MATERNAL PSYCHOSOCIAL STRESS AND NEONATE OUTCOMES

ON THE PACIFIC ISLAND OF TUTUILA

by

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Maternal Psychosocial Stress and Neonate Outcomes on the Pacific Island of Tutuila

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## Abstract

This dissertation explores the association between chronic maternal psychosocial stress and neonate body size, size for gestational age and gestation length in Samoan women living on the Pacific island of Tutuila, American Samoa. Two interrelated studies were conducted to address this goal. First, the medical charts of all women of Samoan descent giving birth on island (n=1052) were reviewed to determine whether their marital status impacted the amount of prenatal care they accessed, the types and amounts of surgical interventions they received during pregnancy and their neonates' size and gestation length. Results indicated that married women accessed prenatal care earlier and more frequently and were less likely to have an episiotomy or operative vaginal delivery than unmarried women. However, women's marital status was not associated with any other medical interventions used during delivery. Although marital status was significantly related to some neonate outcomes, these differences are unlikely to be biologically significant and more likely to be an artifact of the large sample size.

The second study recruited 151 women from their initial prenatal care appointments. Multiple measures of psychosocial stress were conducted throughout their pregnancies and their delivery and neonate outcomes were collected post-partum. A physiological response to psychosocial stress was measured using a minimally invasive indirect biomarker: Epstein-Barr Virus antibody levels (EBV). EBV was compared to three self-reported stress measures (status congruence, Perceived Stress Scale, Monthly Stress Questionnaire) in 78 pregnant women to determine if any of these self-reported scales accurately reflect psychosocial stress in Samoan women. There was no relationship between EBV and any of the self-reported measures of stress. Finally, the relationship between psychosocial stress (as measured by EBV), maternal characteristics and neonate outcomes was investigated. No relationship was found. Taken together, this study provides no evidence that psychosocial stress impacts pregnancy outcomes in Samoan women giving birth in American Samoa. These results were somewhat surprising in light of previous research conducted in the United States and Europe that has found a relationship between psychosocial stress and neonate outcomes.

*For James and Richard*

*Who helped me make the bread*

v

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# CHAPTER 1: INTRODUCTION TO THE STUDY

INTRODUCTION

The objective of this dissertation is to determine the association of chronic psychosocial stress on neonate body size, size for gestational age and gestation length. In order to achieve this goal I conducted a biocultural, longitudinal, prospective study of pregnancy outcomes in Samoan women living on the Pacific island of Tutuila. Short-term, cross-sectional studies set in North America and Western Europe have uncovered a pattern of pregnancy disruption, including spontaneous abortions (SAB), stillbirths, low birth weights and premature deliveries associated with stressful psychosocial events. It is unclear if this pattern extends beyond North American and Western European populations and whether some kinds of psychosocial stress (marital status, immigration status etc.) impact pregnancy more than others.

In this study I utilized a non-invasive biomarker of psychosocial stress, Epstein-Barr virus (EBV) antibody concentrations to determine the association between stress and maternal and pregnancy outcomes. EBV antibody concentrations represent a broad, non-specific response to psychosocial stressors. I recruited 151 pregnant women from their initial antenatal care appointment and continued following them until their pregnancy's natural conclusion. In addition I reviewed the medical charts of 1052 pregnant Samoan women giving birth in American Samoa and determined whether marital status impacted prenatal care, medical interventions and pregnancy outcomes. Pregnancy outcomes were assessed in terms of infant size and gestation length.

This chapter provides an in-depth context for my dissertation and centers around four goals. First, I introduce the physiological stress response. Secondly, I focus on the physiological

role of stress during pregnancy and review the literature associated with stress and pregnancy outcomes. Next, I provide a theoretical orientation for the current study based around reproductive ecology and stress. I finish the chapter with a brief discussion of the goals of each of following chapters.

## THE PHYSIOLOGICAL STRESS REPONSE

In order to appreciate the role of stress in impacting pregnancy, it is important to understand the fundamentals of the stress response. Simplified, the stress response is initiated by an external stimulus (a stressor) which leads to stress perception of the hypothalamus and pituitary. The stress perception in the brain triggers the response of the physiological supersystems. The supersystems include the endocrine, immune and nervous system. After being triggered, the supersystems activate the stress response throughout the body (Cacioppo et al., 1998).

In 1914 Walter Cannon suggested an adaptive role of the stress response which he labeled the emergency reaction hypothesis (Cannon, 1914). This increased efficiency of operation is commonly referred to as the fight or flight response. This is an individual's response to acute stressors such as a predator or an intergroup disruption. The physiological responses to stress include an elevated heart rate, vasoconstriction, mobilization of liver glycogen and free fatty acids, the relaxation of bronchiolar muscles, piloerection and vasodialation of arterioles in skeletal muscles. As a result, energy is diverted from non-essential systems towards the immediate needs of an animal (Cannon, 1914).

The stress response represents a complex series of pathophysiological changes that alter the homeostasis of the super systems (e.g., the endocrine system, the cardiovascular system etc.). These stress related modifications to the system aggravate the inflammatory, autoimmune and

allergic pathogenesis of many diseases (Nakamura et al., 2008). Although this system evolved as a short term response to acute stressors, modern humans experience chronic stress which can be detrimental to their health (Sapolsky, 1998).

In 1914 Cannon first described the hormonal cascade associated with the stress response and the role of cortisol as a psycho-physiological survival mechanism. Cortisol helps reduce or terminate any nonessential physiological processes that can be spared in times of eminent danger. The release of cortisol is a heavily conserved adaptive response to short-term stressors. The release of this glucocorticoid during periods of stress or anxiety physiologically prepares the body to deal with potentially hazardous environmental and social conditions. Cortisol is released in response to anxiety or stress by freeing glucose into the system for instant energy, increasing blood pressure and suppressing immune response. This response is also helpful in short-term stress exposure when all energy is shunted to more immediate needs. However, when activated for prolonged periods (e.g., chronic stress) the stress response can be deleterious to the functioning of non-essential systems.

The release of cortisol results in a rise in blood pressure, the release of glucose to the brain and muscles and a rerouting of the energy typically used for immune response and reproduction. Excess cortisol returns to the adenohypophysis and results in a negative feedback cycle that inhibits the release of adrenocorticotropic hormone (ACTH) (Glaser and Kiecolt-Glaser, 1986; Cacioppo et al., 1998; Blalock, 1994). This hormonal cascade has been associated with pregnancy stress syndrome and negative pregnancy outcomes (Chrousos, 2007a; Chrousos, 2007b; Nepomnaschy et al., 2006).

Due to the increased production of cortisol during psychological, energetic or immunological events it has been commonly used as a physiological stress marker (Kanaley and

Hartman, 2002; Padgett, 2003; Altemus, 2001). However, cortisol can be problematic as a marker for stress as it can be confounded by multiple variables. The use of alcohol, tobacco and some prescription drugs can all impact the cortisol levels of an individual (Pollard, 1995). In addition, an individual's age, reproductive status, circadian rhythms, types of food consumed, physical activity and BMI can impact an individual cortisol level (Kudielka et al., 2004; Nepomnaschy et al., 2006; Wilcox et al., 1988).

*Epstein-Barr virus antibody levels as an indirect measure of psychosocial stress*

This study utilizes the physiological maker of psychosocial stress, Epstein-Barr virus (EBV) antibody levels. Unlike cortisol levels which rise and fall in response to acute stressors over a matter of minutes or hours, EBV provides a measure of cell-mediated immune function that reflects psychosocial stress levels over a period of days or weeks, making it an ideal measure for chronic exposure to stress (McDade et al., 2000; Glaser et al., 1991). In addition, EBV is not sensitive to diurnal variation, acute stressors, age, or food and beverage consumption like cortisol (McDade 2007; Pruessner et al., 1997; Weitzman et al., 1971).

Henle and Henle (1982) explain EBV is a ubiquitous herpes virus carried by nearly 100% of adults in developing countries. Seropositive individuals harbor the EBV in infected cells throughout their lives and depend on cell-mediated immune function to maintain the latent state of this virus. Stress-induced immunosuppression leads to the reactivation of the EBV which triggers the release of viral antigens into general circulation. An interpretation of elevated EBV antibody levels as signaling psychosocial stress is potentially confounded by infection and can be controlled for by excluding EBV samples collected from individuals who had active infection (measured by C-reactive protein levels). Although elevated EBV has not been directly implicated

in the disruption of pregnancy, it is a useful marker of the general psychosocial stress that has been tied to negative pregnancy outcomes.

In naturalistic studies, increased EBV antibody levels have been associated with marital problems, medical school exams, caring for family members with Alzheimer's disease and cultural incongruence (Kiecolt-Glaser et al., 1997; Glaser et al., 1994; Kiecolt-Glaser et al., 1987; McDade 2002). The presence of Epstein-Barr virus (EBV) antibodies without active infection is one of the most robust and consistent immunological markers of chronic stress (Herbert and Cohen 1993).

## STRESS AND REPRODUCTION

### *The implications of psychosocial stress on pregnancy outcomes*

Anthropologists define stress as the "process by which a stimulus elicits an emotional, behavioral and/or physiological response, which is conditioned by an individual's personal, biological and cultural context" (Ice and James, 2007). Psychosocial stress is stress stemming from interactions within the social environment. While numerous studies have been conducted regarding the impact of psychosocial stress on pregnancy outcomes, the majority focused on women from North America and Western Europe.

There is evidence that psychosocial stress has biological impacts on pregnancy manifested in spontaneous abortion (SAB), preterm birth and small for gestational age infants. Women with higher levels of self-reported stress experience an immunological imbalance in their decidual cells leading to a higher rate of SAB (Arck et al., 2001). In addition, increased cortisol levels have been positively associated progestin and gonadotropin levels during a women's follicular phase and with SAB (Nepomnaschy, 2004; 2005). SAB has also been associated with psychosocial stress linked to increased cortisol, fewer social contacts, poor social

relationships, and maternal depression (Sugiura-Ogasawara et al., 2002; Boyles et al., 2000; Neugebauer et al., 1996; O'Hare and Creed, 1995). However, other studies have found no relationship between maternal stress and the risk of SAB when measured by total cortisol level and psychosocial stress scales (Nelson et al., 2003). In humans, maternal exposure to psychosocial stress has been associated with a higher risk of preterm birth (Mancuso et al., 2004; Dole et al., 2003; Hobel and Culhane, 2003; Rondo et al., 2003; Orr et al., 2002; Austin and Leader 2000; Rini et al., 1999). Further, in North America and Europe, mothers reporting higher levels of psychosocial stress are at an increased risk of delivering neonates who are small for gestational age (Rice et al., 2007; Diego et al., 2006; Hobel and Culhane, 2003; Rondo et al., 2003; Nordentoft et al., 1996; Wadhwa et al., 1993).

Of the above studies, only two focused entirely on women living outside of the United States and Western Europe. Sugiura-Ogasawara et al. (2002) studied 61 Japanese women with recurrent pregnancy loss and found an association between spontaneous abortion and maternal depression. Nepomnaschy et al. (2006) completed a prospective, naturalistic study of early pregnancy loss amongst Mayan women designed to address the impact of psychosocial stress on pregnancy outcomes. He found a significant relationship between self-reports of stress, cortisol levels and spontaneous abortions in the first 30 days of pregnancy.

Taken together previous studies provide strong support for psychosocial stress negatively impacting pregnancy outcomes. These poor pregnancy outcomes can also have long-term health consequences for the developing offspring. According to the World Health Organization (1995), premature delivery and low birth weight are the leading causes of neurodevelopmental impairments, mortality, morbidity and disability among neonates. Compared to full term infants, infants born prematurely are more likely to have an increased risk of immunological,

neurological, cardiovascular, respiratory, gastrointestinal, and hematological complications (Barker, 1998; Leon, 1998, Rich-Edwards et al., 1997).

Researchers interested in the fetal origins of disease have found that low birth weight infants also experience an increased risk of coronary heart disease, hypertension, diabetes and stroke in adulthood (Watve and Yajnik 2007; McDade et al., 2001; Godfrey et al., 1996; Barker and Osmund 1986). Although many variables associated with poor pregnancy outcome have been recognized, there has been little reduction in these of negative pregnancy outcomes globally (Buekens and Kleanoff, 2001; Branun and Schoendorf, 2002). By examining the impact of maternal psychosocial stress on gestation length it may be possible to isolate the most influential variables associated with pregnancy outcomes. The biochemical pathways that may impact pregnancy outcomes are discussed in next section.

*The physiological impact of stress on reproduction and fetal growth*

Multiple biochemical pathways are involved in negative pregnancy outcomes, and these pathways shift during fetal development. It is not entirely clear what mechanisms are involved in the suppression of pregnancy due to stress. However, there is some evidence that corticotropin-releasing hormone (CRH) acts as a bioregulator of luteinizing hormone (LH) and that as CRH elevates with the stress response it acts to suppress the reproductive axis (Norris, 2007). During the time of implantation there is also a negative association between cortisol and progesterone, a hormone necessary for pregnancy maintenance (Nepomnaschy et al., 2004).

In a naturalistic study of gravid Mayan women, daily concerns were positively associated with increased cortisol levels (Nepomnaschy et al., 2004; Nepomnaschy, 2005). In addition, increased cortisol levels were positively associated with increased progestin and gonadotropin levels during the follicular phase. However, lower progestin levels in the fourth and tenth days of

the luteal phase were negatively associated with cortisol levels. These trends have been associated with interrupted ovulation and implantation. High cortisol levels were associated significantly with an increased risk of SAB in the first three weeks of pregnancy (Nepomnaschy et al., 2004; Nepomnaschy, 2005).

Nepomnaschy (2006) argues that whether cortisol has a direct or indirect impact on progesterone, it is clear that cortisol is involved in the proximate mechanisms that mediate the alleged association between pregnancy loss and maternal stress. Taken together, the bioregulation of LH by CRH and the negative association between progesterone and cortisol help explain the observed relationship between SAB and increased cortisol. In addition, the physiological stress response of newly pregnant women also results in inflammation of uterine tissues leading to a disruption in the uterus and a "blighted" environment for the developing embryo (Blois et al., 2004; Kalinka and Szekeres-Bartho, 2005; Arck, 2005; Arck, 2007). These effects are most intense prior to full placentation (~30 days) due to the developing embryo's inability to filter maternal hormones.

Following full placentation, maternal psychosocial stress is more likely to result in premature delivery and/or neonates born small-for-gestational age (Field et al., 2004; Rondo et al., 2003; Wadwhwa et al., 2001, Hoffman and Hatch 2000; Sandman et al., 1997). This is likely due to stress-induced changes in neuroendocrine function associated with uteroplacental perfusion (Hobel et al., 1998). Increased uteroplacental perfusion can result in the restriction of nutrients and oxygen to the developing fetus, impair growth and in some cases precipitate preterm delivery (Wadhwa et al., 1997; Cooper et al., 1996).

Elevated maternal norepinephrine and cortisol levels have been associated with low birth weight and intrauterine growth restriction (Diego et al., 2006; Field et al., 2004). When

administered to pregnant ewes, norepinephrine affected uterine placental blood flow and decreased fetal insulin concentration while increasing the growth factor binding protein 1 (IG) (Basset et al., 1998; Hooper et al., 1994). In humans, an infusion of norepinephrine decreases blood flow to the uterine artery while inducing uterine artery contractions (Damron et al., 2004; Stjermnquist and Owman 1990).

Although cortisol can cross the placenta (Gitau et al., 2004; Gitau et al., 2001), it is unlikely that norepinephrine does (Giannakoulopoulos et al., 1999). By dysregulating placental CRH levels unbound cortisol in the placenta can affect fetal development (Erickson et al., 2001; King et al., 2001; Hobel et al., 1999; Jones et al., 1989), possibly by inducing uterine artery contractions (Donoghue et al., 2000). Throughout pregnancy, increased maternal cortisol levels negatively impact fetal growth; however this impact may be assuaged after mid-gestation when the placenta is able to convert cortisol into the less potent cortisone (Hobel et al., 1999; Seckl 1997). This conversion may help explain why some researchers found no direct association between maternal psychosocial stress and the CRH function of the placenta (Petraglia et al., 2001).

## EVOLUTIONARY PERSPECTIVES

Evidence from non-human primates suggests an evolutionary foundation for the relationship between psychosocial stress and pregnancy disruption. In nonhuman primates, lower ranking females experience longer interbirth intervals and reduced lifetime reproductive success compared to higher ranking females (Wasser et al., 2004; Setchell et al., 2002; Fairbanks and McGuire, 1984). The increased social stress experienced by lower ranking females has been associated with disruption of their reproductive cycles resulting in early pregnancy loss, restricted fetal growth and increased infant mortality (Wasser and Starling, 1988).

Humans have less than a 50% likelihood of carrying a pregnancy to term (Chard, 1991). This high expected loss rate has led some scholars in the medical community to argue that human pregnancy is an 'evolutionary paradox' or 'inefficient' and discuss pregnancy loss as a maladaptive trait that needs to be fixed (Norwitz et al., 2001; Bentley and Mascie-Taylor 2000). However, from an anthropological perspective this seemingly high level of spontaneous abortion (miscarriage) has been discussed as a way for human females to maximize their reproductive success while conserving valuable resources during times of environmental, nutritional and psychosocial stress (Nepomnaschy et al., 2006). In times of chronic stress, females are able to maintain resources for themselves and their post-natal dependent offspring, reducing competition. As a short-term adaptation, and pregnancy disruption can reflect the ability of the female's body to preserve resources for a later pregnancy with a higher probability of success (Vitzthum 2009, 2001; Wasser and Barash 1983). Taken together, this research suggests that psychosocial stress may play an important role in a woman's reproductive life history.

The relationship between maternal psychosocial stress and pregnancy outcomes are particularly interesting from an evolutionary perspective. Spontaneous abortions are the most common adverse reproductive outcome of psychosocial stress, with the majority occurring prior to placentation (Neugebauer et al., 1996). Initially, this high rate of loss was associated with the maternal rejection of chromosomally abnormal fetuses (Kozlowski and Sterns, 1989); however mothers experiencing a major psychosocial stress event prior to pregnancy loss were more likely to abort a chromosomally-normal fetus than women who did not experience a stress event (Neugebauer et al., 1996). Spontaneous abortion, although personally distressing, may represent an adaptive mechanism by which a mother's body is able to terminate a pregnancy and redirect resources for later pregnancy before too much physiological effort has been expended (Vitzthum

2009, 2001; Peacock 1991). The lack of a filter between maternal and fetal hormones makes early pregnancy (first 30 days past conception) the most vulnerable period for the developing embryo (Hobel and Culhane, 2003).

AN INTRODUCTION FOR THE GOALS FOR EACH CHAPTER

This dissertation addresses the role of psychosocial stress on the pregnancy outcomes of Samoan women giving birth on American Samoa. Broadly, this dissertation creates a population level context for pregnancy outcomes in Samoan women and tests the impact of psychosocial stress on a smaller sample of this population.

Chapter Two provides an ethnographic context for Samoan women's pregnancy. This includes a brief history of the islands, a review of traditional family organization and westernization pressures and provides a medical context for prenatal care and delivery in American Samoa. In chapter Three I provide an in depth and detailed description of the methods used throughout this dissertation.

Chapter Four provides a population level context for pregnancy outcomes in American Samoa. There are four goals in this chapter: (1) to present descriptive statistics of Samoan women giving birth in American Samoa; (2) to determine if marital status is related to utilization of prenatal care in American Samoa, (3) to determine if marital status is related to delivery outcomes in American Samoa, especially neonate size and of medical interventions, and (4) to contextualize Samoa in comparison to the mainland United States.

Chapter Five compares four measures of psychosocial stress in 78 pregnancy Samoan women giving birth in American Samoa. These include Epstein-Barr virus (EBV) antibody levels and three self-reported stress scales including status congruence, a monthly stress questionnaire and the Perceived Stress Scale. The three goals of this chapter are (1) to compare

the effectiveness of the three self-reported stress scales in detecting psychosocial stress by comparing them to EBV levels; (2) to determine if the three self-reported stress scales detect comparable levels of psychosocial stress; and (3) to identify which self-reported measure best correlates with psychosocial stress as measured by EBV in Samoan women.

Chapter Six compares the EBV levels and pregnancy outcomes in 151 women. The three goals of this chapter are (1) to determine if mothers with higher levels of psychosocial stress (as measured by EBV levels) will have smaller neonates; (2) to determine whether mothers with higher levels of psychosocial stress will have shorter gestations and (3) to determine if married women were less likely to have higher EBV scores than their unmarried peers. In addition, I compared the demographics and pregnancy outcomes with women in this community to those presented in chapter four. Finally, in Chapter seven I summarize the results and provide concluding thoughts.

CONCLUSION

Psychosocial stress remains a poorly understood variable in human life history. By providing insight into the impact of psychosocial stress on human reproductive success, this project contributes to anthropological theory and the discipline in two ways. First, this is the only longitudinal, naturalistic, prospective study of the relationship between psychosocial stress and negative pregnancy outcomes. It is unique in that it begins monitoring maternal stress at the first antenatal care appointment and follows pregnancies to the natural conclusions. In addition, this biocultural study will be among the first to address the impact of psychosocial stress in Polynesian women. This study will be among the first to address the role of psychosocial stress in non-North American and Western Europe women and the first to focus on Pacific Islanders.

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## CHAPTER 2: HISTORY, POLITICS, *FA'ASAMOA* AND PRENATAL CARE IN AMERICAN SAMOA

INTRODUCTION

The objective of this chapter is to provide a historical, political and cultural context for the remainder of this dissertation. Central to Samoan life is the concept of *fa'asamoa*, or the Samoan way of life. *Fa'asamoa* is invoked frequently when discussing politics, immigration, family, church and medical issues and is meant to remind Samoans of their heritage. In this chapter I provide an overview of some of the most significant components of Samoan society in order to cast pregnancy and prenatal care in the framework of *fa'asamoa*. First, I introduce Samoan history and provide a brief introduction to the political separation of Independent Samoa and American Samoa. Second, I discuss the more recent history of American Samoa with a focus on infrastructure development, immigration and employment. Third, I introduce family organization and the role of the church and marriage in American Samoa. I conclude the chapter with an introduction to prenatal care and delivery in American Samoa

AMERICAN SAMOA PAST AND PRESENT

*A brief history of American Samoa*

The Samoan archipelago is located in the central South Pacific and consists of six main islands with a total land mass of 3,030 km$^2$. With over 250,000 inhabitants, the Samoan islands have one of the largest populations in Polynesia. Genetic and linguistic evidence suggests a Southeastern Asian origin of Samoa's settlers approximately 3,000 years ago (Lum and Cann, 2000; Kayser et al., 2006). Throughout the areas occupation, interisland travel and trade

remained the norm. European explorers rediscovered the Samoas in 1722 and English missionaries and traders settled on the islands in the 1830s (Kennedy, 2009).

In 1870 the United States (US) Navy required a coal refueling station to promote the shipping interests of the United States. Tutuila (the largest island of what is now American Samoa) was an attractive option both because of its location and natural harbor. During this period Germany was asserting protectorate over any unclaimed islands throughout the South Pacific and the US government offered its protection to Tutuila in exchange for use of the harbor. Chiefs from Tutuila agreed to protection by the United States; however a German presence remained in Upulu and Savaii. Land disputes among British, German and American powers resulted in the Tripartite Convention of 1899, which defined the western island group as Western Samoa, a German colony, and the eastern islands as American Samoa, a US territory. Western Samoa was claimed by New Zealand in 1914 and was held as a Class C mandate under trusteeship through the League of Nations until its independence in 1962 (Kennedy, 2009). In 1997, the country changed its official name from Western Samoa to the Independent State of Samoa and then simply Samoa - despite protest from the American Samoa government who found the new name offensive to the territory's identity (Figure 2.1). To increase clarity throughout this dissertation I will refer to it as the Independent State of Samoa instead of Samoa.

*Figure 2.1 Map of the Samoan Archipelago*



American Samoa became an unorganized and unincorporated US territory in 1900 and President McKinley put the Navy in charge of governing the territory. During the Naval rule the policy was to keep "Samoa for Samoans". The Navy provided minimal health and educational services but otherwise left human services in the hands of the Samoans (Hall, 1961). However, in the early 1940's American Samoa was used as a staging area for Guadalcanal; a battle fought against the Japanese to defend the supply and communication routes between the US, Australia and New Zealand. Schools were closed, copra production was put on hold and fishing all but ceased in order to direct all Samoan effort towards the war. The intense contact with westerners led to an increased interest in western style goods and services (Kennedy, 2009). Unfortunately the prosperity that accompanied this work had a shorter life than this interest. "War provided tastes beyond their ability to support, aspirations beyond the Navy's ability to satisfy" (Hall, 1961). The end of the war meant an end to military support jobs and many people found themselves unemployed with fallow gardens.

In 1951 the Department of Interior took over control from the Navy and the budget for American Samoa was substantially reduced. Customs duties increased between 15-100% putting additional financial constrictions on American Samoa. Although a territory of the United States,

areas not developed for military use remained underdeveloped. Throughout Tutuila a decline in

infrastructure resulted in decaying buildings, non-existent sewers, lack of portable water and

inadequate medical and educational facilities (Kennedy, 2009). This decline continued into the

early 1960's when cold war patriotism combined with a widely circulated *Readers Digest* article

motivated President Johnson to financially support infrastructure development in American

Samoa. In this article American Samoa was referred to as a "national disgrace" that poorly

showcased the power, strength and wealth of the United States (Hall 1961). Hall (1961) writes:

> "….[American Samoa is filled] with government buildings peeling and rotting on their foundations, beautiful Pago Pago Bay marred and befouled by hideous over-water outhouses, rutty and teeth-jarring roads unrepaired for years, crumbling reservoirs and ancient leaky water mains that cause frequent water shortages – despite an average annual rainfall of 200 inches…Agriculture is fast going to seed; coconut trees and banana plants, the territory's most abundant crops, are destroyed by insects and disease; the islands, once self-sufficient, now have to make heavy importations of canned goods. The medical service, manned by able but too small staffs, wrestles with high case loads, inadequate laboratory equipment, an overcrowded hospital partly housed in a former Navy barracks. Public schools are unequipped shacks or tiny one-room Samoan *fales*, thatched-roofed structures with no sides. A largely untrained and poorly paid teaching force struggles to teach some 5,500 eager pupils on the lowest budget (less than $50 per pupil) of any U.S. state or territory in the world."

This article brought American Samoa into the US public's mind and provided the

opportunity for American Samoa's then governor Rex Lee to address members of the US House

of Representatives subcommittee on deficiency appropriations. "When the islands were

necessary for our defense, up to and including World War II, we used them and used their

people….Here's our chance to show the world how we can help underdeveloped peoples toward

a self-sufficient life" (Gov. Rex Lee as quoted in Hall, 1965).

*Modern American Samoa*

Reinvestment on behalf of the United States resulted in significant improvements to

American Samoa's infrastructure. In addition to paving roads and building schools, the Lyndon

Baines Johnson Tropical Medical Center (LBJ), the territory's only hospital was commissioned.

Four years later Hall (1965) wrote another article for Readers Digest calling American Samoa

"America's showcase in the South Pacific". The island has continued to face financial

challenges, however they are now more closely associated with misappropriation of funds and mismanagement of resources by the American Samoa government and leadership. Attaining potable water remains a challenge with more affluent families buying water from dispensers and less affluent families being exposed to contaminated water supplies. The cost of electricity makes it expensive to boil water for safety. Although roads have improved from the 1950s and 1960s, they remain poorly maintained and disrupted with pot holes. In addition American Samoa's government has faced a series of educational, management and health related challenges.

In 2010 the Department of Education threatened to withdraw funding from American Samoa when they realized that the majority of K-12 educators did not have teaching licenses (Hurst 2011, personal communication) . These same schools were closed by the Department of Health for an extra week at the beginning of the 2013-2014 school year when school administrators failed to eradicate the rodent and cockroach infestations that were posing a health risk. After the American Samoan Government (ASG) spent their entire 2011 budget within five months all government employees were forced to take furlough days and budgets were dramatically reduced. On multiple occasions ASG employees received their pay checks several weeks to a month late leading to significant financial challenges for individuals. These cuts rarely affected management or higher ups and impacted individuals in the lowest positions the most (personal observation). In addition, LBJ was severely impacted by ASGs financial crisis. LBJ is a semi-autonomous authority which was denied 2.5 million dollars budgeted by ASG which would have been matched by Medicare. With a 5 million dollar shortfall, half of the hospitals working budget, LBJ was unable to pay its creditors and supplies to the hospital were

halted. In addition LBJ Tropical Medical Center threatened permanent closure and had to refuse service to all non-critical patients (personal communication, Gerstenberger, 2011).

ASG became the largest employer on the island after the 2008 closure of the Samoa Packing Company. The closure of this cannery meant the loss of thousands of jobs and an increase in the cost of goods delivered to the island. When the cannery was open, shipments of tuna to the mainland US would result in boats returning empty to American Samoa resulting in reduced shipping cost to the island on return vessels. After the cannery's closure the shipping company had to significantly increase the costs of transporting everything from building materials, to vehicles, clothing and food. These additional costs were passed onto the consumer and resulted in a dramatic increase in the cost of consumer goods. This was particularly problematic for an island that relies heavily on packaged and canned foods to feed its people.

*Immigration and residency status in American Samoa*

Although there are significant financial and infrastructure constraints in American Samoa it remains a popular migration destination for individuals from the Independent State of Samoa. American Samoa is an attractive destination for Independent Samoans because of family and language ties and opportunities for immigration to the mainland United States. Individuals born in American Samoa are US Nationals and can hold US passports, live in the US, and serve in the US armed forces. These individuals are also considered residents. Individuals from the Independent State of Samoa who move to American Samoa are considered non-residents. In order to move to American Samoa non-residents require a resident sponsor. These sponsors are most frequently family members and have to ensure that they will be employed either inside or outside of the home. As a result, non-residents are entirely dependent on family members for

cash and associated securities, a situation which can lead to financial, physical and sexual abuses (Samoan informants, personal communication).

Immigration is widely viewed as problematic by American Samoans and laws have been enacted to control the access of non-residents to the island's resources. Non-residents have poorer job security. For example, after the closure of the Samoa Packing Company, Starkist's tuna cannery fired a large number of their non-resident employees and replaced them with recently fired unemployed residents. In addition to lower job security, non-residents experience increased fees for advanced education and medical care including prenatal care. A reduced access to funds paired with increased costs may put non-residents at financial risk and creates a caste of second class citizens.

*Employment*

Minimum wage in American Samoa is significantly lower than the mainland United States and varies from $4.18 to $5.59 depending on the industry (United States Department of Labor 2013). The unemployment rate in American Samoa is 29.8% compared to 9% in the mainland United States (CIA World Fact Book, 2012). This rate does not take into account unreported employment (people being paid under the table) and underemployment. Regardless, lower status individuals, including non-residents and unmarried women reportedly have a much harder time finding and maintaining employment, in part because they have fewer social connections (personal observation). These challenges are exacerbated by unscrupulous employers who lay off women when they announce their pregnancy by citing unsafe working conditions and suggesting pregnant women are incapable of performing their jobs (Samoan informants, personal communication). Women also reported being pressured to leave their jobs by their employers, family members and spouses (married and non-married) when they became

pregnant. However, the majority of women I spoke with who retained their jobs through their

pregnancy held more desirable positions, for instance with the ASG, that provided benefits and a

social safety net that allowed women to maintain these jobs through their pregnancy and return

to them postpartum. Women working for the ASG are typically married women. Employment

outside of the home provides women with an additional level of security and independence

beyond family and church.

*Family organization*

The influence of traditional Samoan social organization and trade remains even though

traditional markets have been replaced by cash economies. This lingering influence is most

obvious in the system of reciprocity that connects Samoan families and villages to each other.

The traditional structure and expectations associated with reciprocity have remained, however

financial compensation has emerged as a crucial component of this system (Macpherson and

Macpherson, 2009).

In the Samoan system, extended families (*'āiga*) elect representative chiefs (*matai*) who

comprise the executive, judicial and legislative body in traditional local governance (Shore,

1982). The members of a household with the *matai* enjoy a greater level of respect in their

community and are expected to provide financial and material support to those without a *matai*

(McDade et al., 2002). Other members of the *'āiga* are financially and socially obligated to the

*matai* through the service obligation (*tautua*). This system of reciprocity combined with a

dedication to the Samoan way of life (*fa'asamoa*) has resulted in a status-conscious and

community-minded population.

Despite the significant social changes occurring in Samoa, the importance of *matai* status

has been maintained. However, the transformative effects of nontraditional religious,

educational, political, economic and legal institutions have altered the Samoan view of social

status (Tisdell, 2002). Remittances from overseas relatives, increased access to globally

manufactured goods, and influences from Christian religious groups provide opportunities to

circumvent the *matai* system of status. An individual's ability to balance traditional (*matai*) and

non-traditional (e.g., cash, education) markers of social status results in status congruence.

Accordingly, incongruence arises when those with *matai* status lack the material goods and

economic resources necessary to fulfill their *matai* responsibilities, as well as in those individuals

with high levels of material benefits who lack the traditional *matai* status. In this way, it is not

globalization per se which results in psychosocial stress but instead the inability to resolve two

competing systems of status (McDade et al., 2002).

The importance of the *matai* extends throughout the lives of American Samoans and

especially impacts their living arrangements. One of the most common living arrangements is a

series of smaller houses surrounding a larger house, all owned by the *matai*. The larger house is

typically occupied by the *matai* and the smaller houses are occupied by *'āiga* members. This

property is provided to members of the *aiga* with the understanding that they will continue

serving the *matai*. This provides an important support network for *'āiga* members, however it

has also been used by unscrupulous *matai* as a tool to control their behavior. *'Āiga* members

recognized that inconsistent financial and in some cases political support to their *matai* could

result in removal from their homes and rare cases expulsion from their village.

*'Āiga* members pay a monthly fee (~$25) to the *matai* which is meant to be kept in a

general fund. Occasionally the *matai* requires a greater contribution from 'āiga members for a

*fa'alavelave*. *Fa'alavelave* translates into "in the way of the emergency" and developed as a way

of handling the enormous financial requirements of weddings, funerals and other events. At its

core, *fa'alavelaves* remove the need for a nuclear family to shoulder the cost of hosting and

feeding large numbers of people, and shares the cost in an egalitarian method across the ʻāiga.

However, traditionally *fa'alavelaves* were based on the donation of fine mats, time invested in

weaving of baskets, creating clothing and harvesting and cooking by the by smaller components

of the *ʻāiga*. In the traditional models it was time, not money that was expected from members of

the family. Today both money and time are expected, creating a new strain and duty

unprecedented by Samoan tradition (Macpherson and Macpherson, 2007).

In American Samoa, cash and purchased items have replaced labor intensive trade items.

This extends to one of the most important trade items in the Samoas – the fine mat. Fine mats are

given as gifts at funerals, weddings and other important social events. The larger and more

intricate the mat, the higher the level of compensation in goods and prestige the giver is expected

to receive. Depending on the size, each mat takes weeks to months of continuous labor to

complete and were traditionally hand produced by the women of each family (Shore, 1982).

Although fine mats continue to be among the most important prestige items given at social

events in the Samoas, there were no individuals trained in weaving these mats in American

Samoa at the time I conducted this study (Herdrick, personal communication). Production of fine

mats had transitioned from a family enterprise to a financial transaction. Instead of hand making

fine mats, families travel to Independent Samoa and purchase these items from dealers. As a

result, those with more money were able to buy larger, better quality mats and in this way they

are able to translate their access to cash into increased social status. Those with little access to

cash had less opportunity to secure these mats and face public scrutiny when they fail to give

these items at important social events (personal communication, Herdrick).

*The role of church in American Samoa*

Samoan social organization combined with the 'westernization" of American Samoa provided the ideal scaffolding for missionary objectives. Church has become a central component of Samoan life and has successfully utilized the *matai / 'āiga* relationship that Samoans were accustomed to and has created a parallel relationship between the pastor (*faifeau*) and congregation. As a result the exonerated role of the *matai* in Samoan extends to the *faifeau*. Members of all denominations were expected to tithe and physically care for the church. Even women late in their pregnancy were expected to do heavy labor tasks like scrub the church steps unless they got a letter excusing them from the task from their doctor. The role of the church extends into every component of Samoan society, including prenatal care. For example, a 23 year old woman who was 8 weeks pregnant was scared to seek prenatal care in case someone from her church saw her and told her *faifeau.* She explained that the *faifeau* had preached in church that a woman who had faith in God would not need to access medical care before delivery and that prenatal care was for those who didn't believe in the power of God (Samoan informants, personal communication). In addition, physicians at LBJ reported women unwilling to undergo post- term induction or caesarean sections because they were told by church leaders it was not "God's way". Clearly, these stories do not reflect the sentiments of all churches but they do indicate the pervasiveness of the church throughout Samoan society. The relationship between social status, reciprocity and the church may also influence a person's ability to get legally married.

*Marriage in modern American Samoa*

In American Samoa, there are two broad types of marriage: legal marriage and non-legally binding marriage (cohabitation). Although the path to legal marriage is similar to that on

the mainland, the social and financial resources necessary for a western-styled church wedding (widely viewed as a culturally legitimate marriage) may be prohibitive for women holding lower status in their households. The couple must gain a marriage license from the Register of Vital Statistics. Legally, wedding officiates are expected to charge no more than $10 for performing the marriage. According to these laws, couples should be able to get married for $30. However, the speed at which a couple receives their license and the total social and financial cost of hosting a wedding, including the actual cost of officiating, is not encapsulated by these laws.

According to anonymous sources within the ASG, the processing of marriage licenses progress at varying rates depending on the couple's status within the community. For instance, a socially higher ranking couple's application for a license is likely to move faster through the system than a lower ranking couple's application. In 2011, there were internal reports that the individual in charge of processing these requests was selectively processing these applications and left the remaining applications to pile up in a desk draw. Some of the women I spoke with complained of long waits to obtain a marriage license (six+ months). Others were able to partially circumvent the system of long waits by getting a special "rush" license. This license was available to unmarried pregnant women who received a letter from their medical provider. I was unable to determine how many of these applications are submitted each year and whether these applications were indeed granted more quickly.

However, legitimate marriage for many Samoan couples is not achieved through the courts but through a Christian style church wedding (completed after obtaining a legal marriage license). Samoan church weddings are expensive and require enormous financial and social support from the ʻāiga. Weddings are hosted by the entire extended family and require financial organization by the *matai*. Couples from more affluent families or those who hold a higher status

within their families are likely to have their weddings prioritized over other family needs and events. As a result, lower ranking women have less access to church style (legal) weddings. In this way, accessibility of a church style wedding is representative of a couple's status in their family and village.

The size and style of wedding is reflective of the family's status and is similar to traditional weddings between *taupou* (chief's daughters) and high ranking men. Wedding guests bring large quantities of canned meat and other foods, bolts of cloth, fine mats and money. The couple's family reciprocates with similar gifts as well as ample prepared food for the reception and for guests to take home. In addition special (and expensive) gifts are given to high ranking guests such as other *matai*, government representatives, and *faifeau*. For instance, it is customary for each attending church leader to receive at least $100 from the family as a sign of respect. Although some church leaders legitimately attend these weddings to give their respects and blessing to the couple, it was not uncommon to hear stories of church leaders who would "do the rounds" – effectively attending weddings for a check (Samoan informants, personal communication). Taken together, Christian styled church weddings can cost thousands of dollars in a place where unemployment is the norm and the minimum wage is significantly lower than the mainland United States.

For many reasons, including the cost of weddings, some Samoan couples choose to cohabitate as domestic partners. Frequently these couples and their families consider themselves married and refer to each other as husband and wife. Many of these relationships result in children, and it is not uncommon for couples to live as domestic partners for the course of their lives. Although these relationships seem to be generally accepted within Samoan culture there are unseen societal ramifications. When these relationships break up, women have tremendous

challenges in obtaining child support from the father. In addition "widowed" women have very few rights to their husband's assets.

Another example suggesting cohabitating relationships are not considered economically or socially equal can be found in the exclusion of the father's name on the birth certificates of newborns. Studies conducted in the USA and Britain indicates that the exclusion of the father's name on the birth certificate is linked to increased neonate mortality in both married and unmarried women (Geudino et al., 1999; Leon 1991). This difference is attributed to the decreased social support available to those mothers. Paternal inclusion on the birth certificate makes it easier for women to file for child support (although this is very rare in American Samoa), health insurance, and death benefits for the child (through social security, insurance or military service).

In American Samoa, married women's husbands are immediately added to their newborns' birth certificates. According to official LBJ guidelines, unmarried women can elect to have the father's name included on the birth certificate as long as he agrees. However, numerous conversations with cohabitating women who wished to have their baby's fathers names included on the birth certificate indicate that these guidelines are not always honored. Instead, women reported being told by hospital employees that it would be easier to add the father's name later. When women tried to add the father of their child to the birth certificate they were directed to the American Samoan Attorney General's (AG) Office. Several women reported being told by secretaries at the AG office that the necessary affidavit to add the father of their child's name to the birth certificate would cost upwards of $500 per child – a prohibitive expense for most couples.

PRENATAL CARE AND DELIVERY IN AMERICAN SAMOA

Children are a very welcome addition to most Samoan families. However, there are strong beliefs regarding who should have children and when those children should be born. These are related to women's marital and immigration statuses and reified by the *'āiga,* church and health care communities.

The relationship between the individual, culture, family, church and the medical care system is represented by the Coalition for Teen Pregnancy Prevention in American Samoa's model of care for the individual (Figure 2.2). According to Dr. John AhChing, then chief of OBGYN services at LBJ, this model represents as an interactive structure with strong interplays between its three points that act together to strengthen the individual. He explained that church (*lotu*) and culture (*aganu'u*) are dependent on the strength of the 'āiga. Together these result in love (*alofa*), faith (*fa'atuatua*), mutual respect (*fa'aaloalo avafatafata*), and the nurturing of children (*aputiputi fanau*).

*Figure 2.2 Perceived relationship between church, culture and family on the individual in American Samoa[a].*
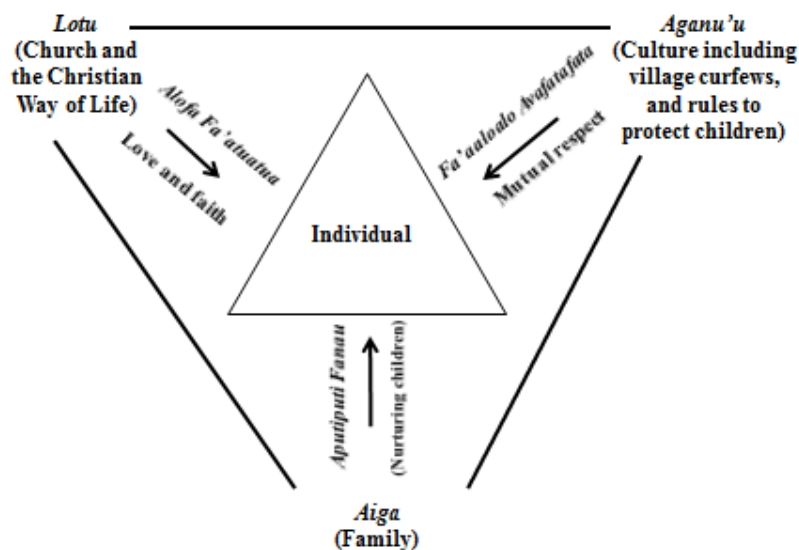


*[a]Figure modified from the Coalition for Teen Pregnancy Prevention in American Samoa*

This pyramid was originally created as part of an anti-teenage pregnancy program and was meant to make a long term impact on future parents. Taken together this flow chart represents the widely held belief that with a strong family, a respectful and obedient demeanor and dedication to the church, all pregnancies would be planned and within the bounds of marriage. Although this program did not successfully reduce teen-pregnancy rates on the island, it accurately represents the interplay between these important social components of Samoan life and reproductive medical care (Ah-Ching, personal communication).

*Prenatal care in American Samoa*

Originally all prenatal care (PNC) was provided by LBJ Tropical Medical Center in *Fagaalu*, a central point of the island. However, this distance was prohibitive for women living on the far eastern and western edges of the island who were balancing jobs, family and church commitments. In response, the American Samoan Department of Health (DOH) established three additional PNC facilities; an eastern location in *Amouli*, a western location in *Leone* and a central locations at the *Tafuna* Health Clinic and LBJ (Figure 2.3). Women are welcome to attend any clinic but it is likely that the clinics proximity to their home village impacts their choice. It is the long term goal of LBJ that they will only provide prenatal care in high risk pregnancies; however at the times of this study LBJ accepted both high and low risk pregnancies out of concern that women may not seek PNC elsewhere if they were turned away.

*Figure 2.3 Map of American Samoan villages and prenatal care clinics*
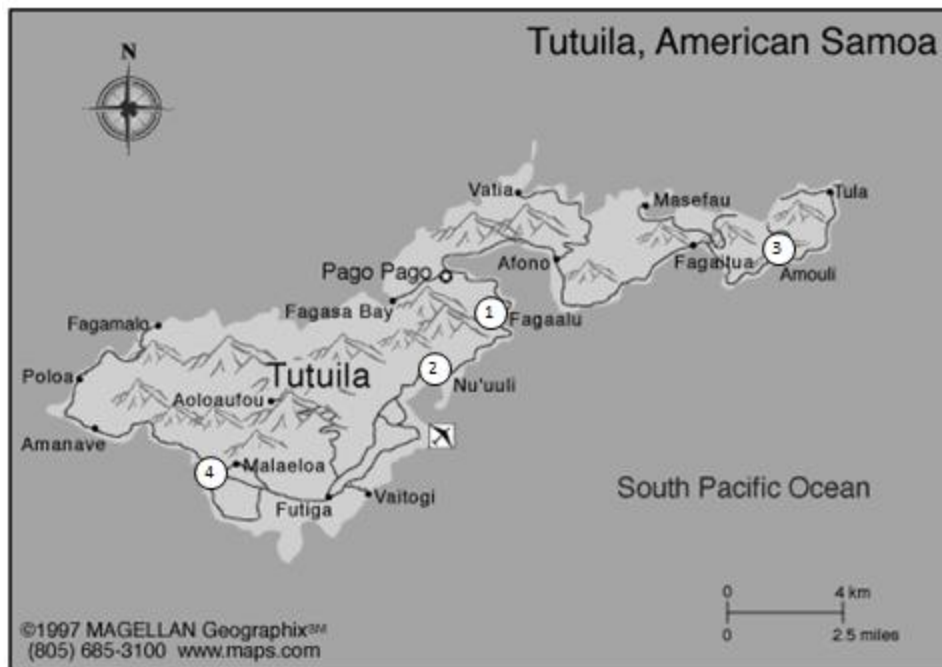


*[1]LBJ Tropical Medical Center, [2]Tafuna Family Heath Center, [3]Amouli Family Health Center,
[4]Leone Family Health Center*

Each of the three prenatal clinics was headed by a Samoan nurse practitioner. These

nurse practitioners were trained in Fiji, New Zealand and the United States. Two of them held a

practitioner license from the United States. All three practitioners were in their late 50s to early

60s and had been employed by the DOH for 20+ years. Women who seek prenatal care from one

of the three facilities will most likely see the same practitioner through the majority of their

pregnancy. As a result women enjoy a consistency of care during their PNC at the DOH. These

practitioners are trained in providing prenatal care to women with low risk pregnancies and

identifying women with high risk pregnancies that need to be referred to LBJ. Both high risk

pregnancies and low risk pregnancies in their final month are referred to LBJ for closer

monitoring by doctors.

Prenatal care in American Samoa had three components: the two initial visits, the follow up visits and weekly visits at LBJ prior to delivery. In the first visit women provided basic information about themselves and prior pregnancies. They received a prescription for prenatal vitamins to fill at one of the island's two pharmacies. Finally, they underwent hepatitis and HIV counseling, took a pregnancy test if needed and were directed to the laboratory at LBJ to get a basic blood work panel completed.

After their blood work returned from the lab, the women underwent their second initial visit. In this visit women received a pelvic examination which included a pap smear and a chlamydia test, and if needed, were given their first hepatitis shot. On occasion women were given basic nutritional guidance which usually consisted of broad statements like eat breakfast, drink juice and milk not soda and were directed to reduce sodium in their diet although it is unclear if they knew what sodium was. In addition, they received contradictory messages about their diet from the medical community. For instance a woman would be told to reduce sodium in her diet and then be told to add a can of Vienna sausages to their instant noodles (both foods high in sodium) to increase their protein levels. During this meeting women also received a referral to Women Infant Children (WIC), a nutritional support system for pregnant and nursing women provided by the federal government. It was the expectation that WIC would provide additional nutritional education to expectant mothers.

After completing the initial visits woman began their follow up appointments once a month. These visits were conducted primarily on Wednesdays and included an abdominal measurement and a Doppler test to determine the fetus' heartbeat. All women were given a 9 am appointment time, although no appointments were honored by the DOH. Instead, they were seen on a first come first served basis on the appointed day. Women would begin to arrive at the clinic

around 7 am and would start being seen between 8:30 and 9:30 am. It was typical for all women to be seen before 12:30 pm, but on extremely busy days women would have to wait in an uncomfortable waiting room until the early afternoon. Follow-up appointments were assigned without concern for women's schedules.

Adding to the time constraints were mandatory educational workshops held sporadically on Wednesday mornings. These unannounced hour long workshops would start between 8:30 and 9 am and focus on maternal nutrition, sexually transmitted infection prevention and hygiene. Unfortunately, much of these messages seemed to be lost on women concerned with returning to work or relieving a family member or sitter of their younger children. Hurried, whispered phone calls to their families and employers were common, as were women leaving before being seen for their appointment.

In order to establish the estimated date of delivery and determine the position of the fetus two ultrasounds were conducted - the first prior to the 20th week and the second in the final month of pregnancy. However, the timing of the first prenatal care appointment, lack of equipment and trained personnel meant that few women got an ultrasound until they are referred to LBJ in their 36th week. Women were referred to radiology the week following their first physical although the radiology department was not always staffed for these appointments. In 2011 a portable ultrasound machine was purchased by LBJ. The intention was to use the machine at the DOH to expand ultrasound services to the community. However, the nurse practitioners were not trained in providing ultrasounds and the significant understaffing by LBJ made it unpredictable when a physician was able to come to the clinic and provide the service. As a result, women would come for their appointment, wait for a couple of hours and then be sent home unattended.

*Delivery*

The majority of births occur at LBJ. In American Samoa home births are heavily discouraged by the medical community and not supported by the general public. According to physician reports the rare occasion when women gave birth outside of the hospital was related to women misjudging their contractions or who were in denial about their labor. Frequently these women gave birth in the ambulance on the way to the hospital.

During the time of this study LBJ Tropical Medical Center's OBGYN department was staffed by two Fijian trained Samoan doctors, one Mexican trained doctor and an American trained midwife. The department was periodically supported by *locum tenuns* – mainland physicians who commit two weeks to three months to work at this underserved medical center. Periodically these professionals choose to extend their commitment and sign on for a one to two year contract as was the case with the Mexican trained physician. At the time of this study this physician held the only United States Medical License, the standard license all physicians practicing on the mainland United States have to obtain to practice medicine.

Labor and delivery is a stark but clean department. Women in labor share rooms with two to three other women. They are encouraged to walk around the hospital to move their labor forward but spend the rest of the time prostrate in bed connected to monitors. When they were fully dilated they were brought into the delivery room. Women giving birth in American Samoa had no option for any pain medication during delivery and had to deliver in the lithotomy position (knees bent, spread apart and positioned above the hips with the use of stirrups). Women who need a cesarean section were delivered in the operating room.

*Financial Aspects of Prenatal Care*

Prior to 2007 there was a significant issue with women not seeking PNC until late in their pregnancy. In response, Dr. John AhChing, then chief of OBGYN services at LBJ implemented a reduced pay schedule to financially encourage women to seek prenatal care in their first trimester. After the plan initiation, the number of women starting their PNC in their first trimester increased (Hawley et al., 2013). According to cost specialists in the LBJ business office, women qualify for the program if they begin their PNC in the first trimester and have a low risk pregnancy and deliver vaginally. Women with high risk pregnancies are dropped from the program and are made to pay out of pocket for all fees accrued. Although residents can never be charged more than $500 a day for medical care, there is no limit on how much non-residents can be charged. Women can also be considered high risk after the completion of their pregnancy if review of their medical records reveals too many appointments, however it was unclear how many appointments or what kind of appointments were considered too many. Women not enrolled in the prenatal program are expected to pay all expenses out of pocket.

Regardless of residency status, all women prior to being admitted into the program paid a $10 registration fee, and a $10 fee for their first visit. In addition, all women also received a basic panel of five lab tests at $10 each and paid $14 for PNC vitamins and iron tablets. Together, the initial prenatal visit cost $84 out of pocket for each woman. After being admitted into the program, resident and nonresident women had two different pay scales and pay schedules. Resident women enrolled in the program get 13 PNC visits, an ultrasound, any additional labs and a two day stay in the hospital for themselves and their newborn at no additional cost. In comparison, non-residents pay $500 for the same services. The fee schedule is presented in Table 2.1.

*Table 2.1 Cost of non-surgical vaginal delivery for resident and non-resident women enrolled in the prenatal care program in their first trimester*

| Item | Resident | Non-Resident |
|---|---|---|
| Registration | $10 | $10 |
| First Visit | $10 | $10 |
| 5 labs ($10 each) | $50 | $50 |
| Prenatal Vitamins | $14 | $14 |
| 13 PNC Visits | | |
| Ultrasound | | |
| 2 Day Hospital Stay | Free | $500 |

| | | |
|---|---|---|
| *Total* | $84 | $584 |

Cesarean section were not considered part of the program, however women who were enrolled in the program were given a discount. Resident women who had to undergo a C-section were charged $150 for the surgery and an additional $50 per night in the hospital. Non-resident women were charged $1000 for a cesarean section and an additional $50 per night in the hospital (Hawley et al., 2013).

*Barriers to prenatal care*

Cost is likely to play a role in the timing of beginning PNC. Although non-residents had a higher overall cost of care, the initial cost of prenatal care could be daunting to all woman. The combination of high unemployment, low minimum wage and high financial pressures from the ʻāiga and *matai* could make paying the fees challenging. Added to this issue was the pay schedule that women are expected to follow. These fees are due by the end of first trimester or women risk being dropped by the program. Unless assisted by their ʻāiga it would have been challenging for many women in American Samoa to be able to pay these fees.

In addition, women may avoid PNC when trying to keep their pregnancy private. For instance, unmarried women may try to keep their pregnancy private longer than married women

because of fear of repercussions within their family and church. However, the health care system of American Samoa offers little privacy because of crowded waiting rooms and long waits. As a result, beginning PNC or even going to a clinic inadvertently announces one's pregnancy on an island where word spreads quickly. Avoiding PNC helps maintain a woman's secret longer.

Inconvenience may also have limited some women's assess to PNC. In addition to unpredictable appointment times, and occasional unexpected clinic closures, women were discouraged from bringing their children into the clinic. On several occasions women who brought their children had to leave them in their cars or were forced to leave them in the waiting room while the mothers went in for their appointments. On occasion children as young as three could be seen sitting in the waiting room alone while waiting for their mothers. For women without the social support systems necessary to garner a babysitter the long wait for a PNC appointment could be challenging. There was also evidence that harsh treatment or fear of harsh treatment may impact a woman's decision to seek care.

The utilization of traditional PNC could also affect which women choose to access western styled PNC. Samoans have traditional healers, *fou fous*, who use traditional massage, salves and medicines to help their patients. *Fou fous* use a special massage for pregnant women that is meant to turn the fetus in the last month before delivery. According to some Samoans, the fetus is unable to turn by itself and without these massages they are likely to be breech births. In Independent Samoa traditional and western medical practitioners work together. However, in American Samoa they are kept completely separate. Women who attend *fou fous* worry that their DOH and LBJ practitioners will get mad at them and actively keep this information to themselves. However, some women reportedly preferred *fou fous* to western styled care because they found it gentler and more comforting (Barclay et al., 2005).

SUMMARY AND CONCLUSION

American Samoans are proud of their focus on the Samoan way of life or *fa'asamoa*. *Fa'asamoa* incorporates all forms of culture and is invoked when discussing politics, immigration, family, church and medical issues. In this chapter I provided a historical and political context for American Samoa. Within this context I discussed how the territory's infrastructure, immigration, employment, family, church and marriage impact individual's social status and how this social status may influence their access to prenatal care. I model this relationship in Figure 2.4.

*Figure 2.4 Sociocultural context of pregnancy of American Samoan women*
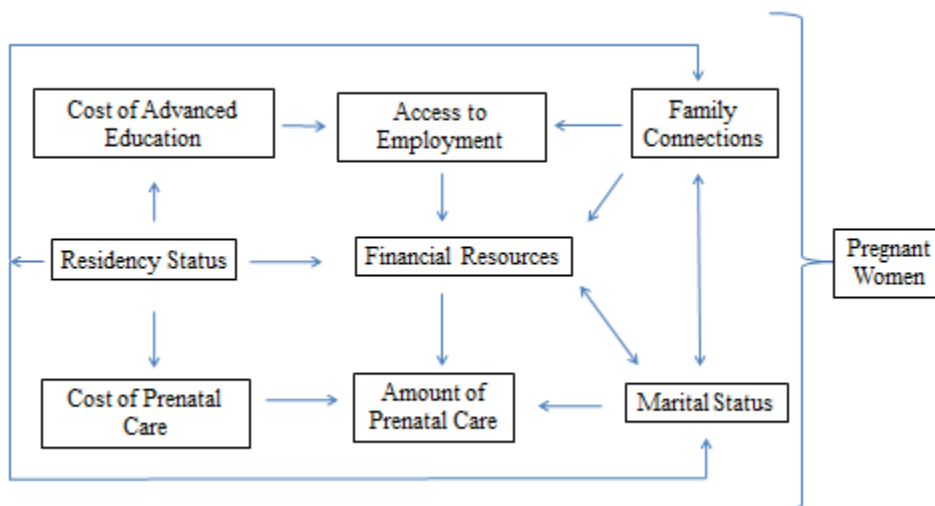


Social status impacts every component of American Samoan lives. This relationship may be particularly important for pregnant women and their unborn children who are especially vulnerable. In addition, there is evidence that certain social classes may experience greater levels of stress than others. For example, being a non-resident or unmarried woman in this community may result in increased levels of stress and may impact health and pregnancy outcomes. The remainder of this dissertation is dedicated to the role that increased stress may play on women's

pregnancy outcomes.

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# CHAPTER 3: DETAILED METHODOLOGY

INTRODUCTION

This chapter provides a detailed narrative explanation of the methodology I used throughout the course of this study. It focuses on information too detailed for a scientific article but of possible interest to other anthropologists. It is my intention that this information acts as a supplement to the database chapters that follow. I conducted two interconnected projects. The first and more in-depth study included interviews, biological and self-reported measures of stress and pregnancy outcomes. In comparison, my secondary study utilized the medical charts of all women giving birth on the island within a year long period. I focus the majority of this chapter on the primary study and begin with an introduction to my preliminary field work and project preparation. I follow this with a discussion focused on my recruitment and primary interview technique. I continue with a section on participant follow-up, ethnographic interviews and measuring birth outcomes and laboratory analysis.

PRELIMINARY FIELDWORK AND PROJECT PREPARATION

In January 2010, I completed a three-week visit to American Samoa to determine the feasibility of this study and to conduct preliminary fieldwork. During this time, I lived with a surgeon who worked at the Lyndon B. Johnson Tropical Medical Center (LBJ), the territory's only hospital. This trip allowed me to visit the villages where I was planning to conduct research and to meet with officials at LBJ and the Department of Health (DOH).

While visiting the villages, I explained the objectives of the research project to women's groups, church groups and individuals. In addition, I conducted informal discussions with groups of Samoan women which provided preliminary data on the specific stressors experienced by this

demographic. Samoans are particularly community-orientated and are very interested in research focusing on the Samoan way of life (*fa'asamoa*) and the health of mothers and infants. Many women voiced their interest in the project and shared personal stories of pregnancy loss, as well as traditions associated with pregnancy and delivery. Particularly disruptive components of women's lives that repeatedly arose during these conversations included church and family obligations, closure of one of the largest employers on the island, and destruction associated with the tsunami of September 2009.

In addition to meeting with women in the villages, I spoke at length with officials at LBJ and the DOH regarding the possibility of gaining affiliation with these institutions. LBJ and the DOH work closely together to provide basic maternal care to women across the island of Tutuila. At LBJ I met with the Chief Medical Officer, Dr. Aloiamoa Anesi, and the Chief of Service OB-GYN, Dr. John AhChing. At the DOH, I met with the Director of Health, Dr. Tuiasina Salamo Laumoli, the primary physician for the Maternal and Childhood Health division, Dr. Olita Koria-Laititi, the Medical Director, Dr. John Tuitele, and the founder and Director of the Women's Health Clinics, Marylin Anesi NP. LBJ and DOH officials expressed interest in the project and indicated the need for this type of research, and offered institutional affiliation.

After returning to Colorado, I gained research permission from the Department of Health in American Samoa (OHRP Federalwide Assurance #: 00001749) and the University of Colorado (OHRP Federalwide Assurance #: 00003492). During this time I sought and was awarded funding from the National Science Foundation Doctoral Dissertation Research Improvement Grant (BCS 1028966), and a Dissertation Fieldwork Grant from The Wenner-Gren Foundation (Gr. 8371). Additional funding was provided through the University of Colorado

Boulder by the Beverly Sears Graduate Student Grant Margaret Hoenich Award, the Haskell-Houghlin Scholarship Fund and the Dorothy Martin Award.

I returned to American Samoa in October 2010 to initiate the data collection stage of this project. I dedicated the first month and a half to meetings with leaders at LBJ and the DOH and to introducing myself to the medical staff at the various clinics. In November 2010 I met with Margaret Sesepasara, one of the three US trained nurse practitioners in American Samoa. Ms. Sesepasara is the women's health coordinator for the Tafuna Health Clinic, a satellite clinic of the DOH and the largest health clinic within the territory. She invited me to conduct my research from her clinic and provided invaluable logistical support throughout the data collection process.

RECRUITMENT AND CONSENT

Recruitment took place entirely at the Tafuna Health Clinic during women's first prenatal care visit. The DOH maintains three clinics; however, the Tafuna clinic manages the majority of the island's low-risk prenatal care patients. Candidates for this study were women of Polynesian decent between the ages of 18-40 years who were tobacco free and reported minimal alcohol use. They were also free of chronic infection, metabolic diseases, a history of hypertension, preeclampsia or eclampsia.

Women seeking prenatal care were registered at the prenatal clinic at the Tafuna Health Clinic. During registration they were given an HgB (pregnancy) test by the clinic staff, occasionally received counseling from the AIDS education program, and were given a referral to the LBJ laboratory for a standard series of blood tests (hemoglobin, hematocrit and blood glucose level). Women with high glucose levels were asked to return to LBJ for a three-hour fasting glucose tolerance test. Women with a high three-hour fasting blood glucose level were transferred to the high-risk clinic at LBJ for the duration of the pregnancy and were not included

in this study. After completing their blood work, women returned to the Tafuna Health Center where they were scheduled for a physical with Margaret Sesepasara, Tafuna's only nurse practitioner.

Women would begin their clinic visit by checking-in with the nursing staff who would take their weight, blood pressure and a basic medical history. Check-in was completed in front of 2-3 other pregnant women and one other staff member. Women were asked to remove their shoes and set their purses down prior to stepping on the Tanita BWB 80 electronic scale. Women's blood pressures were collected with an Omron – 90XL sphygmomanometer while the individual was in a sitting position. Basic medical information included reproductive history, approximate timing of their last menstrual period and surgical history.

After completing check-in, women would wait for their appointment within a narrow, crowded hallway outside of the examination room. Women were seen on a first come, first serve basis. It was not uncommon for women to wait up to three hours. When their turn came the nurse practitioner would direct women to the changing room. The changing room connected the hallway to the examination room and doubled as my office. I would welcome each woman and instruct her to change out of her clothes and into a *lavalava* (a traditional piece of cloth that wraps around the body and covers the chest and upper legs). Before she started changing I would excuse myself and ask her to come into the examination room when she was finished. At no point was the participant's body exposed to me, and I was not in the examination room while she changed or during the physical examination.

The average physical would take between 30 and 40 minutes. All physical examinations were conducted by Margaret Sesepasara. During the physical examination women's medical histories were collected, a pelvic examination was conducted, and women's blood tests were

reviewed. After completing the physical women were asked to change and return back to the examination room where they received various levels of basic nutritional and life style counseling. Women who met the basic criteria of my study were formally introduced to me by the nurse practitioner. During the introduction, Ms. Sesepasara briefly explained the study in Samoan to the candidate and asked them if they would be interested in learning more. If she agreed, I asked the woman to join me in my office to speak privately. The majority of women I approached at this stage agreed to meet. The main reasons women gave for not wanting to speak with me were needing to return to work or take care of another pressing obligation (picking up kids, etc.) or, less frequently, their discomfort with conversing in English. Interviews were conducted in English although all documents were available in Samoan.

When we were alone, I explained the research in greater detail and clarified that there was no obligation to participate. I further explained that participants could withdraw from the study at any time without any kind of impact on their prenatal care. Less than 10 women chose not to participate at this stage. I gained written and verbal consent from the remaining 219 women. Women were offered consent forms in Samoan or English. Three participants chose to fill out the interview forms in written Samoan and the remaining 216 women chose an English version. I then verbally reviewed the consent form in English. After participants had time to review the consent forms, I asked them to sign the documents. I gave each participant a copy of the unsigned consent form.

In order to support my recruitment efforts and increase my exposure within the community, I produced a series of fliers and handouts and gave interviews to local media outlets. The fliers and handouts presented the basic goal of the study and provided the recruitment criteria. I hung the fliers on community bulletin boards around the island and placed handouts

with the education materials at the DOH and LBJ. I also arranged radio, television and

newspaper interviews with the island's media organizations. These interviews originally focused

on the objectives and recruitment criterion of the study. As the project progressed I would give

interviews about the development of the study and outcomes. I also used broadcast and print

media to alert participants of thank you gifts offered after the completion of the study.

PRIMARY INTERVIEW

After gaining consent, I gave participants the choice between completing the interview

questionnaire in written Samoan, written English or spoken English. Three participants chose to

fill out the interview forms in written Samoan and one requested spoken English. The remaining

215 participants chose to fill out the questionnaire in written English. I first administered a two-

page perceived stress survey (PSS) and monthly stress questionnaire (MSQ) to each participant.

The PSS is a global measure of psychosocial stress that attempts to measure how uncontrollable,

overloaded and unpredictable respondents find their lives to be (Cohen et al. 1983). I designed

the MSQ to take a quick measure of the stress experienced during the last month and included

questions about family health, financial obligations to church and family, financial stress, and

relationships with partners, parents and in-laws. Both of these questionnaires were available in

English and Samoan.

While participants completed the PSS and the MSQ, I reviewed their medical charts and

filled out the majority of their medical questionnaire. The medical questionnaire focused on the

participant's reproductive history and medical conditions known to disrupt pregnancy (e.g.,

diabetes and hypertension). Blood pressure, weight and stature were recorded on the medical

questionnaire. Stature was measured using a GPM portable stadiometer mounted on the wall of

my office in accordance with standard anthropometric methods (Lohman, 1988). I collected the

stature of my fifteen original recruits after they delivered due to a missing stadiometer.

I clarified participant medical histories when they had completed the PSS and MSQ. In

addition I administered a psychosocial stress questionnaire (PSQ), a questionnaire I designed to

gain a deeper understanding of participants' personal histories including family structures, living

arrangements, church membership and a measure of status incongruence (discussed below).

The final component of the primary interview was collecting a dried blood spot (DBS)

sample from each participant. Prior to beginning the interview, I had set out a pair of latex-free

gloves, two Unistik 3 lancets, a cotton ball, an alcohol wipe, two finger bandages, and filter

paper (Whatman Protein Saver Snap Apart Card). The participant's name and the date of

collection were written on the outside of the collection card. Using gloved hands, I pulled the

ends of the card to remove its protective cover. Utilizing the DBS collection techniques

described by McDade et al (2007), I cleaned the woman's left index finger with an isopropyl

alcohol wipe and administered a small puncture with a sterile lancet. The lancet was designed to

deliver a controlled, uniform puncture that stimulates capillary blood flow with minimal injury

and pain. The first droplet was wiped away. Subsequent drops were collected on filter paper with

pre-printed circles to increase consistency and reduce researcher error. Four blood spots were

collected from each participant. In cases where there was not enough blood, I punctured the right

index finger using the same technique. After completion, I asked the participant to hold a cotton

ball to the puncture site and shortly thereafter applied a finger bandage.

The card was immediately folded and placed out of the way of possible contamination.

Each card was air-dried for 24 – 48 hours and then frozen at LBJ in a subzero freezer at -26 ˚C.

These blood samples were sealed in four large Ziploc bags with desiccant packets. Samples

collected before August 14, 2011 were transferred to the University of Colorado's Department of Anthropology where they were stored at an average of -80 ˚C. All samples collected after August 14, 2011 were stored in a new freezer at LBJ at an average of -50 ˚C. In September 2012 all samples were moved to Dr. Jay Westcott's freezer (-80 ˚C) at ELISA Tech, Denver. In all cases, desiccant packets were changed as needed (average every 2 weeks) to keep samples dry and viable.

PARTICIPANT FOLLOW-UP

Originally, Wednesdays, Thursdays and Fridays were follow-up days in the Tafuna clinic; however, this was later reduced to Wednesdays for the convenience of the clinicians. Women who had completed their initial blood work and physical were scheduled to return to the clinic once per month until the final month of their pregnancies when they would be seen by physicians at LBJ. During these monthly appointments the nurse practitioner would take abdominal measurements to determine fundal height (the distance from the mother's pubic bone to the top of her uterus). In addition an Elite 3 MHz OB Doppler test measured the fetus's heart rate. Women were not required to disrobe during the follow-up appointments and there was no pelvic exam.

I would ask participants to join me in my office after meeting with the nurse practitioner. During our follow-up women were given a repeat MSQ, PSS and a DBS test. This follow-up meeting typically took under 10 minutes and women quickly became accustomed to the procedure. As with the first meeting I gave participants the choice to fill out their questionnaire in Samoan or English or to be read the questionnaire in English. All participants chose to fill out the questionnaire in English or to be read the questionnaire. Some of the reasons women reported asking for assistance in completing the questionnaire included having their hands full with

children, uncertainty with their reading skills, vision challenges and wanting to be inclusive of the researcher. If the conversation was out of the ordinary I made note in my field notes.

The number of follow-ups collected for each participant was impacted by participant and staff behavior.  Women had variable compliance with attending their prenatal care (PNC) appointments. Common reasons for missing appointments included lack of child care, family obligations, lack of transportation and lack of motivation. Staff behavior also impacted the success rates of follow-ups early in the study. Trying to be helpful, the clinic's nurse practitioner would decide which of my participants were 'worth my time' and would send others away without being interviewed. After recognizing this issue, I reviewed my inclusion and exclusion criteria with the clinic which seemed to help increase the number of follow-ups. Finally, clinic closures for holidays, vacations and other activities in the clinic led to last minute and often unpredictable cancelations and rescheduling of participant appointments.

*Ethnographic / interview data*

In addition to the PSQ, PSS and MSQ six women were given an informal interview. These women were particularly comfortable with me during their monthly follow-up and in some cases I had developed a personal relationship with them outside of the clinic. In selecting these women I attempted to represent a range of ages, parities and socioeconomic statuses. The informal interview was open ended and sought to gain elaboration and explanations of information gathered during the closed ended questions of the PSQ. In some cases participants volunteered extra information which I recorded in the form of field notes.

Women were given a choice to meet in their homes, in a public space, or at my home. I conducted parts of the interviews at the Tafuna Health Clinic, LBJ, hospital, over the phone, in restaurants and in some cases, chance meetings in public markets. It was my goal to meet with

women alone, but the nature of the Samoan household makes everything a public experience. I conducted these interviews with women during and after pregnancy, and in one case while the woman was in the early stages of labor. Women were asked open ended questions about their lives including their partners, village, church and family. My goal was to gain a more in-depth understanding of the lives of Samoan women.

*Measuring birth outcomes: post-natal follow up*

I accessed each participant's medical charts post-partum to complete their socioeconomic, pregnancy and delivery information. All medical charts were stored and accessed at LBJ. These charts were provided and reviewed at the LBJ medical record office. The director of the medical record office, Ms. Suafa Toluao, thoughtfully provided desk space for me to review these charts, in addition to supplying the manpower required to find each chart.

After reviewing the hard copy of the medical record, I reviewed the Labor and Delivery Ward log book (LDLB). The LDLB is kept by the attending nurses and is used by the hospital to generate monthly statistics. Data from the log book were used to supplement the information recorded from the participant's chart. When discrepancies occurred the medical record was prioritized over the LDLB.

Finally, I accessed the electronic records of participants with missing data from both the hard copies of the medical records and the LDLB. I received a 'view only' authorization from LBJ to access its Computerized Patient Record System (CPRS). During the course of this project, LBJ was in a transitional state with its record keeping. Doctors were not required to enter data electronically until April 2012. As a result, the medical records were a mixture of paper and electronic formats to varying degrees of completion.

In order to contextualize this study, I also undertook a large inclusive chart review of all women of Polynesian decent born in American or Independent Samoa who delivered between October 2010 and October 2011. These women were identified from the Labor and Delivery Ward Log Book (LDLB) and follow-up data were collected from the patient charts with the same methodology described above. I used these data in chapter four.

*Participant compensation*

At the completion of the study each participant was given a $5 phone card for each interview they completed. Due to initial funding constrictions participants were told during their original interview that there would be no compensation for their time. As a result, the phone cards came as a pleasant surprise. Phone cards are necessary to add minutes to cell phones in American Samoa and are a strongly desired commodity. Study participants were alerted to the availability of these gifts through a front page newspaper article and radio interviews played during hourly news updates. In addition, my research assistant called each of the participants to alert them of the availability of the phone cards. Participants had to return to the clinic to claim their phone cards.

After conclusion of data collection, an additional inclusion and exclusion assessment was completed for each participant. Women were excluded from the study due to high risk pregnancies associated with gestational diabetes, ectopic pregnancies and multiple births. Women that did not complete the majority of their socio-demographic interview or had missing consent forms were also excluded.

Laboratory analysis

In January 2013 I began the laboratory analysis of the blood spots I collected over the course of this study. Through colleagues at National Jewish Hospital in Denver, I met and began working with Dr. Jay Westcott, owner of ELISA Tech in Denver. ELISA Tech's laboratory was located on Anschutz Medical Campus, although it was not part of the University of Colorado at Denver. Dr. Westcott agreed to help me with my samples with the expectation that I would complete the most time consuming and least technical component of the process, extracting eluates from the blood spot sample. Although Dr. Westcott handled the majority of sample analysis, he agreed to refresh my understanding of laboratory techniques and to demonstrate the remainder of the process after extraction.

I spent three days a week in Dr. Westcott's lab. I spent the first two weeks getting orientated to the laboratory and supplies. I had originally recorded all of my samples with the preprinted six digit number located on each of the blood spot cards. However, these became unwieldy and at Dr. Westcott's suggestion I relabeled all of my samples with 'simple numbers' (1 − 480). In addition I created a data base that reflected these numbers for easier tracking of the samples through the process.

The majority of my laboratory time was spent using a hand held hole punch to punch a 6 mm sample from the blood spot card. Using tweezers I would transfer the sample into a vial I had previously labeled with the simple number. After completing a tray of samples I would use a pipette to add 1 mL of assay buffer (PBS, 0.05% tween) to each vial and close the lid. I would wrap the tray in plastic wrap (to keep the vials in place), gently shake the tray by hand to fully saturate the blood spot, and then let the tray sit for 1-3 hours. Finally, the samples were incubated

overnight at 4˚C. This process separated the eluates from the filter paper making it possible to run the ELISAs.

While I created the eluates, Dr. Westcott began processing them for CRP. Typically he would call me over and explain the process. We would also discuss the results and determine which samples needed to be re-run due to errors with the plate reader and levels of dilution. Due to time constrictions, Dr. Westcott chose to run the final EBV samples by himself. The specific details of dried blood spot analysis are discussed in chapters 5 and 6.

Women experiencing spontaneous abortions (SAB) were not included in this study due to the unreliable record keeping associated with a dilation and curettage (D&C) in American Samoa. For instance, an HCG (pregnancy) test would not necessarily be administered to a patient with heavy bleeding prior to conducting a D&C, and it was impossible to determine from the chart if the patient experienced a SAB or another gynecological condition.

<div align="center">REFERENCES</div>

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## CHAPTER 4: YOU JUST HAVE TO WAIT: MARITAL STATUS AND PREGNANCY OUTCOME IN AMERICAN SAMOA

INTRODUCTION

This chapter addresses the relationship between marital status and prenatal care, medical interventions during delivery and neonate size, while providing a population level overview of Samoan women giving birth in American Samoa over the course of a year. Cross-culturally, married women are more likely to utilize prenatal care (Glei et al., 2003; McCaw-Binns et., 1995), have improved health (Wood et al., 2007) and have better pregnancy outcomes in terms of neonate size (Raatikainen et al., 2005).

Adequate prenatal care (PNC) is widely recognized to improve neonate health and reduce pregnancy interventions by decreasing neurologic, developmental and congenital anomalies (Kotelchuck, 1994; Kessner et al., 1973). In addition, adequate PNC is meant to reduce intrauterine growth restriction, fetal loss and preterm birth (US Public Health Service, 1989). Although there is general agreement that PNC is beneficial, socioeconomic vulnerability, like that caused by not being married, influences which women received care (Raatikainen et al., 2007; Bennett, 1992).

There is evidence that marital status can affect the type and frequency of medical care received, but there is little research focusing specifically on medical interventions used during delivery (Wood et al., 2007). The most common medical interventions utilized in American Samoa are labor inductions and assistance. Labor induction is a method of artificially or prematurely stimulating childbirth either hormonally or through artificial rupturing a woman's membranes. Assistance during delivery includes operative vaginal deliveries (forceps/vacuum

assist), episiotomies and cesarean births (Weber and Meyn, 2002; Franman et al., 2009; Gibbons et al., 2010). Lastly, neonate body size, a proxy for physical maturity and an important indicator of neonate health (Catalano et al., 1995), has been found to be larger in married women (Siza, 2008).

The differences between married and unmarried women in PNC, medical interventions and neonate size have typically been associated with differential access to social and financial resources associated with their status (Kalinka et al., 2003; Bennett 1992). For instance, in the mainland United States single women were 2-3 times less likely to have medical insurance then their married peers (Short 1998; Gold 1985, 1987). In Great Britain, studies found that mortality was greatest in those infants born to unmarried women (Leon, 1991), especially those in disadvantaged social classes (Whitehead and Drever, 1999). These differences in perinatal outcomes were attributed to the quality of care available to the mother and baby, and were intensified by a lack of resources.

It is unclear if this pattern of disproportionate access to resources continues in American Samoa where large extended families are the norm and family finances are systematically shared. Extended families may provide a social buffer against many of the stressors associated with pregnancy conceived out of wedlock (Hedegaard et al., 1993). American Samoa has an intensely hierarchical social organization that places the chief (*matai*) at the head of the extended family (*'āiga*) (Shore, 1982). The *matai* manages family property and controls the flow and distribution of resources. This system ensures that families deal with financial strain as a collective and provides a financial network beyond the nuclear family. Without the financial and social support of the family, prenatal care costs and associated time and travel expenses can be challenging to meet. I predict that the particular nuances of American Samoan family organization may mitigate

some of the social and financial barriers to prenatal care amongst unmarried women and result in

equal access to prenatal care, medical interventions during pregnancy and neonate outcomes.

There are four goals of this chapter: (1) to present descriptive statistics of Samoan women

giving birth in American Samoa; (2) to determine if marital status is related to utilization of

prenatal care in American Samoa; (3) to determine if marital status is related to delivery

outcomes in American Samoa, especially neonate size and of medical interventions and (4) to

contextualize Samoa in comparison to the mainland United States.

## METHODS

This study includes all Polynesian women born in either Independent or American Samoa

who had viable deliveries between October 2010 and October 2011. Women with gestational

diabetes (n=39) were excluded from this study due to the negative impact of the disease on fetal

development and pregnancy outcomes (Nold and Georgieff, 2004; Buchanan and Kitzmiller,

1994). I initially identified participants from the Labor and Delivery Ward log book (LDLB) and

the Maternity Ward log book (MLB). The LDLB is kept by the attending nurses in labor and

delivery and is used by the hospital to generate monthly statistics. Women with scheduled

caesarian-sections were not registered in the LDLB and instead went directly to the maternity

ward after delivery and were registered in the MLB.

After identifying participants, I reviewed each woman's medical record. All medical

records were stored and accessed at the Lyndon B. Johnson Tropical Medical Center (LBJ). The

medical record was prioritized when discrepancies between the LDLB, MLB and the medical

record occurred. The medical records were a mixture of paper and electronic formats and in

varying degrees of completion and accuracy. Data of interest included maternal characteristics,

prenatal, delivery and neonate outcomes. These variables are presented in Table 4.1. Marital

status in the medical records was coded as married or unmarried. Consequently, married refers

only to legally married women and excludes women who describe themselves as married who

are in non-legal domestic partnerships.

*Table 4.1. Maternal characteristics, prenatal, delivery and neonate outcomes*

---

**Maternal characteristics**
-Marital status (married vs unmarried)
-Employment at delivery
-Residency status
-Age at delivery
-Number of previous deliveries
-Number of previous pregnancies
-Maternal weight at delivery

**Prenatal Outcomes**
-Gestation period (days) (gestation periods identified only as 'term' were coded as 40 weeks)
-Number of prenatal care (PNC) appointments
-Gestation age at 1st PNC visit
-Adequacy of PNC
-Presence of gestational diabetes (GDM)

**Delivery outcomes – Medical Interventions**
-Method of membrane rupture (spontaneous or artificial)
-Episiotomy
-Induction
-Maternal anemia
-Presence of meconium
-Operative vaginal delivery (vacuum assist, forceps)
-Mode of delivery (vaginal or C-section)
-Presentation (low risk: vertex; high risk: breech, cephalic, transverse, footling, left occiput
          posterior)
-Total medical interventions (artificial rupturing of membranes, episiotomy, induction, vacuum
          assist, cesarean section)

**Neonate outcomes**
-Neonate weight (g)
-Percentile weight for gestation age
-Neonate crown to heel length (cm)
-Ponderal Index
-1st minute APGAR
-5th minute APGAR

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*Interviews*

In order to provide a context for the data discussed in this chapter I conducted a series of scripted and unscripted interviews with pregnant women living on the main island of Tutuila. These interviews were mostly conducted at the Tafuna health clinic, the islands largest provider of prenatal care to low-risk patients. Additional impromptu informal interviews were conducted during routine social interactions throughout the community. These interviews addressed the role of marriage, immigration status and employment on Samoan women's lives.

*Adequacy of prenatal care*

Adequacy of prenatal care (PNC) was determined using the Adequacy of Prenatal Care Utilization (APNCU) index (Kotelchuck, 1994). The APNCU combines a measure of the adequacy of initiation of prenatal care with the adequacy of received services and follows the American Congress of Obstetricians and Gynecologists guidelines for proper PNC utilization (Alexander and Kotelchuck, 1996). Women who began their PNC early and continued to receive care regularly throughout their gestational period are classified as receiving 'adequate' PNC. For this study, women who began their PNC prior to the 4th month of gestation and received at least 50% of recommended services were classified as having adequate PNC. A breakdown of the categories of the APNCU are in Appendix A.

*Neonate size*

Local weight for gestation age percentiles were determined using the World Health Organization's Sexual and Reproductive Health weight percentiles calculator (Mikolajczyk et al., 2011). The complete local percentiles table for this population is available in Appendix B. Neonates who were below the 10th percentile for those of the same gestational age were considered to have undergone intrauterine growth restrictions (IUGR) and have not reached their

growth potential. These neonates are considered small for gestational age (SGA). Neonates who were above the 90th percentile for those of the same gestational age are considered large for gestational age (LGA). Those between the 10th and 90th percentiles are considered appropriate for gestational age (AGA) (Battaglia and Lubchenco, 1967).

The ponderal index (PI) is an additional measure of neonate body size that makes it possible to identify newborns who are an appropriate size for gestational age (AGA) but show evidence of growth restrictions (Chard et al., 1992).The PI is defined as the ratio of neonate body weight to crown to heel length [weight (in g) x 100] ÷ [length (in cm)$^3$] (Chard et al., 1992). During the 30 to 37th week of gestation the PI increases gradually and then remains constant unless there is a decrease in skeletal muscle and adipose tissue (Chard et al., 1992). Neonates with a PI below the 10th percentile are considered malnourished, where as those with a PI below the 3rd percentile suffer from severe wasting (Miller and Hassanein, 1971).

*Research permission*

Research permission was gained from the Department of Health in American Samoa (OHRP Federalwide Assurance #: 00001749) and the University of Colorado (OHRP Federalwide Assurance #: 00003492).

*Data analysis*

All statistical analyses were conducted with IBM SPSS Statistics 19.0. Statistical significance for all analyses was set at $p < 0.05$. The chi-square test for independence was used to compare the frequencies of discrete variables between groups. Independent-sample t-tests were used to compare the means of continuous variables between groups. A Mann-Whitney U was used for non-normally distributed variables. An ANCOVA was used to control for co-variance associated with maternal age and number of previous deliveries.

RESULTS

Of the women in this population 57.8% were married, 65.9% were residents and 75.5% were unemployed. The majority of women's membranes were artificially ruptured (59.6%). Women were less likely to have an episiotomy (8.7%) or be induced into labor (18%). A minority of women were anemic (13.7%). Neonates were less likely to be delivered with an operative vaginal delivery (3%), to have a high risk presentation (4.1%) or be exposed to meconium (24.6%). Women were more likely to deliver vaginally (77.5%) than by cesarean section (See Table 4.2). The majority of neonates were average size for gestational age (AGA) (80.6%), few were small for gestational age (SGA) (11%) or large for gestational age (LGA) (8.4%).

*Table 4.2. Descriptive variables: maternal characteristics and delivery outcomes*

| Variable | $N^a$ | Category | Frequency (%) |
|---|---|---|---|
| Marital status | 1033 | Married | 597 (57.8%) |
| | | Unmarried | 436 (42.2%) |
| Residency status | 1048 | Resident | 691 (65.9%) |
| | | Non-Resident | 357 (34.1%) |
| Employment status | 1006 | Employed | 244 (24.3%) |
| | | Unemployed | 762 (75.7%) |
| Membranes | 824 | Spontaneous Rupture | 333 (40.4%) |
| | | Artificial Rupture | 491 (59.6%) |
| Episiotomy | 1097 | Presence | 95 (8.7%) |
| | | Absence | 1002 (91.3%) |
| Induction | 1097 | Presence | 197 (18%) |
| | | Absence | 900 (82%) |
| Anemia | 1097 | Presence | 150 (13.7%) |
| | | Absence | 947 (86.3%) |
| Meconium | 1097 | Presence | 270 (24.6%) |
| | | Absence | 827 (75.4%) |
| Operative vaginal delivery | 1097 | Presence | 33 (3%) |
| | | Absence | 1064 (97%) |
| Vaginal delivery | 1097 | Presence | 247 (22.5%) |
| | | Absence | 850 (77.5%) |
| Presentation | 1033 | High Risk | 42 (4.1%) |
| | | Low Risk | 991 (95.9%) |
| $SGA^b$ (>10th Percentile) | 1002 | SGA | 110 (11%) |
| | | Not SGA | 892 (89%) |
| $LGA^b$ (<90th Percentile) | 1002 | LGA | 84 (8.4%) |
| | | Not LGA | 918 (91.6%) |
| $AGA^b$ (≤10-≥90th %) | 1002 | AGA | 808 (80.6%) |
| | | Not AGA | 194 (19.4%) |

[a]*Total sample size is lower for some variables due to incomplete medical records.*
[b]*SGA=Small for gestational age, AGA=average for gestational age, LGA=Large for gestational age*

The mean age of women in this study was 26.8 (± 6.5) years and average maternal weight was 203.6 (± 44.68) pounds. Women in this study attended an average of 8.25 (± 4.68) prenatal care appointments starting an average of 147.6  (± 69.5) days into their pregnancy. The average woman in this study had 3.24 (± 2.17) previous pregnancies and 3.1 (± 2.07) previous deliveries. The gestation period for this population averaged 277.1 (± 13.72) days. The average neonate weight was 3408.3 (± 572.7) grams. Average neonate length was 50.24 (± 2.94) cm, and the average ponderal index was 2.72 (± 0.75). First minute APGAR scores averaged 8.34 (± 1.14) and the average five minute APGAR scores 8.95 (± 0.75). The average woman in this study had 0.97 (± 0.78) medical interventions. Descriptive variables for maternal characteristics and birth outcomes for continuous data are presented in Table 4.3.

*Table 4.3. Descriptive variables: maternal characteristics and birth outcomes for continuous data*

| | $N^a$ | Range | Median | Mean |
|---|---|---|---|---|
| Maternal age | 1087 | 12 - 50 | 26 | $26.83 \pm 6.5$ |
| Maternal weight at 1st visit | 944 | 103 - 435 | 200 | $203.65 \pm 44.68$ |
| Maternal weight at delivery | 915 | 129 - 320 | 221 | $224.91 \pm 45.07$ |
| Number of prenatal care appointments | 1088 | 0 -24 | 9 | $8.25 \pm 4.68$ |
| Gestation age 1st visit (days) | 1020 | 7 - 294 | 133 | $147.6 \pm 69.5$ |
| Number of previous pregnancies | 1096 | 1 - 12 | 3 | $3.24 \pm 2.17$ |
| Number of previous deliveries | 1094 | 0 - 12 | 3 | $3.1 \pm 2.07$ |
| Gestation period days | 1067 | 168 - 309 | 280 | $277.11 \pm 13.72$ |
| Neonate weight (g) | 1091 | 1043 - 5488 | 3401 | $3408.2 \pm 572.7$ |
| Neonate length (cm) | 1026 | 29.5 - 62 | 50.5 | $50.24 \pm 2.94$ |
| Ponderal Index | 969 | 0.97-12.57 | 2.6 | $2.72 \pm 0.75$ |
| 1st minute APGAR | 1064 | 0 - 10 | 9 | $8.34 \pm 1.14$ |
| 5 minute APGAR | 1064 | 0 - 10 | 9 | $8.95 \pm 0.75$ |
| Total medical interventions | 1097 | 0 - 3 | 1 | $0.97 \pm 0.78$ |

[a]*Total sample size is lower for some variables due to incomplete medical records.*

### Marital Status Descriptive Statistics

I used a chi-square test for independence to compare the frequencies of discrete variables between married and unmarried women (Table 4.4). Married women were more likely to be residents of American Samoa and be employed at the time of delivery (p =0.001). However, married women were less likely to have an episiotomy (p =0.005) or an operative vaginal delivery (p =0.011). Married women were more likely to be categorized as having adequate care

(p=0.001). There were no differences between marital status and method of membrane rupture, induction of labor, maternal anemia, type of delivery, presence of meconium, or neonate presentation at labor. Finally, there was no difference between SGA, LGA or AGA between married and unmarried women (Table 4.4).

*Table 4.4. Marital status descriptive table nominal data*

|  | Breakdown of Variable | $N =$ Married | $N =$ Not Married | p-value |
|---|---|---|---|---|
| Residency Status | Resident | 426 | 253 | |
| | Non-Resident | 171 | 182 | <0.001 |
| Employment Status | Employed | 171 | 72 | |
| | Not Employed | 416 | 346 | <0.001 |
| Adequacy of PNC Utilization | Adequate | 251 | 118 | |
| | Inadequate | 279 | 251 | <0.001 |
| Occupation | Occupied Outside of Home | 180 | 130 | |
| | Not Occupied Outside of Home | 382 | 276 | 0.998 |
| Birth Place | Born American Samoa | 307 | 228 | |
| | Born Western Samoa | 290 | 208 | 0.782 |
| Rupture of Membrane | Spontaneous Rupture of Membranes | 175 | 137 | |
| | Artificial Rupture of Membranes | 270 | 198 | 0.658 |
| Episiotomy | Episiotomy | 40 | 51 | |
| | No Episiotomy | 557 | 385 | 0.005 |
| Induction | Induction | 117 | 66 | |
| | No Induction | 480 | 370 | 0.064 |
| Anemia | Anemia | 84 | 66 | |
| | No Anemia | 513 | 370 | 0.631 |
| Meconium | Meconium | 149 | 109 | |
| | No Meconium | 448 | 327 | 0.998 |
| Operative Vaginal Delivery | Operative Vaginal Delivery | 12 | 21 | |
| | No Operative Vaginal Delivery | 585 | 415 | 0.011 |
| Delivery Type | Vaginal Delivery | 460 | 137 | |
| | C-Section | 89 | 347 | 0.330 |
| Presentation | Low Risk | 531 | 404 | |
| | High Risk | 26 | 15 | 0.402 |
| SGA[b] (>10th Percentile) | SGA | 55 | 51 | |
| | Not SGA | 493 | 350 | 0.211 |
| LGA[b] (<90th Percentile) | LGA | 53 | 26 | |
| | Not LGA | 495 | 375 | 0.095 |
| AGA[b] (≤10 - ≥90th Percentile) | AGA | 440 | 324 | |
| | Not AGA | 108 | 77 | 0.869 |

[a]*Total sample size is lower for some variables due to incomplete medical records.* [b]*SGA=Small for gestational age, AGA=average for gestational age, LGA=Large for gestational age*

I used independent-sample t-tests were used to compare the means of continuous variables between married and unmarried women (Table 4.5). A Mann-Whitney U was performed on all non-normally distributed variables. Married women were older and heavier at delivery and had more previous pregnancies and deliveries (p =<0.001), and longer gestation period (p=0.016). Married women were more likely to start their PNC earlier and attend more PNC appointments (p=<0.001). In addition, married women's neonates had higher 1st minute APGARs (p=0.044), were heavier (p =<0.001) and longer (p=0.015). There was no difference based on marital status with the 5 minute APGAR, ponderal index or total medical interventions (Table 4.5).

*Table 4.5. Marital status descriptive table quantitative data*

| | Breakdown of Variable | $N$ | Mean | p-value (t-test) | p-value (ANCOVA) |
|---|---|---|---|---|---|
| Weight at delivery (lbs) | Married | 549 | 230.1 ± 44.19 | | |
| | Not married | 365 | 217.01 ± 45.36 | <0.001 | <0.001 |
| Number of previous pregnancies | Married | 596 | 3.9 ± 2.22 | | |
| | Not married | 436 | 2.3 ± 1.7 | <0.001 | – |
| Number of previous deliveries | Married | 594 | 3.7 ± 2.12 | | |
| | Not married | 436 | 2.3 ± 1.66 | <0.001 | – |
| Gestation period (days) | Married | 584 | 277.9 ± 12.1 | | |
| | Not married | 426 | 275.7 ± 15.6 | 0.016 | 0.011 |
| 1st minute APGAR | Married | 583 | 8.4 ± 0.96 | | |
| | Not married | 425 | 8.2 ± 1.35 | 0.011 | 0.019 |
| 5 minute APGAR | Married | 583 | 9 ± 0.61 | | |
| | Not married | 425 | 8.9 ± 0.94 | 0.079 | – |
| Maternal age | Married | 594 | 28.8 ± 6.26 | | |
| | Not married | 434 | 24.1 ± 5.97 | <0.001 | – |
| Number of prenatal care appointments | Married | 595 | 9.1 ± 4.5 | | |
| | Not married | 435 | 7.1 ± 4.6 | <0.001 | <0.001 |
| Neonate weight (g) | Married | 596 | 3453.76 ± 568.58 | | |
| | Not married | 433 | 3322.34 ± 593.92 | <0.001 | – |
| Neonate length (cm) | Married | 567 | 50.3 ± 3.41 | | |
| | Not married | 407 | 49.6 ± 4.8 | 0.014 | – |
| Ponderal Index | Married | 566 | 2.7 ± 0.78 | | |
| | Not married | 403 | 2.7 ± 0.76 | 0.67 | – |
| Gestation age at 1st visit | Married | 561 | 135 ± 66.7 | | |
| | Not married | 409 | 162.5 ± 69.15 | <0.001 | <0.001 |
| Total medical intervention | Married | 597 | 1 ± 0.76 | | |
| | Not married | 436 | 1 ± 0.82 | 0.843 | – |

[a]*Total sample size is lower for some variables due to incomplete medical records.*

I used an ANCOVA to model the possible confounding effects of age and parity on prenatal and pregnancy outcomes. After controlling for maternal age and number of previous deliveries, maternal weight at delivery remained significant ($p < 0.001$), as did total gestation period ($p=0.011$) and $1^{st}$ minute APGAR scores also retained their significance ($p=0.019$). Married women were also more likely to start their PNC earlier and attend more PNC appointments ($p < 0.001$). However, after controlling for maternal age and number of previous deliveries the effect of marital status on total medical interventions disappeared. The assumption of homogeneity of slopes was violated for number of previous deliveries, neonate weight and neonate length and as a result these variables were excluded from the ANCOVA. Details of the ANCOVA can be found in Appendix C and results can be found in Table 4.5.

## DISCUSSION

### *Prenatal Care*

Marital status affects the timing and amount of PNC Samoan women receive. Prenatal care is important for improving neonate and maternal health within a population (US Department of Health and Human Services, 2000; Kessner et al., 1973; US Public Health Service 1989). However, in American Samoa married women are more likely to start their prenatal care earlier and have more appointments than unmarried women. Married women were also more likely to have adequate PNC based on the Adequacy of Prenatal Care Utilization (APNCU) index. This difference is likely due to a combination of financial and social restrictions associated with marital status in American Samoa.

Because of American Samoa's relationship with the United States, medical costs are kept to a minimum. These fees are further reduced for women who begin their prenatal care in the first trimester of their pregnancy and attend all of their PNC appointments. However, women are

still expected to pay $70 for their first appointment, a fee which is approximately 10.5% of an

average monthly salary in the territory (CIA World Fact Book 2009). These funds may be

unobtainable for unmarried women who, compared to their married peers are less likely to be

employed, have residency status and may not have the same access to funds as married women.

Although Samoan extended families (*'āiga*) may provide some of the social support

typically supplied by the partner, women reported being apprehensive of how their family and

the medical community may respond to their pregnancies. In my interviews, unmarried women

would frequently indicate that they started their PNC late or avoided PNC in order to circumvent

admonishment from their health care providers and *'āiga*. When asked about the timing of their

PNC some unmarried women indicated the anticipation of embarrassment and rough treatment

based off on their previous experience or that of their peers. Women reported being reprimanded

by their PNC providers for being pregnant and unmarried. Even women in long-term

relationships reported being asked antagonistically why they were not married to the father of

their children. Anticipation of negative responses from their *aigas* was also frequently reported

as a deterrent to accessing PNC (Hawley et al., 2013).

In recent Samoan history, unmarried pregnant women could be beaten publically by their

male *'āiga* members and frequently had their waist long hair forcibly cut to punish them for their

perceived indiscretion. Unfortunately, although women are less likely to have their hair cut

today, stories of physical assault by family members due to unwanted pregnancies were still

common. Physical and verbal abuse were most frequently instigated by male family members as

a response to the perceived shame and embarrassment that an unmarried pregnancy would

generate in the *aiga's* church community. Finally, some women confessed waiting to share their

pregnancy status to avoid potential entanglements with family members who may aggressively try to adopt their children.

### Delivery Outcomes – Medical Interventions

Marital status appeared to have little impact on the number and type of medical interventions women received. Medical interventions during delivery are not themselves indicative of a poor pregnancy outcomes or an unhealthy pregnancy. However, married women in American Samoa seemed to be treated more courteously and with more respect at every stage of the prenatal and delivery process. This was recognized by women who would on occasion lie about their marital status to avoid confrontations with then medical staff.

In this study, married women were less likely to have an episiotomy or an operative vaginal delivery. It is unclear why this difference occurs, however it may suggest different decision making on behalf of the medical professionals during delivery. Interestingly, there were no differences in membrane rupturing, rates of induction, the method of delivery or the total number of medical interventions. American Samoan doctors perform fewer operative vaginal deliveries, episiotomies and cesarean sections than their counterparts on the mainland United States (Table 4.6).

*Table 4.6: Comparisons of percentage of operative vaginal deliveries, episiotomies and cesarean sections performed on the mainland United States compared to American Samoa.*

|  | United States | American Samoa |
| --- | --- | --- |
| Operative Vaginal Deliveries[a] | 3.60% | 3% |
| Episiotomies[b] | 24.50% | 8.70% |
| Cesarean Section[c] | 30.30% | 22.50% |

[a]Natl Vital Stat Rep, 2012; [b]Frankman et al., 2009; [c]Gibbons et al., 2010

*Delivery outcomes – neonate size*

Neonate body size has been recognized as an important indicator of neonate health and is used as a proxy for physical maturity (Catalano et al., 1995). Gestation length, measures of neonate body size (weight, crown to heel length) and combined measures like the ponderal index and weight for gestational age provide a strong measure of neonate growth and development (Chard 1992; Draper and Field 2007).

Married women in this study had heavier and longer neonates. However, these differences were small and unlikely to be biologically significant. For these results to be biologically significant I would expect a 5% difference between groups. This encapsulates the difference between the 5th and 10th percentile categories according to the World Health Organization's Sexual and Reproductive Health weight percentiles calculator (Mikolajczyk et al., 2011; appendix B). The mean neonate weight in these women is 3408.2g. The difference in neonate weight between married and unmarried women is 131.42g which is below the 5% difference of 170.41g. The mean neonate length in these women is 50.24g. The difference in neonate length between married and unmarried women is 0.7 which is below the 5% difference of 2.5cm. In addition, I found no differences in ponderal index scores or the number of SGA, AGA or LGA neonates associated with marital status.

As a territory of the United States, American Samoa birth outcomes can be compared to those occurring on the mainland. Because there was no difference between marital status and birthplace I combined for women born in American and Independent Samoa for this comparison. Samoan women were compared to U.S born whites, foreign-born Asian Indians, U.S. born Asian Indians, foreign-born Mexican and U.S. born Mexicans. Samoan women had slightly longer gestation lengths then white, Mexican or Asian American women and lower rates of prematurity

than any other group of women. They also had the largest neonates of any group besides white

Americans. Samoan women had a higher percentage of low birth weight (≤2500) neonates than

white or Mexican American women. White and Mexican born women were the only ones to

have lower rates of percentage of very low birth weight (≤1500g) compared to Samoan women.

Samoan woman had the lowest percentile of small for gestational age infants (SGA <5th

percentile).  Taken together, these results indicate that Samoan infants are well within the ranges

of mainland populations of women (Table 4.7).

*Table 4.7: Cross Cultural Comparison of Birth Outcomes Based on Maternal Birth Place*

| | U.S. Born White[a] | Foreign-Born Asian Indian[a] | U.S. Born Asian-Indian[a] | Foreign-born Mexican[a] | U.S. born Mexican[a] | Samoan Born |
|---|---|---|---|---|---|---|
| N | 4,005,671 | 76,618 | 4,285 | 1,408,797 | 928,801 | 1091 |
| Mean Gestational Age (wk) | 39.1 | 38.9 | 38.9 | 39.1 | 38.9 | 39.6 |
| % Prematurity (<37wk) | 14.85 | 16.73 | 16.64 | 16.04 | 18.21 | 5.34 |
| Mean birth weight (g) | 3439 | 2174 | 3203 | 3388 | 3332 | 3408 |
| % LBW (≤2500g) | 3.71 | 6.91 | 6.7 | 3.66 | 4.65 | 5.5 |
| % VLBW (≤1500g) | 0.67 | 0.79 | 0.93 | 0.69 | 0.9 | 0.73 |
| % SGA[b] | 2.61 | 6.34 | 5.58 | 2.93 | 3.37 | 1.01 |

[a]*Comparative data from Madan et al., 2006;*

[b]*SGA (small for gestational age) represents neonate below the 5th percentile for  weight for body size.*

*Social status and legitimate marriage in American Samoa*

Unmarried pregnant women in American Samoa face stigma that impacts their utilization of prenatal care. This is surprising because many women in Samoa cohabitate with partners for many years in relationships that produce children and seem to be socially accepted as married. Because it costs so little to get legally married through the court it initially seems as though these women have made a personal decision to not get married. However, in American Samoa, culturally legitimate marriage refers to large Christian-styled church weddings that require tremendous social and financial resources.

Weddings are hosted by the entire extended family and require financial organization by the *matai*. Couples from more affluent families or those who hold a higher status within their families are likely to have their weddings prioritized over other family needs and events. As a result, lower ranking women have less access to church-styled (legal) weddings. In this way, accessibility of a church-styled wedding is representative of a couple's status in their family and village. Legal marriage acts to legitimize couples within their family and society and reifies status hierarchies already present in American Samoa. Other measures of social status including residency status, employment and education levels were measured but were non-significant and not discussed in this chapter.

## CONCLUSIONS

Marital status has been recognized cross-culturally as impacting prenatal care, medical interventions during delivery and neonate outcomes. The results of this study challenge this pattern by addressing these outcomes in Samoan women giving birth in American Samoa. Married women in this population accessed prenatal care earlier and more frequently than their unmarried peers, and were less likely to have an episiotomy or an operative vaginal delivery.

However, there are no differences based on of marital status with any other medical interventions during pregnancy or neonate outcomes. The lack of differences between married and unmarried Samoan women may be related to the additional social and financial support associated with extended families and centralized family incomes. Taken together this support may mitigate some of the barriers and social pressures associated with unmarried pregnancy. However, these close knit communities can also increase pressure on unmarried pregnant women from their families and medical communities. In addition, this system may reduce access to marriage for lower ranking women.

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## CHAPTER 5: DO SELF-REPORTED MEASURES OF PSYCHOSOCIAL STRESS ALIGN WITH A BIOMARKER OF STRESS IN SAMOAN WOMEN?

INTRODUCTION

The growing recognition of the importance of psychosocial stress in the disruption of health has gained a great deal of attention from anthropologists (Ice and James, 2007; Nepomnaschy et al., 2006). Stress is defined as a "process by which a stimulus elicits an emotional, behavioral and/or physiological response, which is conditioned by an individual's personal, biological and cultural context" (Ice and James, 2007). By extension, psychosocial stress is stress stemming from interactions within the social environment. Psychosocial stress has been associated with a number of negative health outcomes including high blood pressure, depression, obesity and reproductive disruption (Rice et al., 2007; Brown, 2007; James, 2007; Pollard and Ice, 2007; Nepomnaschy et al., 2006).

This chapter builds on this understanding by comparing one physiological measure of psychosocial stress (Epstein-Barr virus antibody levels) with three self-reported measures of stress (status congruence, a Monthly Stress Questionnaire and Perceived Stress Scale). Each measure of self-reported stress is meant to address a different potential stressor in women's lives. Comparing these self-reported measures of stress to Epstein-Barr virus (EBV) antibody levels will enable me to determine if these measures are accurately reflecting psychosocial stress in pregnant American Samoan women.

EBV, a biomarker of cell-mediated immunity, provides a useful measure of chronic psychosocial stress (Cacioppo et al., 2002; McDade et al., 2000b). EBV is a ubiquitous and chronic herpes virus that infects approximately 90% of individuals in developing countries by

the age of five and 98% by twenty years old, with the majority remaining clinically

asymptomatic (McDade et al., 2000a; Henle and Henle, 1982). EBV is typically maintained in its

latent state by cell mediated immune function; however, stress-induced immunosuppression

triggers the reactivation of EBV and the release of viral antigens (Glaser et al., 1991). EBV

antibody titers are negatively associated with cell-mediated immune response.

Multiple studies have used EBV as an indirect measure of stress-induced cell-mediated

immune suppression linked to psychosocial stress. Increased EBV levels have been associated

with psychosocial stress caused by family pressures such as being the primary caretaker of a

family member with Alzheimer's disease and having a poor quality marriage (Kiecolt-Glaser et

al., 1987a, Kiecolt-Glaser et al., 1988; Glaser et al., 1993). Increased levels of EBV are also

associated with social pressures such as medical school exams, perception of discrimination and

reduced access to material lifestyle and socioeconomic status (Borders et al., 2010; Sorensen et

al., 2009; Glaser et al., 1987, 1993).  In addition, a positive association was found between EBV

antibody levels and status incongruence in Samoan children (McDade 2001, 2000a).

Status incongruence (McDade, 2002) or status inconsistency (Dressler 1988) is the

inability of an individual to resolve nontraditional and traditional markers of status into a

coherent social identity. Status incongruence (a concept that originated with sociological theories

of social stratification) arises when an individual fulfills contradictory positions of social status

within their community which leads to a discrepancy in lifestyle aspirations and actual lifestyles

(McDade 2002; Dressler 2007, 2004a, 2004b). This measure could be particularly important in

developing nations like American Samoa where globalization is rapidly transforming women's

identities.

In addition to status incongruence, other self-reported stress measures can provide useful information. In this study I used a culturally specific measure of psychosocial stress the Monthly Stress Questionnaire (MSQ), and a broader measure of stress, the Perceived Stress Scale (PSS) to capture each woman's perception of stress over the previous month. The MSQ was developed specifically for this project and population to provide a culturally specific measure of psychosocial stress. This measure includes questions about family health, financial stress and obligations, and relationships.

The PSS was developed by Cohen et al. (1983) in an attempt to capture how individuals appraise their lives as uncontrollable, overloading and unpredictable. Instead of measuring reactions to specific events, the PSS addresses general beliefs about perceived stress and assesses the individuals comprehensive stress level (Cohen, 1986; Cohen et al., 1983). The PSS measures two broad factors: adaptation symptoms and coping ability (Hewitt et al., 1992). High PSS has been positively associated with physical illness, anxiety, poor health behaviors (smoking, etc.), psychosomatic symptoms, depression and physical symptoms (Cohen et al., 1993; Pbert et al., 1992; Cohen and Williamson, 1988; Cohen et al., 1983). In addition, PSS scores in pregnant women have been negatively associated with gestation length (Glynn et al., 2008; Skok et al., 2006). PSS was found to be a better predictor of dysfunction in individuals than self-rated life event scales (Cohen et al., 1983). The PSS has been validated against numerous psychological measures including the life-event scores, depressive and physical symptomatology and measures of social anxiety and was found to have an adequate degree of internal consistency (Cohen et al., 1983; Hewitt et al., 1992).

Comparing status congruence, the MSQ and PSS to EBV levels will provide insight into which scale is best able to capture the stress response of Samoan women. Physiological measures

of stress like EBV provide a measure of an individual's reaction to their psychosocial environment unbiased by participant interpretation or response. In addition, EBV levels assist researchers in identifying stress that is not otherwise readily communicated or observable with self-reported measures (McDade, 2002). By comparing EBV to three measures of self-reported stress we will be able to determine the effectiveness of these scales in assessing stress in Samoan women. There are two goals in this study: (1) to compare the effectiveness of the three self-reported stress scales in detecting psychosocial stress by comparing them to EBV levels; (2) to determine if the three self-reported stress scales detect comparable levels of psychosocial stress.

METHODS

*Subjects*

This study was conducted on the American Samoan island of Tutuila between October 2009 and June 2012. Participants were 78 pregnant women of Samoan decent recruited from the Tafuna Health Center, the largest provider of prenatal care in the territory. Participants were women between the ages of 18-40, and women who reported no alcohol or tobacco use. Clinic records indicated they were free of chronic infections, metabolic diseases and did not have a history of hypertension or preeclampsia, and had low risk pregnancies. All women gave birth on island.

Research permission was gained from the Department of Health in American Samoa and the University of Colorado.

*Demographics and Anthropometry*

I conducted a basic demographic interview which determined participant marital, residency, employment status and age. Non-scripted interviews were conducted at the health center and throughout the community. The trimester of participant recruitment was determined

by taking each woman's total gestation length and subtracting the days of the pregnancy before recruitment took place. The remaining number was compared to the American Association of Gynecology and Obstetrics guidelines and each participant was assigned a trimester. Participant weight was collected using a Tanita BWB 80 electronic scale. Stature was measured using a mounted GPM portable stadiometer in accordance with standard anthropometric methods (Lohman, 1988).

*Physiological Marker of Psychosocial Stress*

EBV antibody levels were measured using the Epstein-Barr virus nuclear antigen (EBNA) and were measured from dried blood spots (DBS). DBS were collected from participants at each of their prenatal care appointments at the Tafuna Health Center. A sterile safety lancet was used to collect capillary blood with a finger prick. The first drop of blood was wiped away and the following drops were collected on filter paper. DBS were prepared using Whatman Protein Saver Snap Apart Cards with preprinted circles, dried thoroughly for 24 – 48 hours at room temperature, and stored in sealed plastic bags with desiccant packets. Samples were frozen at -26 ˚C until processing.

I processed the DBS with Dr. Jay Westcott at Denver's ELISA Tech. DBS were eluted by immersing one 6 mm punch from the periphery of the sample in 1 mL of assay buffer (PBS, 0.05% tween). The samples were allowed to shake for 1-3 hours before being incubated overnight at 4˚C to separate the eluates from the filter paper.

Coated EBNA plates were purchased from ELISA Tech. A standard curve was developed by doing serial dilutions on samples. Eluates extracted from DBS were diluted 1-40 and 1-100 µL was pipetted into the wells. After incubating for two hours at room temperature, the eluates were flicked out. The plate was washed five times with wash buffer and 100 µL of goat anti-

human IgG HRP (obtained from KPL) was added to the wells. The samples were incubated for one hour at room temperature before flicking off the excess liquid and the plates were washed five times with wash buffer. After adding 100 μL TMB the samples were incubated 8-20 minutes and 100 μL 1M phosphoric acid was added. The plates were read with a colormetric plate reader (μ quant:, BioTek Instruments, Inc.) and concentrations were estimated with a four-parameter logistic calibration curve (Gen5, BioTek Instruments Inc.). For this study EBNA levels were averaged for each participant. The average EBNA levels were not normally distributed and were $\log_{10}$ transformed. Throughout this chapter EBV will refer to $\log_{10}$ transformed EBNA levels. After a total score was assessed for each participant the data were divided into tertiles. The extremes were classified as high (3.25-2.53) and low (2.24-1.61) stress.

In order to control for the impact of general infection on EBV levels, I excluded all samples with a C-reactive protein (CRP) levels $\geq 5$ mg/L (McDade et al., 2000b). No women were excluded from the study based on these criteria, but five individual samples were excluded. Although, other studies have used CRP as a stress measure (Borders et al., 2010), this study used CRP solely as an excluding factor. CRP assay kits were purchased from ELISA Tech. Eluates were diluted from 1-10 to 1-100 and the standards ranged from 1 ng/mL to 10 pg/mL. We added 100μL of standard, sample or buffer into the wells. The samples were incubated at room temperatures for two hours before being flicked off and washed five times with PBS buffer. Following the wash, 100 μL of biotylated antibody were added to each well and the plate was incubated at 4˚ overnight. Plates were washed five more times with PBS buffer before adding 100 μL of horseradish peroxidase streptavidin (HPS) to each well and incubated at room temperature for 1-2 hours. After incubation, the plate was flicked out and washed 5 times with PBS buffer and 100 μL of Tetramethyl Benzidine (TMB) was added as a substrate for the HPS.

Color was allowed to develop for 8-20 minutes before 100 μL 1M phosphoric acid was added to halt the enzyme's reaction. The plates were read with a colormetric plate reader (μ quant:, BioTek Instruments, Inc.) and concentrations were estimated with a four-parameter logistic calibration curve (Gen5, BioTek Instruments Inc.).

*Self-Reported Measures of Stress*

Status congruence was measured using a modified version of the scale originally developed by McDade (2002). This two part scale measures the level of congruity between a woman's traditional and non-traditional life experiences. Traditional experience was measured by the presence of a chief or *matai* in the immediate household. Non-traditional life experiences were assessed with a positively scaled westernization scale that measures participants exposure to nontraditional lifestyles associated with travel abroad (personal and family), amount of television watched, friendships with non-Samoans and cell phone ownership. In brief, positive answers were coded as one, each negative answer was coded as zero. Amount of television watched was coded as never (0), once a week (1) and everyday (2). Although McDade's original scale included a 'once a month' option for amount of television watched, none of the participants in the current study chose it as an option so it was excluded. Finally the scale used deviated from McDade's original formulation (McDade, 2002) in that it incorporates cell phone ownership (Appendix D).

The median score for this sample was used to separate women by "low / western" and "high / western". Women with a score of six or less were assigned to the "low / western" group, and those with a score of seven or greater were assigned to the "high / western" group. Participants were considered status congruent if they had a *matai* titleholder in their household

and were in the high westernization group or did not have a *matai* in their household and were in the low westernization group. All others were categorized as non-congruent.

Women included in this analysis had at least two MSQ and PSS scores which were averaged for each woman. Although both these questionnaires were available in English and Samoan, all participants chose to answer the questionnaires in English. Questionnaires that were seemingly rushed through were excluded in this study. The MSQ measures self-reported stress levels and consists of 12 questions, eight of which were scaled from one to five with one being least stressful and five being most stressful (Appendix E). The remaining four were presence absence questions with presence being scored as one, and absence being scored as 0. A total score was assessed for each participant and the data were divided into tertiles. The extremes of the tertiles were classified as high (25.3-17.5) and low (12.8-6.8) stress.

The PSS is a 14-question test with answers scaled to range from "never" to "very often" with higher scores reflecting greater perceived stress (Appendix F). Seven of the items on the scale were reverse keyed prior to summing up the final score. A total score was assessed for each participant and the data were divided into tertiles. The extremes of each were classified as high (42.7 – 29.7) and low (27.8-16.8) stress.

*Data Analysis*

All statistical analyses were conducted with IBM SPSS Statistics 19.0. Statistical significance for all analyses was set at $p < 0.05$. Independent-sample t-tests were used to compare EBV to status congruence and the MSQ and PSS. A correlation analysis was used to test the relationship between participant's EBV levels, MSQ and PSS scores. I divided these variables into tertiles and used a chi-square test for independence to compare the first and third tertiles defined as high versus low stress levels.

RESULTS

*Maternal Characteristics*

Participants in this study were predominantly married (62.8%), legal residents of

American Samoa (66.7%), unemployed (72.6%) and were status congruent (57.7%) (Table 5.1).

*Table 5.1. Descriptive statistics of maternal sociodemographic characteristics*

| Variable | N[a] | Category | Frequency (%) |
|---|---|---|---|
| Marital status | 78 | Married | 49 (62.8%) |
| | | Unmarried | 29 (37.2%) |
| Residency status | 78 | Resident | 52 (66.7%) |
| | | Non-Resident | 26 (33.3%) |
| Employment status | 73 | Employed | 20 (27.4%) |
| | | Unemployed | 53 (72.6%) |
| Status Congruence | 78 | Congruent | 45 (57.7%) |
| | | Incongruent | 33 (42.3%) |

[a]*Total sample size is lower for some variables due to incomplete records.*

The mean age of women in this study was 25.1 (± 5.2) years old. The average participant

weighed 89.6 (±20) kg, was 1.66 (± 0.1) meters tall with a BMI of 32.4 (± 6.4). Participants in

this study had an average monthly stress questionnaire result of 15.1 (± 4.5) and an average

perceived stress scale score of 28.7 (± 3.2) (Table 5.2).

*Table 5.2. Descriptive statistics maternal characteristics and stress measures*

|  | N[a] | Range | Median | Mean |
|---|---|---|---|---|
| Maternal age | 78 | 18 – 38 | 24 | $25.1 \pm 5.2$ |
| Maternal weight at delivery (kg) | 77 | 60-164.6 | 84.5 | $89.6 \pm 20$ |
| Height (m) | 76 | 1.57-1.78 | 1.65 | $1.66 \pm 0.1$ |
| BMI | 75 | 22.7-55.5 | 31.7 | $32.4 \pm 6.4$ |
| MSQ | 78 | 6.8 - 25.3 | 15.1 | $15.1 \pm 4.5$ |
| PSS | 78 | 16.8 - 42.7 | 28.7 | $28.7 \pm 3.2$ |
| EBV[b] | 78 | 1.61-3.25 | 2.43 | $2.4 \pm 0.4$ |

[a]*Total sample size is lower for some variables due to incomplete records.*
[b]*EBV levels were determined using Log EBNA.*

Participants were recruited in all trimesters of pregnancy. Of these women, 28.2% were recruited during the first trimester, 52.6% during the second semester and 9% during the third trimester. Finally, the trimester of enrollment into the study was unknown for 10.2% of participants (Table 5.3).

*Table 5.3 Trimester of participant enrollment*

| Trimester Enrolled | N | Frequency (%) |
|---|---|---|
| 1 | 22 | 28.2 |
| 2 | 41 | 52.6 |
| 3 | 7 | 9 |
| unknown | 8 | 10.2 |

Status congruent individuals either had no *matai* in their household and were classified as low westernization (42.3%) or had a *matai* in their household and were classified as high westernization (16.7%). Status incongruent individuals either had no *matai* in their household

and were classified as high westernization (28.5%) or had a *matai* in their household and were

classified as low westernization (11.5%) (Table 5.4).

*Table 5.4. Frequency of status congruent individuals according to matai presence in household and westernization scale*

|  | Low Westernization | High Westernization | Total |
|---|---|---|---|
| No *Matai* | 33 (42.3%)[a] | 23 (29.5%) | 56 |
| *Matai* | 9 (11.5%) | 13 (16.7%)[a] | 22 |
| Total | 42 | 36 | 78 |

[a]*Status congruent*

### EBV and Reported Stress Scores

The relationship between our biomarker of stress, EBV (as measured by EBNA), and the

three types of self-reported stress was investigated. I found no relationship between EBV levels

and status congruence using an independent-sample t-tests (p=0.949). When I divided EBV

scores into tertiles and used a chi-square test for independence I found no relationship between

high versus low EBV and status congruence (p = 0.780) (Table 5.5).

*Table 5.5 Comparison of high and low EBV tertiles with status congruence*

|  |  | $N$ = EBV High Stress | $N$ = EBV Low Stress | p-value |
|---|---|---|---|---|
| Status Congruence | Congruent | 12 | 11 |  |
|  | Incongruent | 14 | 15 | 0.078 |

Using a correlation analysis I found no relationship between EBV and MSQ (p =0.337,

$r^2$=0.012) (Figure 5.1) or PSS levels (p =0.755, $r^2$=0.001) (Figure 5.2).

*Figure 5.1 EBV levels compared to Monthly Stress Questionnaire levels*
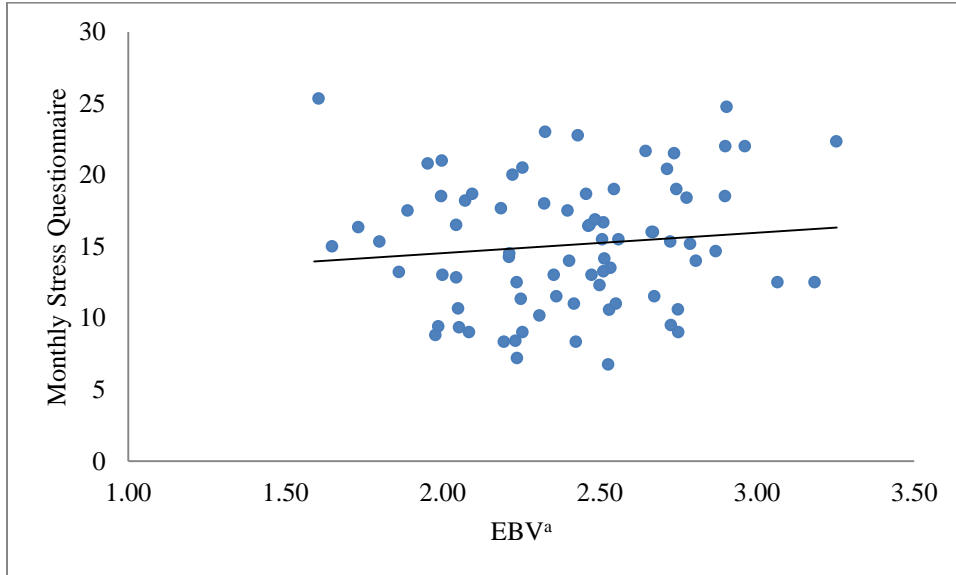


*[a]EBV levels were determined using Log_{10} EBNA*

*Figure 5.2 EBV levels compared to Perceived Stress Scale levels*
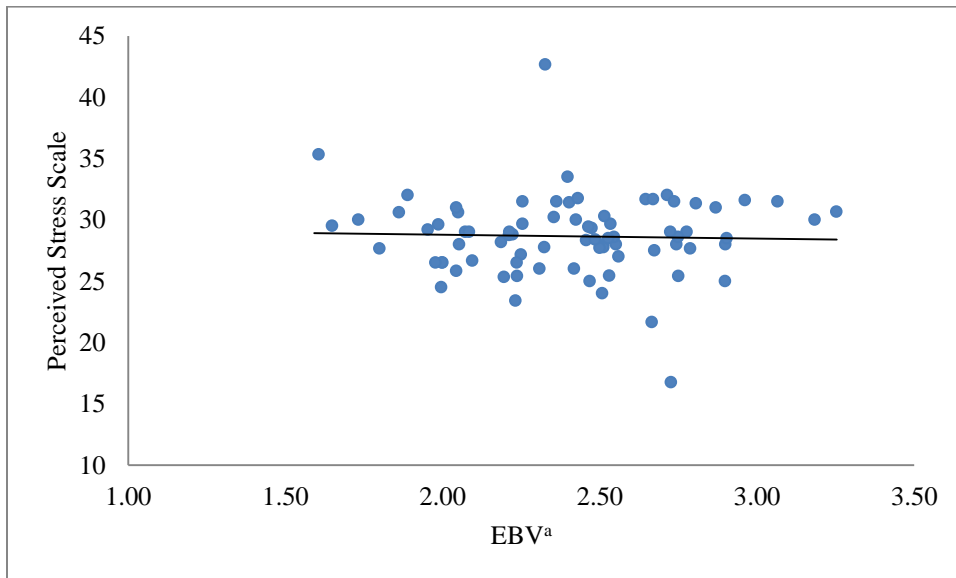


*[a]EBV levels were determined using Log_{10} EBNA*

These results were further tested using a chi-square test for independence to compare the frequency of high / low EBV levels and high / low MSQ and PSS scores. No relationship was found between EBV and MSQ (p = 0.502) or PSS (p = 0.169) (Table 5.6).

*5.6 Frequency of high and low EBV values compared with monthly stress questionnaires and perceived stress scale.*

|  |  | EBV[a] High | EBV Low | p-value |
|---|---|---|---|---|
| Monthly stress scale | High | 11 | 9 |  |
|  | Low | 7 | 9 | 0.502 |
|  |  |  |  |  |
| Perceived stress scale | High | 11 | 6 |  |
|  | Low | 7 | 10 | 0.169 |

*[a]EBV levels were determined using $Log_{10}$ EBNA*

Only five women from this study had high EBV values as well as high MSQ and PSS scores. Only seven women from this study had low EBV levels as well as MSQ and PSS scores. The characteristics of these women are shown in Table 5.7.

*5.7 Characteristics of women categorized as high stress by EBV, MSQ, PSS*

|  | High Stress n=5 |  | Low Stress n=7 |  |
|---|---|---|---|---|
| Category | Mean (SD) | % | Mean (SD) | % |
| Gestation length, (weeks) | 39.4 (1.9) | — | 38.7 (1.4) | — |
| Neonate wt (g) | 3301.2 (327.5) | — | 3369.5 (519.6) | — |
| Neonate length (cm) | 49.7 (2.7) | — | 49.2 (3.6) | — |
| Ponderal index | 2.7 (0.2) | — | 2.9 (1.0) | — |
| Neonate head circumference (cm) | 35 (0.4) | — | 33.9 (1.2) | — |
| Neonate chest circumference (cm) | 32.9 (2.3) | — | 32.6 (1.2) | — |
| Employed | — | 20 | — | 14.1 |
| Married | — | 100 | — | 28.6 |
| Residents | — | 100 | — | 42.9 |
| Neonates size for gestational age | — | 100 | — | 85.7 |
| Status Incongruent | — | 20 | — | 42.9 |

I used independent-sample t-tests to compare the status congruence classifications to the means of the EBV, MSQ and PSS. There were no differences between congruence and EBV levels (p=0.949), the MSQ (p=0.763) or the PSS (p=0.460) (Table 5.8).

*Table 5.8 Status congruence compared to EBV levels, the Monthly Stress Questionnaire and Perceived Stress Scale.*

| | Breakdown of Variable | N | Mean | p-value (t-test) |
|---|---|---|---|---|
| EBV[a] | Congruent | 45 | 2.4 (±0.4) | |
| | Incongruent | 33 | 2.4 (±0.3) | 0.949 |
| Monthly stress questionnaire | Congruent | 45 | 15.2 (±4.9) | |
| | Incongruent | 33 | 14.9 (±4) | 0.763 |
| Perceived stress scale | Congruent | 45 | 28.9 (±3.1) | |
| | Incongruent | 33 | 28.3 (±3.4) | 0.460 |

[a]*EBV levels were determined using $Log_{10}$ EBNA*

In addition I used a chi-square test for independence to assess the association between status congruence and nominal stress categories (high / low) of the MSQ and PSS. There was no relationship between status congruence and the MSQ (p=0.262) or the PSS, (p=0.575)(Table 5.9).

*Table 5.9 Comparison of status congruence with high and low measures of stress from the monthly stress questionnaire and perceived stress scale*

| | | Congruent | Non Congruent | p-value |
|---|---|---|---|---|
| Monthly stress scale | High | 17 | 9 | |
| | Low | 13 | 13 | 0.262 |
| Perceived stress scale | High | 16 | 10 | |
| | Low | 14 | 12 | 0.575 |

*Monthly stress questionnaire and perceived stress scale*

The relationship between the MSQ and PSS was investigated. Using a correlation analysis we found a significant but weak relationship between the monthly stress questionnaire and the perceived stress scale ($p \leq 0.001$, $r^2=0.167$) (Figure 5.3).

*Figure 5.3 Monthly Stress Questionnaire levels compared to Perceived Stress Scale*
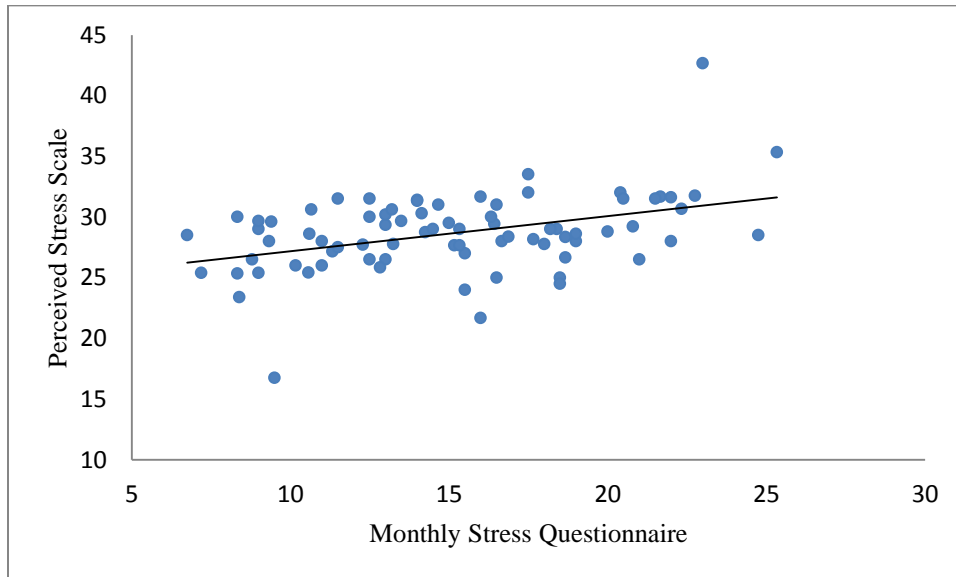


In addition I used a chi-square test for independence to assess the association between the high / low stress categories of the MSQ and PSS. These results suggest an association between MSQ and PSS stress levels ($p=0.006$) (Table 5.13).

*5.10 Comparison of high and low measures of stress from the Monthly Stress Questionnaire and Perceived Stress Scale*

|  |  | Perceived Stress Scale | |
|---|---|---|---|
|  |  | *Low* | *High* |
| Monthly Stress Scale | *Low* | 14 | 5 |
|  | *High* | 4 | 11 |

DISCUSSION

This chapter compared EBV antibody levels with three measures self-reported stress: status incongruence, the Monthly Stress Questionnaire (MSQ) and the Perceived Stress Scale (PSS). I used EBV (an indirect measure of stress induced cell-mediated immune suppression) as a measure of chronic stress (Cacioppo et al., 2002; McDade et al., 2000b). Previous research has found a positive relationship between EBV and family pressures, medical school exams, discrimination, and socioeconomic status (Christian et al., 2012; Borders et al., 2010; Sorensen et al., 2009; Glaser et al., 1987, 1993). In addition, EBV provides a biological measure that is not biased by poor recall or under reporting (McDade 2002). Taken together EBV provides a strong indirect measure of stress useful for this population.

The first goal of this chapter was to compare the effectiveness of the three self-reported stress scales in detecting psychological stress by comparing them to EBV levels. After controlling for infection (using CRP), I was able to compare the effectiveness of the three self-reported stress scales in detecting psychosocial stress by comparing them to EBV levels. None of the self-reported measures of stress (status incongruence, MSQ and PSS) were related to EBV levels (as measured by EBNA). Only five women were classified as high stress for all three measures, EBV, MSQ and PSS, and only seven were classified as low stress for all three measures. It was interesting that although all of the high stress women were married and legal residents of American Samoa, only 28.6% of the low stress women were married and 42.9% were legal residents. Based on the ethnographic interviews, I would have expected the low stress individuals to be predominantly married and for there to be no difference in residency status. Finally, it was surprising that there were a higher percentage of status incongruent women in the low stress group then the high stress group.

These results were particularly surprising in light of McDade's (2002) work linking status incongruence to high EBV levels. Samoans are community oriented and measures of social status are clearly demarcated (Shore, 1982). Traditionally, status was acquired through chiefly (*matai*) titles, and despite significant social changes in Samoa, the importance of the *matai* status has persisted (Macpherson and Macpherson, 2009). However, the transformative effects of nontraditional religious, educational, political, economic and legal institutions have altered the Samoan view of social status (Tisdell, 2002). Remittances from overseas relatives, increased access to globally manufactured goods, and influences from Christian religious groups provide opportunities to circumvent the *matai* system (Macpherson and Macpherson, 2009).

In Samoa, status congruence results from the ability to resolve traditional (*matai*) and non-traditional (e.g. cash, education) markers of social status (McDade 2002). McDade (2002) found a significant relationship between psychosocial stress (as measured by EBV levels) and status congruence, with a stronger relationship in females than males. Conversely, incongruence arises in those associated with *matai* status who lack the material goods and economic resources necessary to fulfill their *matai* responsibilities, as well as in those individuals with high levels of material benefits who lack the traditional *matai* status. Although I expected this relationship to extend to the adults in our study, I found no evidence of a relationship between EBV and status congruence. This lack of relationship suggests pregnant Samoan women living in American Samoa may experience a more integrated relationship between traditional and non-traditional measures of status than the individuals from Independent Samoa (previously Western Samoa) that McDade studied. In addition, pregnant women may experience a temporary status change which may buffer some of the psychosocial stress typically associated with status congruence in

other studies (Rutter and Quine 1990). Finally, these differences may reflect an adjustment to globalization pressures associated with traditional and nontraditional markers of status.

The second goal of this chapter was to determine if the three self-reported measures of stress detected comparable levels of psychosocial stress. Surprisingly, status congruence was not related to either the MSQ or the PSS. The lack of relationship between status congruence and the MSQ and PSS may reflect the different dimensions of stress in a woman's life. Status incongruence was used to assess psychosocial stress associated with a woman's ability to resolve differing expectations between traditional and non-traditional lifestyles. In comparison, the PSS provides a comprehensive measure of reported stress (Herbert and Cohen 1993; Cohen et al., 1983), whereas the MSQ provides a population specific stress measure. Alternatively, the absence of association between these measures may reflect reporting and methodological issues – especially with the MSQ and PSS.

The MSQ and PSS were filled out each month by participants. Although questionnaires that were filled out in haste (e.g, not reading the questionnaire, selecting the same answer for all questions in a clearly haphazard way etc.) were not included in this study, there were other less clear cases where women seemed to be reading the questionnaire but when asked for clarification later they provided alternative answers. In addition, women would fill out their questionnaires while talking even when encouraged to focus on the task at hand. Finally, it was not uncommon for Samoans to admit to being much more comfortable speaking English than reading in either English or Samoan. This may have impacted their ability to understand the outcomes of MSQ and PSS. In comparison, status congruence was administered orally reducing distractions and eliminating barriers to comprehension.

However, the MSQ and the PSS were found to be significantly related as both continuous variables and when divided into high/low levels of stress. This suggests that women who are classified as having high levels of stress by the MSQ are also likely to be categorized the same way by the PSS. However, the small sample size created by spitting the database into tertiles may have weakened the value of these results.

The MSQ was developed specifically for this study. As a result it is not possible to compare it to results from other populations. However, it is possible to compare the average PSS scores from this chapter to other studies. Table 5.11 includes some of the original research utilizing PSS as well as a selection of other studies that have utilized this instrument. Mean PSS scores in these eight studies ranged from 18.3-29.1. The mean PSS score of Samoan women in the present study was 28.7, the second highest of these studies.

*Table 5.11 Comparison of perceived stress status results in different samples*

| Reference | n | Mean PSS (SD) | Participants |
|---|---|---|---|
| Current Study | 78 | 28.7 (3.2) | Pregnant Samoan women in American Samoa |
| Mimura and Griffiths 2008 | 1542 | 27.6 (8.42) | 222 native English speakers, 1320 native Japanese speakers |
| Skok et al., 2002 | 51 | 28.2 (6.5) | Mothers caring for school-aged children with cerebral palsy - Royal Children's Hospital in Melbourne, Australia |
| Hewitt et al., 1992 | 96 | 29.1 (8.8) | Psychiatric patients - Brockville Psychiatric Hospital |
| Pbert et al., 1992 | 59 | 19.6 | Participants in a health promotion program - University of Massachusetts Medical Center |
| Pbert et al., 1992 | 41 | 18.3 | Cardiac rehabilitation program - University of Massachusetts Medical Center |
| Cohen et al., 1983 | 332 | 23.2 (7.3) | College students - University of Oregon students living in dorms |
| Cohen et al., 1983 | 114 | 23.7 (7.8) | College students - University of Oregon students in Introduction to Personality Psychology |
| Cohen et al., 1983 | 64 | 25 (8) | Participants in a smoking cessation program - University of Oregon |

## *Conclusion*

This study investigated the relationship between a biomarker of stress, EBV, and the

three types of self-reported stress. None of the self-reported measures of stress were found to

correlate with psychosocial stress in pregnant Samoan women as measured by EBV. Very few of

the same women were classified as high stress by all three measures, EBV, MSQ and the PSS.

Stress as measured by EBV, MSQ and PSS were not related to our measure of status congruence.

As a result, this study failed to isolate a self-reported measure of stress that correlates with

psychosocial stress in Samoan women as measured by EBV.

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**CHAPTER 6: IS THERE A RELATIONSHIP BETWEEN PSYCHOSOCIAL STRESS AND PREGNANCY OUTCOMES IN SAMOAN WOMEN?**

INTRODUCTION

Premature delivery and low birth weight are the leading causes of neurodevelopmental impairments, mortality, morbidity and disabilities among neonates (Barker, 1998; Leon, 1998, Rich-Edwards et al., 1997; WHO, 1995). Although extensive programs have attempted to reduce the rates of premature delivery and low birth weight globally, this progress has been slower than expected (Buekens and Kleanoff, 2001; Branun and Schoendorf, 2002). The insufficient reduction of poor pregnancy outcomes globally underscores the importance of addressing additional social and environmental factors that may challenge maternal health and the intrauterine environment and lead to weight constrictions in the fetus. One environmental factor which is gaining attention for its role in impacting fetal development is maternal psychosocial stress.

Maternal exposure to psychosocial stress has been associated with an increased risk of spontaneous abortion (Nepomnaschy et al., 2006; Sagiura-Ogasawara et al., 2002; Boyles et al., 2000; Neugebauer et al., 1996; O'Hare and Creed, 1995) and higher risk of preterm birth (Mancuso et al., 2004; Dole et al., 2003; Hobel and Culhane, 2003; Rondo et al., 2003; Orr et al., 2002; Austin and Leader, 2000; Rini et al., 1999). In North America and Europe, mothers reporting higher levels of psychosocial stress are at an increased risk of delivering neonates who are small-for-gestational age (Rice et al., 2007; Hobel and Culhane 2003; Rondo et al., 2003; Pinto and Shetty, 1995; Nordentoft et al., 1996; Wadhwa et al., 1993; Anderson et al., 1985).

Taken together, these studies indicate an important relationship between psychosocial stress and pregnancy. However, there is a dearth of information regarding this relationship in

women from developing nations who have different psychosocial stressors (Nepomnaschy et al., 2006)**.** This study aims to address this deficiency in our knowledge by using a non-specific bio-marker of psychosocial stress, Epstein-Barr Virus (EBV) antibody levels to determine if maternal psychosocial stress affects pregnancy outcomes in Samoan women.

Psychological measures of stress, like EBV, provide an opportunity to assess the condition of an individual's social environment and can help researchers recognize stress that is not otherwise readily communicated or observable (McDade, 2002). EBV represents an indirect measure of stress-induced cell-mediated immune suppression and provides a useful measure of chronic psychosocial stress (Cacioppo et al., 2002; McDade et al., 2000b).

EBV antibody titers are negatively associated with cell-mediated immune response. Although EBV is typically maintained in its latent state by cell mediated immune function, stress-induced immunosuppression triggers the reactivation of EBV and the release of viral antigens. Humoral-mediated immunity is activated in response and EBV antibodies are released (Glaser et al., 1991). EBV is a ubiquitous and chronic herpes virus in developing nations and infects approximately 90% of individuals by the age of five and 98% by the age of twenty years, although the majority will remain clinically asymptomatic (McDade et al., 2000a; Henle and Henle, 1982). The use of the EBV antibody titer as an indirect measure of cell mediated immunity has been validated through association between reduced cytotoxic T-cell lysis of EBV infected cells and when collected as a dried blood spot it has the same degree of reliability and precision as collection through venipuncture (Mei et al., 2001; McDade et al., 2000b; Glaser et al., 1993).

Increased EBV levels have been associated with psychosocial stress due to family pressures such as being the primary caretaker of a family member with Alzheimer's disease,

status incongruence and a poor quality marriage (McDade, 2001; 2000a, Glaser et al., 1993, Kiecolt-Glaser et al., 1988, Kiecolt-Glaser et al., 1987). Increased levels of EBV have also been associated with social pressures related to medical school exams, perception of discrimination and reduced access to material lifestyle and socioeconomic status (Christian et al., 2012; Borders et al., 2010; Sorensen et al., 2009; Glaser et al., 1987; 1993).

Maternal EBV levels have also been linked to neonate health. There is also evidence that EBV reactivation during pregnancy is linked to risks of testicular cancer and leukemia in offspring (Holl et al., 2008; Tedeschi et al., 2007; Lehtinen et al., 2003). Maternal EBV reactivation has also been linked to negative pregnancy outcomes including birth defects, lower birth weight, shorter gestations and stillbirths (Icart et al., 1981; Eskild et al., 2005).

It is clear that psychosocial stress and health are interconnected. In this chapter I evaluate whether psychosocial stress (as measured by EBV) impacts pregnancy outcomes in American Samoan women. In this chapter I ask whether: (1) mothers with higher levels of psychosocial stress (as measured by EBV levels) had smaller neonates; (2) mothers with higher levels of psychosocial stress had shorter gestations, and (3) married women had higher levels of psychosocial stress (as measured by EBV levels) than unmarried women. Finally, I compared the demographics and pregnancy outcomes of women in this study to those in the greater population.

## METHODS

This study was conducted on the American Samoan island of Tutuila between October 2009 and June 2012. Participants in this study were recruited from the largest provider of low risk prenatal care in the territory, the Tafuna Health Center, and included pregnant women of Samoan decent. These women were non-smokers, and did not have gestational diabetes.

Ethnographic and biomarker data were collected from 151 women.

During the first meeting I attained participant consent and administered a basic demographic questionnaire that assessed marital, residency and employment status. I determined the trimester that each participant was recruited by taking each woman's total gestation length and then subtracting the number of days of the pregnancy prior to our first meeting. This final number was compared to the trimester cut offs for a 40 week pregnancy. During this first meeting I also collected each woman's stature using a mounted GPM portable stadiometer and weight using a Tanita BWB 80 electronic scale following standard procedures (Lohman, 1988). Finally, I collected a dried blood spot (DBS) from each woman during the first and subsequent prenatal care appointments.

EBV antibody levels were measured from DBS using the Epstein-Barr virus nuclear antigen (EBNA). DBS were collected from participants using a sterile safety lancet to collect capillary blood with a finger prick. The first drop of blood was wiped away and the following drops were collected on filter paper. DBS were prepared using Whatman Protein Saver Snap Apart Cards with preprinted circles, dried thoroughly for 24 – 48 hours at room temperature, and stored in sealed plastic bags with desiccant packets. Samples were frozen at -26 ˚C until processing.

I processed the DBS with Dr. Jay Westcott at Denver's ELISA Tech. DBS were eluted by immersing one 6 mm punch from the periphery of the sample in 1 mL of assay buffer (PBS, 0.05% tween). The samples were allowed to shake for 1-3 hours before being incubated overnight at 4˚C to separate the eluates from the filter paper.

Coated EBNA plates were purchased from ELISA Tech. A standard curve was developed by doing serial dilutions on samples. Eluates extracted from DBS were diluted 1-40 and 1-100

μL was pipetted into the wells. After incubating for two hours at room temperature, the eluates were flicked out. The plate was washed 5 times with wash buffer and 100 μL of goat anti-human IgG HRP (from KPL) was added to the wells. The samples were incubated for one hour at room temperature before flicking off the excess liquid and the plates were washed 5 times with wash buffer. After adding 100 μL TMB the samples were incubated 8-20 minutes and 100 μL 1M phosphoric acid was added. The plates were read with a colormetric plate reader (μ quant:, BioTek Instruments, Inc.) and concentrations were estimated with a four-parameter logistic calibration curve (Gen5, BioTek Instruments Inc.). EBNA levels were not normally distributed and so after being averaged for each participant they were $\log_{10}$ transformed. Throughout this chapter EBV will refer to $\log_{10}$ transformed EBNA levels. Prior to log transforming this data EBNA levels were averaged for each participant. After a total score was assessed for each participant the data were divided into tertiles. The extremes were classified as high (3.25-2.53) and low (2.24-1.61) stress.

In order to control for the impact of general infection on EBV levels, I excluded all samples with a C-reactive protein (CRP) levels ≥5 mg/L (McDade et al., 2000b). No women were excluded from the study based on these criteria, however five individual samples were excluded. Although, other studies have used CRP as a stress measure (Borders et al., 2010), this study used CRP solely as a excluding factor. CRP assay kits were purchased from ELISA Tech. Eluates were diluted from 1-10 to 1-100 and the standards ranged from 1 ng/mL to 10 pg/mL. We added 100μL of standard, sample or buffer into the wells. The samples were incubated at room temperatures for two hours before being flicked off and washed five times with PBS buffer. Following the wash, 100 μL of biotylated antibody were added to each well and the plate was incubated at 4˚ overnight. Plates were washed five more times with PBS buffer before

adding 100 μL of horseradish peroxidase streptavidin (HPS) to each well and incubated at room temperature for 1-2 hours. After incubation, the plate was flicked out and washed 5 times with PBS buffer and 100 μL of Tetramethyl Benzidine (TMB) was added as a substrate for the HPS. Color was allowed to develop for 8-20 minutes before 100 μL 1M phosphoric acid was added to halt the enzymes reaction. The plates were read with a colormetric plate reader (μ quant:, BioTek Instruments, Inc.) and concentrations were estimated with a four-parameter logistic calibration curve (Gen5, BioTek Instruments Inc.).

I reviewed the medical records of each participant after they delivered to determine neonate outcomes. These measurements were taken within the first 24 hours of the neonate's life. The medical records were a mixture of paper and electronic formats in varying degrees of completion and accuracy and were stored and accessed at the Lyndon B. Johnson Tropical Medical Center (LBJ). Ponderal index (PI) was determined using a ratio of neonate body weight to crown to heel length [weight (in g) x 100] ÷ [length (in cm)$^3$] (Chard et al., 1992). Local weight for gestation age percentiles were determined using the World Health Organization's Sexual and Reproductive Health weight percentiles calculator (Mikolajczyk et al., 2011). Neonates below the 10$^{th}$ percentile were considered small for gestational age (SGA). Those above the 90$^{th}$ percentile for gestational age are considered large for gestational age (LGA). Those between were considered appropriate for gestational age (AGA) (Battaglia and Lubchenco 1967). In order to compare this sample with the general population I collected data on 1097 women giving birth on island between October 2010 and October 2011. Details on this study were presented in chapter four of this dissertation.

*Data Analysis*

All statistical analyses were conducted with IBM SPSS Statistics 19.0. Statistical

significance for all analyses was set at p <0.05. Z-scores were used to compare maternal and

pregnancy outcomes between sample and population. Correlation analysis was used to compare

EBV levels and maternal and pregnancy outcomes. Independent sample t-tests were used to test

differences in maternal and pregnancy outcomes associated with the high and low tertiles of

EBV. Finally, interaction terms in multiple linear regression models were used to test whether

the effect of EBV values on maternal characteristics and pregnancy outcomes was significantly

different between the married and unmarried groups.

*Research Permission*

Research permission was gained from the Department of Health in American Samoa

(OHRP Federalwide Assurance #: 00001749) and the University of Colorado (OHRP

Federalwide Assurance #: 00003492).

RESULTS

Participants in this study were predominantly married (55.7%), legal residents of

American Samoa (61.5%), and unemployed (73%) (Table 6.1).

*Table 6.1 Frequency of maternal characteristics*

| Variable | N[a] | Category | Frequency (%) |
|---|---|---|---|
| Marital status | 149 | Married | 83 (55.7) |
| | | Unmarried | 66 (44.3) |
| Residency status | 143 | Resident | 88 (61.5) |
| | | Non-Resident | 55 (38.5) |
| Employment status | 141 | Employed | 38 (27) |
| | | Unemployed | 103 (73) |

*[a]Total sample size is lower for some variables due to incomplete records.*

Descriptive variables for maternal characteristics and birth outcomes for continuous data are presented in Table 6.2. The mean age of women in this study was 23.5 ($\pm$ 5.4) years old and average maternal weight was 88.6 ($\pm$ 17.6) kg. The average maternal height was 1.66 ($\pm$ 0.05) m with an average BMI of 32.4 ($\pm$ 5.9). Women in this study had an average of 2.8 ($\pm$ 1.9) previous pregnancies and 2.6 ($\pm$ 1.8) previous deliveries and an average EBV of 2.39 ($\pm$0.35). The average neonate weighed 3451.7 ($\pm$ 568.9) grams. Average neonate length was 50.8 ($\pm$ 2.04) cm, and the average ponderal index was 2.64 ($\pm$ 0.36). Neonates in this study have an average head circumference of 34.6 ($\pm$1.44) cm and an average neonate chest circumference of 33.2 ($\pm$ 1.8) cm and gestated an average of 277.2 ($\pm$ 12.6) days.

*Table 6.2 Maternal and neonate descriptive variables*

|  | Nᵃ | Range | Median | Mean |
|---|---|---|---|---|
| Maternal age (years) | 150 | 18 – 38 | 23.5 | 25.1 ± 5.4 |
| Maternal weight at delivery (kg) | 139 | 60 - 164.5 | 84.5 | 88.6 ± 17.6 |
| Height (m) | 132 | 1.55 - 1.79 | 1.65 | 1.66 ± 0.05 |
| BMI | 124 | 22.1 - 55.5 | 31.9 | 32.4 ± 5.9 |
| Number of previous pregnancies | 150 | 1 - 9 | 2 | 2.8 ± 1.9 |
| Number of previous deliveries | 150 | 0 – 8 | 2 | 2.6 ± 1.8 |
| EBV | 150 | 1.59 - 3.25 | 2.42 | 2.39 ± 0.35 |
| Neonate weight (g) | 150 | 1179.3 - 4898.8 | 3401.9 | 3451.7 ± 568.9 |
| Neonate length (cm) | 148 | 41.5 – 55 | 51 | 50.8 ± 2.04 |
| Ponderal index | 148 | 1.99 - 5.01 | 2.62 | 2.64 ± 0.36 |
| Neonate head circumference (cm) | 143 | 27 – 39 | 34.5 | 34.6 ± 1.44 |
| Neonate chest circumference (cm) | 139 | 28 – 37 | 33 | 33.2 ± 1.8 |
| Gestation length delivery (weeks) | 149 | 203 -308 | 280 | 277.2 ± 12.6 |

Frequencies of neonate weights are presented in Figure 6.1.

*Figure 6.1 Frequency distribution of neonate weight*
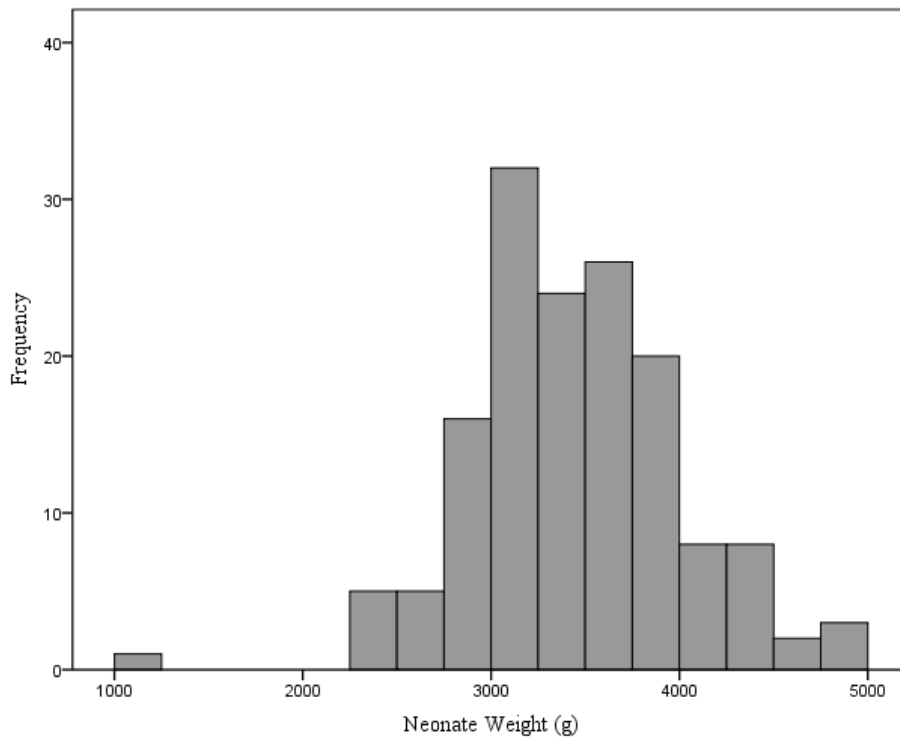


Participants were recruited in all trimesters of pregnancy. Of these women, 22.7% were recruited during the first trimester, 41.3% during the second semester and 20% during the third trimester. Finally, the trimester of initiation into the study was unknown for 16% of participants (Table 6.3).

*6.3 Trimester of participant enrollment*

| Trimester Enrolled | n | Frequency (%) |
|---|---|---|
| 1 | 34 | 22.7 |
| 2 | 62 | 41.3 |
| 3 | 30 | 20 |
| unknown | 37 | 16 |

In Table 6.4 I show the frequencies of size for gestational age of neonates in this study. Compared to population standards, 3.4% of neonates were small for gestational age, 82.2% were average for gestational age and 14.4% were large for gestational age.

*Table 6.4 Frequency of size for gestational age*

| Size for gestational age | Frequency (%) |
| --- | --- |
| Small for gestational age | 5 (3.4) |
| Average for gestational age | 120 (82.2) |
| Large for gestational age | 21 (14.4) |

The majority of births in this sample were live births (99.3%) with only one still birth (0.7%) and no spontaneous abortions (0%). In this sample only 6% of all births were premature, 72.2% were within a normal gestation period and 21.9% were post term (Table 6.5).

*Table 6.5 Frequency of birth outcomes and gestation length*

| Size for gestational age | Frequency (%) |
| --- | --- |
| Small for gestational age | 5 (3.4) |
| Average for gestational age | 120 (82.2) |
| Large for gestational age | 21 (14.4) |
| Premature delivery <37 weeks | 9 (6) |
| Normal | 109 (72.2) |
| Post term delivery >40 weeks | 33 (21.9) |

This sample was compared to a population level measure of American Samoan women giving birth on Tutuila (Howells, Chapter Four). These results are presented in Table 6.6. The participants in the study were younger, lighter at delivery and had fewer previous pregnancies and deliveries than the comparison group. Although neonates in this sample were significantly longer than the group ($z = 2.32$; $p = 0.010$), there was no difference in infant weight ($z = 0.93$; p

= 0.824) or ponderal indices (z = -1.30; p= 0.097). Finally, there was no difference in the gestation length of the sample when compared to the population (z = 0.06; p = 0.524) (Table 6.6).

*6.6 A comparison of maternal and pregnancy outcomes between sample and population.*

|  | z-score |
| --- | --- |
| Maternal age | -3.26 |
| Maternal weight at delivery (kg) | -2.27 |
| Number of previous pregnancies | -2.48 |
| Number of previous deliveries | -2.96 |
| Neonate weight (g) | 0.93 |
| Neonate length (cm) | 2.32 |
| Ponderal index | -1.30 |
| Gestation length delivery (weeks) | 0.06 |

The linear association between EBV levels and maternal characteristics and pregnancy outcome was determined using correlation analysis. None of the correlations were significant (Table 6.7).

*Table 6.7 Correlations between EBV levels, and maternal characteristics and pregnancy outcomes*

|  | EBV | |
|---|---|---|
|  | $r^2$ | p-value |
| Maternal age | <0.001 | 0.913 |
| Maternal weight at delivery (kg) | <0.001 | 0.749 |
| Height (m) | 0.007 | 0.352 |
| BMI | <0.001 | 0.777 |
| Number of previous pregnancies | 0.001 | 0.696 |
| Number of previous deliveries | 0.006 | 0.336 |
| Neonate weight (g) | <0.001 | 0.194 |
| Neonate length (cm) | 0.005 | 0.749 |
| Ponderal index | 0.002 | 0.194 |
| Neonate head circumference (cm) | 0.003 | 0.499 |
| Neonate chest circumference | 0.009 | 0.275 |
| Gestation length delivery (weeks) | 0.011 | 0.194 |

I used an independent sample t-test to compare neonate size and gestational age to EBV levels. None of the relationships were significant (Table 6.8).

*Table 6.8 Relationship between neonate size for gestational age and EBV levels*

|  | Breakdown of Variable[a] | N | Mean | p-value (t-test) |
|---|---|---|---|---|
| Small for gestational age (SGA) | SGA | 5 | 2.36 (±0.29) |  |
|  | Not SGA | 141 | 2.39 (±0.35) | 0.850 |
|  |  |  |  |  |
| Average for gestational age (AGA) | AGA | 120 | 2.40 (± 0.35) |  |
|  | Not AGA | 26 | 2.33 (± 0.33) | 0.366 |
|  |  |  |  |  |
| Large for gestational age (LGA) | LGA | 21 | 2.33 (± 0.34) |  |
|  | Not LGA | 125 | 2.40 (± 0.35) | 0.389 |

Using independent sample t-test I tested maternal characteristics and pregnancy outcomes against the high and low tertiles of EBV. EBV levels between 3.25 − 2.53 were classified as high, whereas EBV levels between 1.61-2.24 were classified as low. None of these relationships were significant (Table 6.9).

*Table 6.9 Comparison of maternal characteristics and neonate outcomes with high and low EBV levels*

| | EBV Level | N | Mean | p-value |
|---|---|---|---|---|
| Maternal age | High | 50 | 25.1 ± 5.1 | |
| | Low | 51 | 25.5 ± 5.8 | 0.682 |
| Maternal weight at delivery (kg) | High | 49 | 90.7 ± 19.8 | |
| | Low | 47 | 88.5 ± 16.3 | 0.555 |
| Height (m) | High | 44 | 1.65 ± 0.05 | |
| | Low | 44 | 1.65 ± 0.05 | 0.506 |
| BMI | High | 43 | 33.1 ± 6.3 | |
| | Low | 41 | 33.0 ± 5.6 | 0.979 |
| Number of previous pregnancies | High | 50 | 2.66 ± 1.82 | |
| | Low | 51 | 3.10 ± 2.17 | 0.274 |
| Number of previous deliveries | High | 50 | 2.00 ± 1.51 | |
| | Low | 51 | 2.51 ± 2.11 | 0.166 |
| Neonate weight (g) | High | 50 | 3447.8 ± 516.8 | |
| | Low | 51 | 3408.3 ± 677.1 | 0.742 |
| Neonate length (cm) | High | 50 | 51.0 ± 1.9 | |
| | Low | 49 | 50.4 ± 2.5 | 0.195 |
| Ponderal index | High | 50 | 2.59 ± 0.26 | |
| | Low | 49 | 2.69 ± 0.50 | 0.227 |
| Neonate head circumference (cm) | High | 50 | 34.9 ± 1.2 | |
| | Low | 48 | 34.5 ± 1.7 | 0.161 |
| Neonate chest circumference | High | 48 | 33.3 ± 1.6 | |
| | Low | 46 | 32.8 ± 2.1 | 0.241 |
| Gestation length delivery (weeks) | High | 50 | 279.3 ± 11.2 | |
| | Low | 50 | 274.4 ± 16.8 | 0.095 |

Previous research indicated a relationship between marital status and pregnancy

outcomes (Howells et al., 2013). To assess whether the associations between EBV values and

maternal characteristics/pregnancy outcomes differed according to marital status, correlation

values were calculated separately for the married and unmarried groups (Table 6.10). Although

the $r^2$ values did not approach significance, there was a tendency for maternal age, BMI, number

of previous pregnancies and deliveries and EBV levels to be higher in married women. All other

associations were greater in unmarried women. Interaction terms in multiple linear regression

models were used to test whether the effect of EBV values on maternal characteristics and

pregnancy outcomes was significantly different between the married and unmarried groups.

None of the interaction terms were significant.

*Table 6.10 Multiple linear regression between EBV and maternal characteristics and pregnancy outcomes controlled for marital status.*

| | Married $r^2$ | Unmarried $r^2$ | p-value of interaction term |
|---|---|---|---|
| Maternal age | 0.015 | 0.014 | 0.15 |
| Maternal weight at delivery (kg) | < 0.001 | 0.004 | 0.729 |
| Height (m) | 0.004 | 0.011 | 0.822 |
| BMI | 0.003 | < 0.001 | 0.837 |
| Number of previous pregnancies | 0.022 | < 0.001 | 0.29 |
| Number of previous deliveries | 0.013 | 0.003 | 0.345 |
| Neonate weight (g) | < 0.001 | 0.002 | 0.79 |
| Neonate length (cm) | < 0.001 | 0.03 | 0.306 |
| Ponderal index | < 0.001 | 0.007 | 0.613 |
| Neonate head circumference (cm) | < 0.001 | 0.015 | 0.364 |
| Neonate chest circumference | < 0.001 | 0.039 | 0.298 |
| Gestation length delivery (weeks) | 0.003 | 0.049 | 0.81 |

DISCUSSION

In this chapter I sought to assess whether maternal psychosocial stress impacts pregnancy outcomes in Samoan women. Stress was measured using a non-specific bio-marker of psychosocial stress, Epstein-Barr Virus (EBV) antibody levels after controlling for infection with CRP. Here I use EBV to determine whether mothers with higher levels of psychosocial stress have smaller neonates and shorter gestations. In addition I compared this sample with a population to determine if there were any fundamental differences. I found no association between maternal psychosocial stress levels as measured by EBV and neonate size, or gestation length. Similarly I found no differences in neonate size or gestation length in mothers with high versus low EBV levels. Maternal characteristics and infant outcomes in this sample were broadly similar to the population.

Previous research has found a relationship between maternal stress and pregnancy outcomes. Increased maternal stress has been positively associated with the risk of spontaneous abortion, preterm birth, and small-for-gestational age neonates (Rice et al., 2007; Nepomnaschy et al., 2006; Mancuso et al., 2004; Dole et al., 2003; Hobel and Culhane 2003; Sagiura-Ogasawara et al., 2002). Specifically, high EBV levels have also been associated with negative pregnancy outcomes including lower birth weight and shorter gestations (Eskild et al., 2005).

Eskild et al. (2005) conducted a nested case-controlled study of 35,940 pregnant women in Norway. Researchers in this study collected serum samples during women's first prenatal visit and during the 22$^{nd}$ and 38$^{th}$ week of pregnancy. They found that mothers with significant reactivation of EBV infection during the first trimester in pregnancy were more likely to have shorter gestations (mean = 8 days) and neonates who weighed less (mean = 210g).

Although previous research indicates a strong relationship between maternal stress and pregnancy outcomes, I was unable to support these findings. According to my results, there was no relationship between EBV levels and neonate size as measured by neonate weight, neonate length, ponderal index or gestation length. The lack of relationship between EBV and maternal and neonate outcomes was surprising given the results of previous research on the impact of maternal stress on pregnancy outcomes.

There are several possible explanations for this difference. First, it is unclear if the lack of relationship between EBV and pregnancy outcomes is a reflection of the use of EBNA instead of the commonly used viral capsid antigen (VCA) (Eskild et al., 2005; McDade et al., 2002). The focus by other studies on VCA makes it challenging to directly compare the results of this sample to other researchers work. Future studies will assess the VCA levels within this population.

Second, it is possible that these data were collected too late in the pregnancy to reflect differences in gestation length and pregnancy outcomes. Prior to placentation (~30 days), maternal stress has a greater chance of leading to spontaneous abortion due to a "blighted" uterine environment and the direct effects of cortisol (Arck, 2007; Kalinka and Szekeres-Bartho, 2005; Blois et al., 2004). All of the women in this study were recruited post-placentation when stress is more likely to impact fetal growth rather than mortality. However, the impact may be less intense after mid-gestation when the placenta is able to reduce the physiological impact of stress (Hobel et al., 1999; Seckl, 1997). In this chapter I utilized an average EBV level that combines each participant's sample across her pregnancy possibly skewing the results toward the null hypothesis. It is also possible that the overall level of stress experienced by participants may not have been high enough to impact fetal development.

Third, participant stress may be buffered by social networks and social support. An older study addressing the relationship between stressful life events, social support and pregnancy complications in army wives found that high and low stress were not linked to pregnancy outcomes alone. However, women who experienced high stress and had little social support were more likely to have complications in pregnancy and delivery (Nuckolls et al., 1971). Social support acts to reduce depression and anxiety and may counter the effects of stress (Rutter and Quine, 1990). I did not measure social support and social buffering in this current study. However, as discussed in chapter four, I found differences (albeit weak) in pregnancy outcomes based on marital status.

In the current study I was unable to find a relationship between EBV levels and marital status. I further tested the impact of marital status on the relationship between EBV and pregnancy outcomes. None of the interaction terms were significant which indicates that the relationship between EBV and neonate outcomes was not impacted by marital status.

Participants in this study were compared to 1097 Samoan women giving birth on Tutuila in the same year. Women in the current study were younger, weighed less and had fewer previous pregnancies and deliveries. Although neonates in this study were longer than those in the comparative sample, there are no other differences in neonate size including neonate weight, ponderal index and gestation length. Participants in this study were recruited at the island's largest prenatal provider and it is possible that the differences between groups may be linked to the demographic of women accessing prenatal care. Although it was not examined here, it is possible that younger, less experienced mothers may seek out prenatal care more frequently than their older more experienced peers. Regardless, the sample is overall representative of the population.

## Conclusion

The relationship between psychosocial stress (as measured by EBV), maternal

characteristics and pregnancy outcomes was investigated in 151 Samoan women giving birth in

American Samoa. There was no relationship found between EBV levels and any maternal

characteristics or pregnancy outcomes. This lack of relationship may reflect the use of EBNA

instead of VCA, the timing of recruitment and the impact of stress on fetal development, the use

of average values and/or buffering effects of social support networks.

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## CHAPTER 7: DISSERTATION SUMMARY, CONCLUSIONS AND FUTURE DIRECTIONS

### SUMMARY AND CONCLUSIONS

In American Samoa, the relationship between the individual and the collective is reflected in the Samoan way of life or *fa'asamoa*. *Fa'asamoa* broadly refers to an understanding of the pervasive role of Samoan culture in an individual's life. An important component of *fa'asamoa* is the controlling and protective role of the family, or *'āiga* and the chief, or *matai* over the individual. Western style religion, church obligations and nationalistic pride are also included in *fa'asamoa*. This permeating role of family, church and nationalism can impact an individual's access to higher education, employment and medical care.

I use *fa'asamoa* as a context for this dissertation and discuss it's intersections with the broader historical, political and social milieu. I argue that these interactions could potentially impact pregnant Samoan women's lives and may ultimately lead to low birth weight and other negative pregnancy outcomes. In chapter two I introduce a simplified model of these pressures and how they intersect with pregnant women in Samoan culture (re-presented in figure 7.1). The scope of this dissertation enabled me to test portions of this model including the role of marital status, residency status and prenatal care of pregnancy outcomes.

*Figure 7.1 Sociocultural context of pregnancy of American Samoan women*
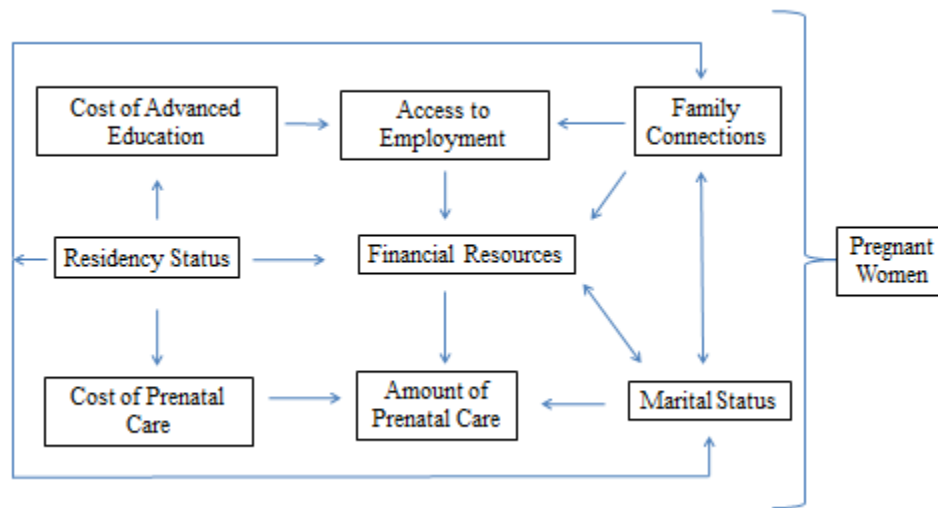


The objective of this dissertation was to determine if there was an association between chronic psychosocial stress on neonate body size, size for gestational age and gestation length. I achieved this goal by conducting an 18 month long biocultural, longitudinal, prospective study of pregnancy outcomes in Samoan women living on the Pacific island of Tutuila. I utilized multiple measures of potential psychosocial stress including identity markers (marital status), self-reported stress measures (status congruence, Perceived Stress Scale, Monthly Stress Questionnaire) and a biological measure of stress (Epstein-Barr Virus antibody levels).

Cross-culturally marital status has been shown to impact pregnant women's access to medical care associated with her pregnancy and to increase risk of negative pregnancy outcomes. I tested whether this relationship held in American Samoa where the social support typically provided by spouses may be provided by the extended family. Using medical charts I extracted demographic, medical and neonate outcome on 1097 Samoan women giving birth in American Samoa. I found that married women accessed prenatal care earlier and more frequently and were less likely to have an episiotomy or operative vaginal delivery than unmarried women. However, woman's marital status did not impact any other medical interventions used during delivery.

Although I found some differences between neonate outcomes based on marital status, these differences are unlikely to be biologically significant and are more likely a reflection of the large sample size.

I was interested in determining if there was a non-invasive self-reported stress scale that accurately captured psychosocial stress in the women of American Samoa. I compared the effectiveness of three self-reported stress scales in detecting stress by comparing them to the Epstein Barr Virus levels of 78 pregnant Samoan women. The self-reported stress scales included status congruence, the Perceived Stress Scale (PSS) and a monthly stress questionnaire (MSQ). In previous studies status congruence was related to lower levels of stress (as measured by EBV) in adolescence in Independent Samoa.

However, I did not find a relationship between any of the self-reported measures of stress and EBV. In addition, there was no relationship between status congruence and PSS or the MSQ. As a result, I was unable to isolate a self-reported measure of stress that correlates with psychosocial stress in Samoan women. Previous research has linked status congruence to low levels of stress in teens living in Independent Samoa. However, I did not find any relationship between status congruence in stress in the current study. This may be due to the differences in the age or status of the individual's in this study. For instance, mothers may gain some kind of protective social buffering during their pregnancy. However, I think this is unlikely based on my ethnographic work. Instead, I think the difference may be associated with the changing social landscape between the traditional and nontraditional status markers between independent Samoa and American Samoa.

At the core of this study was a focus on the relationship between psychosocial stress and pregnancy outcomes. I investigated the relationship between psychosocial stress (as measured by

EBV), maternal characteristics and neonate outcomes in 151 Samoan women giving birth in American Samoa. I found no relationship between EBV levels and maternal characteristics or neonate outcomes.

Taken together, this study provides no evidence that psychosocial stress impacts pregnancy outcomes in Samoan women giving birth in American Samoa. These results were somewhat surprising in light of previous research focusing on women in the United States and Europe. In chapter six I discuss the differences between my study and others that may have affected my results. The utilization of Epstein-Barr nuclear antigen (EBNA) instead of the more widely used viral capsid antigen (VCA) may have contributed to this difference. However, preliminary results comparing VCA and neonate outcomes suggest that there is no difference between the VCA and EBNA results. More likely the inclusion of women from all trimesters may have skewed the results because many of the participants were enrolled post placentation thus buffering fetuses from the biological stress effects I was indirectly measuring. Finally, there may be enough social buffering to support women and counteract psychosocial stress built into the Samoan community.

*Strengths and weaknesses of study*

This study had an ambitious research design that encapsulated the entirety of pregnancy including its earliest stages. Originally, I had planned to enroll participants prior to pregnancy and use fertility monitors to help collect data during the first 30 days of gestation. This period is particularly interesting to me when framed in evolutionary theory and pregnancy loss. However, the monitors required a higher level of technological expertise than the average woman possessed, and I could not be sure that they were being used correctly. This technological barrier

led to high rates of noncompliance and I decided to suspend the use of the monitors for this study.

In addition I had planned to follow up with women outside of the department of health but the combination of lack of reliable transportation, personal safety issues and constant scheduling problems made me reassess my research location. Instead I opted to meet with women when they returned to the Tafuna Family Health Center for their prenatal visits. This may have biased my results if some groups of women are more likely than others to get prenatal care. I had also planned to collect skinfold measurements at the initial and final meetings and tympanic temperature at each follow-up. However, participants were distressed by these procedures and I opted not to continue.

Although I had to modify my original study, the resulting study provided important information regarding the impact of psychosocial stress on pregnancy outcomes. The next steps in this research are three fold. First, I will analyze the results from the second EBV antibody VCA. Due to circumstances beyond my control, I received the VCA results too late to incorporate into this dissertation. These results combined with the EBNA results presented throughout this dissertation will provide a richer understanding of stress in this community. Second, I plan on analyzing the remaining interview material I collected throughout the course of this study and comparing it to women's EBV levels. This information includes details regarding participant's individual family structures and living arrangements, financial obligations to church and family, education levels and relationships with partners, parents and in-laws. This will provide a richer context to psychosocial stress experienced by Samoan women. Third, I would like to further analyze my data by comparing high and low psychosocial stress levels in each stage of pregnancy. Finally, I would like to refocus my attention to the impact of stress in the

first 30 days of pregnancy. My next study will utilize the methodology developed for my original

field work but will be conducted in a more controlled environment.

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*Appendix A Adequacy of prenatal care utilization: adequacy of initiation of prenatal care, adequacy of received services and summary of adequacy of prenatal care utilization index*

*Adequacy of Initiation of Prenatal Care*

| Adequacy of Initiation | Month Care Initiated |
|---|---|
| Adequacy Plus | 1-2 |
| Adequate | 3-4 |
| Intermediate | 5-6 |
| Inadequate | 7-9 (or no PNC) |

*Adequacy of Received Services*

| Adequacy of Received Services | Expected Visits (%) |
|---|---|
| Adequacy Plus | $\geq 110\%$ |
| Adequate | 80% -109% |
| Intermediate | 50-79% |
| Inadequate | $< 50\%$ |

*Summary Adequacy of Prenatal Care Utilization (APNCU)*

| Month PNC Initiated | Adequacy of Received Services | Adequacy of PNC Utilization (APNCU) | Classification of Adequacy For Samoan Women |
|---|---|---|---|
| < 4th month | $\geq 110\%$ | Adequacy Plus | Adequate |
| < 4th month | 80% -109% | Adequate | Adequate |
| < 4th month | 50-79% | Intermediate | Adequate |
| > 4th month | $< 50\%$ | Inadequate | Inadequate |

*Appendix B Neonate weight percentiles for American Samoan births*

Mean birth weight at 40 weeks = 3510.9g
Standard deviation of birth weight expressed as a percentage of mean birth weight = 13.72%

| Weight percentiles for the local population | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gestational age | Percentile | | | | | | | | | | |
| | 99th | 97th | 95th | 90th | 75th | Mean | 25th | 10th | 5th | 3rd | 1st |
| 24 | 896 | 856 | 835 | 802 | 748 | 688 | 627 | 573 | 541 | 520 | 480 |
| 25 | 1046 | 999 | 975 | 937 | 873 | 803 | 733 | 669 | 631 | 607 | 560 |
| 26 | 1212 | 1159 | 1130 | 1086 | 1013 | 931 | 849 | 776 | 732 | 703 | 649 |
| 27 | 1396 | 1334 | 1301 | 1250 | 1166 | 1072 | 978 | 893 | 843 | 810 | 748 |
| 28 | 1596 | 1525 | 1487 | 1429 | 1333 | 1225 | 1118 | 1021 | 963 | 926 | 855 |
| 29 | 1811 | 1731 | 1688 | 1622 | 1513 | 1391 | 1269 | 1159 | 1093 | 1051 | 970 |
| 30 | 2041 | 1950 | 1902 | 1828 | 1705 | 1567 | 1430 | 1306 | 1232 | 1184 | 1093 |
| 31 | 2284 | 2183 | 2129 | 2046 | 1908 | 1754 | 1600 | 1462 | 1379 | 1325 | 1224 |
| 32 | 2538 | 2425 | 2366 | 2274 | 2120 | 1949 | 1778 | 1624 | 1532 | 1473 | 1360 |
| 33 | 2801 | 2676 | 2610 | 2509 | 2339 | 2150 | 1962 | 1792 | 1691 | 1625 | 1500 |
| 34 | 3068 | 2932 | 2860 | 2748 | 2562 | 2356 | 2149 | 1964 | 1852 | 1780 | 1644 |
| 35 | 3338 | 3189 | 3111 | 2990 | 2788 | 2563 | 2338 | 2136 | 2015 | 1936 | 1788 |
| 36 | 3605 | 3445 | 3360 | 3230 | 3011 | 2768 | 2526 | 2307 | 2177 | 2092 | 1931 |
| 37 | 3867 | 3695 | 3604 | 3464 | 3230 | 2969 | 2709 | 2475 | 2334 | 2243 | 2071 |
| 38 | 4118 | 3935 | 3838 | 3689 | 3439 | 3162 | 2885 | 2635 | 2486 | 2389 | 2206 |
| 39 | 4355 | 4161 | 4059 | 3901 | 3637 | 3344 | 3051 | 2787 | 2629 | 2526 | 2333 |
| 40 | 4573 | 4369 | 4262 | 4096 | 3819 | 3511 | 3203 | 2926 | 2761 | 2653 | 2450 |
| 41 | 4768 | 4556 | 4443 | 4271 | 3982 | 3661 | 3340 | 3051 | 2878 | 2766 | 2554 |
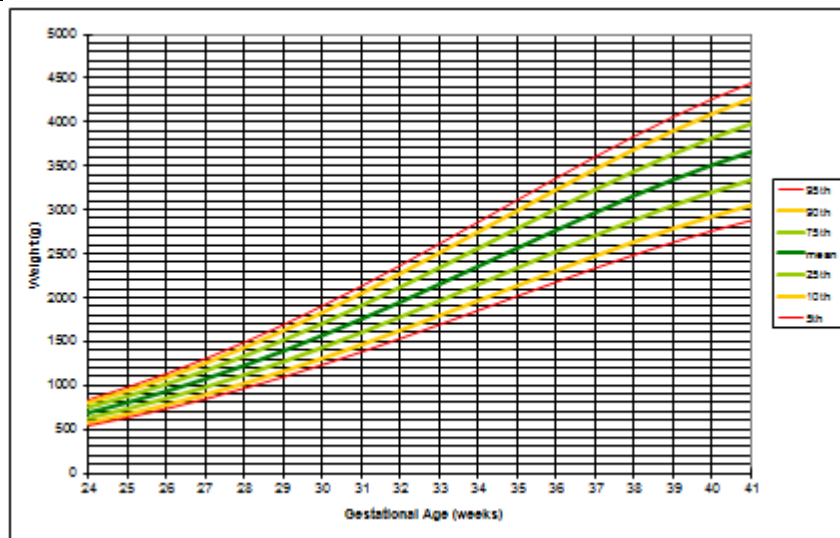


The standard deviation of birth weight is derived from the 2004-2008 WHO Global Survey on Maternal and Perinatal Health. This excel calculation requires the mean birth weight of infants born at 40 weeks (40 weeks+0 days to 40 weeks+6 days) with no risk of having small for gestational age infants.

*Appendix C ANCOVA results for married and unmarried women controlling for maternal age and number of previous deliveries*

| | Adjusted $r^2$ | Corrected Model F(p) | Marital Status F(p) | Maternal Age F(p) | Number of Previous Deliveries F(p) |
|---|---|---|---|---|---|
| Maternal weight at delivery | 0.04 | 13.48 (<0.001) | 7.59 (0.006) | 19.32 (<0.001) | 2.10 (0.148) |
| Gestation period days | 0.008 | 3.721 (0.011) | 4.62 (0.032) | 2.28 (0.131) | 4.44 (0.035) |
| APGAR at 1st minute | 0.007 | 3.32 (0.019) | 6.02 (0.014) | 2.23 (0.135) | 2.32 (0.128) |
| APGAR at 5th minute | 0.004 | 2.25 (0.081) | 4.95 (0.026) | 2.84 (0.092) | 0.38 (0.538) |
| Number of prenatal care appointments | 0.092 | 35.69 (<0.001) | 64.98 (<0.001) | 19.47 (<0.001) | 52.46 (<0.001) |
| Gestational Age 1st visit days | 0.066 | 23.90 (<0.001) | 49.41 (<0.001) | 8.37 (0.004) | 31.439 (<0.001) |
| Total medical interventions (birth) | 0.011 | 4.79 (0.003) | 1.34 (0.248) | 0.02 (0.876) | 9.54 (0.002) |

*Appendix D Status Congruence*

**Western Experience**

1.) Have you traveled overseas to any of the following places (circle your reply)?

| | | |
|---|---|---|
| New Zealand | Yes | No |
| Hawai'i | Yes | No |
| Mainland USA | Yes | No |

2.) Are any of your siblings overseas in (circle your reply)?

| | | |
|---|---|---|
| Western Samoa | Yes | No |
| New Zealand | Yes | No |
| Hawai'i | Yes | No |
| Mainland USA | Yes | No |

3.) Do you watch television?       Never       Once a Week       Everyday

4.) Do you have friends who are *palagi* (white/European)       Yes       No

5.) Do you own a cell phone?     Yes       No

**Matai Status**

6.) Does anyone in your household have *Matai* status?

**Bi-Monthly Personal Interview**

**Name:** _____ **Date:** _____

1.) Has your ʻāiga hosted a *fa'alavelave* in the past 3 weeks?            **Yes    No**

2.) How much money did your household contribute to the *fa'alavelave*?

3.) How worried have you been about money over the past three weeks (circle one)?
      [*1= Least Worried, 5= Most Worried*]
            **1      2      3      4      5**

4.) Have you had any financial problems in the last three weeks?            **Yes         No**

5.) How worried about these financial problems are you? [*1=Not worried, 5= Very Worried*]
            **1      2      3      4      5**

6.) Have you had any unexpected expenses in the last three weeks?
            **Yes    No**

      How easy was it for you to take care of this unexpected expense? [*1=Easy, 5=Hard*]
                  **1      2      3      4      5**

7.) How worried about work have you been in the last three weeks (circle one)?
      [*1= Least Worried, 5= Most Worried*]
            **1      2      3      4      5      Not Employed**

8.) Has anyone in your household been sick or hurt over the last three weeks (circle one)?
            **Yes         No**

9.) How worried have you been about their sickness / injury (circle one)?
      [*1=Not worried, 5= Very Worried*]
            **1      2      3      4      5      No One Sick/Hurt**

10.) How would you describe your health over the past two weeks? [*1=Excellent, 5= Very Sick*]
            **1      2      3      4      5**

11.) How has your relationship with your parents been over the last 3 weeks (circle one)?
      [*1=Excellent, 5= Very Bad*]
            **1      2      3      4      5**

12.) How has your relationship with your husband/ boyfriend been over the last 3 weeks one)?
      [*1=Excellent, 5= Very Bad*]
            **1      2      3      4      5      No Husband/Boyfriend**

*Appendix F Perceived Stress Scale*

**Participants were asked to rate the following questions as never, almost never, sometimes, fairly often, very often. Items 4, 5, 6, 7, 9, 10 and 13 were reverse keyed.**

1. In the last month, how often have you been upset because of something that happened unexpectedly?

2. In the last month, how often have you felt that you were unable to control the important things in your life?

3. In the last month, how often have you felt nervous and "stressed"?

4. In the last month, how often have you dealt successfully with day to day problems and annoyances?

5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?

6. In the last month, how often have you felt confident about your ability to handle your personal problems?

7. In the last month, how often have you felt that things were going your way?

8. In the last month, how often have you found that you could not cope with all the things that you had to do?

9. In the last month, how often have you been able to control irritations in your life?

10. In the last month, how often have you felt that you were on top of things?

11. In the last month, how often have you been angered because of things that happened that were outside of your control?

12. In the last month, how often have you found yourself thinking about things that you have to accomplish?

13. In the last month, how often have you been able to control the way you spend your time?

14. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?