range, nor a boom in the 0-4 age range.

In 2014, Cambodia's population pyramid reveals an age-sex structure with a continuing deficit of individuals who would have born shortly before and during the time of the genocide. This can be seen in the 35-39 age range. Therefore, this population pyramid continues to illustrate high mortality and low fertility as a result of the genocide. In addition to reflecting the increased mortality rates and decreased fertility rates, the rebound in the 30-34 age range reaffirms that tumultuous events resulting in substantial deaths were followed by immediate increased fertility shortly after the atrocious event ended (Frankenberg et al., 2014). This same result was evident in the 2022 population pyramid for Cambodia, particularly among individuals between the ages of 43-50, who would have been born a little before or during the genocide. By contrast, when examining the population pyramids for Thailand in 2014 and 2022, there were no indentations in the demographic composition, particularly among the previously specified age

groups. This visual representation reaffirmed that fertility and mortality were not severely impacted in Thailand, which did not experience a mass genocide.

Morbidities: Comparisons Between Those Exposed to the Cambodian Genocide in Early Childhood and Those Born Shortly After

Weighted Descriptive Statistics for Smoking

Table 2.2 illustrates the weighted descriptive analyses for smoking among Cambodian women aged 27-50 (N=24,902) by survey year: 2014 (N=11,277) and 2021-2022 (N=13,625). The overall prevalence for smoking among Cambodian women aged 27-50 was a little more than double in 2014 (3.07%) compared to 2021-2022 (1.29%). The prevalence of smoking among women aged 35-42 in 2014 who were born before or during the genocide (1972-1979) was more than three times that of women aged 35-42 in 2021-2022 who were born shortly after the genocide (1980-1987), respectively 4.23% and 1.31%. Overall, there was a general decrease in smoking among each age group over time.

Moreover, differences between age groups can be observed in each survey wave. In 2014, women aged 35-42 and 43-50 (who experienced the genocide) were much more likely to smoke than women aged 27-34 (who were born after the genocide). Additionally, in 2021-2022, women aged 43-50 (who experienced genocide) were much more likely to smoke compared to women aged 27-34 and 35-42 (who did not experience genocide).

Table 2.2 also includes weighted descriptive statistics for age, educational attainment, marital status, and wealth index pertaining to the analytic sample for smoking. In 2014, 44.32% of women were ages 27-34, 27.86% were ages 35-42, and 27.82% were ages 43-50; in 2021-2022, the age breakdown was 39.49%, 39.28%, and 21.23%, respectively. In relation to educational attainment, in 2014, 18.63% of women between the ages of 27-50 reported having

either no formal education or a pre-school education, 55.44% reported having completed primary school, and 25.93% reported completion of secondary education or higher. In 2021-2022, 16.78% of women between the ages of 27-50 reported having either no formal education or a pre-school education, 46.22% reported having completed primary school, and 37.01% reported completion of secondary education or higher. The rates of marriage slightly increased over time from 2014 (92.39%) to 2021-2022 (92.94%). The wealth index among women aged 27-50 illustrates some slight changes between 2014 and 2021-2022; for example, the percent in the highest wealth categories increased from 41.67% to 45.03%.

Weighted Logistic Regression for Smoking

Table 2.3 illustrates the results from the weighted logistic regression model for smoking among Cambodian women aged 27-50, stratified by survey year. There is a positive association between trauma symptoms and engagement with risk health behaviors; therefore, individuals with increased trauma symptoms may be more likely to smoke cigarettes (Wagner et al., 2013). The results from the weighted logistic regression model reveal that women aged 27-34 in 2014 (born shortly after the genocide) were 60% less likely to report smoking compared to women aged 35-42 (born shortly before or during the genocide). Additionally, women aged 43-50 in 2021-2022 (born shortly before or during the genocide) were 80% more likely to report smoking compared to women aged 35-42 (born shortly after the genocide). These results from 2014 and 2021-2022 data are similar in that women who were born after the genocide were much less likely to smoke than women who experienced the genocide in early childhood despite being close to them in age. This reaffirms the take-away from the descriptive statistics that individuals exposed to the genocide during early childhood were more likely to smoke compared to their counterparts who did not experience the genocide directly. These results align with Wagner et al.

(2013) and may suggest that the genocide exposure during early childhood exacerbated the smoking habits as a coping mechanism for experiencing trauma and toxic stress.

With respect to the control variables, respondents in 2014 whose highest educational attainment was primary school were 67% less likely to report smoking than those with no education or only pre-school education, while respondents whose highest educational attainment was secondary school or higher were 77% less likely to report smoking. Similarly, respondents in 2021-2022 whose highest educational attainment was primary school were 72% less likely to report smoking than the reference group, while respondents whose highest educational attainment was secondary school or higher were 92% less likely to report smoking. Married Cambodian women were more likely to report smoking than their never married counterparts. Overall, in 2014, Cambodian women were least likely to report smoking if they were between the ages of 27-34, completed secondary education or higher, were rich, or were never married. In 2021-2022, Cambodian women were least likely to report smoking if they were aged 27-42, completed secondary education or higher, or were rich.

Table 2.4 displays results from the weighted logistic regression for smoking among Cambodian women aged 35-42, pooling survey waves. The results revealed that women aged 35-42 in 2021-2022 (born after the genocide) were 71% less likely to report smoking compared to women aged 35-42 in 2014 (born shortly before or during the genocide). This result is consistent with the idea that women born shortly before or during the genocide were more likely to report smoking compared to their counterparts who were born after the genocide. In other words, this finding reaffirms that individuals exposed to genocide during early childhood may have been more likely to smoke as a way to cope with toxic stress experienced during the genocide. However, this result is also consistent with a general decrease in smoking prevalence across

time; thus, the findings should be taken together with the intra-wave results (Table 2.3) that also indicated higher rates of smoking at a single point in time among women exposed to the genocide relative to those who did not have this exposure.

Weighted Descriptive Statistics for Stunted Growth

Table 2.5 illustrates results from the weighted descriptive statistics for stunted growth among Cambodian women aged 35-42 (N=8,403) by survey year (2014 and 2021-2022). The prevalence of stunted growth was higher among women aged 35-42 in 2014 (27.71%) compared to women aged 35-42 in 2021-2022 (22.91%). This is consistent with the notion that women exposed to the genocide experienced more malnutrition in early childhood, and hence more stunting, compared to those born after the genocide.

Table 2.5 also includes weighted descriptive statistics for the covariates among women in the analytic sample for stunted growth. In general, women aged 35-42 in 2021-2022 achieved higher educational attainment than women aged 35-42 in 2014. Specifically, the prevalence of secondary education or higher slightly increased from 25.30% in 2014 to 28.37% in 2021-2022. In relation to marital status, the share of Cambodian women aged 35-42 who reported never being married was similar across both survey years, 5.82% in 2014 and 5.18% in 2021-2022. Wealth index reports improved over time for women aged 35-42 between 2014 and 2021-2022.

Weighted Logistic Regression for Stunted Growth

Table 2.6 shows results from the weighted logistic regression for stunted growth among Cambodian women aged 35-42, using pooled data from the 2014 and 2021-2022 DHS survey waves. In line with the descriptive results illustrating a higher prevalence of stunted growth among women aged 35-42 in 2014 compared to 2021-2022, the results from the weighted logistic regression model revealed that women aged 35-42 in 2021-2022 were 21% less likely to

report stunted growth compared to women aged 35-42 in 2014, net of the other covariates. This result indicates that women born shortly before or during the genocide were more likely to report stunting compared to their counterparts who were born after the genocide. In other words, this finding reaffirms that individuals exposed to genocide during early childhood were more likely to experience stunted growth, likely as a result of malnutrition during the genocide.

With respect to the control variables, women aged 35-42 who received a secondary education or higher were 22% less likely to report stunted growth compared to their counterparts who had no more than a preschool level education. Respondents who were currently married were 39% less likely to report stunted growth compared to respondents who were never married. Respondents who were previously married were 32% less likely to report stunted growth compared to their counterparts who were never married. Respondents who were rich were 27% less likely to report stunted growth compared to their counterparts who were poor.

Weighted Descriptive Statistics for Disability

Table 2.7 illustrates the weighted descriptive statistics for disability among Cambodian men and women aged 27-50 (N=48,672) by survey year (2014 and 2021-2022). The analytic sample size for 2014 was 21,957 respondents, and the analytic sample size for 2021-2022 was 26,715 respondents. The share of the sample who were men (a little over 48%) vs. women (a little over 51%) was similar between the survey years. The age group breakdowns between 2014 and 2021-2022 respectively are as follows: ages 27-34, 44.63% and 39.60%; ages 35-42, 27.99% and 39.36%; ages 43-50, 27.38% and 21.04%.

There was a higher reporting of disability among respondents in 2021-2022 (21.16%) compared to 2014 (7.94%). Moreover, the prevalence of disability was higher across all age groups in 2021-2022 compared to 2014. More specifically, the prevalence of respondents ages

27-34 with any disability more than doubled from 2014 to 2021-2022 (from 5.02% to 13.08%), whereas the prevalence of respondents ages 35-42 with any disability nearly tripled from 2014 to 2021-2022 (from 7.26% to 19.93%). Lastly, the prevalence of respondents ages 43-50 with any disability more than doubled from 2014 to 2021-2022, from 13.39% to 38.65%. Thus, the prevalence of disability drastically increased between survey years. The differences in question wording between the two survey waves may have impacted how the respondents answered. As noted above, the questions for sight and hearing asked respondents to report difficulty *even with* use of glasses or hearing aids in 2014, whereas in 2021-2022 they simply asked about difficulty seeing or hearing. Other changes in how the questions were asked included longer lead-up to the questions and longer questions in 2021-2022 and provision of answer choices in the actual questions referencing different levels of disability severity.

Within survey wave, men and women born before or during the genocide experienced a higher prevalence of disability compared to those born after the genocide. Specifically, in 2014, 5.02% of men and women aged 27-34 (born after the genocide) reported a disability, compared to 7.26% of those aged 35-42 and 13.39% of those aged 43-50. In 2021-2022, men and women aged 43-50 (born shortly before or during the genocide) experienced a far higher prevalence of disability (38.65%) relative to those aged 35-42 (19.93%) and 27-34 (13.08%).

Table 2.7 also includes weighted descriptive statistics for the covariates: educational attainment, marital status, and wealth index. The rates of educational attainment and wealth index appear to be improving across survey years. The prevalence of marriage was similar between 2014 and 2021-2022, 92.73% and 91.58%, respectively.

Weighted Logistic Regression for Disability

Table 2.8 shows the results from the weighted logistic regression for disability among Cambodian men and women aged 27-50, stratified by survey year (2014 and 2021-2022). In 2014, individuals aged 27-34, who were born after the genocide, were 37% less likely to report having any disability compared to those aged 35-42. Those aged 43-50 were almost twice as likely to have a disability as those aged 35-42. In 2021-2022, the odds of reporting a disability were 2.5 times higher for those aged 43-50, who were exposed to the genocide, compared to those aged 35-42, who were not. Those aged 27-34 were 39% less likely to have a disability than those aged 35-42. In both waves, the likelihood of reporting of any disability was higher among older respondents, consistent with the idea that the prevalence of disabilities increases with age as well as with the idea that disability was higher among those who experienced the genocide. These findings illustrate the difficulty in disentangling differences in disability by age from differences in genocide exposure. Furthermore, given that the disability questions varied between survey waves, it was not possible to compare individuals of the same age between survey years.

Regarding the control variables in 2014, female respondents were 13% less likely to report disability compared to their male counterparts. However, in 2021-2022, female respondents were 14% more likely to report disability compared to their male counterparts. Individuals with a primary and secondary school education or higher had a lower odds of reporting disability compared to their counterparts who have no more than a preschool education. In relation to marital status, women who were never married had the highest likelihood of reporting a disability in both survey years.

Discussion

The purpose of this study was to examine the long-term impacts of the Cambodian

genocide on Cambodia's population in relation to fertility, mortality, and morbidity. For some analyses, data was available only for women.

In the first part of this study, I hypothesized that Cambodia's population pyramids in recent decades would illustrate increased mortality and decreased fertility for certain age groups because of the genocide. The hypothesis aligned with the results. Findings revealed an evident indentation in the population pyramids over time for female and male Cambodians who would have been born shortly before or during the genocide, with a population boom immediately following the genocide. This pattern was not observed for Thailand, a neighboring country that did not experience a genocide. However, differing from Thailand's population structure over time, Cambodia's population structure shows a shift in demographic composition throughout the years as a result of the genocide.

In the second part of this study, I hypothesized that individuals born in Cambodia between 1972-1979 (shortly before or during the time of the genocide) would be more likely to smoke, be of lower height, and have greater prevalence of disabilities compared to their counterparts born shortly after the genocide (born between 1980-1987). The findings support the notion that there is an association between exposure to the genocide in early childhood and adverse health outcomes in adulthood (smoking, stunted growth, disability). These results are consistent with prior research in relation to the genocide, which focused on different age groups (Blaser, 2002; Friis et al., 2006; Moyano, 2017). The results for smoking and stunted growth aligned with the expectations that individuals born shortly before or during the genocide were more likely to smoke and to have experienced stunted growth compared to individuals who were born shortly after the genocide. However, the findings for disability are difficult to distinguish from the aging process, particularly because of data constraints that limit the comparability of the

disability measures between survey waves.

Smoking

The results revealing that women born shortly before or during the time of the genocide were more likely to report smoking compared to those born shortly after the genocide suggest that exposure to genocide is linked to toxic stress. In other words, those who experience a traumatic event such as the genocide at a young age are likely to find other ways to cope with stress and one of these ways is through substance use such as cigarettes (Friis et al., 2006). This may also illustrate that individuals born after the genocide experienced lower levels of toxic stress than those who were exposed to genocide at a young age. This suggests that smoking may be an enduring coping mechanism for toxic stress experienced during the Cambodian genocide. Given the adverse effects of smoking, individuals who experienced the genocide should be introduced, informed, or educated on healthy ways to cope with toxic stress rather than turning to smoking cigarettes.

Stunted Growth

The results that women born shortly before or during the genocide were more likely to report stunted growth compared to those born shortly after the genocide reveal that exposure to the genocide may have been linked to childhood malnutrition. Contributing factors attributed to increased likelihood of stunted growth include low levels of parental education, poor family wealth index, maternal age at marriage and low maternal body mass index (Sumon et al., 2024). Individuals born during or before the genocide likely experienced malnutrition and food insecurity themselves, and their mothers may have also experienced food insecurity while they were in utero; both may have rendered them more susceptible to experiencing stunted growth (Tyner & Rice, 2016). Due to the adverse impacts of stunted growth, such as poor academic

performance, death, and cognitive delays (Sumon et al., 2024), individuals who had childhood exposure to the genocide should be given the opportunity to learn more about the long-term impacts of the genocide on their health, and the health of subsequent generations. Although Cambodian experienced a 10% decrease in stunted growth between 2014 and 2022 from 32% to 22%, stunted growth among children five years of age and younger remains a public health problem (Sumon et al., 2024). Therefore, Sumon et al. (2024) hope that the findings from their study can inform policymakers in Cambodia to decrease the prevalence of stunted growth among children five years of age and younger and achieve the Sustainable Development Goals of Cambodia by 2030. Sumon et al. (2024) also believes it would be important for future studies to explore the other causes of stunted growth among children under the age of five in Cambodia. Consequently, this study explored stunted growth in the context of early childhood exposure to the genocide utilizing Cambodia Demographic and Health Surveys data (2014 and 2021-2022) in which individuals born shortly before or during the genocide were 7 years old and younger (1972-1979).

Disability

The results for disability revealed a higher rate of disabilities among participants in the 2021-2022 survey year compared to the 2014 survey year, across all age groups. These results likely reflect differences in how the disability questions were formatted and worded, as noted above. Results across age groups within survey wave did indicate a higher prevalence of disability among those with exposure to the genocide; however, these differences in prevalence are also consistent with higher prevalence of disability at older ages. Future research should attempt to further tease out age-linked morbidity from disability linked to the genocide. Given that some morbidities have a positive association with increased age, or that increased age may

be attributed to specific age-related diseases, it would be important to separate age-related conditions with conditions that directly resulted from the genocide.

Limitations

This study has several limitations. The data source (Cambodia DHS) did not include data for the male population for smoking behavior and stunting outcomes. Given that DHS primarily collects data on women of reproductive age, such data on the male population in relation to smoking behavior and stunted growth were not collected nor provided.

Since the data was collected through self-reported survey format, there may also be bias in self-reporting some of these measures. For example, there may be stigma around disability or smoking which may lead to underestimations of these outcomes. Although most Cambodians are familiar with physical disabilities (Burkhardt, n.d.), they may be less familiar with other forms of disability, including cognitive disabilities such as memory.

Survival bias is another possible limitation in studying the long-term health impacts of the Cambodian genocide on the Cambodian population (Milazzo & Cuesta, 2021). This is evident for this specific study because the results from the DHS surveys are limited to those who survived the Cambodian genocide and individuals born after the genocide. Consequently, the exclusion of individuals who passed away during or after the genocide are not accounted for, and they may have had health problems related to toxic stress, malnutrition, and disability.

Importantly, the 2014 and 2021-2022 Cambodia Demographic and Health Surveys lacked detailed health measures of chronic and mental health conditions including but not limited to diabetes, depression, trauma, anxiety and substance abuse. Therefore, the inclusion of more mental health measures would allow for further examination of the effects of toxic stress during early childhood on physical health. Prior research indicates that some mental health issues

prevalent among Cambodians exposed to the genocide include anxiety, depression and post-traumatic stress disorder (Berthold et al., 2014). Given that the impacts of disasters extend beyond physical health (Frankenberg et al., 2014), the survey should incorporate questions on mental health, a crucial aspect to learning about the Cambodian population's health outcomes as a result of the genocide.

As noted earlier, another important limitation of the study was that the wording for disability varied between the two survey years. This difference in wording likely contributed to the markedly higher prevalence of disability in the later survey wave. This made it difficult to distinguish genocide-linked disability, especially from age-related differences in morbidity.

Implications

Given that children are one of the most vulnerable populations (Landrigan, 2005), this research contributes to understanding of the long-term detrimental health and health behavioral impacts of early childhood exposures to war- and genocide-linked physical trauma, toxic stress, and malnutrition. The findings may help inform what can be done for victims who remain in impacted countries as well as those who become refugees. Additionally, this study may serve as a basis for others to explore the impacts of genocide and war conflicts on the populations of other countries of interest, such as Vietnam and Rwanda, given that the DHS has also collected data in such countries.

One of the hopes of this study is that it can help manage refugee cases for future populations or current populations encountering such catastrophic events. At the time this study was written, we are currently undergoing various wars simultaneously across the globe. Thus, by utilizing this study, we can anticipate what to expect in the future in relation to the demographic and long-term health impacts caused by genocide and war on its victims and survivors. This

study may provide a sense of understanding the consequences of genocide in relation to adverse health outcomes among the potential influx of refugees who may continue to experience long-term impacts of genocide. These negative health conditions may also be generational.

To fully understand the effects of the genocide on demographic and health outcomes, it would also be useful to include information on the children of these generations to follow any health impacts that may have been intergenerational as a result of the genocide. For example, prior research revealed that women who experienced malnutrition during the genocide had children who later experienced stunted growth (Ying et al., 2015). Therefore, children born after the genocide may still have experienced the impacts of the genocide indirectly through their mothers who were exposed to the genocide. In this and other ways, residual trauma may be transmitted from one generation to the next. This study may serve as a foundation for examining generational health implications stemming from genocide, with future studies further examining the intergenerational aspect of genocide-linked health consequences. Malnutrition is linked to stunted growth, and stunted growth remains a public health problem in Cambodia (Sumon et al., 2024). Individuals who were more likely to experience stunted growth were more likely to be malnourished, have parents with lower educational attainment rates, live in rural areas, and come from households with a low wealth index (Sumon et al., 2024). These factors were notable among genocide survivors and therefore may be attributed to their own adverse health outcomes. Thus, it is crucial that stunted growth is addressed at an early age to possibly prevent any other health problems.

Some of the Cambodians who survived the genocide sought refuge in countries such as Australia, France and the United States of America (Chan, 2004). Given that many of the Cambodian genocide survivors relocated to places outside of Cambodia, it would be ideal to

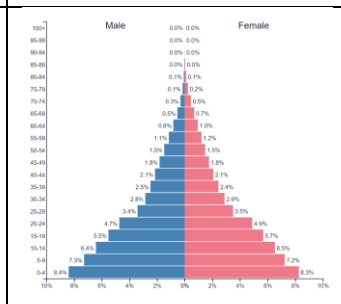
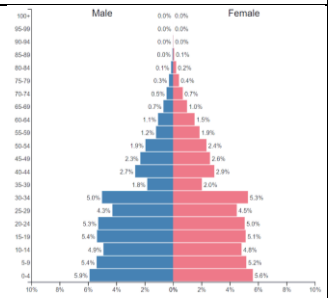
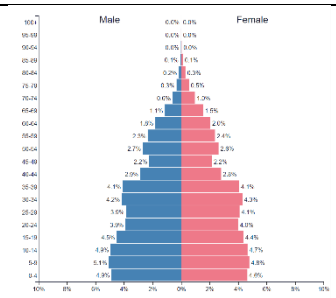
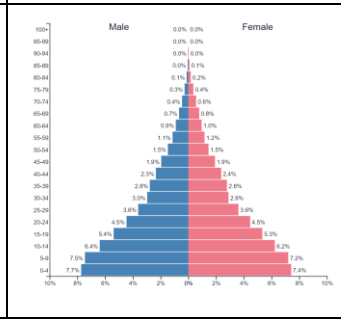
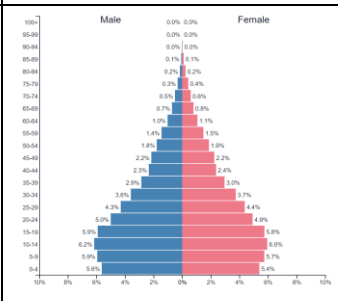
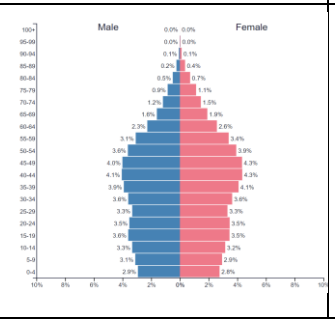
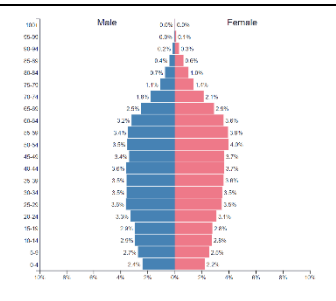
replicate these analyses for Cambodians refugees in the U.S. or other countries to learn more about their health outcomes, should the data be available or attainable from other databases. These findings may also allow for comparisons between Cambodian refugee health outcomes and health outcomes of Cambodians in Cambodia who experienced the genocide and possibly those post-genocide to learn about whether diasporic conditions led to any potential differences or similarities.

Finally, this study may be replicated in the future with more recent Cambodia DHS data on Cambodia, upon availability. Conducting similar analyses with new sets of Cambodia DHS survey waves provide the opportunity to examine longer-term exposure of the genocide on aging. Following the same birth cohort over time utilizing the newest sets of Cambodia DHS data would have the potential to reveal any further long-term health implications as a result of the early childhood exposure to the Cambodian genocide.

Conclusion

The purpose of this paper was to examine how the genocide may have influenced the mortality, fertility and morbidity of Cambodia's population. It focused on Cambodian individuals born shortly before or during the genocide compared with those born shortly after the genocide. Overall, Cambodia's demographic composition was changed substantially over the long-term by genocide-linked changes in mortality and fertility. Early childhood exposure to the genocide also impacted the long-term health outcomes of those surviving. Cambodian women who experienced the genocide in early childhood reported higher rates of smoking and stunted growth than those born shortly after the genocide ended. Cambodian men and women also reported higher rates of disability with older age, whether a result of genocide exposure or typical aging processes.

Figure 2.1. Age-Sex Structure Comparison: Cambodia and Thailand (1975, 1985, 2014, 2022)

	1975	1985	2014	2022
Cambodia				
Thailand				

Source: PopulationPyramind.Net, Cambodia and Thailand (1975, 1985, 2014, 2022)

Table 2.1. Age Groups and Birth

Survey Year	Age Group	Birth Years	Timing of birth relative to genocide
2014	27-34	1980-1987	Born after
	35-42	1972-1979	Born shortly before/during
2021-2022	35-42	1980-1987	Born after
	43-50	1972-1979	Born shortly before/during

Table 2.2. Weighted Descriptive Statistics for Smoking among Cambodian Women Aged 27-50, by Survey Year

	Total (N=24,902)	
	Survey Year	
	2014	**2021-2022**
N	11,277	13,625
Smoking	3.07%	1.29%
Age Group		
Ages 27-34	44.32%	39.49%
Ages 35-42	27.86%	39.28%
Ages 43-50	27.82%	21.23%
Educational Attainment		
No Education/Pre-K	18.63%	16.78%
Primary	55.44%	46.22%
Secondary or Higher	25.93%	37.01%
Marital Status		
Never	7.61%	7.06%
Married	82.13%	84.56%
Widowed/Divorced	10.26%	8.38%
Wealth Index		
Poor	38.66%	35.71%
Middle	19.67%	19.27%
Rich	41.67%	45.03%
Smoking x Age Group		
Ages 27-34	1.71%	0.53%
Ages 35-42	4.23%	1.31%
Ages 43-50	4.14%	2.86%

Table 2.3. Weighted Logistic Regression for Smoking among Cambodian Women Aged 27-50, by Survey Year

	2014				2021-2022			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Age Group								
Ages 35-42	1.00							
Ages 27-34	0.40	*0.000	0.28	0.58	0.60	0.106	0.32	1.11
Ages 43-50	0.88	0.457	0.63	1.23	1.80	*0.016	1.11	2.90
Educational Attainment								
No Education/Pre-K	1.00				1.00			
Primary	0.33	*0.000	0.25	0.45	0.28	*0.000	0.18	0.44
Secondary or Higher	0.23	*0.000	0.13	0.42	0.08	*0.000	0.02	0.26
Marital Status								
Never Married	1.00				1.00			
Married	2.81	*0.040	1.05	7.56	0.74	0.531	0.29	1.91
Widowed/Divorced	1.71	0.335	0.57	5.11	1.02	0.972	0.33	3.11
Wealth Index								
Poor	1.00				1.00			
Middle	0.56	*0.003	0.38	0.82	0.31	*0.001	0.16	0.60
Rich	0.13	*0.000	0.07	0.22	0.04	*0.000	0.01	0.17
Constant	0.68	*0.000	0.02	0.19	0.09	*0.000	0.03	0.24

*p<0.05

Table 2.4. Weighted Logistic Regression for Smoking among Cambodian Women Aged 35-42

	Odds Ratio	p-value	95% CI	
Survey Year				
2014	1.00			
2021-2022	0.29	*0.000	0.20	0.44
Educational Attainment				
No Education/Pre-K	1.00			
Primary	0.25	*0.000	0.17	0.38
Secondary or Higher	0.23	*0.000	0.11	0.49
Marital Status				
Never Married	1.00			
Married	1.25	0.642	0.48	3.26
Widowed/Divorced	0.97	0.961	0.31	3.08
Wealth Index				
Poor	1.00			
Middle	0.34	*0.000	0.18	0.62
Rich	0.10	*0.000	0.05	0.21
Constant	0.18	*0.000	0.07	0.47

*p<0.05

Table 2.5. Weighted Descriptive Statistics for Stunted Growth among Cambodian Women Aged 35-42, by Survey Year

	Total (N=8,403)	
	Survey Year	
	2014	**2021-2022**
N	3,091	5,312
Stunted Growth	27.71%	22.91%
Educational Attainment		
No Education/Pre-K	17.00%	19.36%
Primary	57.70%	52.27%
Secondary or Higher	25.30%	28.37%
Marital Status		
Never	5.82%	5.18%
Married	83.35%	86.39%
Widowed/Divorced	10.83%	8.43%
Wealth Index		
Poor	40.02%	35.34%
Middle	19.55%	19.25%
Rich	40.43%	45.41%

Table 2.6. Weighted Logistic Regression for Stunted Growth among Cambodian Women Aged 35-42

	Odds Ratio	p-value	95% CI	
Survey Year				
2014	1.00			
2021-2022	0.79	*0.001	0.69	0.91
Educational Attainment				
No Education/Pre-K	1.00			
Primary	1.02	0.850	0.85	1.21
Secondary or Higher	0.78	*0.025	0.63	0.97
Marital Status				
Never Married	1.00			
Married	0.61	*0.000	0.47	0.80
Widowed/Divorced	0.68	*0.025	0.49	0.95
Wealth Index				
Poor	1.00			
Middle	0.86	0.112	0.72	1.04
Rich	0.73	*0.000	0.62	0.86
Constant	0.73	*0.047	0.54	0.996

*$p<0.05$

Table 2.7. Weighted Descriptive Statistic for Disability among Cambodian Men and Women Aged 27-50, by Survey Year

	Total (N=48,672)	
	Survey Year	
	2014	**2021-2022**
N	21,957	26,715
Disability	7.94%	21.16%
Sex		
Male	48.66%	48.85%
Female	51.34%	51.15%
Age		
Age 27-34	44.63%	39.60%
Age 35-42	27.99%	39.36%
Age 43-50	27.38%	21.04%
Educational Attainment		
No Education/Pre-K	14.41%	13.87%
Primary	50.01%	42.58%
Secondary or Higher	35.58%	43.55%
Marital Status		
Never	7.27%	8.42%
Married	86.34%	85.45%
Widowed/Divorced	6.39%	6.13%
Wealth Index		
Poor	38.37%	36.02%
Middle	19.67%	19.12%
Rich	41.95%	44.86%
Disability x Age Group		
Ages 27-34 with Disability	5.02%	13.08%
Ages 35-42 with Disability	7.26%	19.93%
Ages 43-50 with Disability	13.39%	38.65%
Disability x Sex: Ages 27-50		
Males with Disability	7.88%	19.84%
Females with Disability	7.99%	22.42%

Table 2.8. Weighted Logistic Regression for Disability among Cambodian Men and Women Aged 27-50, by Survey Year

	2014				2021-2022			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Age Group								
Ages 35-42	1.00				1.00			
Ages 27-34	0.63	*0.000	0.55	0.72	0.61	*0.000	0.57	0.66
Ages 43-50	1.96	*0.000	1.73	2.21	2.50	*0.000	2.33	2.69
Sex								
Male	1.00				1.00			
Female	0.87	*0.007	0.78	0.96	1.14	*0.000	1.07	1.21
Educational Attainment								
No Education/Pre-K	1.00				1.00			
Primary	0.69	*0.000	0.60	0.79	0.85	*0.000	0.78	0.93
Secondary or Higher	0.50	*0.000	0.42	0.59	0.71	*0.000	0.65	0.79
Marital Status								
Never Married	1.00				1.00			
Married	0.40	*0.000	0.34	0.48	0.71	*0.000	0.64	0.80
Widowed/Divorced	0.52	*0.000	0.41	0.66	0.74	*0.000	0.63	0.86
Wealth Index								
Poor	1.00				1.00			
Middle	0.88	0.078	0.76	1.01	0.67	*0.000	0.61	0.73
Rich	1.16	*0.013	1.03	1.31	0.60	*0.000	0.56	0.65
Constant	0.28	*0.000	0.23	0.35	0.52	*0.000	0.45	0.60

*p<0.05

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CHAPTER 3: EXAMINING THE RISK FACTORS OF LOW BIRTH WEIGHT AMONG CAMBODIAN WOMEN IN CAMBODIA

Low Birth Weight

Low birth weight (LBW) is a major public health concern worldwide, especially in underdeveloped countries (Chhea et al., 2018; Diabelková et al., 2022; Mahumud et al., 2016). Low birth weight refers to when a baby weighs less than 2,500 grams at birth (Arsyi et al., 2022; Hughes et al., 2017; Loreto et al., 2019; Okui et al., 2023; Sutan et al, 2014). This is equivalent to approximately 5.5 pounds (Arsyi et al., 2022; Chhea et al., 2018). According to Arsyi et al. (2022), about 20.5 million (14.6%) live births around the world resulted in low-birth-weight births, and of those births, 96.5% of low-birth-weight babies were delivered in developing countries. According to Khan et al. (2016), approximately 72% of babies born low birthweight in developing countries are born in Asia. Southeast Asia is the second largest contributor to global LBW rates next to South Asia (Arsyi et al., 2022). Worldwide each day, there are about 800 women who pass away from childbirth and pregnancy-related complications (Diabelková et al., 2022). A baby who weighs between 1,500–2,500 grams is 5–10 times more likely to experience infant mortality compared to their counterparts who are born normal weight at birth (Oulay et al., 2018). Consequently, among maternal and child health outcomes, low birth weight is a major detrimental birth outcome in the childbearing stage (Olusanya & Ofovwe, 2010).

LBW is considered a major predictor of disabilities, disease, and death (Olusanya & Ofovwe, 2010; Sutan et al, 2014). Low birth weight is linked to adverse health outcomes such as infant mortality, neonatal morbidity, attention deficit disorders, poor academic achievement (Diabelková et al., 2022; Khan et al., 2016; Martel et al, 2007; Ranjbar et al., 2023; Sutan et al, 2014; Wilcox, 2001). Globally, low birth weight is responsible for 60-80% of neonatal deaths (Arsyi et al., 2022; Olusanya & Ofovwe, 2010). In comparison to babies who are born at a

normal birth weight, babies who are born with low birth weight are 20 times more likely to pass away within their first year of life (Chhea et al., 2018; Wilcox, 2001). Of the babies who survive, they are at greater risk for stunted growth and developmental delays (Arsyi et al., 2022). LBW is also associated with adverse health outcomes in adulthood including but not limited to asthma, breast and testicular cancer, cardiovascular disease, depression, diabetes, high blood pressure, hypertension, obesity, osteoporosis, schizophrenia, and stroke (Arsyi et al., 2022; Chhea et al., 2018; Diabelková et al., 2022; Negrato & Gomes, 2013; Sutan et al, 2014). Therefore, low birth weight is linked to multiple detrimental health conditions in both childhood and adulthood (Martinson & Choi, 2019). Given this, it is important to mitigate ongoing adverse perinatal health outcomes through health interventions and by learning about the various risk factors that may increase the likelihood of delivering a low-birth-weight baby.

Risk Factors for Low Birth Weight

Risk factors closely linked to low birth weight globally include maternal age, mother's level of educational attainment, household wealth, body mass index, and marital status (Chhea et al., 2018; Diabelková et al., 2022). Younger (under 19) and older mothers (over 35) are more likely to give birth to a baby with low birth weight compared to mothers in their 20's and early 30's (De Bernabé et al., 2004; Sutan et al., 2014). Sutan et al. (2014) believes that mothers who are younger or older may engage in unhealthy eating behaviors which may impact their baby and in turn the baby's health outcome. However, De Bernabé et al. (2004) states that mothers of adolescent age (15-19 years old) are more likely to be unmarried, have low income, and disengage in adequate prenatal care visits, whereas mothers of geriatric age (35 years old and older) are more likely to have pregnancy complications linked to age-related chronic diseases

such as hypertension and diabetes and for these reasons, mothers who are younger or older may be at greater risk for delivering a low birth weight baby.

Mothers with a lower educational attainment are more likely to deliver a baby with an adverse health outcome compared to mothers who have a higher level of educational attainment (Begum et al., 2017; De Bernabé et al, 2004; Merklinger-Gruchala & Kapiszewska, 2023). Therefore, the inverse relationship reveals that maternal education is linked to adverse perinatal birth outcomes, and that higher maternal education level is a protective factor for poor birth outcomes. Given that low-socioeconomic status is also linked to increased risk of low birth weight (De Bernabé et al., 2004), level of educational attainment is also associated with socioeconomic status. Stevenson et al. (2000) found that baby males were at greater risk of infant mortality and adverse birth outcomes compared to female babies. Loreto et al. (2019) utilized data mining to predict low birth weight and one of their variables of interest included baby's sex. Therefore, sex of the baby may be a possible risk factor for determining low birth weight.

Protective factors associated with low birth weight include engagement in prenatal care visits and an adequate nutritional diet (De Bernabé et al., 2004; Khan et al., 2016). However, frequent testing while pregnant may lead to increased anxiety levels and result in a greater risk of adverse birth outcomes like low birth weight (Begum et al., 2017; De Bernabé et al., 2004). Therefore, it is important to maintain mental and emotional well-being during pregnancy to ensure a more positive birth outcome.

Low Birth Weight in Cambodia

Compared to East Asia and the Pacific, the prevalence of low birth weight is higher in Cambodia (Chhea et al., 2018). In 2000, the percentage of live births with low birth weight in Cambodia was 11% and as of 2010, the low-birth-weight rate decreased to about 8% (Chhea et

al., 2018). This is still higher than the average rate in East Asia and the Pacific (6%) (Chhea et al., 2018). More specifically, the low-birth-weight rates for China, Japan, and Korea are 1.90, 5.36%, and 3.39% (Okui et al., 2023). According to the World Health Organization, infant deaths linked to low birth weight accounted for approximately 3% of mortality in Cambodia (Chhea et al., 2018). Furthermore, in Cambodia, approximately 50% of children under 5 mortality is linked to infant deaths (Suzuki et al., 2021). Overall, low birth weight remains a critical public health concern in Cambodia (Chhea et al., 2018).

Low birth weight is determined in part by genetics (40%) and in part by environmental factors (60%) (De Bernabé et al., 2004). Due to environmental conditions, over 70% of low-birth-weight babies are small (Khan et al., 2016). Therefore, Cambodian mothers who were exposed to the genocide in early childhood or who grew up in unhealthy surroundings post-genocide may be at greater risk for delivering a baby with a detrimental perinatal health outcome. Moreover, compared to Cambodian mothers who lived in urban areas, Cambodian mothers who lived in rural areas were at greater risk of giving birth to a low birth baby (Chhea et al., 2018). Since the genocide, infant mortality rates remain high, particularly higher in rural areas than urban areas due to lack of financial investments with the healthcare system, inadequate quality for prenatal and post-natal care, and scarcity of trained birth attendants (Jimenez-Soto et al., 2014). In short, rural areas have had little economic growth and poverty remains most persistent (Cantor-Graae et al., 2014) which in turn negatively impacts the investment of resources and services, particularly in health. During the genocide, the Khmer Rouge occupation was most prevalent in the rural areas of Cambodia; therefore, the trauma derived from the Cambodian genocide is most evident in rural areas of Cambodia (Cantor-Graae et al., 2014). Thus, the type of place of residence is a potential risk factor for low birth weight.

In addition to inadequate maternal nutritional intake prior to and during pregnancy, low maternal educational attainment level, young maternal age, and adverse genetic makeup are linked to low birth weight in Cambodia (Bekele, 2022). During the genocide and even after the downfall of the genocide, malnutrition remained a persistent health concern (Heuveline, 2001). Consequently, survivors of the genocide and those born shortly after may have experienced inadequate nutritional intake which impacted both their own health and that of their child's.

Given the high infant and child mortality rates in developing countries that have experienced war and genocide, Hong et al. (2007) utilized the 2000 Cambodia Demographic and Health Survey data to examine the relationship between economic disparity and infant mortality. Findings revealed that male babies were more likely to pass away from infant mortality compared to female babies (Hong et al., 2007). Therefore, in this study, sex of the baby was one of the covariates included to predict low birth weight.

Conceptual Framework

Culhane & Elo (2005) developed a conceptual framework for adverse birth outcomes. The framework illustrates the interplay of contributing factors such as neighborhood context (social environment, service environment, physical characteristics), individual socioeconomic and demographic characteristics, individual characteristics (psychosocial factors, social support, health behaviors) and maternal stress (acute or chronic) in influencing poor birth health outcomes including infant mortality, preterm births, and low birth weight (Culhane & Elo, 2005). Olusanya & Ofovwe (2010) adapted this conceptual framework as the theoretical underpinning for predicting low birth weight among women giving birth in an inner-city hospital in Sub-Saharan Africa (see Figure 3.1).

The framework depicts the relationships between potential risk factors such as neighborhood context (residential accommodation, housing sanitation), demographic/socio-economic factors (age, marital status, parity, ethnicity, religion, education, occupation, social class), maternal obstetric characteristics (antenatal care, herbal drug use in pregnancy, previous cesarian section, prolonged or obstructed labor, induced labor, mode of delivery, maternal disease, infections, illness, malnutrition, stress), infant characteristics (sex, congenital defects, fetal growth restriction, fetal distress, cord accidents) and adverse perinatal health outcomes (preterm birth, low birthweight, and stillbirth) (Olusanya & Ofovwe, 2010).

For this study, a similar framework will be utilized to examine the potential risk factors for low birth weight among mothers in Cambodia, accounting for their age and controlling for other variables available in the Cambodia Demographic and Health Surveys (DHS) including sex of the baby, maternal education level, prenatal care visits, and type of place of residence. Age is a proxy for exposure to the genocide as a child, at birth, or after the genocide has ended.

Research Contribution

Given high maternal and child health mortality rates in Cambodia, some studies have utilized DHS data to examine risk factors for adverse maternal and child health outcomes in recent years. For example, Zhou et al. (2020) utilized 2000 and 2014 DHS data to analyze the progress of maternal healthcare services since 2000. Um & Sopheab (2021) utilized 2014 DHS data to analyze potential risk factors that may be attributed to the mortality of children under 5 years of age in Cambodia. Ikeda et al. (2013) utilized Cambodia 2000, 2005, and 2014 DHS data to explore potential factors associated with stunted growth among 5-year-old children and to examine the reduction of child stunting over time. Miyazaki et al. (2023) utilized the 2014 DHS data to examine the relationship between complementary feeding practices and linear growth faltering among

Cambodian children aged 6-23 months. Linear growth faltering is a synonym for stunted growth, which is a common health outcome among low-income and middle-income countries (Roth et al., 2017). Consequently, Miyazaki et al. (2023) suggest that maternal and child health must be improved in Cambodia to yield better health outcomes for both the mother and the child.

Um et al. (2022) utilized 2000, 2005, 2014 DHS data to analyze anemia among pregnant women. Chhea et al. (2018) utilized 2010 and 2014 DHS data to analyze the prevalence of low birth weight across different Cambodian provinces. Although Um et al. (2024) utilized a similar approach to Chhea et al. (2018), they utilized more recent 2021-2022 DHS data to explore factors associated with low birth weight.

Although there are a number of maternal and child health research studies conducted on the Cambodian population utilizing various survey waves from the Demographic and Health Surveys database, there has not yet been a study that examines the relationship between genocide exposure during early childhood and the perinatal health of the subsequent generation. Therefore, this study is unique in utilizing Cambodia Demographic and Health Surveys from 2000, 2005, and 2010 to examine risk factors associated with low birth weight and small birth size among infants born to mothers before, during, and after the Cambodian genocide. Mother's age is a proxy for exposure to the genocide during early childhood. Again, although various survey waves from the Cambodia DHS data have been utilized to explore maternal and child health and health outcomes, there has not yet been a study that considers intergenerational impacts from the genocide in this way, particular whether a mother being born before, during, or after the genocide may be a predictive factor in delivering a baby with low birth weight or small for birth size. As a result, this study is innovative and may serve as a basis for other research studies to replicate either for other countries that have experienced genocide.

Research Question and Hypothesis

Research Question 1. Is maternal early life exposure to the Cambodian genocide associated with adverse birth outcomes during women's reproductive years?

> **Hypothesis 1.** If a Cambodian woman was exposed to the Cambodian genocide in early childhood, then she may be more likely to experience adverse birth outcomes during her reproductive years than a woman who did not have such exposure.

Methodology and Data

Study Design

The study uses a quantitative retrospective cohort design conducted through secondary analysis of data from three waves of the Cambodia DHS. The analysis compares low birth weight and small birth size outcomes between mothers who were exposed to the Cambodian genocide during early childhood and mothers who were not exposed to the Cambodian genocide during early childhood. In the first set of analyses, the study compares the same age group (ages 21-25) across different survey years (2000, 2005 and 2010) while controlling for the following covariates: sex of the baby (male, female), mother's level of educational attainment (none, primary, secondary or higher), engagement in prenatal care visits (no, yes), and type of residence (rural, urban). Here, survey year proxies for early childhood genocide exposure. In subsequent analyses for low birth weight and small birth size, in each survey wave, the study compares mothers who were born in different years (before, during, and after the genocide) while controlling for the aforementioned factors. The expectation across all analyses is that mothers who experienced the genocide during early childhood were more likely to deliver a baby that is considered low birth weight or small for birth size.

Dataset: Cambodia Demographic and Health Surveys

The Cambodia Demographic and Health Surveys (DHS) is a nationally representative

survey consisting of face-to-face interviews with women of reproductive age (primarily ages 15-49), face-to-face interviews with a sub-sample of men (ages 15-49), and household surveys capturing data on all household members. Data was retrieved from the individual and household surveys of the 2000, 2005, and 2010 Cambodia DHS. Thus, cross-sectional data for this analysis focuses on 2000, 2005, and 2010 survey years, as they are some of the earliest DHS data on Cambodia. The three years (2000, 2005, and 2010) were selected because they were the years when those exposed to the genocide would have been of the average ages for fertility in Cambodia. Later years were beyond the typical reproductive window. Therefore, although 2014 and 2021-2022 DHS data were available, they were not utilized for the purpose of this study.

The adverse birth health outcome, low birth weight, was analyzed through female respondents to learn about the risk factors associated with low birth weight. The analysis for low birth weight included Cambodian women aged 15-49 who had a singleton birth (N=31, 984). All survey respondents were residing in Cambodia at the time of survey.

Methodology

Data were derived from the DHS individual and household surveys from the following survey years: 2000, 2005, and 2010. The analytic sample was comprised of women ages 15-49 who had a singleton birth in the last five years. Depending on the survey year and the comparisons being made, the sample size differed ranging from 908 to 6,161 across the multivariate models. For this study, StataMP 18 (64-bit) was utilized to conduct all analyses. Logistic regression models were created to analyze the relationship between risk factors for adverse birth outcomes (low birth weight and small birth size) and childhood exposure to the genocide by using age and survey year as proxies. Statistical significance was at p-value < 0.05

Measures

The Cambodia 2000, 2005, and 2010 Demographic and Health Surveys dataset contain individual-level information for the mother (age, educational attainment, engagement in prenatal care visits, type of residence) and the newborn (sex at birth, low birth weight, small birth size). Although household-level information is also available, individuals are the unit of analysis for this study. Women were only asked detailed information about births in the last five years. However, for the purposes of this study, the focus is on the most recent birth reported.

The dependent variables are low birth weight and small birth size. For this study, both variables were recoded into a binary variable (yes, no). Small birth size serves as an alternate subjective measure of low birth weight because not all mothers knew their baby's birth weight.

There are two main independent variables of interest depending on the model: survey year and age. In the first multivariate model, survey year is the main independent variable. In the other three models, within survey year comparisons were conducted with age group as the independent variable. These variables were utilized as proxies for childhood exposure to the genocide, distinguishing mothers who were born prior to, during, and after the genocide. The covariates consistent across all four models include sex of the baby (male, female), mother's educational attainment level (none, primary, secondary or higher), prenatal care visits (no, yes) and residence (rural, urban).

Dependent Variable: Low Birth Weight

Low birth weight was measured with a question inquiring, "How much did (name) weigh?" For the 2000 survey, the response options include filling in the blank in grams from the health card (coded as 1), filling in the blank in grams from recall (coded as 2) and "don't know" which is coded as 99998. The "don't know" responses were excluded. For the 2005 and the 2010

survey, the response options were similar to the 2000 survey except the weight was recorded in kilograms. In this study, after appending the three survey years, low birth weight was determined by recategorizing the values in which any baby weighing more than 2,500 grams were the reference group and coded as 0. Babies who weighed less than 2,500 grams were coded as 1 meaning that they were considered low birth weight.

Dependent Variable: Small Birth Size

Given that many Cambodian mothers did not know their baby's exact birth weight (see results below), I also report results from a more subjective measure of birth size. Across all surveys, information to determine if a baby was considered small at birth included a question asking, "When (name) was born, was he/she: very large, larger than average, smaller than average, or very small?" The response options include very large (1), larger than average (2), average (3), smaller than average (4), very small (5), and don't know (8). For this study, the responses were recoded into a binary variable: small (combined smaller than average and very small) and not small (included very large, larger than average, average). The small number of cases with "don't know" responses were excluded. Thus, babies who were not born small were the reference group and coded as 0, whereas babies who were considered being born small during birth were coded as 1.

Age, Sex of Baby, Educational Attainment, Prenatal Care Visits, Type of Residence

Across all surveys, age was determined by a question asking, "In what month and year were you born?" For the first model, age group was limited to 21–25-year-old mothers across the three survey years to reflect mothers who were born during and after the genocide. According to the Cambodia DHS reports, the median age at first birth was 23.1 in 2000, 22 in 2005, and 22.3 in 2010. Therefore, the age group 21-25 years of age was selected to reflect this. The reference

group for the survey years is 2000, which is representative of mothers who were born during the genocide. In subsequent models, although the particular age groups compared differed across survey years, they are reflective of birth before, during, and after the genocide. For instance, for the model utilizing 2000 data, the age groups are as follows: 20 & under (born after the genocide), 21-25 (born during the genocide), and 26 & over (born before the genocide). The model utilizing 2005 data contains the following age groups: 25 & under (born after the genocide), 26-30 (born during the genocide), and 31 & over (born before the genocide). The model utilizing 2010 data includes three age groups: 30 & under (born after the genocide), 31-35 (born during the genocide), and 36 & over (born before the genocide). Across the within-survey analyses, the reference groups are mothers who were born during the genocide. Across all analyses, the reference groups are coded as 1 and following groups are subsequently coded in numerical order (2 and 3, respectively).

All three surveys were consistent in gathering information on the baby's sex at birth. The question was, "Is (name) a boy or girl?" The options for the survey responses include "Boy 1" and "Girl 2." For the purposes of this study, the sex of the baby was categorized as "male" and "female." Babies who were born male at birth were reference group and coded as 0, whereas their female counterparts were coded as 1.

Maternal educational attainment was measured by asking, "What is the highest level of school you attended?" and "What is the highest grade you completed at that level?" The coded responses in the datasets include "none (0)," "primary (1)," "secondary (2)," and "higher (3)." Therefore, mother's educational attainment level was recategorized as "none," "primary," and "secondary or higher." Mothers who did not have any education were reference group and coded

as 0. Mothers who completed primary school were coded as 1, and mothers who obtained a secondary education or higher were coded as 2.

Across all survey years, prenatal care visits were determined by asking, "How many times did you receive antenatal care during this pregnancy?" The response options include a fill in the blank for "number of times" and "don't know" which was coded as 98. The small number of cases responding "don't know" were excluded. Prenatal care visits were categorized as "no" and "yes." Mothers who did not engage in prenatal care visits were the reference group and coded as 0. Mothers who engaged in at least one prenatal care visit were coded as 1.

For the 2000 survey, type of residence was measured by filling in the blank, "Urban/Rural (Urban=1, Rural=2)." For the 2005 and 2010 survey, the dataset also coded the responses the same as the 2000 survey. In this study, the type of place of residence was categorized as "rural" and "urban." Mothers who lived in a rural area were the reference group and coded as 0. Mothers who lived in an urban area were coded as 1.

Weighted Logistic Regression Models

Multivariable logistic regression was utilized to analyze the risk factors of low birth weight among Cambodian women (ages 15-49) in relation to early childhood exposure to the genocide. Sampling weights provided by the DHS were utilized to adjust for the sample design and survey non-response.

Weighted logistic regression models were used because the dependent variables (low birth weight and small birth size) were operationalized categorically. Depending on the model, age or survey year were the main independent variables. Control variables across all logistic regression analyses include baby's sex, mother's educational attainment, engagement in prenatal care visits, and type of residence.

Results

Weighted Univariate Descriptive Statistics for Mothers in Cambodia

Table 3.1 contains the weighted univariate descriptive statistics for mothers and their babies in Cambodia. In utilizing the 2000, 2005, and 2010 Cambodia DHS data and upon restricting the sample size to mothers who had singleton births, the sample size was N=31,984. Of mothers who reported at least one singleton birth in the last five years, 7.62% (N=591) reported that their most recent birth was under the threshold for low birth weight, whereas 92.38% reported otherwise. Prior to excluding the "not weighted/don't know" responses, the breakdown included a prevalence of 3.13% low birth weight births, 42.69% of non-low birth weight births, and 53.99% of unweighted births or not knowing the baby's birth weight at birth. The prevalence of small birth size was 12.91% (N=2,262), and 1.79% responded "don't know" for birth size.

Table 3.1 also provides the percentage distribution for mothers surveyed for each survey year (2000, 2005, 2010), sex of the baby (male, female), age group of the mothers (20 and under, 21-25, 26-30, 31-35, 36 and over), maternal education attainment level (none, primary, secondary or higher), engagement in prenatal care visits (yes, no), and type of residence (rural, urban). There were slightly more babies born male than female, 50.48% and 49.52% respectively. 82% of mothers did not obtain a secondary education or higher. Nearly one-third of the mothers did not engage in any prenatal care visits (30.57%). A large proportion of mothers lived in a rural area (83.71%).

Weighted Bivariate Descriptive Statistics for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2000, 2005, 2010)

Table 3.2 illustrates the weighted bivariate descriptive statistics for low birth weight and small birth size among Cambodian mothers in Cambodia from the 2000, 2005, and 2010

Cambodia DHS data. In comparing the three survey years, the prevalence of low birth weight appears to increase over time, whereas the prevalence of small birth size appears to decrease over time. Among both perinatal health outcomes, there was a smaller reporting of male babies being born low birth weight and small birth size compared to their female counterparts. Across all age groups, mothers who were of geriatric age (36 and over) had the highest recorded prevalence of delivering a baby low birth weight (8%) and second highest recorded prevalence of small birth size (14.07%) compared to their younger mothers. In comparison to their counterparts, the prevalence of low birth weight and small birth size were lower among mothers who had a secondary education or higher, mother who engaged with prenatal care visits, and mothers who lived in an urban area.

Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers Ages 21-25 in Cambodia (2000, 2005, 2010)

Table 3.3 depicts two weighted logistic regression models: 1) low birth weight and 2) small birth size. The weighted logistic regression models compare mothers aged 21-25 years old across the survey years (2000, 2005, and 2010) to learn about any potential influences on low birth weight and small birth size while controlling for the following covariates: sex of the baby, mother's level of educational attainment, engagement in prenatal care visits, and type of residential area. Mothers who were 21-25 years of age in the year 2000 were born during the time of the Cambodian genocide (1975-1979), whereas mothers who were 21-25 years of age in the year 2005 were born shortly after the Cambodian genocide, and mothers who were 21-25 years old in 2010 were born well after the Cambodian genocide. Across the survey years, there was no evidence of statistically significant differences in low birthweight or birth size between mothers aged 21-25.

Low Birth Weight

Among mothers who were 21-25 years of age, female babies were 33% more likely than male babies to be born low birth weight. Mothers who had higher education or lived in an urban area were less likely to have a low-birth-weight baby compared to mothers with a lower educational level or who lived in a rural area. Mothers who engaged in prenatal care visits were 49.6% less likely to deliver a low-birth-weight baby compared to their counterparts who did not engage in prenatal care visits. This reveals that no exposure to the genocide during early childhood, baby's sex at birth, maternal education level, and type of residence were not significant factors in determining low birth weight. However, engagement of at least one prenatal care visit during pregnancy was a significant factor in determining low birth weight.

Small for Birth Size

However, the two significant factors in determining small birth size are prenatal care visits (yes or no) and the type of area in which the mother lives (rural or urban residence). Mothers who engaged in at least one prenatal care visit during pregnancy were 26.5% less likely to give birth to a baby small for birth. Mothers who lived in an urban province were 32.4% less likely to deliver a baby small for birth size. Therefore, prenatal care and rurality are important factors that may be attributed to delivering an infant small for birth size.

Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2000)

Table 3.4 shows the weighted logistic regression model for low birth weight and small birth size among Cambodian mothers in Cambodia from the 2000 Cambodia DHS data. Within survey comparisons were made with age groups as the independent variable and a proxy for exposure to the genocide. The weighted logistic regression model for low birth weight reveals no

significant differences by age. Engagement in prenatal care visits during pregnancy and type of residence were significant factors in determining low birth weight. In comparison to mothers who did not engage in prenatal care visits, mothers who engaged in prenatal care visits were 55.3% less likely to give birth to a baby considered low birth weight. Mothers who live in an urban area in Cambodia were 55.2% less likely to have a low-birth-weight baby compared to mothers who lived in a rural area.

The weighted logistic regression model for small birth size also shows no significant differences by age, although sex of the baby (female), engagement in at least one prenatal care visits during pregnancy (yes), and type of residence (urban) were all significant factors in predicting a baby born small for birth size. Female babies were 21.8% more likely to be born small compared to their male counterparts. Mothers who engaged in at least one prenatal care visit during pregnancy were 20.3% less likely to deliver a baby small for birth size compared to their counterparts who did not engage in prenatal care visits. Mothers who lived in an urban area were 36.3% less likely to deliver a baby small for birth size compared to their counterparts who lived in a rural area.

Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2005)

Table 3.5 demonstrates the weighted logistic regression model for low birth weight and small birth size among Cambodian mothers in Cambodia from the 2005 Cambodia DHS data. As with the 2000 wave, within survey comparisons were made with age groups as the independent variable and a proxy for exposure to the genocide. The weighted logistic regression model for low birth weight reveals no significant differences by age group, but baby's sex at birth (female), maternal education level (primary), and prenatal care visits (yes) were all significant factors in

predicting low birth weight. Similarly, the results for the weighted logistic regression model also reveal that the following factors were significant in determining that a baby is born small birth size: baby's sex at birth (female), maternal education level (primary and secondary or higher), and prenatal care visits (yes).

Compared to male babies, female babies were slightly more likely to be born low birth weight (1.6 times) or small birth size (1.2 times). Compared to mothers who did not obtain any education, mothers with a primary education were almost twice as likely to deliver a low-birth-weight baby. However, mothers with a primary or secondary or higher education were less likely to deliver a baby small for birth size, 23.3% and 55.1% respectively. Compared to mothers who did not engage in prenatal care visits, mothers who engaged in prenatal care visits were 38% less likely to give birth to a low-birth-weight baby and 34.8% less likely to give birth to a baby that is considered small at birth.

Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2010)

Table 3.6 illustrates the weighted logistic regression model for low birth weight and small birth size among Cambodian mothers in Cambodia from the 2010 Cambodia DHS data. Within survey comparisons were made with age groups as the independent variable and a proxy for exposure to the genocide. The weighted logistic regression model for low birth weight reveals that mothers who born prior to the genocide were 1.5 times more likely to give birth to a low-birth-weight baby compared to mothers born during the genocide. Mothers who lived in an urban area were 36% less likely to give birth to a low-birth-weight baby compared to mothers who lived in rural areas. In this specific model, maternal age and type of residence were the only two significant factors that predict low birth weight.

The weighted logistic regression model for small birth size reveals that the following factors are significant in predicting that a baby is born small birth size: sex of the baby at birth (female), maternal education level (primary and secondary or higher), prenatal care visits (yes), and type of residence (urban). Compared to male babies, female babies were 1.2 times more likely to be born small for birth size. Compared to mothers who did not obtain any education, mothers with a primary education or a secondary education or higher were less likely to deliver a baby small for birth size, 24.3% and 34.5%, respectively. Compared to their counterparts, mothers who engaged in prenatal care visits were 32.8% less likely to give birth to a baby that is considered small at birth. In comparison to mothers who lived in rural areas, mothers who lived in urban areas were 24.5% less likely to deliver a baby that is considered small at birth.

Discussion

The purpose of this study was to analyze to what extent exposure to the genocide during birth might predict adverse perinatal health outcomes such as low birth weight and small birth size. I hypothesized that mothers born in Cambodia who were either born before or during the genocide would be more likely to deliver a low-birth-weight baby or a baby who is considered small at birth. However, only the findings from 2010 aligned with the hypothesis. More specifically, the oldest age group who were born during or before the genocide were more likely to deliver a baby with low birth weight compared to their counterparts who were born after the genocide. These health implications may reveal some intergenerational impacts of the genocide on adverse health outcomes among the Cambodian community. In other words, an individual exposed to genocide during early childhood may be more likely to deliver an infant with an adverse perinatal outcome compared to their counterparts who were not exposed to the genocide. This notion may suggest that infants who did not directly experience the genocide may still be indirectly impacted in terms of their health and wellbeing. However, this was not supported in

most of the results. This can be further explored in future studies upon having more variables/ risk factors available that may predict increased risk of adverse perinatal birth outcomes such as income and maternal health habits (like smoking during pregnancy).

Compared to mothers born during the genocide, the results from the 2010 survey revealed that mothers born after the genocide were slightly less likely to give birth to a low-birth-weight baby and mothers who were born before the genocide were more likely to deliver a low-birth-weight baby. However, mothers who were born before or after the genocide were 1.2 and 1.3 times more likely to give birth to a small birth size baby compared to mothers who were born during the genocide.

Low Birth Weight

The results for low birth weight reveals that across survey years while controlling for baby's sex, mother's education level, prenatal care visits, and type of residence had greater odds of delivering a low-birth-weight baby compared to mothers who were born during the genocide. This finding illustrates that the health impacts from exposure to genocide negatively affects the health of subsequent generations, and that there may be alternative explanations such as increased fetal loss among mothers with early childhood exposure to the genocide and survival bias. Future research should continue to examine the potential risk factors of adverse infant health outcomes among Cambodian mothers, so that findings from such studies can inform health policies, programs, and resources to prevent or mitigate increased poor perinatal health conditions among such a vulnerable population.

The results from within survey waves slightly differed. When controlling for sex of the baby at birth, maternal educational attainment, prenatal care visits, and type of place of residence, the results from the models utilizing the 2000 data set reveal that although mothers

who were born before the genocide had lower odds of having a low-birth-weight baby and mothers who were born after the genocide had higher odds of having a low-birth-weight baby compared to mothers who were born during the genocide, these age groups were not significant predictors for adverse health outcomes. Compared to mothers who were born during the genocide, although mothers who were born before the genocide were at a slightly higher risk of delivering a baby small for birth size and mothers who were born after the genocide were at a slightly lower risk of delivering a baby small for birth size, maternal age was not a significant risk factor for determining small birth size. However, these findings may reinforce the notion of intergenerational impacts from the genocide.

While controlling for baby's sex, mother's education level, prenatal care visits, and type of residence and compared to mothers who were born during the genocide, the results from the models utilizing the 2005 data set reveal that mothers who were born after the genocide were slightly more likely to deliver a low-birth weight baby or a baby small for birth size. On the contrary, mothers who were born prior to the genocide were slightly less likely to deliver a low-birth weight baby or a baby small for birth size compared to mothers who were born during the genocide. Although the results were not significant, these findings show exposure to the genocide during early childhood may not severely affect subsequent generations as much as mothers who were born during or after the time of the genocide as they were more likely to deliver a baby with an adverse health outcome (low birth weight or small birth size). Health education and other forms of health interventions may be implemented to inform Cambodian mothers and families on how to take care of their health as a way to increase the likelihood of delivering a healthier baby. This suggestion is also supported by Yanagisawa et al. (2015) as the findings from the authors' study revealed the benefits of providing maternal and child health

handbooks to mothers in Cambodia as prenatal and postnatal care knowledge improved. This suggests a positive association between infant health outcomes and mothers' knowledge on how to take care of themselves and their children. In Cambodia, maternal and child health handbooks served as an effective educational health tool for expecting/new mothers given the improved interactions between the mothers and healthcare professionals, increased awareness of childhood immunizations and illnesses, and provided illustrations to convey certain health information for mothers who may not have a high education to follow and enhance quality of life for themselves along with their children (Yanagisawa et al., 2015). Therefore, given that these handbooks were inexpensive to manufacture (Yanagisawa et al., 2015), the Cambodian government should continue to provide such informational resources for free to improve maternal and child health as the negative impacts of such perinatal health outcomes are detrimental. In comparison to mothers who lived in urban areas, mothers who lived in rural areas were more likely to encounter barriers (cognitive, financial, physical, sociocultural) which affect accessibility to adequate health access and prenatal care services and thereby contributes to poor maternal and child health (Pierce, 2019). Given the disadvantages that mothers in rural areas are more likely to encounter, the government in Cambodia should continue investing in maternal and child health through implementation of government level support for health care professionals to provide no-cost healthcare and prenatal care services to poor and expecting mothers, quality midwife training in health facilities, and monetary incentives for mothers to deliver their babies in hospitals (Pierce, 2019). These recommendations may help promote the mitigation of poor health outcomes in Cambodia while improving maternal and child health outcomes throughout the country.

In controlling sex of the baby at birth, mother's educational attainment level, prenatal care visits, and type of residence, the results from the model utilizing the 2010 data set reveal

that mothers who were born before the genocide were at greater odds for having a low-birth-weight baby or a baby small in birth size compared to mothers who were born during the genocide, even though the results were not significant. On the other hand, significant results revealed that mothers who were born after the genocide were less likely to deliver a low-birth-weight baby and slightly more likely to deliver a baby small for birth size compared to their counterparts who were born during the genocide. This finding affirms the intergenerational health impacts deriving from the genocide and affecting the health of subsequent generations who did not directly experience the genocide. Future research should attempt to study the health impacts of the genocide and its link to the health outcomes of following generations who had no exposure to the Cambodian genocide. Depending on the findings, the results may affirm the long-term intergenerational impacts of the genocide on subsequent generations.

Limitations

This study is not without limitations. Given that not all mothers knew their newborn's birth weight at birth, small birth size served as an alternative birth outcome for low birth weight. Additionally, the surveys did not collect information on the mental health conditions of mothers. This would be an important risk factor in determining adverse perinatal health outcomes such as low birth weight; mothers who have been abused (sexually, physically, or emotionally) during pregnancy were at greater risk of delivering a low-birth-weight baby (De Bernabé et al., 2004). Therefore, any amount of stressful or traumatic experiences may contribute to the poor health outcome of the infant at birth.

Given that the data was collected through self-reported surveys, this format may result in some bias. There is some possibility for the information being collected to be falsified or exaggerated to a certain extent. For instance, sometimes Cambodian individuals will add a year

to their age. If an individual did this, the information collected would not truly reflect which birth cohort they are part of (born before, during, or after the genocide). Another potential self-reporting bias may include reporting the mother's highest educational attainment level.

The surveys did not provide information on maternal health behaviors such as whether the expecting mother was smoking or engaging with alcoholic beverages. These health behaviors are known to be strongly associated with negative birth outcomes (Sheehan, 1998). Although marital status was a predictive factor of low birth weight (Mohd Zain et al., 2015), it was not included as a covariate in this study due to collinearity.

Another potential limitation to the study is survival bias in relation to analyzing the long-term and generational health impacts of the Cambodian genocide on its population (Milazzo & Cuesta, 2021). In this study, the results from the surveys only capture information from survivors of the genocide or individuals born after the genocide ended. Individuals who passed away either during or from the genocide are excluded from the dataset and therefore, information on their health was not collected as they have encountered adverse health conditions. In short, there is a possibility that survivor bias also impacts birth outcomes.

The surveys lacked detailed health measures on chronic illnesses and poor mental health conditions such as diabetes, heart diseases, depression, anxiety, trauma, and substance abuse. Berthold et al. (2014) found that Cambodian individuals who experienced the genocide also experienced some mental health issues such as depression, anxiety, and post-traumatic stress disorder. Such detrimental health outcomes like abuse (sexual, mental, emotional), hypertension, diabetes, autoimmune diseases like lupus are linked to increased risk of adverse perinatal health conditions like low birth weight (De Bernabé et al., 2004). Therefore, collecting information on mental health conditions would allow for further analysis on poor birth outcomes in relation to

the effects of childhood exposure from the Cambodian genocide. In other words, mental health conditions experienced by the mother could potentially be a valuable risk factor in predicting low birth weight or small birth size.

Implications

One of the hopes of this study is that it may serve as a basis for researchers to examine the potential risk factors for low birth weight and other poor infant health outcomes among mothers who have experienced genocide or war or were born shortly after. The Demographic and Health Survey data collected information on such countries like Vietnam and Rwanda. Therefore, researchers can replicate this study utilizing DHS data from other war-torn countries to explore any birth disparities.

The findings from this study may highlight the importance of preventing Cambodian mothers from having low-birth-weight babies and or addressing adverse perinatal health outcomes as they occur among the Cambodian community. Health screenings and other preventative measures may contribute to having healthy babies. This is important as adverse infant health outcomes may lead to detrimental infant mortality, infant-related illnesses, and adult diseases.

This study may serve as a foundation for exploring generational health implications stemming from genocide. In other words, future studies may continue to investigate risk factors that may increase the odds of genocide-associated health consequences on adverse infant birth outcomes. Thus, to fully understand the effects of the genocide on perinatal health outcomes, it would be beneficial to include or collect more information on maternal health outcomes, behaviors, and characteristics that may be attributed to intergenerational health outcomes.

If possible and upon availability based on the dataset, future research should include covariates such as smoking status and drinking behaviors during pregnancy as well as maternal marital status as they are linked to adverse birth health outcomes such as low birth weight (Mohd Zain et al., 2015; Sheehan, 1998). Compared to mothers who were married and pregnant, mothers who were unmarried and pregnant were more likely to deliver a low-birth-weight baby (Mohd Zain et al., 2015). Mohd Zain et al. (2015) finds this to be particularly true among mothers in underdeveloped countries given the stress-induced circumstances they may encounter: job instability, forced marriage, and adverse mental health conditions.

Given that many of the Cambodian genocide survivors sought refuge in countries such as Australia, France and the U.S. (Chan, 2004), future research could replicate these analyses for Cambodians refugees or immigrants in these countries if data is available. The findings from these potential studies may allow for Cambodian birth health outcome comparisons between different countries in which Cambodian individuals have migrated.

Lastly, this study may be replicated with more recent data as it becomes available. Conducting similar analyses with new sets (or more sets) of Cambodia DHS survey waves would provide the opportunity to further explore the potential generational health impacts from childhood exposure to the genocide. If newer sets of survey data provide measures on mental health conditions or chronic diseases, they could be possible covariates to include in the models to predict low birth weight and small birth size.

Conclusion

The purpose of this study was to examine risk factors for low birth weight among Cambodian mothers by age group (those born before or during the genocide and those born after the genocide). In comparing the same age group (21-25) across survey years, Although the results did not reveal that Cambodian mothers who were born after the genocide were more

likely to deliver a baby with low birth weight compared to their counterparts who were born during the genocide, the 2010 results revealed that mothers who were born during or before the genocide had greater odds of delivering a low birth weight baby compared to their counterparts who were born after the genocide. This reveals that direct exposure to the Cambodian genocide at birth may be attributed to increased risk of delivering a baby with an adverse perinatal health outcome. Given this and detrimental infant and adult health conditions linked to low birth weight, health interventions should be carefully implemented to detect and mitigate the rates of low birth weight among Cambodian mothers. Consequently, the overall well-being of the baby's health and life course may be improved.

Figure 3.1. Conceptual Framework for Adverse Birth Outcomes

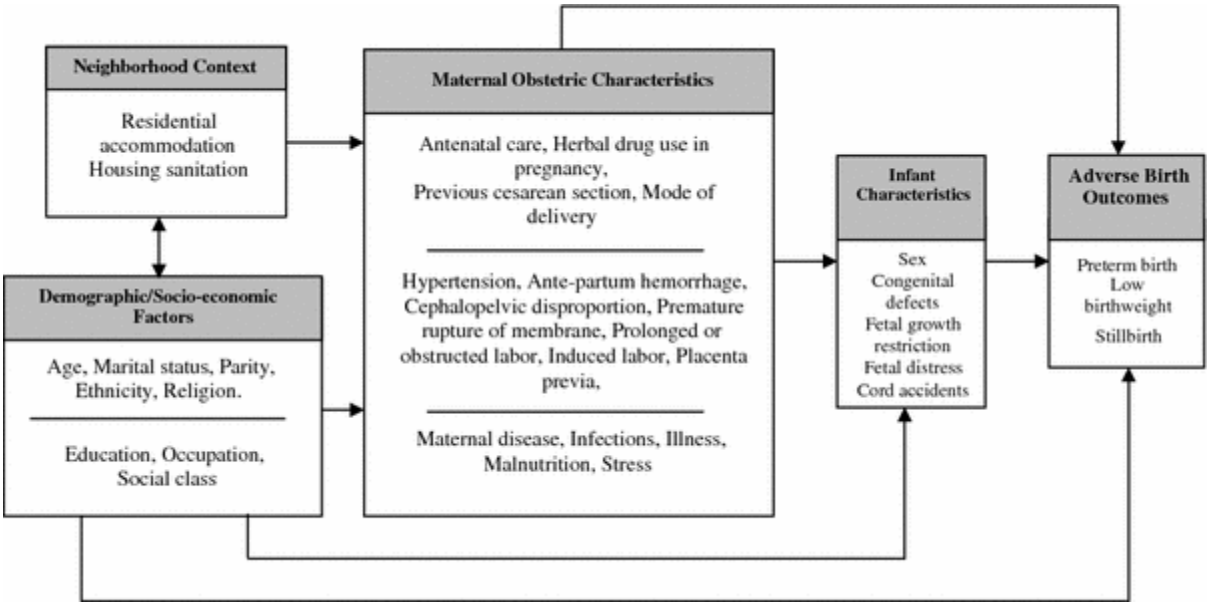

Table 3.1. Weighted Univariate Descriptive Statistics for Mothers in Cambodia

	Total
N	31, 984
Low Birth Weight	7.62%
Small Birth Size	12.91%
Year	
2000	29.95%
2005	32.86%
2010	37.19%
Sex of Baby	
Male	50.48%
Female	49.52%
Age Groups of Mothers	
20 & under	3.52%
21-25	13.76%
26-30	18.41%
31-35	17.12%
36 & over	47.19%
Mother's Education	
None	25.16%
Primary	56.83%
Secondary or higher	18%
Prenatal Care Visit	
No	30.57%
Yes	69.43%
Residence	
Rural	83.71%
Urban	16.29%

Table 3.2. Weighted Bivariate Descriptive Statistics for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2000, 2005, 2010)

	Birth Outcome	
	Low Birth Weight (N=591)	**Small Birth Size** (N=2,262)
N	7.62%	12.91%
Year		
2000	5.64%	13.43%
2005	7.14%	14.17%
2010	7.56%	11.26%
Sex of Baby		
Male	6.67%	11.92%
Female	7.75%	13.93%
Age Groups of Mothers		
20 & under	7.38%	14.85%
21-25	7.82%	12.90%
26-30	6.45%	12.22%
31-35	6.64%	11.82%
36 & over	8%	14.07%
Mother's Education		
None	7.40%	15.82%
Primary	8.20%	13.05%
Secondary or higher	5.38%	9.02%
Prenatal Care Visit		
No	10.37%	16.44%
Yes	6.85%	11.31%
Residence		
Rural	7.78%	13.56%
Urban	5.26%	9.18%

Table 3.3. Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers Ages 21-25 in Cambodia (2000, 2005, 2010)

	Low Birth Weight				Small Birth Size			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Year								
2000	1.00				1.00			
2005	1.351	0.374	0.696	2.621	1.161	0.249	0.901	1.496
2010	1.527	0.201	0.798	2.919	1.100	0.496	0.836	1.447
Sex of Baby								
Male	1.00				1.00			
Female	1.330	0.074	0.973	1.817	1.138	0.166	0.948	1.367
Mother's Education								
None	1.00				1.00			
Primary	0.853	0.537	0.515	1.414	0.845	0.160	0.669	1.068
Secondary or higher	0.803	0.428	0.467	1.381	0.851	0.276	0.635	1.138
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.504	*0.008	0.303	0.837	0.735	*0.010	0.581	0.928
Residence								
Rural	1.00				1.00			
Urban	0.819	0.344	0.542	1.238	0 .676	*0.010	0.502	0.910
Constant	0.118	*0.000	0.052	0.266	0.190	*0.000	0.145	0.249

*p<0.05

Table 3.4. Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2000)

	Low Birth Weight				Small Birth Size			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Age Group of Mother								
21-25	1.00				1.00			
20 & under	1.315	0.584	0.493	3.513	0.969	0.868	0.672	1.398
26 & over	0.840	0.619	0.421	1.674	1.003	0.976	0.811	1.241
Sex of Baby								
Male	1.00				1.00			
Female	1.202	0.511	0.695	2.080	1.218	*0.014	1.041	1.424
Mother's Education								
None	1.00				1.00			
Primary	0.869	0.711	0.412	1.830	1.007	0.936	0.848	1.196
Secondary or higher	0.744	0.497	0.317	1.746	0.814	0.148	0.615	1.076
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.447	*0.007	0.251	0.799	0.797	*0.007	0.675	0.941
Residence								
Rural	1.00				1.00			
Urban	0.448	*0.038	0.209	0.957	0.637	*0.001	0.485	0.838
Constant	0.151	*0.000	0.059	0.389	0.164	*0.000	0.128	0.209

*$p<0.05$

Table 3.5. Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2005)

	Low Birth Weight				Small Birth Size			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Age Group of Mother								
26-30	1.00				1.00			
25 & under	1.146	0.522	0.755	1.738	1.063	0.561	0.864	1.309
31 & over	0.798	0.308	0.518	1.230	0.929	0.470	0.761	1.134
Sex of Baby								
Male	1.00				1.00			
Female	1.577	*0.005	1.147	2.167	1.193	*0.021	1.027	1.385
Mother's Education								
None	1.00				1.00			
Primary	1.916	*0.023	1.094	3.353	0.767	*0.002	0.646	0.911
Secondary or higher	1.338	0.363	0.715	2.502	0.449	*0.000	0.341	0.592
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.620	*0.026	0.408	0.944	0.652	*0.000	0.555	0.767
Residence								
Rural	1.00				1.00			
Urban	1.164	0.417	0.807	1.679	0.821	0.107	0.647	1.043
Constant	0.055	*0.000	0.028	0.109	0.275	*0.000	0.219	0.345

*$p<0.05$

Table 3.6. Weighted Logistic Regression for Low Birth Weight and Small Birth Size among Cambodian Mothers in Cambodia (2010)

	Low Birth Weight				Small Birth Size			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Age Group of Mother								
31-35	1.00				1.00			
30 & under	0.987	0.938	0.717	1.359	1.238	0.080	0.975	1.571
36 & over	1.494	*0.032	1.036	2.153	1.285	0.076	0.974	1.695
Sex of Baby								
Male	1.00				1.00			
Female	1.051	0.655	0.846	1.304	1.192	*0.030	1.017	1.397
Mother's Education								
None	1.00				1.00			
Primary	0.974	0.870	0.713	1.332	0.757	*0.007	0.617	0.928
Secondary or higher	0.706	0.063	0.488	1.019	0.655	*0.001	0.509	0.843
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.766	0.224	0.499	1.177	0.672	*0.001	0.528	0.856
Residence								
Rural	1.00				1.00			
Urban	0.640	*0.007	0.464	0.884	0.755	*0.025	0.590	0.964
Constant	0.115	*0.000	0.068	0.193	0.185	*0.000	0.135	0.253

*p<0.05

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CHAPTER 4: ANALYZING RISK FACTORS FOR SMALL FOR GESTATIONAL AGE AND LOW BIRTH WEIGHT AMONG CAMBODIAN WOMEN IN CALIFORNIA BY NATIVITY STATUS

Asian American Health Disparities

In the United States (U.S.), the Asian American population is one of the fastest growing groups in the country (Bane et al., 2022; Cheng et al., 2015; Dongarwar et al., 2022a; Lee et al., 2016; Salihu et al., 2019; Tran et al., 2024; Yusuf et al., 2021). However, Asian American health continues to be an understudied topic (Tran et al., 2024). Within Asian American health, there is a paucity of research related to preterm births and other birth outcomes among ethnic groups (Dongarwar et al., 2022a). Although Asian American ethnic groups are not homogeneous (Cheng et al., 2015), the Asian American community is usually aggregated as one group despite the numerous ethnicities that make up the Asian American population (Qin & Gould, 2006), and as a result, health disparities within the umbrella category are often masked (Bane et al., 2022; Tran et al., 2024; Yusuf et al., 2021). Consequently, it is important to focus on a specific Asian American population that is an underserved community that continues to encounter severe health disparities such as the Cambodian population (Grigg-Saito et al., 2010; Lee et al., 2016; Weng & Ordaz, 2021).

Within the U.S. and among the broader Asian community, Southeast Asians (including Cambodians) have among the worst obstetric health risk profiles (Cripe et al., 2011; Tran et al., 2024). Tran et al. (2024) conducted a scoping review on maternal, perinatal, and infant health of disaggregated Asian American ethnic groups and found that 1) Southeast Asian groups were understudied in such research, and 2) were more susceptible to negative health consequences as a result of their experiences with war, genocide, displacement, and resettlement. Given this, and the scantness of research among the Cambodian community in the U.S. (Chheang & Connolly,

2018), it is valuable to study the perinatal health outcomes of Cambodian mothers. Furthermore, given that California contains the largest Cambodian population outside of Cambodia in the U.S. (Bankston, 2009; Chan, 2015), this study utilizes California birth data to learn more about maternal and child health among this specific community. Among New York, Texas, Hawaii, and New Jersey, California is one of the five states that contain the largest number of births to Asian American women (Cheng et al., 2015). According to Lee et al. (2020), the highest number of Asian Americans reside in California (14.7%). This study explores adverse birth outcomes (small for gestational age and low birth weight) in California among multiple Asian American subgroups, particularly centering Cambodian mothers by nativity status.

Immigrant Health Advantage

The immigrant health advantage refers to the phenomenon that foreign-born individuals tend to have better health outcomes than their native-born counterparts (Bacong & Menjívar, 2021; Brabete, 2017; Riosmena & Jochem, 2017). However, overtime as they stay longer in the host country, the health of the immigrants tends to worsen (Bacong & Menjívar, 2021; Brabete, 2017). The decline in immigrant health status may be attributed to various factors including cultural customs, behavioral habits, discrimination, and racialized policies that target immigrants (Bacong & Menjívar, 2021). Social stigma in relation to having blue-collared jobs is also a contributing factor to decreased health outcomes among the immigrant population (Jang et al., 2023). Given that the health of foreign-born individuals gradually reflects the health of native-born U.S. individuals over time, it would be important to explore the differences in specific health outcomes such as small for gestational age in relation to nativity status.

Consistent with the immigrant health advantage, studies have found that foreign-born Asian American mothers had more optimal maternal and birthing health outcomes compared to

their U.S.-born counterparts (Dongarwar et al., 2022b). However, the immigrant health advantage among the foreign-born Asian American population tends to dissipate over time as a result of living in the U.S. and acculturation to the host country's culture (Dongarwar et al., 2022a; Dongarwar et al., 2022b). Therefore, it would be invaluable to explore nativity in relation to small for gestational age, especially among the Cambodian population in comparison to their Asian American counterparts as well as to their White counterparts.

Exposure to trauma linked to genocide, conflict, and violence are associated with long-term consequences beyond poor mental health outcomes (Cantor-Graae et al., 2014). Consequently, foreign-born Cambodian women may have higher risk for adverse perinatal health outcomes than U.S.-born Cambodian women given that foreign-born Cambodian women are more likely to have been exposed to genocide and subsequent traumatic experiences than the U.S.-born Cambodian counterparts. However, the immigrant health advantage literature suggest that foreign-born mothers will have better health outcomes than U.S.-born mothers (Bacong & Menjívar, 2021; Brabete, 2017; Dongarwar et al., 2022b; Riosmena & Jochem, 2017). Thus, U.S.-born mothers may be at higher risk than foreign-born mothers for adverse health outcomes and in turn poor perinatal health outcomes given the structural conditions they may experience in the U.S. such as poverty, teenage pregnancies, higher average parity, higher risk of being single (Forna et al., 2003).

Nativity and Health Outcomes

Between 1990 and 2022, the immigrant population in the U.S. has greatly increased from 7.9% to 13.9% (Read, 2024). Although there is not as much research on immigrant health among the Asian American population as there is the Hispanic population (Read, 2024), it is important to explore the relationship between nativity and health outcomes, specifically among infant

health outcomes given that it is an area where the immigrant health advantage has been shown to be particularly salient (Montoya-Williams et al., 2022). Given the increase of immigrants in the country, it is critical to learn about the healthcare system and the population's health (Read, 2024). This study examines the previous statement by exploring nativity status among various Asian subgroups in comparison to White counterparts to learn more about the risk factors of small for gestational age and low birth weight. The results may inform people and stakeholders of the importance of improving birth health outcomes among such groups

Adverse Birth Outcomes

Small for Gestational Age

Small for gestational age (SGA) describes when a baby is born in the lowest decile of population-based weight-for-gestational age curves (Carberry et al., 2011; Damhuis, Ganzevoort, & Gordijn, 2021; Hoftiezer et al, 2016; Yusuf et al., 2021). SGA is associated with numerous adverse infant health outcomes including infant mortality, neonatal death, child morbidity, an increased risk of delays in neurological development, and chronic conditions in adulthood such as type 2 diabetes and heart disease (Carberry et al., 2011; Estañ-Capell et al., 2024; Kramer et al., 2006; Lee et al., 2020; Yusuf et al., 2021). Therefore, it is important to learn about the various factors that may contribute to small for gestational age as one means to mitigate the adverse birth outcome.

In the U.S., there is an estimation that 11.1% of live births are small for gestational age (Yusuf et al., 2021). However, the rate of small for gestational age was higher among the Asian American population in comparison to the Non-Hispanic White population (Yusuf et al., 2021). According to 2014-2018 National Vital Statistics System (NVSS) live birth data, among the Asian American population, approximately 14.9% of live births were small for gestational age

(Salihu et al., 2021). In California specifically, according to 2008-2012 birth data from the California Perinatal Quality Care Collaborative (CPQCC), the prevalence of small for gestational age among Asian Americans was 21% (Lee et al., 2020). Given that the rate of small for gestational age among Asian Americans in California is nearly twice that of the national prevalence, it is important to disaggregate data for the Asian American population by ethnicity to reveal potential perinatal health disparities. These findings may inform services and resources to help reduce the prevalence of small for gestational age given its possible health consequences.

Low Birth Weight

Low birth weight (LBW) is also a major public health concern (Chhea et al., 2018; Zheng et al., 2024). LBW refers to when a baby weights less than 2,500 grams at birth (Hughes et al., 2017; Zheng et al., 2024). This is equivalent to about 5.5 pounds (Chhea et al., 2018; Zheng et al., 2024). In comparison to babies who are not born LBW, babies who are born LBW are 20 times more likely to pass away within their first year of life (Wilcox, 2001). Consequently, LBW is associated with poor health outcomes such as infant mortality, adverse neurological development, and delayed growth (Lee et al., 2020; Wartko et al., 2017; Wilcox, 2001). Babies born low birth weight also had a higher prevalence of unfavorable mental health conditions such as depression and anxiety compared to their counterparts (Zheng et al., 2024). Moreover, LBW is linked to various poor health conditions in adulthood such as type 2 diabetes, high blood pressure, and cardiovascular diseases (Chhea et al., 2018; Wartko et al., 2017). Therefore, being born LBW is detrimental to the baby's overall health regardless of being an infant or an adult.

In 2021, the low-birth-weight rate in the U.S. was estimated to be 8.52% (Frontera & Spicer, 2024). As of 2019, the prevalence of low birth weight among the Asian American and Pacific Islander community in the U.S. was 8.7% (Andrasfay, 2022). The low-birth-weight rates

among non-Hispanic White mothers was 6.9%, Hispanic mothers was 7.6%, and among non-Hispanic Black mothers was 14.2% (Andrasfay, 2022). These statistics suggest that the Asian American and Pacific Islander community has the second highest low birth weight rates in the country. Therefore, overtime it is evident that the Asian American and Pacific Islander communities are at higher odds of adverse perinatal health outcome compared to their non-Hispanic White counterparts. Moreover, low birth weight remains a primary concern among the Asian American population (Cheng et al., 2015). In general, Asian American mothers were at greater risk for delivering a baby with low birthweight than non-Hispanic White mothers (Wong et al., 2008). Consequently, it is important to learn about the low-birth-weight rates and risk factors among the Asian American community in California, particularly focusing on the Cambodian community by nativity status and making comparisons with other Asian and non-Hispanic White groups.

Conceptual Framework

Tran et al. (2024) created a conceptual framework specific to understanding health disparities among the Asian American community, particularly considering their heterogeneous nature and focusing on perinatal health. Tran et al. (2024) noted that the conceptual framework was informed by the ecosocial theory and critical race theory (CRT):

> A central notion of ecosocial theory is that people embody– and biologically express– experiences of economic and social inequality throughout the life course, thereby producing social inequalities in population health. CRT highlights racism as a fundamental force shaping the unequal distributions of resource, power, and opportunities– including as related to the production of knowledge about race and racialized groups. AAs are racialized as both successful “model minorities” and

> dangerous “yellow peril” threatening Western civilization. The ecosocial and CRT perspectives draw attention to past and present systems-level causes of health inequities that is largely shaped by racism. (p.2)

The conceptual framework acknowledges that different experiences and exposures throughout one’s life course may impact their health outcomes in addition to the health outcomes of subsequent generations via pregnancy and perinatal health (Tran et al., 2024). This is illustrated through social, demographic, and historical factors in relation to resettlement (pre-resettlement, during resettlement, and post-resettlement) (Tran et al., 2024). This conceptual framework depicts the association between immigration history and the impacts on health disparities among Asian American subgroups, which includes factors such nativity status, educational attainment level, mental health status, resources, and exposure to war and conflict (Tran et al., 2024).

The Cambodian genocide was one of the primary factors influencing Cambodian individuals to seek refuge in other countries like the U.S. (Chan, 2015). This study will analyze multiple risk factors including nativity status (proxy for exposure to genocide) and educational attainment level, to understand adverse perinatal health outcomes among Cambodian mothers and their counterparts in the United States.

Previous Research

Utilizing 1992 California birth certificate data, a retrospective cohort study explored the relationship between maternal birthplace, race, and births of low-birth-weight singleton infants to foreign-born and U.S.-born mothers (Asian, Black, Latina, and White) (Fuentes-Afflick et al., 1998). The findings revealed that foreign-born Latina and Asian women had worse maternal characteristics (such as having lower educational attainment levels, being less likely to have adequate utilization of prenatal care, and being of older age) compared to their native-born

counterparts (Fuentes-Afflick et al., 1998). However, the findings revealed otherwise for foreign-born Black mothers compared to their native-born counterparts (Fuentes-Afflick et al., 1998). Given the differences in birth outcomes in relation to nativity status, it is important to explore the relationship in more recent years. Therefore, this current study utilizes California data between 2005 and 2019.

Another study explored maternal morbidity and perinatal outcomes among foreign-born Cambodian, Laotian, and Vietnamese mothers in Washington state between 1993-2006 (Cripe et al., 2011). Cripe et al. (2011) found that Cambodian and Laotian mothers were more likely to give birth to low-birth-weight infants and had a higher risk of experiencing preterm births compared to their Vietnamese and White counterparts. Cripe et al. (2011) solely focused on these 3 Southeast Asian subgroups without accounting for nativity in their analyses. However, examining these birth outcomes by nativity status of the mothers (U.S.-born versus foreign-born) has the potential to reveal any differences between infant health disparities. Therefore, this study explores the aforementioned relationship in California utilizing more recent data. Although the study explored low birth weight and preterm birth among specific Southeast Asian foreign-born mothers, small for gestational age was one of the birth outcomes that was not examined.

Utilizing 2003 U.S. birth certificate data, Wong et al. (2008) examined risk factors for different perinatal health outcomes among 9 Asian American subgroups (Asian Indian, Chinese, Filipino, Guamanian, Hawaiian, Japanese, Korean, Samoan, and Vietnamese) in Northern California. Compared to the other Asian subgroups, the findings from this retrospective cohort study revealed that Hawaiian mothers were at greatest risk for having a preterm delivery under 37 weeks and Asian Indian mothers had the highest odds of delivering a low-birth-weight baby (Wong et al., 2008). Consequently, given that the study reveals that different Asian American

subgroups are at higher risk for certain perinatal health outcomes, the importance of disaggregation of Asian American health data is supported. In short, if the Asian American subgroups were aggregated, the health disparities would continue to be masked. Wong et al. (2008) also suggests for future research to stratify Asian American subgroups by nativity to analyze the potential impacts of nativity status on adverse birth outcomes.

Another quantitative cohort study examined maternal nativity, maternal risk factors, and birth outcomes among 6 Asian subgroups in California: Chinese, Japanese, Filipino, Korean, Vietnamese, and Cambodian/Laotian (Qin & Gould, 2010). The data was retrieved from the linkage of 1992-1997 and 1999-2003 California infant birth and infant mortality cohort files which were curated by the Vital Statistics Division of the State Department of Health Services (Qin & Gould, 2010). Qin & Gould (2010) found that U.S.-born Cambodian, Laotian, and Vietnamese mothers had a greater risk and prevalence of small and preterm birth compared to their foreign-born counterparts. Given that the data is over 20 years old, the Cambodian mothers in this study were considered to be high risk teenagers upon their arrival as recent immigrants at the time (Qin & Gould, 2010). Therefore, this study contributes to existing literature by utilizing more recent California data. This current study also contributes to existing research by disaggregating the Cambodian subgroup from other Southeast Asian subgroups. Thus, this disaggregation of ethnicities may reveal differing results as opposed to aggregated data.

A retrospective study analyzed recent trends, risk factors, and disparities in low birth weight in California utilizing 2005-2014 data from the California Birth Statistical Master Files (Ratnasiri et al., 2018). The study population included all racial groups: Asian, American Indian, Black, Hispanic, Pacific Islander, and White (Ratnasiri et al., 2018). However, conducting the

study on the Asian American population in California may be beneficial in addressing any potential health disparities between different Asian ethnicities.

Salihu et al. (2021) utilized 2014-2018 national birth data to examine maternal pre-pregnancy underweight and the risk of small-for-gestational-age among Asian American mothers in comparison to Non-Hispanic Whites. The study found that Asian American mothers who were underweight were more likely to have babies born SGA compared to 1) Asian American mothers who were normal weight, and 2) Non-Hispanic White mothers who were underweight (Salihu et al., 2021). However, the study aggregated all Asian Americans and did not explore maternal nativity. Therefore, this study addresses this gap by disaggregating Cambodian mothers from all Asian American subgroups and exploring nativity among foreign-born and native-born Cambodian mothers in relation to other Asian subgroups and Whites.

The 6 largest Asian American subgroups in the U.S. include Asian Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese (Tran et al., 2024). In utilizing natality data files between 1992-2018 from the National Vital Statistics System, a national study analyzed the temporal trends and risk of small for gestational age infants among the 6 populous Asian American ethnicities (Yusuf et al., 2021). The study revealed that Asian Americans had higher SGA rates than their Non-Hispanic White counterparts and that within the 6 Asian subgroups, Asian Indians had the highest rates of SGA (Yusuf et al., 2021). Similarly to Yusuf et al (2021), Dongarwar et al. (2022b) examined trends and predictors of preterm birth among the aforementioned 6 Asian American ethnic groups utilizing natality data files between 1992-2018 as well. The findings from this study revealed that 1) Asian American mothers were less likely to have a preterm birth compared to their Non-Hispanic White counterparts, and 2) among the Asian American subgroups, Southeast Asian counterparts (Filipinas and Vietnamese) were more

likely to experience preterm births compared to all the other Asian American groups (Dongarwar et al., 2022a). Another retrospective cohort study explored preterm birth and small for gestational age among the 6 largest Asian American subgroups by nativity status (in comparison to White counterparts) utilizing the 2001-2004 Texas birth data files (Kan, 2008). Many studies like Yusuf et al. (2021), Dongarwar et al. (2022b), and Kan (2008) do not often explore marginalized Asian American subgroups such as the Cambodian population. Therefore, it would be beneficial to examine small for gestational age infants among U.S.-born and foreign-born Asian American mothers like Cambodian mothers who are usually aggregated within the well-known Asian American subgroups.

Bane et al. (2022) utilized 2007-2018 California linked birth and infant death certificates to maternal hospital discharge information to analyze the relationship between risk factors and perinatal outcomes among birthing Asian American, Native Hawaiian, and Pacific Islander (AANHPI) individuals in California. Unlike a number of research studies, Bane et al. (2022) examined 15 AANHPI subgroups instead of only the 6 most populous ethnic groups. Therefore, this study also included Cambodians (Bane et al., 2022). The results revealed that the birth outcomes (such as severe maternal mortality and preterm births) for East Asian ethnic groups were at lower extremes compared to Southeast Asian and Pacific Islander subgroups (Bane et al., 2022). This study reinforces the notion that maternal and perinatal health disparities and inequities continue to persist within marginalized Asian subgroups. The findings from Bane et al. (2022) emphasize the importance of data disaggregation among the AANHPI community. Therefore, this study does that by disaggregating the Cambodian ethnic group from the broader Asian American community.

Purpose of the Study

This study is a quantitative retrospective cohort study that utilizes secondary data analysis to examinate maternal health and childbirth outcomes. More specifically, the research study will examine risk factors for small for gestational age and low birth weight among U.S.-born and foreign-born Cambodian mothers in California in relation to their White and Asian counterparts. The purpose of this study is to examine any disparities between birth outcomes based on the Cambodian mothers' nativity status and characteristics. In addition to the mother's birthplace, the study aims to learn about the different factors that may contribute to the baby's health outcome and if so, to what extent.

Research Contribution

Many studies in the field of maternal and child health examine pregnancy and birthing disparities among these three racial groups: Blacks, Hispanics, and Whites (Dongarwar et al., 2022b). However, there is a dearth of published research studies that focus on the perinatal health outcomes of the Asian American population (Dongarwar et al., 2022b). Therefore, this study would contribute to literature by addressing this gap. Research on perinatal health among Asian subgroups is scant and most of the research studies that exist tend to center the more prominent Asian subgroups (Wong et al., 2008). Consequently, this study includes multiple aggregated yet disaggregated Asian subgroups: East Asian (Chinese, Japanese, and Korean), South Asian (Asian Indian), Southeast Asian (Filipino, Hmong, Laos, Thai, and Vietnamese), Native Hawaiian and Pacific Islander (Hawaiian, Guam, Samoan, Pacific Islander), and other Asian (unspecified Asian) and makes comparisons to the Cambodian community in California. Furthermore, Wong et al. (2008) mentions that although perinatal epidemiological studies exist, the main adverse birth outcome of focus was low birth weight. However, this study includes two birth outcomes of interest: small for gestational age and low birth weight.

Until the present day, there is still limited research and studies that examine maternal and child health among and between Cambodian mothers, specifically those born in the U.S. and those born in Cambodia who had children in California. Upon a brief literature review, some studies date back to several decades ago whereas other studies focus on Cambodian mothers in Cambodia (Greffeuille et al., 2016; Um et al., 2024). For example, Wong et al. (2008) conducted a study on low birth weight among various Asian subgroups in Northern California, whereas this study includes various Asian subgroups and explores risk factors for both small for gestational age and low birth weight throughout the state of California. Therefore, this will be among the first studies to utilize such data, Electronic Birth Records from California (2005-2019), to examine small for gestational age in relation to nativity status of the Cambodian mother while exploring additional maternal factors that may potentially impact the baby's health outcome. Moreover, comparisons will be made comparing Cambodian mothers to Asian mothers and Cambodian mothers to White mothers to examine any potential health outcome disparities that may arise.

Given that the aggregation of Asian American subgroups into one serve as a barrier to better understanding perinatal health among this population (Bane et al., 2022), this current study disaggregates Cambodians from the larger Asian group to better understand maternal nativity in relation to maternal risk factors and small for gestational age, particularly among an understudied and underserved population.

Qin & Gould (2006) explored the Asian birth outcome gap among some of the major Asian subgroups in California: Chinese, Filipino, Japanese, Korean, Vietnamese, and Cambodian/Laotian. The findings revealed that of these selected Asian subgroups, Cambodian and Laotian had higher rates of infant mortality than the other ethnic groups (Qin & Gould,

2006). This finding reveals that Cambodian mothers have a higher risk of delivering babies with adverse health outcomes compared to other Asian counterparts. It would be valuable to explore SGA and LBW among this community to explore any potential health disparities in comparison to the broader Asian American population, and to the Non-Hispanic White counterparts while taking nativity status into account. Therefore, this current study aims to add to existing literature by doing this.

There is a dearth of perinatal research among Southeast Asian immigrant subgroups such as Cambodians and Laotians (Cripe et al., 2011). Therefore, this study would be one of the first that we know of to analyze maternal and infant risk factors in relation to small-for-gestational-age and low birth weight by maternal nativity status among Cambodian mothers in California utilizing some of the most recent years of data (2005-2019) with additional comparisons to the broader Asian American community as well as to the Non-Hispanic White counterparts. Singh & Yu (1996) examined the maternal risk factors and low birth weight and preterm birth outcomes among populous Asian subgroups (Chinese, Japanese, Filipino,) among other prominent groups in the California (White, Hispanic, Black counterparts) utilizing 1992-1997 data. The purpose of their study was to examine which Asian subgroup had the poorest birth health outcomes and found that foreign-born mothers had lower risk of delivering a baby that is either low birth weight or preterm birth.

Other studies like Dongarwar et al. (2022b), Kan (2008), and Yusuf et al. (2021) examine maternal risk factors and infant birth outcomes (i.e., small for gestational age, preterm birth) among the top 6 Asian American subgroups: Chinese, Filipino, Japanese, Korean, and Vietnamese. Therefore, other Asian subgroups like the Cambodian population are not as often studied, especially in this particular area. As a result, this would be one of the first studies of its

kind to examine the association between maternal risk factors and small-for-gestational-age among Cambodian American mothers by nativity status while also making comparisons to other racial groups such as the broader Asian population and Non-Hispanic Whites. The findings may reveal any differences in birth outcomes and contribute to emphasizing the importance of disaggregated health data among Asian American ethnic groups.

Research Questions and Hypotheses

Research Question 1. How do perinatal outcomes of Cambodian mothers in California compare to those of other Asian and non-Hispanic White mothers?

> **Hypothesis 1.** If a woman is Cambodian, then she will be more likely to deliver a small for gestational age or low birth weight baby compared to her Asian and non-Hispanic White counterparts.

Research Question 2. Does Cambodian foreign-born status predict the risk of small for gestational age and low birth weight?

> **Hypothesis 2.** If a Cambodian woman is foreign-born, then she will more likely deliver a baby who is small for gestational age or low birth weight, compared to U.S.-born counterparts, other Asian mothers, and White mothers.

Methodology and Data

Study Design

This study is a quantitative retrospective cohort study conducted via secondary data. The analysis explores various maternal and infant characteristics to identify potential risk factors for small for gestational age and low birth weight among U.S.-born and foreign-born Cambodian women in comparison to their White and Asian counterparts. The different analyses in the study compares U.S.-born and foreign-born Cambodian mothers to White and Asian mothers. Some analyses include the aggregation of Asian subgroups, whereas other analyses include the

disaggregation of Asian subgroups. Some analyses exclude White mothers. The expectation across all analyses is that Cambodian mothers will be at greater risk for delivering a baby with small for gestational age or low birth weight compared to White or Asian mothers, regardless of their nativity status. Across generations, Cambodian mothers experienced high rates of low birth weight that may be attributed to encountering structural constraints in the U.S. such as poverty, challenges with resettlement, and history of intergenerational trauma (Andrasfay, 2022).

Dataset: California Birth Cohort/Certificate File Data (2005-2019)

The data for this study is obtained from the Electronic Birth Certificate Records from California. More specifically, data is available for the following years: 2005-2019. The total sample size for this study is 3,108,371. The study analyzes singleton births to U.S.-born and foreign-born Cambodian, White, and other Asian mothers between 2005-2019. All mothers were residing in California at the time of the child's birth.

Methodology

For this study, StataMP 18 (64-bit) was utilized to conduct all analyses. Logistic regression models were used to identify risk factors of small for gestational age and low birth weight by maternal nativity. The specific focus centers U.S.-born and foreign-born Cambodian mothers. However, analyses also include White and other Asian mothers as well as their nativity status. In short, logistic regression models adjusting for potential confounders were curated to estimate the relationship between maternal nativity status and small for gestational age as well as to estimate the relationship between maternal nativity status and low birth weight. Some of the logistic regression models also included interaction terms, specifically between race and nativity status (U.S.-born and foreign-born). Statistical significance was at p-value < 0.05.

Although the Hispanic population comprises of a large immigrant group in the United States (Lichter & Johnson, 2020), they were not one of the comparison groups given that

Hispanic mothers were known to have similar (or better) birth outcomes to non-Hispanic White mothers despite socioeconomic disadvantages (Bediako et al., 2015; Gonzalez-Quintero et al., 2006; James, 1993). There is also a variation in birth outcomes among Hispanic population; for example, Mexican and Cuban mothers tend to have better perinatal birth outcomes (lower prevalence of low birth weight) than Puerto Rican and some Dominican mothers (Bediako et al., 2015). Some studies found evidence that supported the "Latina Epidemiologic Paradox" (Acevedo-Garcia et al., 2007; Flores et al., 2015; Gonzalez-Quintero et al., 2006; Hessol & Fuentes-Afflick, 2014), while other studies did not find evidence that supported this phenomenon (Brown et al., 2007; Sanchez-Vaznaugh et al., 2016). The "Latina Epidemiologic Paradox," or known as "the Hispanic paradox," is a concept that Hispanic mothers have comparable perinatal birth outcomes (low birth weight, small for gestational age, and preterm birth) to non-Hispanic White counterparts irrespective of their socioeconomic background (Brown et al., 2007; Flores et al., 2015; Sanchez-Vaznaugh et al., 2016). Given that Hispanic mothers had similar birth outcomes to non-Hispanic White mothers (Bediako et al., 2015; James, 1993) and that foreign-born Latina mothers were at lower risk for adverse birth outcomes (low birth weight, small for gestational age, and preterm birth) than U.S.-born Latina mothers (Flores et al., 2012), non-Hispanic White mothers were selected as the comparison group for this study. Moreover, data on Hispanic mothers was not provided.

Measures

Nativity status of the mother was categorized as native-born (born in the U.S.) and foreign-born (not born in the U.S.) (Kan, 2008; Lee et al., 2020). Maternal race was measured as White, Cambodian and other Asian subgroups. The Asian subgroups are listed along with their component origin groups in parentheses: East Asian (Chinese, Japanese, and Korean), South Asian (Asian Indian), Southeast Asian (Filipino, Hmong, Laos, Thai, and Vietnamese), Native

Hawaiian and Pacific Islander (Hawaiian, Guam, Samoan, Pacific Islander), and other Asian (unspecified Asian).

Dependent Variables

Small for Gestational Age.

The dependent variable is small for gestational age. This variable was created by coding together three variables: baby's birth weight, gestational age, and baby's sex. Oken et al. (2003) provided small for gestational age cut-offs for babies based on their weight, gestational age, and sex. The generation of this variable was informed by the information and cut-offs provided by Oken et al. (2003). Small for gestational age was coded as 0 if a baby was not born small for gestational age and coded as 1 if a baby was born small for gestational age.

Low Birth Weight.

Baby's birth weight was measured in grams. Low birth weight was coded as 0 if a baby was not considered low birth weight and coded as 1 if a baby was considered low birth weight. Low birth weight was defined as weighing under 2,500 grams at birth; this definition follows the cut-off mark from scholarship on adverse birth outcomes and prenatal health conditions (Chhea et al., 2018; Hughes et al., 2017). Weighing under 2,500 grams is equivalent to weighing less than 5.5 pounds (Chhea et al., 2018).

Covariates

The adjusted covariates include maternal and newborn characteristics: maternal age, baby's sex, maternal education level, mother's body mass index, utilization of Medi-Cal/insurance type, engagement in prenatal care visits during pregnancy, mother's birthplace, prenatal smoking status, and race/ethnicity of the mother. Data on the number of years residing in the U.S. were not available. Overall, these factors may have some influence on the baby's health outcome, particularly small for gestational age.

The aforementioned covariates were included in the model as a result of the following justifications from previous literature and studies. Given that the following covariates significantly contributed to normal infant birth weight, they were also included in our models to explore small for gestational age and low birth weight: maternal characteristics including height and weight (utilized to determine body mass index), race/ethnicity, and baby's sex at birth (Gardosi, 2006). Smoking during pregnancy was found to be a contributing factor to adverse birth outcomes such as small for gestational age (McCowan & Horgan, 2009; Tsukamoto et al., 2007). Other affirmed contributors of small for gestational age include mother's weight (low) and ethnicity (Asian) (McCowan & Horgan, 2009). In other words, Asian mothers who were underweight were more likely to have small for gestational age births (Salihu et al., 2021). Moreover, the baby's birth weight and the mother's weight may contribute to the determination of small for gestational age (Campbell et al., 2012). A retrospective study examining recent trends, risk factors, and disparities in low birth weight in California between 2005-2014 utilized some of the following maternal variables for their analyses: age, place of birth, educational level, race and ethnicity, health insurance status (public and private), utilization of prenatal care during the first trimester (Ratnasiri et al., 2018). Therefore, these variables were included in our models as well. Given that sociodemographic factors attributed to adverse birth outcomes include teenage pregnancy, low levels of maternal education, and low socioeconomic status (Qin & Gould, 2006), one of the age categories was younger than 20 years old, whereas one of the education categories was less than a high school education.

Asian American mothers who were younger than 20 and older than 40 were more likely to experience preterm birth (Dongarwar et al., 2022a). More specifically, pregnancies that occur at the age of 35 years old and older are considered pregnancies of advanced maternal age (Glick

et al., 2021) and are at an increased risk for pregnancy complications and adverse birth outcomes including preterm labor, stillbirth, birth defects, and small for gestational age (Glick et al., 2021). Mothers who experience a teenage pregnancy are at greater risk of having a low-birth-weight baby (Dennis & Mollborn, 2013). Dennis & Mollborn (2013) categorized maternal age into five categories, with 25-29 being the reference group: 19 and under, 20-24, 25-29, 30-24, and 35 and over. This study categorized maternal age into the same five age groups: 19 and under, 20-24, 25-29, 30-24, and 35 and over.

Ratnasiri et al. (2018) categorized maternal education into three categories: less than high school education, high school education (diploma), and some college or associate's degree/ bachelor's degree or higher. This study utilized the same approach for maternal educational attainment. Maternal smoking during pregnancy was categorized as yes and no, indicating that the mother smoked at all versus mother did not smoke (Cripe et al., 2011; Kan, 2008).

Logistic Regression Models (With and Without Interactions)

Multivariable logistic regression was utilized to analyze the risk factors of small for gestational age births and low birth weight births among mothers in California (White, Cambodian, All Other Asian) by nativity status. All other Asian included East Asian (Chinese, Japanese, Korean), South Asian (Asian Indian), Southeast Asian (Vietnamese, Thai, Laos, Hmong, Filipino), Native Hawaiian and Pacific Islander (Hawaiian, Guam, Samoan, Pacific Islander), and Other Asian (unspecified Asian). Sampling weights were not utilized in this study.

Logistic regression models were used because the dependent variables (small for gestational age and low birth weight) were operationalized categorically and dichotomously. Control variables in all logistic regression analyses included baby's sex, maternal demographic characteristics (race, nativity status, age, educational attainment, body mass index), maternal

health behaviors (smoking status, prenatal care visits), and principal payment source (pre-care). Logistic regression models with interaction terms between race and nativity were also conducted.

Results

Univariate Descriptive Statistics for Mothers in California

Table 4.1 illustrates the univariate descriptive statistics for mothers in California between 2005-2019 (N=3,108,371), and stratified by Cambodian, all other Asian, and White mothers. 11.31% of births were small for gestational age and 4.5% of births were low birth weight. Compared to babies born female (48.48%), a little more than half of the babies were males (51.52%). White mothers make up the majority of the sample (66.58%), Cambodian mothers make up a little less than 1% of the sample (0.83%, or 25,723), and all other Asian mothers make up nearly a third of the sample (32.60%). East Asian and Southeast Asians were the largest Asian sub-groups. About two-thirds of mothers in the sample were U.S.-born (65.31%), whereas about one-third of the mothers in the sample were foreign-born (34.69%). Approximately two-thirds of the mothers were above 30 years old (33.88% between 30-34 years old, and 25.34% were 35 years and over). Most mothers obtained some college education (76.81%), attended at least one prenatal care visit (99.55%), had a private principal payment source for pre-care (67.86%), did not smoke during pregnancy (82.88%), and had a normal body mass index (49.69%).

White mothers had the lowest prevalence of small for gestational age and low birth weight compared to Cambodian and all other Asian mothers. The prevalence of small for gestational age and low birth weight was approximately doubled among Cambodian mothers compared to White mothers. The majority of Cambodian and all other Asian mothers were foreign-born, whereas the majority of White mothers were U.S.-born. Across all groups, there were slightly more male babies than female babies, over 99% of mothers engaged in prenatal care visits, and over 80% of mothers did smoke during pregnancy. However, the prevalence of

smoking during pregnancy was highest among White mothers compared to Cambodian and all other Asian subgroups. Compared to all other Asian and White mothers, Cambodian mothers had the lowest rates of obtaining higher education and highest rates of utilizing Medi-Cal as a principal payment source for prenatal care services.

Bivariate Descriptive Statistics for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Disaggregated) Mothers in California

Table 4.2 illustrates bivariate descriptive statistics for small for gestational age and low birth weight among White, Cambodian, and all other Asian mothers in California between 2005-2019. The category for all other Asian includes East Asian, South Asian, Southeast Asian, Native Hawaiian/Pacific Islander, and other Asian.

Small for Gestational Age

The percentage of Cambodian mothers who had a baby considered small for gestational age was doubled that of White mothers, 17.96% and 8.92% respectively. On average, foreign-born mothers were more likely to have a small for gestational age baby compared to U.S.-born counterparts. Among Cambodian mothers, there was a higher prevalence of small for gestation age births among those who were U.S.-born (21.16%) compared to those who were foreign-born (16%). Nearly doubled and a half Cambodian U.S.-born mothers (21.16%) experienced a small for gestational age birth compared to their White U.S.-born counterparts (8.81%). Regardless of nativity status, the prevalence of delivering a small for gestational age baby was higher among Cambodian and all other Asian mothers compared to White mothers.

Table 4.2 also shows disparities in small for gestational age based on the covariates. Mothers who had the highest prevalence of having a small for gestational age baby were 19 years of age or younger (14.01%), had less than a high school education (13.56%), participated in

prenatal care visits (13.65%), had Med-Cal as the principal payment source for prenatal care (12.64%), smoked during pregnancy (16.41%), or had a body mass index that was considered overweight (15.76%). The percentage of small for gestational age was slightly higher among mal babies (11.43%) compared to female babies (11.19%). Mothers who had the lowest prevalence of having a small for gestational age baby were 35 years old or older (10.91%), had any college experience or obtained an advanced degree (11.13%), did not smoke during pregnancy (11.28%), or had a body mass index that was considered underweight (6.91%).

Low Birth Weight

Cambodian mothers were more likely to have a low-birth-weight baby than Whites and other Asian mothers. On average, foreign-born mothers were slightly more likely to have a low-birth-weight baby (5.06%) compared to U.S.-born mothers (4.2%). Among Cambodian mothers in California between 2005-2019, there was a higher prevalence of U.S.-born mothers (9.36%) giving birth to a child considered low-birthweight compared to foreign-born mothers (6.49%). However, in relation to White and all other Asian subgroups and irrespective of nativity status, Cambodian mothers had higher rates of a delivering a low-birth-weight baby. The prevalence of low birthweight among Cambodian U.S.-born mothers was nearly triple that of White U.S.-born mothers, 9.36% and 3.89% respectively. Regardless of nativity status, the percentage of White mothers having a baby that was considered low birth weight was less than that of Cambodian and all other Asian mothers.

With respect to the covariates, the percentage of low birth weight was slightly higher among female babies (4.84%) than male babies (4.18%). A low birth weight birth was also most prevalent among mothers who were under the age of 20 (6.02%), had less than a high school education (6.04%), engaged in prenatal care visits (11.59%), utilized Medi-Cal as the principal

payment source for prenatal care (excluding the unknown/ unreported payment sources), smoked during pregnancy (7.87%), and a had body mass index that was considered overweight (5.94%). On the contrary, mothers who had the lowest prevalence of having a low-birth-weight baby were between the ages of 25-29 years old (4.13%), had an education higher than a high school graduate level (4.32%), did not smoke during pregnancy (excluding missing/ unknown responses), or had a body mass index that was considered underweight (2.73%).

Reference Groups

The reference groups are similar across all models. White race is the reference group when models contain data from white mothers. East Asian mothers are the reference group for models that include disaggregated Asian subgroups. U.S.-born is the reference group for nativity status. For models with interaction terms that include race and nativity, White U.S.-born mothers are the reference group.

The reference groups for the covariates are identified with parenthesis. All of the models include baby's sex (ref. male), maternal age (ref. mothers who are 25-29), mother's educational attainment level (ref. mothers who have less than a high school education), prenatal care visits (ref. mothers who did not engage in prenatal care visits), principal payment source for prenatal care visits (ref. mothers who utilized Medi-Cal), smoking status during pregnancy (ref. mothers who did not smoke during pregnancy), and pre-pregnancy body mass index (ref. mothers who have a normal body mass index).

Logistic Regression for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian Mothers (Aggregated) in California

Table 4.3 illustrates the results from logistic regression models for the two birth outcomes (small for gestational age and low birth weight) among White, Cambodian, and all other Asian mothers in California between 2005-2019. All other Asian mothers subgroup was aggregated.

In comparison to White mothers, Cambodian mothers were, on average, 78.2% more likely to have a baby considered small for gestational age and 75% more likely to have a baby born low birth weight. Cambodian mothers were also more likely to have a baby that was small for gestational age or low birth weight compared to all other Asian mothers, although other Asian mothers were at higher risk of both adverse outcomes than White mothers. Therefore, race was a significant risk factor for both adverse birth outcomes. In comparison to U.S.-born mothers, foreign-born mothers were slightly more likely to have a small for gestational age baby (6.5%) and 10.1% less likely to have a low-birth-weight baby on average. Thus, the results reveal that nativity status was also a significant risk factor for having a small for gestational age or low birth weight baby.

Across these models, sex of baby, maternal age, mother's educational attainment level, prenatal care visits, principal payment source for prenatal care visits, smoking status during pregnancy, and pre-pregnancy body mass index were significant risk factors for small for gestational age and low birth weight among mothers in California. Female babies were about 2% less likely to be born small for gestational age compared to babies born male. However, babies who were born female were almost 17% (16.9%) more likely to be born low birth weight compared to their male counterparts. Therefore, male babies were more likely than female babies to be born small for gestational age and less likely to be born low birth weight. Compared to

mothers who were between 25-29 years old, mothers who were 19 years of age or under were 31.3% more likely to have a baby born small for gestational age and 28.6% more likely to have a baby born low birth weight, whereas mothers who were 35 years old and older were less likely to experience a small for gestational age birth (7.3%) and more likely to experience a low-birth-weight birth (24.7%). Specific to low birth weight, mothers of all age groups were more likely to have a baby born low birth weight compared to mothers who were 25-29 years old.

Mothers who obtained higher education had lower odds of delivering a child with an adverse birth outcome compared to their counterparts who had less than a high school education. Mothers who engaged in prenatal care visits were 22% less likely to have a small for gestational age baby and were 66.7% less likely to have a low-birth-weight baby compared to their counterparts who did not engage in prenatal care visits. Therefore, prenatal care visits serve as a protective factor for adverse birth outcomes.

Compared to mothers who did not smoke during pregnancy, mothers who smoked during pregnancy were over 80% more likely to experience an adverse birth outcome (81.3% for small for gestational age and 84.3% for low birth weight). Therefore, smoking during pregnancy is significantly attributed to poor prenatal birth outcomes. In comparison to mothers who had a normal body mass index, mothers who were overweight were more likely to have a baby that is small for gestational age (68.3%) or low birth weight (57.1%).

Logistic Regression for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Disaggregated) Mothers in California

Table 4.4 illustrates the logistic regression models for small for gestational age and low birth weight among White, Cambodian, and all other Asian mothers in California between 2005-

2019. The subgroup for all other Asian mothers was disaggregated into ethnic groups: East Asian, South Asian, Southeast Asian, Native Hawaiian/Pacific Islander, other Asian.

In comparison to White mothers, Cambodian mothers were 81% more likely to have a baby considered small for gestational age and were 78.1% more likely to have a baby born low birth weight. All mothers from the different Asian subgroups were at higher risk of both perinatal outcomes than White mothers. Only South Asian mothers had higher odds of giving birth to a baby with either adverse birth outcomes than Cambodian mothers. In comparison to U.S.-born mothers, foreign-born mothers were slightly more likely to have a small for gestational age baby (1.8%) and less likely to have a low-birth-weight baby (12.2%). Race and nativity status are significant risk factors for having a small for gestational age or low birth weight baby.

The results for the covariates were similar to those observed in Table 4.3. Babies who were born female were 2.1% less likely to be born small for gestational age compared to babies born male. However, babies who were born female were 16.9% more likely to be born low birth weight compared to their male counterparts. In comparison to mothers who had a normal body mass index, mothers who were overweight were 68.2% more likely to have a baby that is small for gestational age and mothers who were obese were 57.8% more likely to have a baby that is considered low birth weight. Thus, having a lower body mass index is a protective factor for experiencing adverse birth outcomes.

Mothers who engaged in prenatal care visits were 20.1% less likely to have a small for gestational age baby and were 63.9% less likely to have a low-birth-weight baby compared to mothers who did not engage in prenatal care visits. Thus, prenatal care visits serve as a protective factor for adverse birth outcomes, especially low birth weight. Compared to mothers who utilized Medi-Cal as the principal payment source for prenatal care services, mothers who

utilized private insurance were at slightly lower odds of giving birth to a baby with either adverse birth health outcomes. Mothers who had higher education were also less likely to deliver a baby with small for gestational age and low birth weight than mothers who had less than a high school education. Compared to mothers who did not smoke during pregnancy, mothers who smoked during pregnancy were 80.5% more likely to have a baby considered small for gestational age and 85% more likely to have a baby considered low birth weight at birth. Thus, smoking during pregnancy is significantly attributed to adverse birth outcomes.

Logistic Regression with Race and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Aggregated) Mothers in California

Table 4.5 illustrates the logistic regression models for small for gestational age and low birth weight among White, Cambodian, and all other Asian mothers in California between 2005-2019 with a race and nativity interaction. All other Asian mothers subgroup was aggregated.

U.S.-born Cambodian mothers were twice as likely to deliver a baby considered small for gestational age or low birth weight compared to their U.S.-born White counterparts. U.S.-born Cambodian mothers were also more likely to have a baby that is small for gestational age or low birth weight compared to U.S.-born other Asian mothers. The difference between foreign-born Cambodian women and U.S.-born White women was smaller than the difference between U.S.-born Cambodian women and U.S.-born White women. Therefore, the results indicate that U.S.-born Cambodians are at particularly high risk for giving birth to small for gestational age or low birth weight babies. The results reveal that race, nativity status, and the interaction (race x nativity) are all significant risk factors for delivering a small for gestational age or low birth weight baby.

Across these models, maternal age, mother's educational attainment level, prenatal care visits, principal payment source for prenatal care visits, smoking status during pregnancy, and pre-pregnancy body mass index continued to be significant risk factors for small for gestational age and low birth weight among mothers, consistent with the results from the previous tables.

Logistic Regression with Combined Race and Nativity Variable for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Aggregated) Mothers

Table 4.6 illustrates logistic regression models for small for gestational age and low birth weight with a race and nativity interaction term among White Cambodian and all other Asian mothers in addition to their nativity status (U.S.-born or foreign-born). U.S.-born Cambodian mothers at greater risk of having a baby born small for gestational age or low birth weight compared to all other mothers (foreign-born White, foreign-born Cambodian, foreign-born Asian, U.S.-born White, and U.S.-born Asian). U.S.-born Cambodian mothers were twice as likely to deliver a baby that is considered small for gestational age or low birth weight compared to their White American counterparts. Among Cambodian mothers in California, U.S.-born mothers were at greater risk of having a baby born small for gestational age or low birth weight compared to their foreign-born counterparts. However, all other groups regardless of their nativity status, were all at greater risk to deliver a small for gestational age baby or a low-birth-weight baby compared to U.S.-born White mothers. The difference in risk for these adverse perinatal outcomes between U.S.-born and foreign-born mothers was much smaller for mothers in the other Asian category than it was for Cambodian mothers. In other words, for other Asian mothers, there was not a large difference between foreign-born and U.S.-born (4.8%), whereas for the Cambodian mothers, there was a big nativity difference (45.1%). Similar to the other

results in previous tables, the following factors are significant in predicting small for gestational age and low birth weight: sex of the baby, maternal age, maternal education level, engagement in prenatal care visits during pregnancy, type of principal payment source for prenatal care services, smoking status during pregnancy, body mass index prior to pregnancy.

Logistic Regression with Race and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Disaggregated) Mothers in California

Table 4.7 illustrates logistic regression models for small for gestational age and low birth weight with race and nativity interactions among White, Cambodian, and all other Asian mothers. The subgroup for all other Asian mothers was disaggregated.

U.S.-born Cambodian mothers were twice as likely to deliver a baby that is considered small for gestational age or low birth weight compared to their U.S.-born White counterparts. Mothers from all the other Asian subgroup were also more likely to deliver a baby that is small for gestational age or low birth weight compared to U.S.-born White mothers. Apart from South Asian mothers, U.S.-born Cambodian mothers had the most elevated risk for adverse birth outcome relative to all the other U.S.-born Asian mothers.

In comparison to U.S.-born White mothers, foreign-born White mothers were 12.5% more likely to give birth to babies small for gestational age and 7.1% less likely to give birth to babies with low birth weight. The results indicate that U.S.-born Cambodians are at greater risk for giving birth to small for gestational age or low birth weight babies compared to their foreign-born counterparts; these results are similar for South Asian mothers. Moreover, the results reveal that race, nativity status, and the interaction (race x nativity) are significant risk factors for delivering a small for gestational age or low birth weight baby. Across these models, as in the

previous tables, maternal age, mother's educational attainment level, prenatal care visits, principal payment source for prenatal care visits, smoking status during pregnancy, and pre-pregnancy body mass index are significant risk factors for small for gestational age and low birth weight among mothers.

Several robustness checks are available in the appendix section (Tables 4.8 to 4.11). The robustness checks include logistic regression models for small for gestational age and low birth weight among Cambodian mothers in comparison to all other Asian mothers (both disaggregated and aggregated subgroups) with White mothers removed from the comparisons. However, the results were fairly similar in that Cambodian mothers were more likely to deliver babies with small for gestational age or low birth weight in comparison to the majority of all other Asian mother subgroups, except for South Asian mothers being more likely to deliver a baby with an adverse health outcome than Cambodian mothers.

Logistic Regression for Small for Gestational Age and Low Birth Weight among Cambodian Mothers in California by Nativity Status (2005-2019)

Table 4.12 illustrates the logistic regression models for small for gestational age and low birth weight among Cambodian mothers in California, by nativity status. Cambodian foreign-born mothers are at lower risk of delivering a small for gestational age baby (18.4%) and low birth weight baby (32.8%) than Cambodian U.S.-born mothers. Therefore, the results affirm the concept of the immigrant health advantage. Compared to male babies, female babies were 15.7% more likely to be born low birth weight. Compared to 25–29-year-old mothers, Cambodian mothers who were 19 years of age and under were more likely to give birth to a small for gestational age baby and low birth weight baby, 37.2% and 38.7%, respectively. Although Cambodian mothers who were 35 years and older were 17.9% less likely to deliver a small for

gestational age baby than their 25–29-year-old counterparts, they were 39.6% more likely to deliver a low-birth-weight baby. Cambodian mothers who smoked during their pregnancy were 39.7% more likely to give birth to a small for gestational age baby and were almost twice as likely (99%) to give birth to a low-birth-weight baby compared to Cambodian mothers who did not smoke during pregnancy. Cambodian mothers whose pre-pregnancy body mass index was considered obese were at higher odds of having a baby small for gestational age (65.9%) and low birth weight (65.5%) than Cambodian mothers whose pre-pregnancy body mass index was considered normal. Significant risk factors for small for gestational age among Cambodian mothers include nativity status, maternal age, smoking status during pregnancy, and pre-pregnancy body mass index. Significant risk factors for low birth weight among Cambodian mothers include nativity status, sex of the baby, maternal age, mother's educational attainment level, engagement in prenatal care visits during pregnancy, smoking status during pregnancy, and pre-pregnancy body mass index.

Discussion

The purpose of this study was to analyze potential risk factors for small for gestational age and low birth weight among Cambodian mothers in California by nativity status and make comparisons to White and Asian mothers. Findings confirmed the health disparities that exist within the Cambodian community. Although perinatal risks were elevated for all Cambodian mothers in comparison to White mothers, analyses revealed major differences by nativity status with U.S.-born Cambodian women at especially high risk compared to foreign-born Cambodian women and other subgroups.

I hypothesized that if a woman is Cambodian (regardless of her nativity status), then she will be more likely to have a baby that is either considered small for gestational age or low birth weight compared to her White and other Asian counterparts. However, the results revealed that

although Cambodian mothers were at greater risk for delivering a baby with adverse birth outcomes (namely small for gestational or low birth weight) in comparison to White mothers, and to most other Asian mothers, they were at slightly lower risk for delivering a baby with small for gestational age or low birth weight in comparison to their South Asian counterparts.

Additionally, I hypothesized that foreign-born Cambodian women, who may have had exposure to the genocide, would have greater risk of adverse birth outcomes (small for gestational age and low birth weight) than U.S.-born Cambodian women. Results revealed that U.S.-born Cambodian mothers were at greater risk of delivering a small for gestational age or low-birth-weight baby compared to foreign-born Cambodian mothers. Therefore, these results are consistent with the immigrant health advantage phenomenon. Results also revealed that although foreign-born Cambodian mothers were at lower risk of giving birth to a small for gestational age or low-birth-weight baby compared to their U.S.-born counterparts, they were still at greater risk for giving birth to a small for gestational age or low birth weight baby compared to U.S.-born and foreign-born White women.

Due to the size of the dataset used for this analysis, there are several variables that are statistically significant despite the magnitude of the effect being very small. Those variables may not be practically significant due to the large sample size. Instead, I focus on the findings with statistically significant p-values that reflect a larger magnitude difference in my interpretation.

Some findings were not consistent with previous studies. Cripe et al. (2011) found that in comparison to mothers who were White, mothers who were Cambodian (regardless of nativity) were more likely to give birth to healthier babies regardless of their poor maternal risk profile (i.e., older age, insufficient prenatal care, lower educational attainment levels, having multiple children). However, the results in our study revealed otherwise; U.S-born and foreign-born

Cambodian mothers were at greater risk of delivering a small for gestational age or low birth weight baby compared to White mothers. Lastly, Cripe et al. (2011) found that in comparison to White mothers, Southeast Asian mothers (specifically Cambodian and Laotian mothers) were more likely to give birth to healthier babies in spite of their adverse risk profiles such as having children at an older age or having a low educational attainment. However, the results from our study reveal that Cambodian mothers were more likely to deliver babies with small for gestational age or low birth weight compared to White mothers.

On the other hand, some of the findings were consistent with previous studies. Jacobson et al. (2022) found that U.S.-born mothers were more likely to deliver low birth weight babies compared to foreign-born mothers. Due to the concept of the immigrant health advantage, immigrants tend to have better health in comparison to their U.S.-born counterparts (Read, 2024). Singh & Yu (1996) also found that native-born mothers had greater risk of delivering a baby with an adverse health outcome. These notions support our general findings from the study because foreign-born Cambodian mothers were less likely to give birth to a small for gestational age or low birth weight baby in comparison to U.S.-born Cambodian mothers.

The results in our study revealed that U.S.-born Cambodian mothers were more likely to give birth to small for gestational age and low birth weight babies compared to their foreign-born counterparts. Lee et al. (2016) reaffirmed that there are heightened differences in maternal risks and perinatal birth outcomes between mothers who are U.S.-born and foreign-born, especially among Asian subgroups. In congruency with these results, the result from this study illustrates the variation of risks among the Asian subgroups. For instance, in comparison to their Asian counterparts and after adjusting for the covariates, South Asian mothers were at greatest risk for giving birth to a small for gestational age or a low-birth-weight baby. Moreover, foreign-born

nativity status was associated with lower risks for adverse birth outcomes among Southeast Asian groups (Cripe et al., 2011). The results from our study aligned with these findings in that foreign-born Cambodian mothers had lower risk of delivering a baby small for gestational age of low birth weight compared to their native-born counterparts.

Findings support the notion that Asian American subgroups are a heterogenous community (Yusuf et al., 2021), specifically in examining maternal nativity in relation to maternal risk factors and birth outcomes (Qin & Gould, 2010). Therefore, it is important to disaggregate Asian American populations to better examine their health outcomes and understand their health needs and in turn provide more tailored interventions and resources. In other words, data disaggregation is critical in addressing health inequities and health disparities, especially within the Asian American community (Tran et al., 2024). Thus, the findings from this study provided information on an underrepresented Asian American subgroup such as the Cambodian community. The findings may inform policy, programs, and services to better serve and meet the health needs of this population in order to mitigate the adverse birth outcomes that they experience.

Cripe et al. (2011) emphasizes the importance of disaggregating Southeast Asian groups as it may be attributed to identifying differences among maternal risks and perinatal birth outcomes. However, this study aggregated the groups due to small sample sizes. Furthermore, among the Asian American population, nativity status coupled with ethnic identification are potentially critical factors to consider as they may determine the severity of risk for adverse birth outcomes (Cripe et al., 2011). Thus, this study examines risk factors for small for gestational age and low birth rate by nativity status and different Asian American subgroups in comparison to White counterparts. In short, the findings from this study reaffirm the importance of better

understanding birth outcomes among different subgroups and utilizing the results to inform future interventions that are more culturally tailored to improve perinatal health outcomes.

Results revealed that mothers with higher body mass index prior to pregnancy were more likely to deliver a baby with a poor perinatal health outcome such as small for gestational age or low birth weight. Similarly, mothers with a higher body mass index during pregnancy were more susceptible to gestational diabetes and cesarean deliveries while their child is at a heighted risk for detrimental health outcome such as stillbirth, prematurity, macrosomia, and fatality (D'Souza et al., 2019). Therefore, to improve health outcomes for both the mothers and their children, it is important to encourage pre-pregnancy and early pregnancy counselling to keep expecting and new mothers informed about their health and their newborn's health (D'Souza et al., 2019). These interventions and services should be affordable and accessible to all mothers.

Limitations and Future Directions

This study is not without limitations. Therefore, the limitations discussed in this section can inform future directions and research. First off, having a larger sample size may have allowed for the exploration of small for gestational age and low birth weight in relation to Cambodian mothers' exposure to the Cambodian genocide. This analysis would have utilized age as a proxy for determining exposure to the Cambodian genocide during early childhood. However, there were not enough mothers in each sample for the age category if this relationship was explored in this study. If there was a large enough sample size, this may have allowed for the exploration of nativity and time of birth (i.e., a mother born in Cambodia during genocide) as potential risk factor for small for gestational age and low birth weight. However, this idea can be pursued in future research as a potential analysis given a large enough sample size.

As a result of the time constraint and de-identified data, receiving neighborhood-level data would allow for neighborhood comparisons throughout California. In other words, learning

more about neighborhood characteristics may provide more information on possible influences on the newborn's health outcome (small for gestational age and low birth weight) in relation to mother's nativity status and characteristics. Therefore, future research studies can explore this concept utilizing some of the most recent years of birth data in California. On the other hand, future studies can also replicate this study for a different state in the U.S. as findings may reveal that baby health outcomes could potentially vary across states.

The dataset did not have certain information on the health conditions of mothers. Maternal risk factors such as existing health conditions prior to conceiving including any mental health conditions, chronic health outcomes, or physical impairments were attributed to small for gestational age (Campbell et al., 2012; McCowan & Horgan, 2009). Therefore, having such covariates would be beneficial to include in the analysis as it may allow for a more comprehensive understanding of the baby's health outcome. This is telling about future research studies in the field of maternal and child health (specifically exploring small for gestational age and low birth weight by U.S-born and foreign-born mothers) to explore the mother's health and its relation to possibly contributing to the baby's health outcome.

The dataset did not have information on Apgar score. Apgar score is the most optimal measurement for a baby's health outcome within the first few minutes of birth (Abukari et al., 2021; Wainstock & Sheiner, 2022). Utilized for over 6 decades, the Apgar score has been an evaluation tool to determine whether the newborn baby will survive (Wainstock & Sheiner, 2022). The Apgar score is usually measured within the first 5 minutes upon the baby's arrival, ranging between 0 and 10, and a score under 7 is considered low (Wainstock & Sheiner, 2022). Therefore, if the information was available, the Apgar score at 5 minutes would have been categorized as under 7 minutes (low) and equal to or greater than 7 (not low) (Cripe et al., 2011).

Overall, future studies should include an Apgar score upon availability as it would be a beneficial indicator of the baby's health at birth (such as for birthweight).

Administrative vital records data have accurate information for specific variables like birthweight and date of birth, other variables are self-reported and may be subject to missingness of bias. For instance, some of the self-reported information include maternal data such as educational attainment, age, and race. Given that there is a possibility that some of the information could be rounded, estimates, or what is thought to be a more favorable response, not all the information recorded may be accurately collected. Self-reporting such data is linked to social desirability bias in which participants may be more inclined to respond to survey questions based on what they believe may be more "favorable" (Prinja et al., 2012). As a result, such bias has the potential to inaccurately capture data or skew the research findings. Policy makers and healthcare researchers should be aware about the biases that derive from self-reported data due to possible errors in measurement and response bias, particularly in relation to inaccuracy of information (Guerard et al., 2015). This may result in reporting errors and recall bias due to misremembering information (Guerard et al., 2015). Therefore, there could be some degree of bias in the self-reports.

Finally, given that this study includes California data between 2005-2019, future research may replicate this study by utilizing more recent data when available. Moreover, more data involved would allow for a larger sample size. Overall, conducting similar analyses with newer data may provide the opportunity to make comparisons between different time periods. Therefore, this suggestion for future research may lead to a more robust analysis or reveal patterns on adverse birth outcomes among the various subgroups of mothers in relation to nativity status.

Conclusion

The purpose of this study was to analyze the potential risk factors for small for gestational age and low birth weight among U.S.-born and foreign-born Cambodian mothers in California (2005-2019) in relation to their White and Asian counterparts. Cambodian mothers, regardless of their nativity, were at greater risk of giving birth to a baby small for gestational age or low birth weight compared to their White mothers. However, among Cambodian mothers, U.S.-born mothers were more likely to deliver babies who are considered small for gestational age or low birth weight in comparison to foreign-born mothers. However, irrespective of nativity status, among the disaggregated Asian subgroups and in comparison to White mothers, South Asian mothers were at greatest risk for delivering a baby who is small for gestational age or low birth weight. Overall, U.S.-born and foreign-born Cambodian mothers were more likely to give birth to a baby who is small for gestational age or low birth weight in comparison to U.S.-born and foreign-born White and other Asian mothers, except for South Asian mothers. Rao et al. (2006) suggest that their research findings can be utilized to inform and educate Asian American mothers on the specific risk factors of certain adverse perinatal health outcomes based on their ethnicity. Given that the findings from this study disaggregates Asian American subgroups, they may inform certain policies, programs, and services for specific Asian American ethnic groups based on their differing risk factors for adverse birth outcomes.

Table 4.1. Univariate Descriptive Statistics for Mothers in California (2005-2019)

	Total	Cambodian	All Other Asian	White
N	3,108,371	25,723	1,013,190	2,069,458
Small for Gestational Age	11.31%	17.95%	16.03%	8.92%
Low Birth Weight	4.50%	7.58%	5.72%	3.86%
Race				
White	66.58%			
Cambodian	0.83%			
All Other Asian	32.60%			
East Asian	12.30%			
Southeast Asian	11.84%			
Native Hawaiian/Pacific Islander	1.21%			
South Asian	5.10%			
Other Asian	2.14%			
Nativity				
Foreign-born	34.69%	62.08%	77.39%	13.45%
U.S.-born	65.31%	37.92%	22.61%	86.55%
Race x Nativity				
White U.S.-born	57.62%			
White Foreign-born	8.96%			
Cambodian U.S.-born	0.31%			
Cambodian Foreign-born	0.51%			
All Other Asian U.S.-born	7.37%			
All Other Asian Foreign-born	25.22%			
Sex of Baby				
Male	51.52%	51.42%	51.86%	51.36%
Female	48.48%	48.58%	48.14%	48.64%
Age Groups of Mothers				
19 & under	2.72%	6.14%	1.34%	3.36%
20-24	12.48%	19.64%	7.48%	14.85%
25-29	25.57%	29.42%	23.38%	26.60%
30-34	33.88%	27.24%	38.41%	31.74%
35 & over	25.34%	17.56%	29.40%	23.45%
Mother's Education				

Less than high school	5.13%	17.09%	3.89%	5.39%
High school	18.06%	34.91%	13.40%	20.12%
Any college/graduate school	76.81%	48%	82.70%	74.30%
Prenatal Care Visit				
No	0.45%	0.82%	0.25%	0.55%
Yes	99.55%	99.18%	99.75%	99.45%
Principal Payment Source (Pre-Care)				
Medi-Cal	21.94%	49.48%	20.21%	22.44%
Private	67.86%	45.21%	66.47%	68.82%
Other	9.83%	5.06%	13.12%	8.27%
Unknown/unreported	0.38%	0.26%	0.20%	0.47%
Smoke During Pregnancy				
No	82.88%	85.09%	86.61%	81.02%
Yes	2.63%	1.14%	0.53%	3.67%
Missing/Unknown	14.49%	13.77%	12.86%	15.30%
Body Mass Index				
Normal	49.69%	21.35%	32.31%	58.55%
Underweight	0.12%	0.06%	0.06%	0.16%
Overweight	31.34%	56.43%	48.37%	22.69%
Obese	18.84%	22.16%	19.27%	18.59%

Table 4.2. Bivariate Descriptive Statistics for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Disaggregated) Mothers in California (2005-2019)

	Birth Outcome (N=3,108,371)	
	Small for Gestational Age (N=351, 768)	**Low Birth Weight** (N=139, 843)
N	11.31%	4.50%
Race		
White	8.92%	3.86%
Cambodian	17.96%	7.58%
All Other Asian	16.04%	5.72%
East Asian	13.93%	4.14%
Southeast Asian	16.85%	6.73%
Native Hawaiian/Pacific Islander	10.10%	5.40%
South Asian	20.87%	7.31%
Other Asian	15.56%	5.66%
Nativity Status		
Foreign-Born	14.35%	5.06%
U.S.-born	9.70%	4.20%
Race x Nativity		
White U.S.-born	8.81%	3.89%
White Foreign-born	9.66%	3.67%
Cambodian U.S.-born	21.16%	9.36%
Cambodian Foreign-born	16%	6.49%
All Other Asian U.S.-born	16.23%	6.39%
All Other Asian Foreign-born	15.98%	5.53%
Sex of Baby		
Male	11.43%	4.18%
Female	11.19%	4.84%
Age Groups of Mothers		
19 & under	14.01%	6.02%
20-24	11.92%	4.61%
25-29	11.22%	4.13%
30-34	11.25%	4.22%
35 & over	10.91%	5.03%

Mother's Education		
Less than high school	13.56%	6.04%
High school	11.38%	4.79%
Any college/graduate school	11.13%	4.32%
Prenatal Care Visit		
No	11.30%	4.47%
Yes	13.65%	11.59%
Principal Payment Source (Pre-Care)		
Medi-Cal	12.64%	5.27%
Private	10.95%	4.32%
Other	10.89%	3.94%
Unknown/unreported	10.24%	7.11%
Smoke During Pregnancy		
No	11.28%	4.41%
Yes	16.41%	7.87%
Missing/Unknown	10.58%	4.40%
Body Mass Index		
Normal	8.51%	3.49%
Underweight	6.91%	2.73%
Overweight	15.76%	5.94%
Obese	11.32%	4.78%

Table 4.3. Logistic Regression for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian Mothers (Aggregated) in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Race								
White	1.00				1.00			
Cambodian	1.782	*0.000	1.723	1.842	1.750	*0.000	1.667	1.837
All Other Asian	1.727	*0.000	1.710	1.744	1.506	*0.000	1.483	1.528
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	1.065	*0.000	1.055	1.075	0.899	*0.000	0.885	0.912
Sex of Baby								
Male	1.00				1.00			
Female	0.979	*0.000	0.972	0.986	1.169	*0.000	1.156	1.182
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.313	*0.000	1.285	1.343	1.286	*0.000	1.244	1.329
20-24	1.112	*0.000	1.098	1.127	1.062	*0.000	1.041	1.083
30-34	0.968	*0.000	0.959	0.978	1.038	*0.000	1.022	1.053
35 & over	0.927	*0.000	0.917	0.936	1.247	*0.000	1.228	1.267
Mother's Education								
Less than high school	1.00				1.00			
High school	0.923	*0.000	0.907	0.939	0.914	*0.000	0.891	0.937
Any college/graduate school	0.946	*0.000	0.930	0.963	0.870	*0.000	0.848	0.892
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.780	*0.000	0.741	0.822	0.333	*0.000	0.315	0.354
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	0.965	*0.000	0.956	0.975	0.895	*0.000	0.882	0.909
Other	0.838	*0.000	0.826	0.850	0.699	*0.000	0.683	0.716
Unknown/unreported	0.921	*0.010	0.865	0.981	1.541	*0.000	1.431	1.659
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.813	*0.000	1.777	1.850	1.843	*0.000	1.792	1.895
Missing/Unknown	0.838	*0.000	0.823	0.853	0.797	*0.000	0.776	0.818
Body Mass Index								
Normal	1.00				1.00			

Underweight	0.824	*0.003	0.727	0.935	0.758	*0.006	0.621	0.925
Overweight	1.683	*0.000	1.669	1.697	1.571	*0.000	1.551	1.591
Obese	1.444	*0.000	1.420	1.468	1.568	*0.000	1.530	1.606
Constant	0.112	*0.000	0.106	0.118	0.104	*0.000	0.098	0.111

*p<0.05

Table 4.4. Logistic Regression for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Disaggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Race								
White	1.00				1.00			
Cambodian	1.810	*0.000	1.751	1.872	1.781	*0.000	1.697	1.870
East Asian	1.591	*0.000	1.571	1.612	1.141	*0.000	1.118	1.165
South Asian	2.544	*0.000	2.505	2.584	2.167	*0.000	2.115	2.219
Southeast Asian	1.743	*0.000	1.722	1.764	1.667	*0.000	1.637	1.697
Native Hawaiian/Pacific Islander	1.084	*0.000	1.047	1.122	1.381	*0.000	1.318	1.447
Other Asian	1.696	*0.000	1.658	1.734	1.442	*0.000	1.392	1.493
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	1.018	*0.001	1.008	1.028	0.878	*0.000	0.865	0.892
Sex of Baby								
Male	1.00				1.00			
Female	0.979	*0.000	0.972	0.986	1.169	*0.000	1.156	1.182
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.320	*0.000	1.291	1.350	1.290	*0.000	1.248	1.333
20-24	1.119	*0.000	1.104	1.133	1.061	*0.000	1.040	1.082
30-34	0.979	*0.000	0.970	0.989	1.057	*0.000	1.042	1.073
35 & over	0.957	*0.000	0.947	0.967	1.300	*0.000	1.280	1.320
Mother's Education								
Less than high school	1.00				1.00			
High school	0.928	*0.000	0.912	0.944	0.916	*0.000	0.894	0.940
Any college/graduate school	0.937	*0.000	0.922	0.954	0.874	*0.000	0.852	0.896
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.799	*0.000	0.758	0.842	0.361	*0.000	0.340	0.383
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	0.945	*0.000	0.936	0.955	0.887	*0.000	0.874	0.900
Other	0.863	*0.000	0.850	0.875	0.757	*0.000	0.739	0.775
Unknown/unreported	0.916	*0.006	0.860	0.976	1.555	*0.000	1.444	1.674
Smoke During Pregnancy								

No	1.00				1.00			
Yes	1.805	*0.000	1.769	1.842	1.850	*0.000	1.799	1.902
Missing/Unknown	0.831	*0.000	0.816	0.847	0.790	*0.000	0.769	0.811
Body Mass Index								
Normal	1.00				1.00			
Underweight	0.833	*0.004	0.734	0.945	0.759	*0.007	0.622	0.926
Overweight	1.682	*0.000	1.668	1.700	1.555	*0.000	1.535	1.575
Obese	1.463	*0.000	1.439	1.488	1.578	*0.000	1.540	1.617
Constant	0.112	*0.000	0.105	0.117	0.095	*0.000	0.089	0.101

*p<0.05

Table 4.5. Logistic Regression with Race and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Aggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Race								
White	1.00				1.00			
Cambodian	2.143	*0.000	2.039	2.254	2.039	*0.000	1.900	2.187
All Other Asian	1.791	*0.000	1.768	1.814	1.535	*0.000	1.506	1.565
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	1.127	*0.000	1.111	1.143	0.932	*0.000	0.912	0.953
Race x Nativity								
White x U.S.-born	1.00							
Cambodian x Foreign-born	0.701	*0.000	0.655	0.750	0.741	*0.000	0.673	0.817
All Other Asian x Foreign-born	0.911	*0.000	0.894	0.929	0.945	*0.000	0.918	0.973
Sex of Baby								
Male	1.00				1.00			
Female	0.979	*0.000	0.972	0.986	1.169	*0.000	1.156	1.182
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.307	*0.000	1.278	1.336	1.280	*0.000	1.238	1.322
20-24	1.110	*0.000	1.096	1.124	1.060	*0.000	1.039	1.081
30-34	0.968	*0.000	0.959	0.978	1.038	*0.000	1.023	1.054
35 & over	0.927	*0.000	0.917	0.936	1.248	*0.000	1.228	1.267
Mother's Education								
Less than high school	1.00				1.00			
High school	0.923	*0.000	0.907	0.939	0.914	*0.000	0.891	0.937
Any college/graduate school	0.944	*0.000	0.928	0.961	0.868	*0.000	0.847	0.890
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.785	*0.000	0.745	0.827	0.335	*0.000	0.316	0.355
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	0.967	*0.000	0.958	0.977	0.897	*0.000	0.883	0.910
Other	0.842	*0.000	0.829	0.854	0.701	*0.000	0.685	0.718
Unknown/unreported	0.919	*0.009	0.863	0.979	1.539	*0.000	1.430	1.657
Smoke During Pregnancy								

No	1.00				1.00			
Yes	1.822	*0.000	1.786	1.859	1.848	*0.000	1.797	1.901
Missing/Unknown	0.839	*0.000	0.824	0.855	0.798	*0.000	0.777	0.819
Body Mass Index								
Normal	1.00				1.00			
Underweight	0.825	*0.003	0.727	0.936	0.758	*0.006	0.621	0.925
Overweight	1.682	*0.000	1.668	1.700	1.570	*0.000	1.550	1.590
Obese	1.444	*0.000	1.420	1.468	1.568	*0.000	1.530	1.606
Constant	0.110	*0.000	0.105	0.117	0.103	*0.000	0.097	0.110

*p<0.05

Table 4.6. Logistic Regression with Race and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Aggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Race x Nativity								
White U.S.-born	1.00				1.00			
White Foreign-born	1.127	*0.000	1.111	1.143	0.932	*0.000	0.912	0.953
Cambodian U.S.-born	2.144	*0.000	2.039	2.254	2.039	*0.000	1.900	2.187
Cambodian Foreign-born	1.693	*0.000	1.620	1.768	1.409	*0.000	1.320	1.504
All Other Asian U.S.-born	1.791	*0.000	1.768	1.814	1.535	*0.000	1.506	1.565
All Other Asian Foreign-born	1.839	*0.000	1.823	1.855	1.353	*0.000	1.335	1.371
Sex of Baby								
Male	1.00				1.00			
Female	0.979	*0.000	0.972	0.986	1.169	*0.000	1.156	1.182
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.307	*0.000	1.278	1.336	1.280	*0.000	1.238	1.322
20-24	1.110	*0.000	1.096	1.124	1.060	*0.000	1.039	1.081
30-34	0.968	*0.000	0.959	0.978	1.038	*0.000	1.023	1.054
35 & over	0.927	*0.000	0.917	0.936	1.248	*0.000	1.228	1.267
Mother's Education								
Less than high school	1.00				1.00			
High school	0.923	*0.000	0.907	0.939	0.914	*0.000	0.891	0.937
Any college/graduate school	0.944	*0.000	0.928	0.961	0.868	*0.000	0.847	0.890
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.785	*0.000	0.745	0.827	0.335	*0.000	0.316	0.355
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	0.967	*0.000	0.958	0.977	0.897	*0.000	0.883	0.910
Other	0.842	*0.000	0.829	0.854	0.701	*0.000	0.685	0.718
Unknown/unreported	0.919	*0.009	0.863	0.979	1.539	*0.000	1.430	1.657
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.822	*0.000	1.786	1.859	1.848	*0.000	1.797	1.901
Missing/Unknown	0.839	*0.000	0.824	0.855	0.798	*0.000	0.777	0.819
Body Mass Index								

Normal	1.00				1.00			
Underweight	0.825	*0.003	0.727	0.936	0.758	*0.006	0.621	0.925
Overweight	1.682	*0.000	1.668	1.696	1.570	*0.000	1.550	1.590
Obese	1.444	*0.000	1.420	1.468	1.568	*0.000	1.530	1.606
Constant	0.110	*0.000	0.105	0.117	0.103	*0.000	0.097	0.110

*p<0.05

Table 4.7. Logistic Regression with Race and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among White, Cambodian, and All Other Asian (Disaggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Race								
White	1.00				1.00			
Cambodian	2.134	*0.000	2.029	2.243	2.066	*0.000	1.926	2.217
East Asian	1.746	*0.000	1.707	1.786	1.306	*0.000	1.260	1.353
South Asian	3.058	*0.000	2.932	3.189	2.356	*0.000	2.214	2.508
Southeast Asian	1.874	*0.000	1.841	1.907	1.700	*0.000	1.657	1.745
Native Hawaiian/Pacific Islander	1.019	0.415	0.973	1.068	1.231	*0.000	1.157	1.310
Other Asian	1.756	*0.000	1.700	1.815	1.395	*0.000	1.325	1.467
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	1.125	*0.000	1.109	1.140	0 .929	*0.000	0.909	0.949
Race x Nativity								
White x U.S.-born	1.00				1.00			
Cambodian x Foreign-born	0.701	*0.000	0.655	0.750	0.736	*0.000	0.668	0.811
East Asian x Foreign-born	0.822	*0.000	0.799	0.845	0.805	*0.000	0.770	0.842
South Asian x Foreign-born	0.753	*0.000	0.719	0.788	0.870	*0.000	0.812	0 .932
Southeast Asian x Foreign- born	0.835	*0.000	0.816	0.856	0.930	*0.000	0.897	0.964
Native Hawaiian/Pacific Islander x Foreign-born	1.076	*0.039	1.004	1.155	1.264	*0.000	1.150	1.389
Other Asian x Foreign-born	0.873	*0.000	0.834	0.913	1.020	0.589	0.950	1.094
Sex of Baby								
Male	1.00				1.00			
Female	0.979	*0.000	0.972	0.986	1.169	*0.000	1.156	1.182
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.314	*0.000	1.285	1.344	0.823	*0.000	0.796	0.851
20-24	1.116	*0.000	1.102	1.130	0.777	*0.000	0.752	0.803
30-34	0.978	*0.000	0.969	0.987	0.821	*0.000	0.794	0.849
35 & over	0.956	*0.000	0.946	0.966	1.009	0.591	0.976	1.043
Mother's Education								
Less than high school	1.00				1.00			
High school	0.928	*0.000	0.912	0.945	0.917	*0.000	0.894	0.941
Any college/graduate school	0.934	*0.000	0.918	0.950	0.873	*0.000	0.851	0.895
Prenatal Care Visit								

No	1.00				1.00			
Yes	0.805	*0.000	0.764	0.849	0.364	*0.000	0.343	0.386
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	0.947	*0.000	0.937	0.956	0.887	*0.000	0.874	0.900
Other	0.869	*0.000	0.857	0.882	0.763	*0.000	0.746	0.782
Unknown/unreported	0.912	*0.004	0.856	0.971	1.551	*0.000	1.441	1.670
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.821	*0.000	1.785	1.858	1.859	*0.000	1.807	1.912
Missing/Unknown	0.834	*0.000	0.819	0.849	0.790	*0.000	0.769	0.811
Body Mass Index								
Normal	1.00				1.00			
Underweight	0.835	*0.005	0.736	0.947	0.760	*0.007	0.623	0.927
Overweight	1.679	*0.000	1.665	1.693	1.553	*0.000	1.533	1.573
Obese	1.464	*0.000	1.439	1.488	1.580	*0.000	1.542	1.619
Constant	0.108	*0.000	0.103	0.114	0.121	*0.000	0.113	0.129

*p<0.05

APPENDIX

Table 4.8. Logistic Regression for Small for Gestational Age and Low Birth Weight among Cambodian and All Other Asian (Aggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Asian Subgroup								
All Other Asians	1.00				1.00			
Cambodian	1.083	*0.000	1.047	1.120	1.212	*0.000	1.154	1.272
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	1.023	*0.001	1.010	1.036	0.890	*0.000	0.872	0.908
Sex of Baby								
Male	1.00				1.00			
Female	0.932	*0.000	0.922	0.942	1.147	*0.000	1.128	1.166
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.354	*0.000	1.296	1.415	1.458	*0.000	1.368	1.555
20-24	1.128	*0.000	1.104	1.153	1.123	*0.000	1.084	1.163
30-34	0.934	*0.000	0.921	0.947	1.026	*0.027	1.003	1.050
35 & over	0.831	*0.000	0.819	0.844	1.196	*0.000	1.168	1.224
Mother's Education								
Less than high school	1.00				1.00			
High school	0.988	0.420	0.958	1.018	0.981	0.409	0.938	1.027
Any college/graduate school	1.103	*0.000	1.071	1.135	0.994	0.786	0.952	1.038
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.920	0.135	0.825	1.026	0.299	*0.000	0.265	0.336
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	1.100	*0.000	1.084	1.117	1.028	*0.020	1.004	1.052
Other	0.877	*0.000	0.859	0.896	0.670	*0.000	0.647	0.694
Unknown/unreported	0.783	*0.000	0.684	0.897	1.223	*0.023	1.028	1.455
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.169	*0.000	1.090	1.253	1.467	*0.000	1.335	1.612
Missing/Unknown	0.812	*0.000	0.791	0.832	0.783	*0.000	0.753	0.814
Body Mass Index								
Normal	1.00				1.00			

Underweight	1.350	*0.009	1.079	1.689	0.843	0.444	0.545	1.304
Overweight	1.620	*0.000	1.599	1.640	1.545	*0.000	1.514	1.577
Obese	1.583	*0.000	1.548	1.620	1.661	*0.000	1.603	1.720
Constant	0.145	*0.000	0.130	0.163	0.147	*0.000	0.187	0.244

*p<0.05

Table 4.9. Logistic Regression for Small for Gestational Age and Low Birth Weight among Cambodian and All Other Asian (Disaggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Asian Subgroup								
East Asian	1.00				1.00			
Cambodian	1.183	*0.000	1.142	1.225	1.669	*0.000	1.585	1.757
South Asian	1.583	*0.000	1.558	1.608	1.881	*0.000	1.832	1.931
Southeast Asian	1.107	*0.000	1.092	1.122	1.487	*0.000	1.454	1.520
Native Hawaiian/Pacific Islander	0.688	*0.000	0.664	0.714	1.267	*0.000	1.204	1.332
Other Asian	1.057	*0.000	1.032	1.082	1.270	*0.000	1.223	1.319
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	0.942	*0.000	0.929	0.954	0.850	*0.000	0.832	0.867
Sex of Baby								
Male	1.00				1.00			
Female	0.932	*0.000	0.922	0.942	1.147	*0.000	1.128	1.166
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.380	*0.000	1.321	1.442	1.435	*0.000	1.346	1.530
20-24	1.145	*0.000	1.120	1.171	1.104	*0.000	1.066	1.143
30-34	0.957	*0.000	0.944	0.971	1.075	*0.000	1.051	1.100
35 & over	0.886	*0.000	0.873	0.900	1.313	*0.000	1.282	1.345
Mother's Education								
Less than high school	1.00				1.00			
High school	1.002	0.915	0.972	1.032	0.992	0.713	0.948	1.037
Any college/graduate school	1.077	*0.000	1.047	1.108	1.013	0.547	0.970	1.058
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.938	0.250	0.840	1.046	0.349	*0.000	0.310	0.393
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	1.059	*0.000	1.043	1.074	1.011	0.342	0.988	1.035
Other	0.931	*0.000	0.911	0.952	0.784	*0.000	0.756	0.813
Unknown/unreported	0.781	*0.000	0.681	0.894	1.264	*0.008	1.062	1.504
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.254	*0.000	1.170	1.345	1.490	*0.000	1.356	1.638

Missing/Unknown	0.813	*0.000	0.792	0.833	0.779	*0.000	0.750	0.810
Body Mass Index								
Normal	1.00				1.00			
Underweight	1.413	*0.003	1.129	1.769	0.855	0.481	0.552	1.323
Overweight	1.618	*0.000	1.597	1.639	1.504	*0.000	1.473	1.536
Obese	1.610	*0.000	1.573	1.647	1.657	*0.000	1.599	1.717
Constant	0.137	*0.000	0.122	0.153	0.092	*0.000	0.081	0.105

*p<0.05

Table 4.10. Logistic Regression with Asian Subgroup and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among Cambodian and All Other Asian (Disaggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Asian Subgroup								
East Asian	1.00				1.00			
Cambodian	1.317	*0.000	1.246	1.392	1.771	*0.000	1.635	1.919
South Asian	1.740	*0.000	1.660	1.824	1.806	*0.000	1.683	1.939
Southeast Asian	1.096	*0.000	1.066	1.127	1.359	*0.000	1.302	1.419
Native Hawaiian/Pacific Islander	0.616	*0.000	0.585	0.648	1.026	0.494	0.954	1.102
Other Asian	1.020	0.320	0.981	1.060	1.099	*0.002	1.635	1.919
Nativity								
U.S.-Born	1.00				1.00			
Foreign-Born	0.937	*0.000	0.914	0.960	0.772	*0.000	0.742	0.804
Asian Subgroup x Nativity								
East Asian x U.S.-born	1.00				1.00			
Cambodian x Foreign-born	0.830	*0.000	0.774	0.891	0.867	*0.007	0.781	0.961
South Asian x Foreign-born	0.902	*0.000	0.858	0.948	1.060	0.135	0.982	1.144
Southeast Asian x Foreign-born	1.013	0.405	0.982	1.046	1.125	*0.000	1.071	1.182
Native Hawaiian/Pacific Islander x Foreign-born	1.297	*0.000	1.206	1.395	1.528	*0.000	1.382	1.688
Other Asian x Foreign-born	1.064	*0.014	1.013	1.118	1.253	*0.000	1.159	1.355
Sex of Baby								
Male	1.00				1.00			
Female	0.932	*0.000	0.922	0.942	1.147	*0.000	1.127	1.166
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.373	*0.000	1.314	1.435	1.430	*0.000	1.341	1.526
20-24	1.144	*0.000	1.112	1.169	1.103	*0.000	1.065	1.143
30-34	0.956	*0.000	0.943	0.970	1.074	*0.000	1.049	1.099
35 & over	0.885	*0.000	0.871	0.898	1.311	*0.000	1.280	1.343
Mother's Education								
Less than high school	1.00				1.00			
High school	1.003	0.835	0.973	1.034	0.994	0.809	0.950	1.041
Any college/graduate school	1.077	*0.000	1.046	1.108	1.014	0.519	0.971	1.059
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.941	0.276	0.843	1.050	0.358	*0.000	0.314	0.398

Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	1.061	*0.000	1.045	1.077	1.013	0.293	0.989	1.037
Other	0.933	*0.000	0.913	0.953	0.793	*0.000	0.764	0.822
Unknown/unreported	0.781	*0.000	0.681	0.894	1.266	*0.008	1.064	1.506
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.259	*0.000	1.174	1.350	1.498	*0.000	1.363	1.647
Missing/Unknown	0.813	*0.000	0.793	0.834	0.778	*0.000	0.749	0.809
Body Mass Index								
Normal	1.00				1.00			
Underweight	1.411	*0.003	1.127	1.767	0.853	0.476	0.551	1.321
Overweight	1.618	*0.000	1.597	1.639	1.503	*0.000	1.472	1.534
Obese	1.611	*0.000	1.574	1.648	1.659	*0.000	1.601	1.719
Constant	0.137	*0.000	0.122	0.153	0.098	*0.000	0.086	0.112

*p<0.05

Table 4.11. Logistic Regression with Asian Subgroup and Nativity Interaction Term for Small for Gestational Age and Low Birth Weight among Cambodian and All Other Asian (Aggregated) Mothers in California (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Asian Subgroup								
All Other Asian	1.00				1.00			
Cambodian	1.283	*0.000	1.219	1.351	1.408	*0.000	1.309	1.514
Nativity								
U.S.-born	1.00				1.00			
Foreign-born	1.033	*0.000	1.019	1.046	0.898	*0.000	0.880	0.917
Asian Subgroup x Nativity								
All Other Asian x U.S.-born	1.00				1.00			
Cambodian x Foreign-born	0.753	*0.000	0.704	0.805	0.770	*0.000	0.699	0.849
Sex of Baby								
Male	1.00				1.00			
Female	0.932	*0.000	0.922	0.942	1.147	*0.000	1.127	1.166
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.336	*0.000	1.279	1.396	1.438	*0.000	1.348	1.533
20-24	1.124	*0.000	1.099	1.149	1.118	*0.000	1.080	1.158
30-34	0.934	*0.000	0.921	0.947	1.027	*0.023	1.004	1.051
35 & over	0.832	*0.000	0.820	0.845	1.197	*0.000	1.169	1.226
Mother's Education								
Less than high school	1.00				1.00			
High school	0.988	0.447	0.959	1.019	0.982	0.430	0.938	1.027
Any college/graduate school	1.101	*0.000	1.070	1.133	0.993	0.735	0.950	1.036
Prenatal Care Visit								
No	1.00				1.00			
Yes	0.921	0.141	0.826	1.028	0.299	*0.000	0.265	0.337
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	1.102	*0.000	1.086	1.119	1.030	*0.014	1.006	1.054
Other	0.877	*0.000	0.859	0.896	0.670	*0.000	0.647	0.694
Unknown/unreported	0.784	*0.000	0.685	0.898	1.224	*0.022	1.029	1.457
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.168	*0.000	1.090	1.252	1.466	*0.000	1.334	1.611

Missing/Unknown	0.812	*0.000	0.792	0.833	0.783	*0.000	0.754	0.814
Body Mass Index								
Normal	1.00				1.00			
Underweight	1.350	*0.009	1.079	1.689	0.843	0.443	0.545	1.304
Overweight	1.620	*0.000	1.599	1.641	1.546	*0.000	1.515	1.578
Obese	1.584	*0.000	1.549	1.621	1.662	*0.000	1.605	1.722
Constant	0.144	*0.000	0.129	0.161	0.146	*0.000	0.128	0.165

*p<0.05

Table 4.12. Logistic Regression for Small for Gestational Age and Low Birth Weight among Cambodian Mothers in California by Nativity Status (2005-2019)

	Small for Gestational Age				Low Birth Weight			
	Odds Ratio	p-value	95% CI		Odds Ratio	p-value	95% CI	
Nativity Status								
Cambodian U.S.-born	1.00				1.00			
Cambodian Foreign-born	0.816	*0.000	0.753	0.883	0.672	*0.000	0.597	0.755
Sex of Baby								
Male	1.00				1.00			
Female	0.939	0.058	0.880	1.002	1.157	*0.003	1.052	1.272
Age Groups of Mothers								
25-29	1.00				1.00			
19 & under	1.372	*0.000	1.188	1.585	1.387	*0.001	1.137	1.692
20-24	1.100	0.051	0.999	1.211	1.012	0.868	0.876	1.170
30-34	0.855	*0.001	0.782	0.936	0.992	0.904	0.865	1.136
35 & over	0.821	*0.000	0.737	0.913	1.396	*0.000	1.202	1.620
Mother's Education								
Less than high school	1.00				1.00			
High school	1.001	0.986	0.907	1.104	0.856	*0.028	0.746	0.983
Any college/graduate school	0.995	0.916	0.900	1.099	0.898	0.134	0.779	1.034
Prenatal Care Visit								
No	1.00				1.00			
Yes	1.140	0.536	0.753	1.724	0.444	*0.000	0.286	0.689
Principal Payment Source (Pre-Care)								
Medi-Cal	1.00				1.00			
Private	0.958	0.265	0.890	1.033	0.901	0.064	0.807	1.006
Other	0.874	0.123	0.738	1.037	0.947	0.660	0.744	1.206
Unknown/unreported	0.605	0.216	0.273	1.340	1.070	0.885	0.425	2.696
Smoke During Pregnancy								
No	1.00				1.00			
Yes	1.397	*0.017	1.063	1.836	1.990	*0.000	1.439	2.751
Missing/Unknown	0.854	*0.026	0.743	0.981	0.812	*0.039	0.666	0.990
Body Mass Index								
Normal	1.00				1.00			
Underweight	1.765	0.381	0.496	6.283	2.683	0.197	0.599	12.023
Overweight	1.648	*0.000	1.505	1.803	1.445	*0.000	1.268	1.647
Obese	1.659	*0.000	1.451	1.897	1.655	*0.000	1.370	1.998
Constant	0.161	*0.000	0.104	0.248	0.230	*0.000	0.147	0.336

*p<0.05

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CHAPTER 5: SUMMARY AND CONCLUSION

The intention of the overall dissertation was to understand the possible health disparities experienced among and within the Cambodian community, both abroad and domestically. The studies in this dissertation achieved this purpose by examining the health impacts of the Cambodian genocide among the Cambodian population in Cambodia and analyzing the risk factors of adverse maternal and child health outcomes among and within the Cambodian community in Cambodia and the U.S.

Health research on long-term impacts of the genocide or birth outcomes of subsequent generations among the Cambodian community, either in Cambodia or in the U.S., is generally limited and/or outdated (Greffeuille et al., 2016; Um et al., 2024). In addition to the utilization of more recent data as well as through weighted data and birth data from health records, results were generalizable to the broader Cambodian community. According to the findings, Cambodian individuals in Cambodia who experienced the Cambodian genocide during early childhood witnessed decreased fertility patterns and increased mortality patterns. The prevalence of adverse health outcomes (smoking, stunted growth, disabilities) was greater among survivors of the Cambodian genocide in Cambodia compared to individuals born after the genocide. Thus, the long-term health impacts of the Cambodian genocide persistently affect individuals who had childhood exposure to the horrific event. However, in relation to Cambodian mothers in Cambodia, those who did not have childhood exposure to the genocide were more likely to deliver a low birthweight baby or a baby small in birth size compared to Cambodian mothers who were exposed to the genocide during early childhood. Therefore, this finding may reveal that young age (20 years of age or younger) is attributed to adverse perinatal health outcomes such as low birth weight and small birth size. This finding is consistent with previous research (Dennis & Mollborn, 2013; Forna et al., 2003; Qin & Gould, 2006). Moreover, native-born

Cambodian mothers in California were more likely to give birth to a baby with low birth weight or small for gestational age compared to foreign-born Cambodian mothers in California. This finding aligns with the concept of the immigrant health advantage in which foreign-born individuals tend to have better health outcomes compared to their native-born counterparts (Bacong & Menjívar, 2021; Brabete, 2017; Riosmena & Jochem, 2017). In general, and irrespective of nativity status, Cambodian mothers in California were more likely than White and all other Asian mothers to deliver a baby that is low birth weight or small for gestational age.

Summary of Findings

In Chapter 2, the objective was to examine the health impacts of the Cambodian genocide on Cambodia's population in relation to fertility, mortality, and morbidities (smoking, stunted growth, and disability). This was achieved by utilizing 1) population pyramids to understand the birth and death patterns in Cambodia while making comparisons to Thailand for the following years: 1975, 1985, 2014, 2022; and 2) Cambodia 2014 and 2021-2022 Demographic and Health Surveys data, the two most recent waves of survey data, to analyze whether age and survey year were predictive of adverse health outcomes such as smoking, stunted growth, and disability while controlling for educational attainment level, marital status, and wealth index. I hypothesized that the impacts of the Cambodian genocide would affect the country's composition, namely decreased birth rates and increased mortality rates. I also hypothesized that individuals born shortly before or during the Cambodian genocide would have worse health outcomes compared to their counterparts who were born shortly after the genocide.

The findings highlight the detrimental health impacts of the Cambodian genocide on Cambodia's population, both during the time of the genocide and after. The population pyramid comparisons within different time points in Cambodia as well as between Cambodia and

Thailand reveal that the Cambodian genocide impacted Cambodia's demographic composition given that there was a steep decrease in fertility patterns and a substantial increase in mortality patterns. The findings from the secondary data analyses reveal that early childhood exposure to the Cambodian genocide was attributed to adverse long-term health conditions among survivors. The prevalence of smoking and stunted growth was higher among Cambodian women who experienced childhood exposure to the Cambodian genocide compared to counterparts who were born shortly after the genocide. Higher rates of disability were apparent among Cambodian men and women who were older in age, whether a result of childhood exposure to the genocide or typical aging processes. The findings from this study highlight the health impacts of the Cambodian genocide on its survivors despite decades since the tragic event. Thus, it is imperative that researchers and other stakeholders continue to examine the long-term health impacts of the genocide and address its implications on health disparities within the Cambodian community in Cambodia to mitigate adverse health outcomes among this population.

In Chapter 3, I analyzed the potential maternal and infant risk factors for low birth weight and small birth size among Cambodian mothers in Cambodia. This was achieved by utilizing the 2000, 2005, and 2010 Cambodia Demographic and Health Surveys data. In comparing the same age group (21-25 years old mothers) across survey years and in comparing age groups within each survey year, I hypothesized that mothers who were born during the genocide would be more likely to give birth to a low-birth-weight baby or a baby small in birth size. The age groups within each survey year consisted of mothers who were born, during, and after the genocide.

Across the three survey years and among 21–25-year-old mothers in Cambodia, results revealed that mothers born after the genocide were more likely to deliver a baby considered low birth weight compared to mothers who were born during the time of the genocide. However, age

was not a significant predictive factor for delivering a small birth size baby. Within-survey year findings slightly varied. Significant results are as follows: 1) As a result of utilizing the 2000 data, Cambodian mothers who were born before the genocide were less likely to deliver a baby small for birth size compared to mothers born during the genocide; 2) As a result of utilizing the 2005 data, Cambodian mothers who were born before the genocide were less likely to give birth to a low birth weight baby or a baby small for birth size in comparison to mothers born during the genocide; 3) As a result of utilizing the 2010 data, Cambodian mothers more after the genocide were more likely to deliver a baby small for birth size than their counterparts. Consequently, findings from this study highlight the importance of intergenerational adverse birth health outcomes. In other words, depending on the survey year, 1) mothers who were born during the genocide were at higher risk of delivering babies who are either low birth weight or small for birth size than mothers who were born prior to the genocide; 2) mothers who were not exposed to the genocide during early childhood were more likely to deliver a baby considered small for birth size. Therefore, it is crucial that researchers continue to investigate generational health impacts as subsequent generations who did not directly experience the genocide were still negatively affected by its long-term impacts.

In Chapter 4, I examined the possible risk factors for low birth weight and small for gestational age among Cambodian mothers in California by nativity status and made comparisons to White mothers as well as all other Asian subgroups (aggregated and disaggregated). This was achieved by using 2005-2019 California Birth Record data. Irrespective of nativity status and compared to White and all other Asian mothers, I hypothesized that Cambodian mothers were more likely to deliver a baby with low birth weight or who was small for gestational age. Among Cambodian mothers, I hypothesized that mothers born in Cambodia

were more likely to give birth to a low-birth-weight baby or a baby that is small for gestational age compared to mothers born in the U.S.

The findings revealed that across nearly all the models and compared to other White and Asian mothers, Cambodian mothers were at greater risk for delivering a low-birth-weight baby or a small for gestational age baby. Accounting for nativity status, another significant result revealed that Cambodian mothers who were born in the U.S. were more likely to give birth to a low-birth-weight baby or a small for gestational age baby compared to Cambodian mothers who were born in Cambodia. The findings convey that being Cambodian is a predictive risk factor for delivering a baby with an adverse health outcome. Lifetime exposure to structural conditions in the U.S. appears to exacerbate the risk for U.S.-born women. Thus, it is important for researchers to continue to disaggregate Asian American health data to ensure that health disparities within marginalized ethnic groups, like the Cambodian community, are addressed and mitigated.

Study Implications

The findings from each study in this dissertation have important implications to this existing field of study. The findings reveal that the aftermath of the Cambodian genocide negatively impacts the health outcomes of survivors and their subsequent generations. Therefore, regardless of having directly experienced the genocide and decades after the tragic event occurred, the Cambodian population in Cambodia and the U.S. continues to experience detrimental health outcomes and adverse birth outcomes. The findings also illuminate the differences in adverse adult and infant health outcomes within the Cambodian community when comparing age groups and or nativity status.

Given that there is a limited amount of research on the long-term health impacts and generational health impacts from the genocide on the Cambodian population (Milazzo & Cuesta,

2021), the findings from these three studies may contribute to the broader literature on Cambodian health outcomes. It is important to highlight that these findings derived from more recent years of data yet still reveal the ongoing health disparities that the Cambodian community encounters, both abroad and domestically. These studies highlight the importance of data disaggregation, particularly among the Asian American community, to unmask health disparities. The overall goal of these studies is to utilize the results to inform health policy, programming, resources, and or services for the Cambodian community both globally and domestically. This can possibly be achieved through culturally tailored and linguistically appropriate improvements and or implementations of the aforementioned tools. For example, it is important to increase health access and health services utilization among the Cambodian and Cambodian American community as the following recommendations may enhance the quality of life for this population: providing translation services so that Cambodian patients can have a greater sense of trust with healthcare professionals; creating a welcoming environment for Cambodian individuals so they can feel comfortable enough to return and utilize such services; cultivate awareness of available health services through community engagement and outreach so that Cambodian community members can remain educated and informed (Weng & Ordaz, 2021). These recommendations may be implemented through partnership between local/government entities along with community organizations, religious institutions, and health care settings. Future research may continue to explore risk factors for adverse adult and perinatal health outcomes among the Cambodian community, and to replicate similar studies for other marginalized populations who may have experienced genocide.

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