

THE TAILORING OF A COMMUNITY-BASED APPROACH
TO REDUCE OBESITY AMONG SAMOANS IN HAWAI'I

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ABSTRACT

Western colonization of the Samoan archipelago resulted in economic, cultural, and behavioral transitions leading to increases in the prevalence of obesity in Samoans over the past 40 years. Currently, a third of men, and half of women in Samoa, and 60% of men and 73% of women in American Samoa are considered obese. Samoans maintain high rates of migration, with nearly one third of Samoans in US. Obesity persists in these migrants, and obesity-related disease contributes to Samoans having the lowest life expectancy of the seven largest ethnic groups in Hawai‘i. Interventions have addressed obesity in Samoans; however there are few reported interventions tackling obesity with Samoans living in Hawai‘i.

Chapter one provides background on the dissertation. Chapter two provides a review of the scientific literature on studies conducted with Samoans, identifying political, institutional, cultural, and behavioral obesogenic factors, including the introduction of market economies, changes in vocations, prominence of processed foods, and transition from agrarian to urban lifestyles. Constructs from the Social Ecological Model of Health (SEM) provided an organizing framework for knowledge on Samoan diet and health, and these constructs can inform the creation of interventions.

Chapter three presents results from interviews with Samoans in Hawai‘i confirming information in the scientific literature on Samoan obesogenic factors. The investigation identified faith-based institutions as appropriate settings within which to reach Hawai‘i’s Samoans. Interviewees suggested culturally-appropriate intervention strategies, including leveraging the Samoan social hierarchy, re-adopting healthy

traditional foods and preparation methods, and conducting group-based intervention activities.

Chapter four presents a secondary analysis of dietary data obtained from more than 1,400 Samoans living in American Samoa, Hawai‘i, and California. Samoan diets were characterized by high daily intake of calories, and saturated fat. Samoan dietary patterns suggest an increase in dietary diversity with acculturation, with healthy consumption patterns obscured by overconsumption of animal food products and processed foods.

Interventions to address obesity in Hawai‘i’s Samoan community should target the relevant obesogenic socio-economic, cultural, and behavioral factors for this group. The adaption of evidence-based interventions that incorporate these factors may prove successful in reducing obesity and chronic diseases in the population.

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CHAPTER 1. INTRODUCTION

Background and Significance

Obesity Prevalence in Samoan Populations

The Samoan archipelago is a group of nine inhabited islands located in the South Pacific midway between Hawai‘i and Australia, comprised of two political jurisdictions American Samoa and (Western) Samoa. These islands are currently home to over a quarter of million people (United States Central Intelligence Agency [CIA], 2008). Today, about 50% of (Western) Samoans and 70% of American Samoans are considered obese (Keighley, McGarvey, Quested, McCuddin, & Viali, 2007). Trends towards obesity in the Samoan jurisdictions have more than doubled the rates of non-communicable diseases including hypertension, and type 2 diabetes during the last twenty years (Keighley et al., 2007).

Table 1.1. Percentage of Adult Obesity† in Samoan Jurisdictions by Sex and Year

Year		Am. Samoa	Samoa
1982	<i>Males</i>	28.2%	7.3%
	<i>Females</i>	50.7%	25.3%
1991	<i>Males</i>	61.3%	22.5%
	<i>Female</i>	69.6%	40.8%
2003	<i>Males</i>	58.8%	29.2%
	<i>Females</i>	71%	52.8%

(Keighley et al., 2007)

Notes: †Ages 18-74; based on BMI >32k/m²

Samoans are also a relatively new group of immigrants to the United States (US), migrating both from (Western) Samoa and American Samoa (CIA, 2008). According the 2000 US Census, nearly 32% of the total Samoan population lives in the US, and 60% of these migrants reside in Hawai‘i and California (United States Census Bureau [US Census], 2007). Samoans represent the second largest population of Pacific Islanders in

the US, following Native Hawaiians (US Census, 2007). The excessive prevalence of obesity persists among these Samoan in the US. According to the 2007 Hawai'i BRFSS, more than 90% of Samoans surveyed in Hawai'i are classified as overweight or obese (based on BMI), and 80% reported having no exercise within the past 30 days (CDC, 2008). Obesity-related chronic diseases contribute to Samoans having the lowest life expectancy in the state of Hawai'i (Park, Braun, Horiuchi, Tottori, & Onaka, 2009).

Table 1.2. Life Expectancy at Birth by Ethnicity and Sex, Hawai'i, 2000

Ethnicity	Combined	Male	Female	Gender Gap
Total	80.5	77.5	83.6	6.1
Caucasian	79.0	76.7	81.7	5.0
Chinese	86.1	83.5	88.7	5.2
Filipino	80.9	78.0	85.9	7.9
Hawaiian	74.3	71.5	77.1	5.6
Japanese	82.8	79.7	88.7	9.0
Korean	81.4	78.3	83.6	5.3
Samoan	72.8	71.1	74.6	3.5

(Park et al., 2009)

Socio-ecological factors, including the arbitrary political division of a previously singular Samoan society, have contributed to rising obesity in Samoan populations (Ezeamama, Viali, Tuitele, & McGarvey, 2006). Economic transitions in American Samoa and (Western) Samoa resulting from recent Western colonial influences in the Samoan archipelago have reduced the cultural value and availability of traditional dietary resources for Samoans (Ezeamama et al., 2006; Keighley et al., 2007). Calorie-dense foods, including baked goods, and highly salted, canned foods, have gained social and dietary prominence in Samoa life (Keighley, McGarvey, Turituri, & Viali, 2006). These western dietary influences are intensified among migrant Samoans living in the U.S.

Samoan cultural and behavioral norms also contribute to the epidemic increases in obesity rates in Samoan populations (Elstad, Tusiofo, Rosen, & McGarvey, 2008; Hanna, 1998). Hierarchal relationships and the importance of maintaining these relationships

through sharing food and other subsistence needs are features of Samoan cultural values that may add to the obesogenic effects of Western dietary patterns. Mutual, freely-given support is a cultural value that is often quantified during cultural ceremonies through contributions of food (Aitaoto, Braun, Dang, & So'a, 2007; Baker, Hanna, & Baker, 1986). Transitions from traditional food sources are evident during these important cultural events, and exacerbate the detrimental effects of Western food products in Samoan life.

Finally, there are phenotypical characteristics that compound the uptake of Western dietary patterns by Samoans, increasing propensities towards obesity. Samoans are descendants of people who migrated via canoes over open oceans. Survivorship required for this migration favored individuals with efficient metabolisms to protect them against starvation and exposure (Crews, 1989; Deka et al., 1994; Hubbell, Luce, & McMullin, 2005). Samoans' physiology reflects this efficient metabolic profile (Keighley et al., 2007). However, researchers who have examined the biological components of Samoan obesogenic traits, have conceded to the powerful effects of behavior modification, including improved nutrition, and physical activity, to inhibit potential obesogenic predisposition (Dai et al., 2007).

Background on Interventions to Address Obesity in Samoan Populations

Several interventions have demonstrated the potential of physical activity and nutritional interventions to reduce the epidemic rates of obesity in Samoan jurisdictions. A pilot study conducted in 2008 tested the effects of culturally-tailored nutrition education, dietary modification, physical activity, and physical activity combined with dietary modification (Afele-Fa'amuli, 2009). This study randomly assigned villages in American Samoa to one of four intervention arms. After 12 weeks, participants in the dietary modification, physical activity, and the combined intervention arms showed significant weight loss over the nutritional education only arm. A feature of this intervention was that it used healthy foods traditional to Samoan culture, and exercise routines that were resonant of Samoan cultural practices, such as picking the breadfruit or tending gardens (Afele-Fa'amuli, 2009).

A second intervention currently being conducted called "Diabetes Care in American Samoa" randomly assigned villages to study an intervention designed to

address the management of diabetes (De Pue, 2009). The study was adapted from an evidence-based intervention originally implemented with African Americans, who share similar cultural perceptions concerning body image, and many of the obesity-related health risks as Samoans. Qualitative research methods were used to identify and adapt the original intervention to suit Samoan populations (Bell, Swinburn, Amosa, & Scragg, 2001). These adaptations included modification of the study's diabetes treatment algorithms to better suit the medical services available to patients in Samoa, and linguistic translation and reformatting of the study's educational materials. The study demonstrated the feasibility, and provides a framework for adapting an evidence-based program initially designed for African Americans, to be suitable for use with Samoans.

Faith-based interventions: For migrant Samoan populations, including those in Hawai'i, the church supplants the village as the primary mechanism for social interaction (Aitaoto et al., 2007). Pastors assume the leadership roles afforded to *matai* or chiefs in the Samoan jurisdictions. In communities outside of Samoa churches are used as the setting for traditional Samoan ceremonies including *fa'alavlave*, or events that involve gatherings of extended family (Baker et al., 1986). Several non-randomized studies have identified and engaged the churches as a setting to deliver health promotion interventions for Samoans (Aitaoto et al., 2007; Levy-Storms & Wallace, 2003).

In 1998, Simmons and colleagues (Simmons et al., 1998) conducted a pilot study of a church-based, diabetes risk reduction program for Samoans in New Zealand. This study used a controlled design, comparing outcomes from an intervention church with a control church. The intervention church received weekly nutritional education sessions led by a trained community health educator, and exercise sessions led by a physical activity instructor, both of whom were members of the local Samoan community. The project's materials were tailored for Samoans, and included education brochures, flip charts, and a video. The sessions also included time for networking and discussion among participants. Pre and post measures of participants in the intervention church showed significant improvements in exercise habits, knowledge about diabetes risks, and reduction in waist circumference from baseline, with no change or increases in these measures among participants in the control church (Simmons et al., 1998).

In 2001, Bell and colleagues (Bell et al., 2001) conducted a church-based quasi-experimental, non-randomized controlled trial with Samoans in New Zealand. This study featured a social-level intervention strategy, using the existing social networks within the local Samoan churches. The intervention was delivered in large church-based groups or to entire congregations by trained nutrition and physical activity counselors who were part of New Zealand's Pacific Islands Heartbeat Health Initiative (PIHB). Pre and post measures of participants' self-reported fruit, vegetable, and dietary fat consumption, as well as changes in physical activity levels showed significant improvements in the intervention churches, and a relative decline in the control church (Bell et al., 2001). A critical feature of this study was the investigator's building of community capacity by training church members to deliver the intervention during the second year of the study (Bell et al., 2001).

Need for Additional Research and Purpose of Dissertation

Although faith-based interventions have shown promise in addressing health issues with Samoan populations in several locations including, Hawai'i, New Zealand, and California, few research studies have been published that report on interventions designed to address obesity in Samoan populations in the US. A major consideration for the development of research interventions for Samoans in the US is that these interventions be designed to attend to multiple-levels of obesity determinants found to be relevant for this population. In other ethnic populations, interventions that influence the environmental, socio-cultural, interpersonal, and intrapersonal aspects of obesity have been proven to be more effective than interventions that solely consider one aspect of this health behavior (Resnicow et al., 2005).

One intervention entitled "Body and Soul" applies features derived from the Social-Ecological Model of Health to promote nutrition and physical activity in faith-based settings, and to reduce the risks for chronic diseases in African Americans (Campbell et al., 1999). Features of this intervention may be ideally adaptable for use with Samoans in the US who share many cultural similarities as African American including obesity, and obesity-related chronic disease risks, perceptions of weight and body size, and affinity with churches (Brewis, McGarvey, Jones, & Swinburn, 1998; Duncan, Anton, Newton, & Perri, 2003; Okosun, Choi, Matamoros, & Dever, 2001).

Body and Soul is designed to accommodate flexible application within churches and is highly suitable for adaptation (Resnicow et al., 2004). These adaptations can include cultural modifications, as well as procedural modifications to fit the congregational practices of the diverse faith orientations of Samoan churches in US.

Another feature supporting the adaptation of the Body and Soul intervention to fit Hawai'i's Samoan community is the program's use of community-based participatory methods to deliver the intervention. Body and Soul' formative research tested the transfer of the research activities from academic researchers to community and church-based partners. The study found that this was feasible and did not diminish the project's effectiveness (Resnicow et al., 2004). The study's use of a participatory approach to deliver the intervention promotes community co-learning and capacity building (Minkler & Wallerstein, 2003). These features increase the likelihood for community buy-in and adoption as community members are engaged in processes used for the adaptation and delivery of the program (Minkler & Wallerstein, 2003).

The adaptation of evidence-based programs provides several benefits over developing a unique intervention from the ground up. Adapting programs that are research-tested provide cost and time savings by reducing needs for formative research (Boyle & Homer, 2006; Brownson, Baker, Leet, & Gillespie, 2003). Additionally, evidence-based interventions have demonstrated an ability to modify behaviors relative to the outcome of interest (Boyle & Homer, 2006). Finally, the adaptation of an intervention shortens the time needed to provide the benefits of an intervention to address a community's health issue (Boyle & Homer, 2006).

The faith-based diet and physical activity programs have shown promise in addressing obesity in Samoan populations elsewhere. The purpose of this dissertation is to provide a foundation for adapting an evidence-based dietary intervention, designed for use in churches, to reduce obesity prevalence among Samoans in Hawai'i. The dissertation will obtain feedback from members of Hawai'i's Samoan community on the appropriateness of a faith-based dietary intervention, and conduct the prerequisite research needed to measure intervention's effectiveness in changing dietary behaviors.

Community buy-in: Samoans in Hawai‘i

The state of Hawai‘i is home to 37,483 Samoans, representing 13% of Samoan populations in the Samoan jurisdictions, 30% of Samoans in the US, and 2.7% of the state’s total population. Samoans are only second to Native Hawaiians as the largest population of Pacific Islanders in the US. Many Samoans in the US and Hawai‘i maintain *fa‘aSamoa* or the Samoan cultural practices found within the Samoan jurisdictions. Church is an important institution among Samoans, and a setting for the articulation of *fa‘aSamoa* in communities outside of Samoa, with 85-90% of American Samoans in Hawai‘i belonging to one of twenty five Samoan churches in Honolulu (Fry, 2010; Mishra, Aoelua, & Hubbell, 2000).

Pilot research with a Samoan church in Hawai‘i found that this church was amenable toward research to identify and adapt components of a diet and exercise intervention to fit Hawai‘i’s Samoan communities. The project suggested features of Samoan cultural values that may lend themselves to the effective intervention translation and delivery. These Samoan cultural values included aspects of *fa‘aSamoa*, which historically have included the healthy nutrition and physically active lifestyles found in pre-Westernized Samoa. Additional Samoan values that may be instrumental included: 1) *Fa‘aaloalo*, or earned respect, typically bestowed upon the pastors in Samoan churches; 2) *Aigupotopoto*, the extended family or the established informal social networks; and 3) *Lima Foai*, freely given support among community members (Fiaua & Tuimaleali‘iffano, 1997).

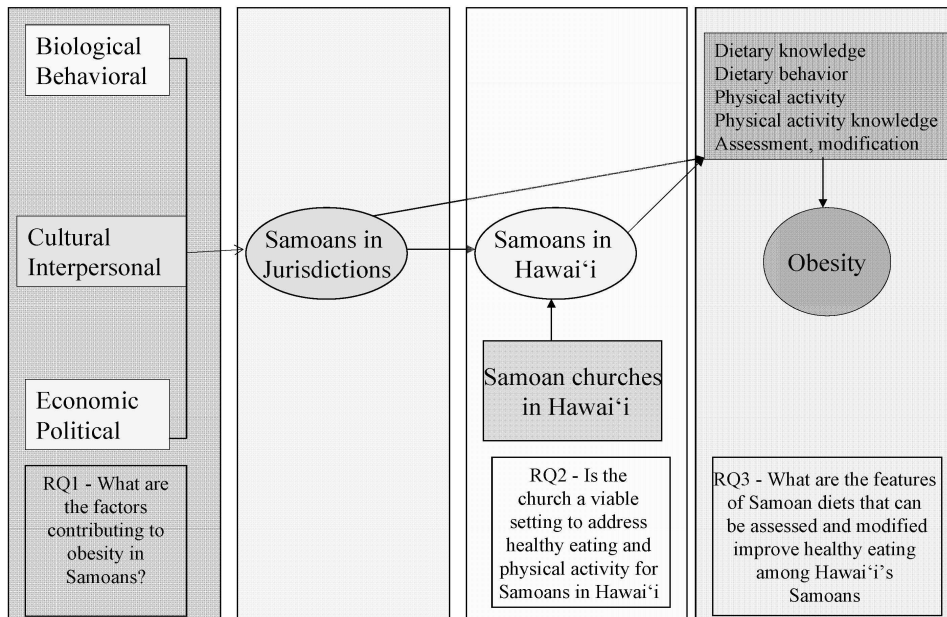
Dissertation Framework

A range of epidemiological studies with Samoan populations began in the 1970s, when sharp increases in obesity rates began to be noted (Baker et al., 1986). Political, economic, cultural, and behavioral changes affecting nutrition and physical activity are believed to be relevant to current the decline in the health status of Samoans. Chapter two seeks to provide a synthesis of the current knowledge pertaining to Samoan obesogenic factors (Figure 1.1). The review will use the Social Ecological Model as a framework to provide a contextual understanding of the determinants of obesity in Samoans and possible intervention points. Also, the review will help guide the implementation of further research towards adapting potential interventions.

The culturally appropriate use of faith-based settings for interventions has improved diet and exercise among many ethnic populations in the US (Gordon-Larsen, Harris, Ward, & Popkin, 2003). Recent studies have identified churches as a potential venue for health promotion and disease prevention activities with Samoans (Aitaoto et al., 2007; Levy-Storms & Wallace, 2003). However research on the use churches to address obesity among Samoans in Hawai'i has not been conducted. Chapter three determines whether a faith-based intervention is an appropriate and feasible mechanism to deliver an exercise and nutrition intervention for Hawai'i's Samoans through use of key informant, and focus group interviews with community members (Figure 1.1). This investigation incorporated community-participatory features providing opportunities for co-learning, as community members conducted aspects of the research. The use of community participatory research methods provides opportunities for community members to offer input concerning the inquiry, and enhances the potential for community ownership of any resulting intervention.

There are indices to assess eating patterns and healthy eating in many US ethnic populations (Thompson et al., 2007; Thompson & Subar, 2001; Thompson et al., 2002). However, these indices do not incorporate Samoan eating patterns as there have been limited population-based assessments of Samoan diets. Chapter four analyzed dietary data obtained from over 1,400 Samoans living in American Samoa, Hawai'i, and California to identify features of Samoan diets and dietary patterns (Figure 1.1). Several approaches to the data analysis were used including Principal Component Analyses (PCA), and Reduced Rank Regression (RRR) analysis. PCA was used as an exploratory method to identify patterns within the Samoan diets, the RRR analysis added predictive features by identifying Samoan food consumption patterns that are linked to obesity (Nothlings et al., 2008). Identifying features of Samoan diets and dietary patterns is a first step towards developing appropriate dietary indicators, and discerning healthy Samoan dietary models. The measurement and promotion of healthy Samoan diets can support interventions to reduce obesity in this population.

Figure 1.1. Dissertation Framework Causal Model



Conceptual Model: The Social Ecological Model of Health

The Socio-Ecological Model of Health was used as an analytic framework for classifying Samoan obesogenic factors to help to identify the multiple-level foci in which to target potential interventions. The Social Ecological Model of Health (SEM) highlights the interactions of individuals with their socio-cultural environments as determinants of health. The SEM proposes that individual health is influenced by biological and genetic functioning, social and familial relationships, environmental contingencies, and broader social and economic trends (Smedley & Syme, 2001). The Model has been used extensively to explain the physical activity and dietary patterns of individuals by examining the dynamic environmental contexts in which these behaviors occur (Sallis & Owen, 2002). Successful international efforts to address obesity have incorporated comprehensive Socio-Ecological approaches, modifying individual behaviors, social norms surrounding food consumption, and governmental and food industry policies regarding the availability of healthy foods (WHO, 2003). The model was streamlined for research purposes into three major determinants—biological/ behavioral, cultural, and socio-economic/political determinants in Samoan populations. Understanding the processes within these three specific determinant levels within the SEM provided

identifiable targets for actionable interventions addressing these levels of influence (Kaholokua JK, 2008).

Research Approach: Community-based Participatory Research Methods

Community-based participatory research (CBPR) describes a process for creating knowledge and developing interventions through partnerships between academia and community (Minkler & Wallerstein, 2003). Israel and colleagues describe eight basic principles of CBPR that serve to transform the researcher and community members into co-learners, whereby each of these research participants share power and bring their relative acumen and skills toward a comprehensive understanding of health and social phenomena (Israel, Schulz, Parker, & Becker, 1998). CBPR seeks to provide the community members with the requisite skills to mobilize and address health and social challenges in a positive and sustainable manner. This dissertation utilized several components of CBPR namely engaging members of Hawai'i's Samoan community actively in aspects of this research. This was achieved by maintaining open and transparent communications with community members on the nature of, and findings from this investigation, and including community representatives as co-investigators in portions of this research. Community members were trained on aspects of qualitative research methods with an emphasis on focus group methodology and served as the moderating teams for the focus group research. A brief description of CBPR principles (Israel et al., 1998) follows:

- *Recognizes community as a unit of identity.* The concept of community as an aspect of collective and individual identity is central to community-based research. Units of identity, for example, membership in a family, friendship network, or geographic neighborhood, are all socially constructed dimensions of identity, created and recreated through social interactions
- *Builds on strengths and resources within the community.* Community-based research seeks to identify and build on strengths, resources, and relationships that exist within communities of identity to address their communal health concerns.
- *Facilitates collaborative partnerships in all phases of the research.* Community-based research involves a collaborative partnership in which all parties participate as equal members and share control over all phases of the research process.

- *Integrates knowledge and action for mutual benefit of all partners.* Community-based research seeks to build a broad body of knowledge related to health and well-being while also integrating that knowledge with community and social change efforts that address the concerns of the communities involved.
- *Promotes a co-learning and empowering process that attends to social inequalities.* Community-based research is a co-learning and empowering process that facilitates the reciprocal transfer of knowledge, skills, capacity, and power.
- *Involves a cyclical and iterative process.* Community-based research involves a cyclical, iterative process that includes partnership development and maintenance, community assessment, problem definition, development of research methodology, data collection and analysis, interpretation of data, determination of action and policy implications, dissemination of results, action taking (as appropriate), specification of learning, and establishment of mechanisms for sustainability.
- *Addresses health from both positive and ecological perspectives.* Community-based research addresses the concept of health from a positive model that emphasizes physical, mental, and social well-being. It also emphasizes an ecological model of health that encompasses biomedical, social, economic, cultural, historical, and political factors as determinants of health and disease.
- *Disseminates findings and knowledge gained to all partners.* Community-based research seeks to disseminate findings and knowledge gained to all partners involved, in language that is understandable and respectful, and “where ownership of knowledge is acknowledged”.

The following chapters describe the investigations conducted as part this dissertation, designed to adapt an evidence-based dietary intervention for use in churches to reduce obesity prevalence among Samoans in Hawai‘i. Portions of this research were conducted with a dedicated effort to engage members of Hawai‘i’s Samoan community as mentors, supporters, and collaborators in building this body of knowledge.

CHAPTER 2. USING THE SOCIO-ECOLOGICAL MODEL AS A RESEARCH AND INTERVENTION FRAMEWORK TO UNDERSTAND AND MITIGATE OBESOGENIC FACTORS IN SAMOAN POPULATIONS

Abstract

The purpose of this study is to identify the relevant contributions and interactions of political, socio-economic, cultural, and biological factors towards the increasing rates of obesity in Samoans. The constructs of the Social Ecological Model of Health, which posits that there are multiple-levels of influence on individual health behaviors, is used as a conceptual framework to synthesize the current research investigating obesity and chronic diseases in Samoan populations.

Twenty five studies, representing over 20 years of empirical research with Samoans, were assessed and synthesized. These studies included quantitative and qualitative designs. The reviewed studies involved participants from (Western) Samoa and American Samoa jurisdictions, as well as migrant Samoan populations living in the U.S. and New Zealand.

Analysis of the current research revealed a convergence of factors, including the effects of recent political and socio-economic changes in Samoan jurisdictions, combined with specific Samoan cultural and biological dynamics, which have contributed to the current trends toward poor health in Samoans. Interventions designed to address obesity in Samoans must be able to modify multiple determinants of personal health, with particular emphasis on the appropriate use of Samoan cultural concepts.

The application of the Social-Ecological Model of Health, as used in this review, provides guidance for future investigations that may identify multiple factors that contribute to disparities in health. The use of intervention strategies designed to improve the health status of Samoans, may also indicate methods to address obesity and the development of chronic diseases in other population groups who share similar social conditions and health trends.

Introduction

The Samoan archipelago is comprised of nine inhabited islands located in the South Pacific midway between Hawai'i and Australia. According to archaeological evidence, Samoans are Polynesians who migrated from the East Indies, the Malay Peninsula, or the Philippines and reached the Samoan island chain around 3,300 Before Present Era (BPE) (Weisler & Kirch, 1996). The relatively disease-free existence of early Samoans is attributed to the isolation of the islands and Samoan cultural practices, including meticulous personal hygiene, high water quality, and a diet rich in fruits, vegetables and seafood (Tsai et al., 2004). In 1722, when the first Europeans reached the Samoan islands, their presence had a detrimental effect on the health of the indigenous people. Infectious diseases inadvertently brought by Europeans decimated 70% to 90% of the Samoan population through the 19th century (Keighley et al., 2007).

In 1900, the Berlin treaty between the United States (US) and Germany established arbitrary political boundaries within the archipelago. The western islands of the archipelago, or Western Samoa, were placed under the control of Germany. During World War I, in 1914, New Zealand took over administration of Western Samoa by military force (Wilson, 1966). The name was changed to Samoa after independence in 1962. The eastern islands became American Samoa and have been under the jurisdiction of the US from 1900 until the present. American Samoa was viewed as a valuable military asset, a U.S. naval coaling station was established in 1872, and a US naval base was maintained until 1951 (Ezeamama et al., 2006). In the early 1960s the US provided substantial investments in roads, water and sewer services, education, and medical care in American Samoa. Today, American Samoa is an unincorporated (not fully incorporated into the US, and not all provisions of the US Constitution apply) and unorganized (has not been granted organic law or constitution by the US Congress) territory of the US (CIA, 2008).

The division of a previously singular Samoan society initiated another disease epidemic. Over the past 40 years, both Samoa jurisdictions have experienced alarming increases in the prevalence of obesity. The political division of the Samoan archipelago has also caused disparate changes in diet, nutrition, and energy balance factors leading to unequal rates and patterns of chronic diseases between jurisdictions. In 2003, a third of

men and more than half of women ages 25-74 in Samoa were considered obese (Keighley et al., 2007). Obesity prevalence is higher in American Samoa, where 60% of men and almost 75% of women were considered obese using standards of the World Health Organization (WHO) of Body Mass Index (BMI) for Polynesians (Keighley et al., 2006, Keighley et al., 2007).

Samoans from both jurisdictions maintain high rates of migration to the US. According the 2000 US Census, nearly 32% of the total Samoan population has migrated to the US. Sixty percent of the 90,000 Samoans living in the US reside in states of Hawai'i and California (CIA, 2008). Samoans represent the second largest population of Pacific Islanders in the US, following Native Hawaiians. High rates of overweight and obesity are persistent, and the consequential sequelae of chronic diseases in Samoans living in the US contribute to disparities in health among US ethnic minorities. In Hawai'i, Samoans have the lowest life expectancy of the state's seven major ethnic groups (Park & Braun, 2008).

This review intends to provide understanding of the political, economic, social, cultural, and biological determinants of obesity, and the consequences of obesity on the health of Samoans. Provided are details of the search methods and source materials identified for inclusion. The presentation of findings is framed by the Social-Ecological Model of Health, which emphasizes a dynamic interaction among biological, cultural, and environmental factors over the life course of individuals, families, and communities contributing to the health of populations (Smedley & Syme, 2001). This is followed by a discussion of the relevance, limitations, and strengths of the research toward understanding the political, socio-economic, cultural, and biological determinants of obesity in Samoans, and the consequences of obesity on Samoans health. The review concludes with implications and recommendations towards the development of intervention strategies to address epidemic obesity trends found in Samoa populations.

Methods

Search Criteria

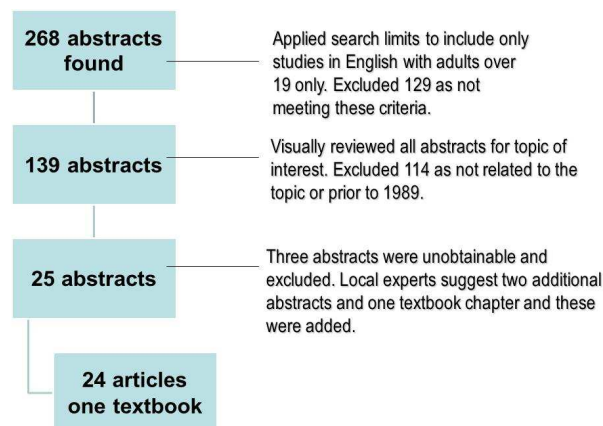
The review included studies published after 1990 in peer-reviewed scientific journals. Studies that were published prior to 1990 were synthesized into a textbook chapter that is included in this review. A preliminary list of published studies was created

through searches of PUBMED, CINAHL, the University of Hawai‘i VOYAGER (book catalogue), ProQuest Digital Dissertations, OPENSIGEL, Pacific Health Dialogue Monographs, and the websites of professional organizations focused on minority and/or Pacific Islander health, including the Intercultural Cancer Council, and the Association of Asian and Pacific Islander Community Health Organization. The search term “Samoa,” was used to identify literature in the queried databases. Limits were applied to include materials in English, and related to adults over 18 years of age. This age group was selected because chronic diseases are more prevalent in adults. The initial search of databases and websites identified 139 combined sources, including research articles, book titles, monographs, and conference proceedings.

Selection Criteria

All 139 abstracts resulting from the search were visually reviewed for titles and content related to the topic of interest and included scans for the terms, “Samoa,” “nutrition,” “diet,” “chronic disease,” “cancer,” “diabetes,” “heart disease,” “cardiovascular disease,” “ischemic heart disease,” “cerebrovascular disease,” “stroke,” “hypertension,” “high blood pressure,” or “obesity.” Upon review, 81 publications were identified as not relevant. Two more journal articles and a textbook chapter were identified through key informant interviews. In all, 24 journal articles, and one textbook chapter were obtained and appraised (Figure 2.1).

Figure 2.1. Literature Review Methods



Publications Reviewed

Selected articles were designated as analytic, descriptive, or qualitative research evaluating or describing associations between political, socio-economic, cultural, or biological determinants of diet, nutrition and energy balance factors in Samoans related to risks for chronic diseases. Study populations included Samoan adults, defined in accordance with the US Census Bureau's ethnicity classification of Samoan as, "a person having origins in any of the original peoples of Samoa"; it includes people who indicate their race as "Samoan" (Census, 2008).

In this review the use of the word "Samoan" will refer to any person that meets US Census definition, regardless of their birthplace or current residence. Individuals in American Samoa or with American Samoa specifically designated as their jurisdiction of origin prior to migration will be referred as American Samoans. Individuals in (Western) Samoa or with (Western) Samoa specifically designated in a study as their jurisdiction of origin prior to migration will be referred as (Western) Samoans.

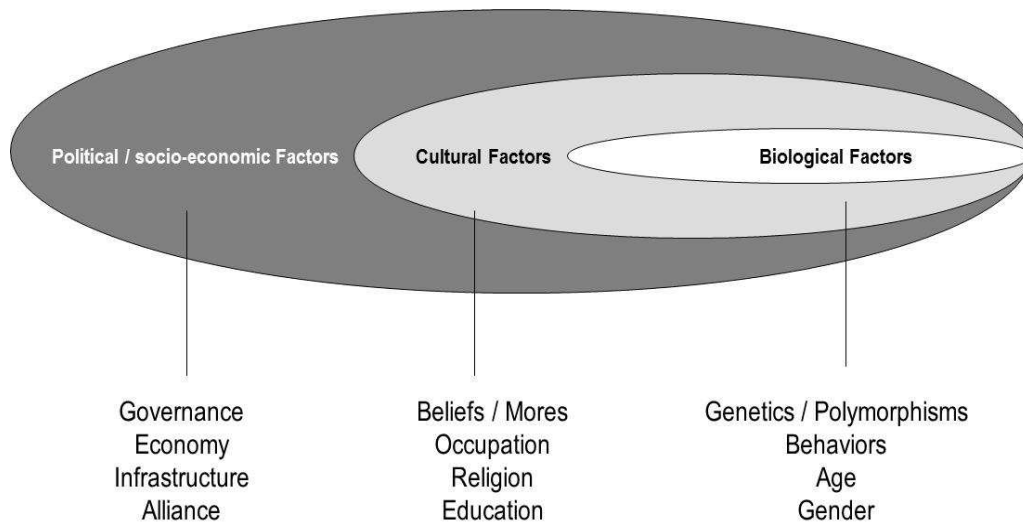
Results

Review framework

The Social-Ecological Model of Health (The Model) proposes that individual health is influenced by biological and genetic functioning, social and familial relationships, environmental contingencies, and broader social and economic trends (Smedley & Syme, 2001). The Model has been used extensively to explain the physical activity and dietary patterns of individuals by examining the dynamic environmental contexts in which these behaviors occur (Sallis & Owen, 2002). Obesity prevention interventions that fail to alter the environmental variables that contribute to overeating and diminished physical activity are unlikely to be effective or sustainable (Egger & Swinburn, 1997). Successful international efforts to address obesity have been focused to incorporate comprehensive Socio-Ecological approaches, modifying individual behaviors, social norms surrounding food consumption, and governmental and food industry policies regarding the availability of healthy foods (WHO, 2003). The use of Socio-Ecological Model of Health in this review not only provides an explanation of the increasing obesity trends in Samoan populations, the Model helps to identify the multiple-level foci in which to target potential interventions.

For this review, The Model was streamlined into three major determinants—biological, cultural, and socio-economic/political determinants and used as an organizing framework for exploring factors related to increased obesity in Samoan populations (Figure 2.2). Studies were classified into the three constructs, with several articles classified into more than one construct (Table 2.1). Of the 24 articles reviewed, seven focused on social-economic and political factors, ten focused on biological determinants and half, or 12 addressed the cultural influences on obesity. Six articles were specifically designed to measure cultural influences as a health determinant.

Figure 2.2. Review Framework Using Select Social-Ecological Model Constructs



Socio-economic and Political Factors: Differences in the health of (Western) Samoans, compared with American Samoans, can be attributed to variations in the types and rates of industrialization—agrarian industrialization in (Western) Samoa versus aquacultural industrialization in American Samoa. Traditional practice of subsistence fishing and agriculture intended for personal use was replaced after colonization by large-scale industrial agriculture and fishing exported for use by foreigners (Ezeamama et al., 2006). Political and economic transitions in American Samoa and (Western) Samoa reduced the intrinsic value and availability of traditional dietary resources for Samoans. Calorie-dense foods, including baked goods, and highly salted, canned foods, gained social and dietary prominence in Samoa life (Keighley et al., 2006). These transitions also led to changes in Samoan society whereby imported foreigner goods, including foods, were viewed as

“classy” and preferred by Samoans, despite the foods limited nutritional value (Finau, Wainiqolo, & Cuboni, 2002).

Differential economic development of (Western) Samoa and American Samoa added to the effects of colonial imperialism in Samoa. After the Berlin treaty, Samoa was economically developed by Germany to focus on industrial agriculture, and these industries were maintained under New Zealand rule. In contrast, the deep water harbor of Pago Pago, American Samoa was seen as a valuable military asset to the US until the close of WWII. It was later valued for industrial fishing, leading to the construction of two tuna canneries near the Pago Pago Harbor (Ezeamama et al., 2006).

The primary health effects of the distinct economies of (Western) Samoa and American Samoa were evaluated in a recent cross-sectional study conducted by Keighley and colleagues (2006), with a sample of more than 1,600 participants from both jurisdictions. The study assessed the effects of vocational patterns in each of the two jurisdictions— agrarian in (Western) Samoa versus industrial and administrative in American Samoa—and the consequent rates of adiposity as measured by BMI in each population (Keighley et al., 2006). Samoans in the jurisdiction of (Western) Samoa had lower rates of adiposity as compared to their counterparts in the jurisdiction of American Samoa. This difference was attributed to (Western) Samoans’ traditional/ subsistence agricultural livelihoods, considerably more active than American Samoa’s industrial and administrative vocations. Even controlling for differences in social economic status (SES) in both jurisdictions, the effect of occupation on BMI remained significant (Keighley et al., 2006).

Table 2.1 Classification of Reviewed Research Studies Using the Social-Ecological Model

Study number	Study (author)	Year	Study design	<i>N</i>	Jurisdiction populations	Biomedical	Cultural	Political socioeconomic
1.	Genome-wide scan for adiposity-related phenotypes in adults from American Samoa. (Keighley)	2007	Case control	1582	American Samoa	×		
2.	Distribution of genome-wide linkage disequilibrium based on microsatellite loci in the Samoan population. (Tsai)	2004	Case control	485	Samoa and American Samoa	×		
3.	Composite estimates of physiological stress, age, and diabetes in American Samoans. (Crews)	2007	Nested Cohort	273	American Samoa	×	×	
4.	Cardiovascular disease (CVD) risk factors in Samoa and American Samoa. (Mcgarvey)	2001	Cohort	1289	Samoa and American Samoa	×		×
5.	Human leptin locus (LEP) alleles and BMI in Samoans. (Mcgarvey)	2002	Proband Cohort	181	Samoa and American Samoa	×	×	
6.	Modernization and catecholamine excretion of young Samoan adults. (Pearson)		Cross-sectional	148	Samoa and American Samoa	×		×
7.	Migration and acculturation among Samoans: some sources of stress and support. (Hanna)	1998	Cross-sectional	143	Samoa and American Samoa and Hawaii	×	×	
8.	Health change in the Asia Pacific region: biocultural and epidemiological approaches. (Keighley)	2007	Literature Review	n/a	Samoa and American Samoa	×	×	×

Table 2.1 (continued)

Study number	Study (author)	Year	Study design	N	Jurisdiction populations	Biomedical	Cultural	Political socioeconomic
9.	Multivariate prediction of total and cardiovascular mortality in an obese Polynesian population. (Crews)	1989	Cohort	5866	American Samoa	×		
10.	The influence of socioeconomic factors on CVD risk factors in the context of economic development in the Samoan archipelago. (Ezeamama)	2006	Cohort	1289	Samoa and American Samoa		×	×
11.	Dietary intake of modernizing Samoans: implications for risk of CVD. (Galanis)	1999	Cross-sectional	946	Samoa and American Samoa		×	×
12.	Health transition among Pacificans: unpacking imperialism. (Finau)	2002	Descriptive Review	n/a	n/a			×
13.	Living with Ma'i Suka: individual, familial, cultural, and environmental stress among patients with Type 2 diabetes mellitus and their caregivers in American Samoa. (Elstad)	2008	Qualitative	64	American Samoa		×	
14.	Exploring beliefs about cancer among American Samoans: focus-group findings. (Hubbell)	2005	Qualitative	80	American Samoa		×	
15.	Farming and adiposity in Samoan adults. (Keighley)	2006	Cross-sectional	1711	Samoa and American Samoa		×	×

Table 2.1 (continued)

Study number	Study (author)	Year	Study design	<i>N</i>	Jurisdiction populations	Biomedical	Cultural	Political socioeconomic
16.	Cultural considerations in developing church-based programs to reduce cancer health disparities among Samoans. (Aitaoto)	2007	Qualitative	66	American Samoa in Hawaii		×	
17.	Breast cancer screening among American Samoan women. (Mishra)	1990	Qualitative	148	American Samoa in Hawaii and California		×	
18.	Impact of traditional Samoan lifestyle (fa'a Samoa) on cancer screening practices. (Puaina)	2008	Qualitative	66	American Samoa in California		×	
19.	A genome-wide linkage scan identifies multiple chromosomal regions influencing serum lipid levels in the population on the Samoan islands. (Aberg)	2008	Proband Cohort	1562	Samoa and American Samoa	×		
20.	Relations of body fat and fat distribution to the serum lipid, apolipoprotein and insulin concentrations of Samoan men and women. (Galanis)	1995	Cross-sectional	325	Samoa and American Samoa	×		
21.	Genetic studies of human apolipoproteins. XVII: population genetics of apolipoprotein polymorphisms in American Samoa. (Crews)	1990	Cross-sectional	67	American Samoa	×		

Table 2.1 (continued)

Study number	Study (author)	Year	Study design	N	Jurisdiction populations	Biomedical	Cultural	Political socioeconomic
22.	Genetic characterization of American and Western Samoans. (Deka)	1994	Proband Cohort	110	Samoa and American Samoa	×		
23.	Genetic effect of two APOA repeat polymorphisms (kringle 4 and pentanucleotide repeats) on plasma Lp(a) levels in American Samoans. (DePrince)	2001	Proband Cohort	309	American Samoa	×		
24.	Cancer-related health disparities in women. (Glanz)	2001	Descriptive Review	n/a	American Samoa		×	
25.	Perceptions of body size in Pacific Islanders. (Brewis)	1998	Cross Section	226			×	

In addition to the vocational differences between American Samoa and (Western) Samoa, economic patterns within both jurisdictions have been compared. Using a cohort derived from the Samoan Studies Project conducted in 1991, Ezeamama and colleagues analyzed a large sample of (Western) Samoans and American Samoans in 2006. The study considered the economic heterogeneity within each Samoan jurisdiction as a determinant of risk for obesity and chronic disease, correlating material lifestyle measures (comprised of several indices of modernized behaviors related to SES including ownership of consumer goods, ability to travel, and exposure to television and media), to cardiovascular disease (CVD) outcomes related to adiposity (Chin-Hong & McGarvey, 1996; Ezeamama et al., 2006).

Although vocational differences between agrarian (Western) Samoa and industrialized American Samoa were correlated with higher rates of adiposity in American Samoa, material lifestyle measures within these jurisdictions attenuate this effect. In the jurisdiction of (Western) Samoa, lower material lifestyle measures were correlated with lower CVD risks. Conversely in American Samoa, higher material lifestyle measures were correlated with lower CVD risks (Ezeamama et al., 2006). The effect of material lifestyle on obesity and chronic disease risks within each jurisdiction of (Western) Samoa and American Samoa suggests that each country is at a unique stage in the epidemiologic transition from infectious to chronic disease, relative to differential rates of economic growth within each country (Ezeamama et al., 2006). Presence of an inverse relationship between material lifestyle and the prevalence of CVD risk factors in more economically developed American Samoa is consistent with reported associations between material lifestyles, SES, and CVD risks in middle and high income countries, including the US, United Kingdom, and Australia (Ezeamama et al., 2006). Negative association between SES and the prevalence of CVD risk factors in less developed (Western) Samoa are consistent with findings from study populations in lower income countries including Brazil, South Africa, and Mexico, where individuals with high income have higher prevalence of obesity and CVD (Ezeamama et al., 2006).

Findings from another analysis of the Samoan Studies Project's cohort by McGarvey (2001) examine modernization on CVD risks in both Samoan jurisdictions (Mc Garvey, 2001). Risks factors and prevalence for several chronic diseases were

evaluated over a 4-year period among the cohort of 600 participants. These risks factors included cholesterol levels, high blood lipid levels, hypertension levels, and rates of type 2 diabetes, correlated with Samoan dietary patterns. The study included analyses of urinary excretion of sodium potassium (most likely from banana consumption), indicative of the retention of some traditional Samoan dietary features (Mc Garvey, 2001). Another outcome was the indication that substantial weight gain continued in already overweight Samoan adults, suggesting that the possible biological and cultural components might be compounding the effects of 50 years of macro-environmental influences on obesity in both Samoa and American Samoa (Mc Garvey, 2001).

Keighley and colleagues (2007) chapter on Samoans in “Health Change in the Asia Pacific Region” provides a thorough overview of the temporal effects of socio-economic determinates on the population health of Samoans (Keighley et al., 2007). The text compares changes in population-based adiposity rates beginning in 1970, shortly after the establishment of tuna canneries in American Samoa, until 2003. Temporal trends towards increased obesity in both polities are made evident by randomized surveys conducted in the 1970’s, questionnaires given to randomly selected people in villages in the 1990’s, and survey data collected from non-random samples in the 2000’s. The BMI indices of adults, ages 18-74 years, by gender and jurisdiction demonstrate high prevalence and increasing rates of overweight and obesity among men in both jurisdictions. In these studies, definitions for overweight and obesity are derived from the adjusted WHO standards for Polynesian populations at 26- 32 kg/m² for overweight and greater than 32 kg/m² for obesity (Keighley et al., 2007).

The aforementioned authors (Keighley et al., 2007) attributed several emergent chronic diseases to the obesity trends in both Samoan jurisdictions, including increasing mean blood pressure rates, CVD disease, and the onset of type 2 diabetes. The review also described recent trends toward the development of type 2 diabetes at increasingly younger ages in both Samoan populations. The link between political and socio-economic factors is made clear, as the authors report a fourfold increase in imported foods to Samoa, including foods high in sodium, starch energy, total and saturated fats, and low or lacking in dietary fiber concomitant with rising obesity. “Walking into many stores on the island of American Samoa the shelves are lined with canned beef, pasta, candy, soda,

chips, frozen turkey tails, with a few costly but low quality vegetables at the very back of the store.”(Keighley et al., 2007)

Finally, Pearson (1990) demonstrates a correlation between political and socio-economic changes on personal stress in Samoans. This cross-sectional study evaluated the norepinephrine and epinephrine levels of 148 Samoans residing in the jurisdictions of (Western) Samoa, American Samoa, and in the State of Hawai`i (Pearson, Hanna, Fitzgerald, & Baker, 1990). These neurotransmitters are linked to the human flight or fight response, and have been used as proxy measures to evaluate individual stress levels. The study found that Samoans in more modernized locations maintained higher norepinephrine levels, relative to personal workloads associated with changes in body weight, work capacity and work patterns that accompany modernization (Pearson et al., 1990). For example, fit individuals have lower relative workloads than less fit individuals, and therefore will tend to have lower levels of norepinephrine. In the study, the increases in norepinephrine secretion in modernized communities were significantly related to weight differences among individuals in each jurisdiction, particularly in Honolulu. The study demonstrated a potential biological mechanism resulting from environmental factors, leading to specific phenotypic characteristics of obesity (Pearson et al., 1990).

Biological Determinants: More than 10 studies examined biological factors, including genotypic and phenotypic analyses, as obesity determinants in Samoan populations. These investigations were based on the following suppositions:

- (1) Samoans in both Samoan jurisdictions are descendants of a common culture, irrespective of the cultural divergence of the two populations. This hypothesis asserts that Austronesian-speaking people from S.E. Asia reached Samoa and Tonga around 3,300 BPE. The inhabitants of the Samoan islands shared a common culture called “Lapita” derived from archeological evidence of common pottery styles in Samoan and in the cultures in the East Indies, the Malay Peninsula, and the Philippines (Tsai et al., 2004, Hubbell et al., 2005).
- (2) Exploration for evidence of the “thrifty” gene in Polynesian populations. This hypothesis extends the idea that Polynesians inhabiting the Samoan islands are descendants of people who migrated via canoes over open oceans (Hubbell et

al., 2005). Survivorship of the long ocean voyages required for this migration would favor individuals with large body masses and efficient metabolisms to protect against both starvation and exposure to cold ocean climates. Descendants of these voyagers may reflect a genetic profile of this metabolic efficiency (Keighley et al., 2007).

(3) The proposition of a correlation between obesity with multiple chronic diseases in Samoan populations (Crews, 1989, 2007; Elstad et al., 2008; Galanis, McGarvey, Quested, Sio, & Afele-Fa'amuli, 1999; Mc Garvey, 2001).

A 1994 study by Deka with 110 participants from (Western) Samoa and American Samoa was one of the first to provide evidence of genetic homogeneity among the inhabitants of the two polities (Deka et al., 1994). The study analyzed genetic and polymorphic variations, and concluded that large proportions, 50% to 100%, of alleles are shared between American Samoans and (Western) Samoans. The study explained that evidence of genetic homogeneity across the Samoan islands is supported by the socio-cultural links between communities and individuals from both jurisdictions based on family lineage, marriages, conferral of chiefly titles, and occupational and residential mobility. These results also support that the differences in health outcomes between American Samoans and (Western) Samoans are not due to genetic differences between the two populations.

A 2004 study by Hui-Ju Tsai confirmed the results of the earlier Deka (1994) study, providing genetic evidence that populations from American Samoa and (Western) Samoa are descendants of common origin and represent a singular culture. The study examined linkage disequilibrium (LD) based on microsatellite loci in Samoans. Analysis of LD has been used to map susceptibility genes and complex disease patterns in isolated populations (Tsai et al., 2004). This study used LD as mechanism to provide a comparative genetic analysis of both Samoan polities, with a population known to be genetically similar, Palauan, and a dissimilar study population of Caucasians from the US. The study found similar LD patterns for Samoans as the Palauan group, and dramatic differences between the LD levels of the Caucasian sample.

Several studies lead by Crews (Crews, 1989, Crews, 2007) and colleagues (Crews, Kamboh, Bindon, & Ferrell, 1991) evaluated other biological factors related to

obesity, solely in American Samoan populations. The researchers examined obesity risks for cardio-vascular disease (CVD). The studies found that although American Samoans experience high rates of obesity, their rates of morbidity and death from CVD do not match those of similarly obese populations from other ethnic groups (Crews, 1989). This study expounded the “thrifty gene” concept, that American Samoans may have a unique ability to tolerate high levels of obesity without detrimental cardiovascular effects. The study considered that this characteristic may stem from factors related to energy metabolism, i.e., American Samoans may have an exaggerated ability to process and store food energy into fat (Crews, 1989).

A later study by Crews attempted to identify genetic correlates of obesity in American Samoans (Crews et al., 1991). The study evaluated six apolipoprotein genetic variations in American Samoans, associated with high blood lipid levels in several other ethnic populations (Crews et al., 1991). Among the six examined genetic variations correlated with obesity, three variations were found among the 67 American Samoans participants, indicating a possible genetics role in this group. Other later and larger studies, including those lead by DePrince, (DePrince et al., 2001) and Dai, (Dai et al., 2007) also sought to identify specific genes or genetic predispositions contributing towards obesity in American Samoans with some success in identifying candidate genetic markers. These studies conceded that these genetic variations and their potential effects on obesity in American Samoans were modified by a range of other biophysical interactions, and modulated by individual behavioral factors including diet and physical activity (Dai et al., 2007; DePrince et al., 2001).

In 2007, Crews evaluated 273 participants from American Samoa to identify stress-related obesity correlates, through assessment of cortisol, adrenaline and noradrenaline (Crews, 2007). These substances, found in urine, were used as proxy measures for allostatic load, or the biological manifestations of bodily wear resulting from the physical and psychological burden of large body size. Allostatic load measures were correlated in other research with an assortment of co-morbidities, including Type 2 diabetes and hypertension, and termed Chronic Degenerative Conditions (CDC). The authors concluded that stress was highly associated with an increased risk for Type 2

diabetes. However, the investigators were not able to distinguish the initial stressors from among the possible psychosocial or physiological sources (Crews, 2007).

Based upon evidence of genetic singularity these findings can be applied to all inhabitants of the Samoan Archipelago. However, four studies of biological factors related to obesity, provide confirmation of cultural concordance between the American Samoan and (Western) Samoa populations through analysis of participants from both jurisdictions.

A cross-sectional study of 325 participants from both American Samoa and (Western) Samoa was conducted in 1995 (Galanis et al., 1999). The aim of the investigation was to understand trends in CVD risk factors across the Samoan Archipelago. This study included a unique measure of adiposity, the abdominal-hip circumference ratio (AHR). The AHR is calculated as the individual's abdominal circumference divided by hip circumference, and used as an indicator of deep abdominal (visceral) fat deposition. The AHR is correlated with the metabolic complications in individuals who present excess abdominal fat (Litwin, 2008). This measure identifies risk for dyslipidemia or abnormal amounts of lipids and lipoproteins in the blood (Elesvier, 2008). The study demonstrated that BMI and AHR were positively associated with increased levels of total cholesterol, triglycerides and other CVD risks in both men and women. Another finding is that there appears to be a threshold or ceiling on the metabolic impact of abdominal adiposity in Samoans, whereby above a particular level of adiposity, the overall metabolic changes associated with this condition becomes less important. The study expanded findings from studies conducted solely in American Samoans that high levels of obesity in both American and (Western) Samoans did not produce the expected levels of LDL and total cholesterol typically found in other obese populations. In fact, levels found in both Samoan populations were closer to the average values for non-overweight US males (Galanis et al., 1999).

A study conducted by McGarvey (2002) evaluated 181 probands, or subjects with a condition of interest in genetic studies. Probands from American and (Western) Samoa were examined to detect differences in the proportions of obesity correlated alleles (McGarvey *et al.*, 2002). American Samoans had significantly higher BMI ratios than counterparts from (Western) Samoa. Results indicated that both groups expressed the

comparable obesity associated genetic patterns found in earlier studies, despite their expressed differences in adiposity (McGarvey et al., 2002). This study confirmed the similar genetic compositions of individuals from both polities, and established that the observed BMI differences between American Samoan and (Western) Samoa could be attributed to factors other than genetics.

A larger study of extended families by Aberg and colleagues (2008) included 34 large pedigrees from American Samoa and 46 large pedigrees from (Western) Samoa, representing 3,016 individuals (Aberg et al., 2008). This study also evaluated genetic obesity correlates to CVD risk and identified several genetic obesity markers in these populations. However, a distinct feature of this study was the use of participants' material lifestyles (MLS) in the analysis. This measure reflected differences in participants' lipid traits relative to their financial resources. (Western) Samoans with high MLS were expected to express similar CVD risks from obesity as American Samoans of comparable financial status. Studies evaluating differences in vocational patterns among the two polities found that increasing MLS had only an effect on the sample from (Western) Samoa (Ezeamama et al., 2006). Again, higher SES in (Western) Samoans was indicative of increased adiposity, whereas in American Samoa there appeared to be an inverse correlation between increases in SES levels and adiposity.

Cultural Determinants: Several studies assessed Samoan cultural factors as determinants of obesity and ensuing chronic diseases. Common among these studies was emphasis on the importance of Samoan cultural concepts as a specific health determinant, regardless of jurisdiction. Samoan culture is defined by the term fa'a Samoa which literally means the Samoan way (Aitaoto, Braun, Dang, & So'a, 2007). Fa'a Samoa includes the social, economic, and political system of the Samoan people, and extends to music and dance, and language. The four major components of fa'a Samoa are a strong belief in the spiritual, hierarchical social orientations, the importance of relationships and obligations, and the importance of the traditional Samoan lifestyle (Aitaoto et al., 2007).

A total of eight studies discussing socio-cultural obesity associations were found: two quantitative cross-sectional studies, five qualitative studies, and one descriptive review. Qualitative research is considered a culturally appropriate method of research in Samoan populations. Qualitative methodologies follow Pacific Islander traditions of

face-to-face meetings, and collective learning (Aitaoto et al., 2007). Studies varied in the inclusion of participants from the two jurisdictions of American and (Western) Samoa. Additionally, several studies included Samoan participants who had migrated to Hawai`i and California.

A study published by Hanna (1998) assessed the effects of migration on Samoans. The study included 143 participants residing in American Samoa, (Western) Samoa, and Hawai`i. The study evaluated epinephrine levels, a hormone indicated as part of the human fight or flight response to stress (Hanna, 1998). Researchers theorize that cognitive events, including stress, have similar effects as physical trauma, and produce a chain of biological responses mobilizing the body's resources to meet adaptive demands. These physiological reactions subsequent to the release of epinephrine include cardiac strain, increased blood pressure and elevated blood sugar levels (Hanna, 1998).

The Hanna study (1998) examined whether Samoan migration and acculturation is associated with epinephrine level changes. These changes may be antecedent to the development of chronic diseases in Samoans experiencing various levels of acculturation. Interestingly, there were no differences found among rural versus urban participants. Assumptions that less stress would be found among rural residents were not confirmed by this study (Hanna, 1998). The study also found that Samoan women in the three jurisdictions had epinephrine levels, and by extension stress, that varied in accordance with networking, but differently, within the three groups. Women in Hawai`i viewed community networking as stressful, whereas with women in American Samoa and (Western) Samoa, community networks buffered them against stress-related outcomes. It was speculated that community networking stress among migrant women was caused by the economic requirements of participating in these networks. Additionally, in Hawai`i there is not an inherent familiarity with the network members, as would be in networks within the Samoan jurisdictions. Other findings supported that, in Hawai`i, extended families appeared to reduce stress in Samoan populations (Hanna, 1998). This stress-reducing effect may be related to economic support provided among extended families in Hawai`i. Also, extended families may modify stress by providing access to traditional cultural knowledge through contact with familial elders (Hanna, 1998).

A study by Elstad and colleagues (2008) in American Samoa contrasts the Hanna (2008) study. This study used qualitative methods to identify perceived stress as contributing to poor disease management among American Samoan patients with Type 2 diabetes (Elstad et al., 2008). Focus groups were conducted with 35 diabetic American Samoans and their caregivers. Themes derived from the groups showed that family members were believed to be mediators of patient's stress, and diabetic symptoms (Elstad et al., 2008). Other findings included that diabetes is viewed as a new disease condition external to Samoan disease concepts, and the stress caused by diabetes had individual, cultural, and environmental features. Finally, the study suggested that interventions emphasizing improvement in diet and exercise habits may be well received in American Samoa (Elstad et al., 2008).

Further studies with participants in American Samoa, Hawai'i, and California describe the cultural aspects of American Samoans' health and health seeking behaviors. Traditional Samoan culture views illnesses as the results of displeasing gods or spirits (aitu) (Hubbell et al., 2005). Illness was also considered an imbalance among the spiritual, social, and personal aspects of one's life. To treat illnesses, Samoans referred to the fofo or priest for assistance. Subsequent to contact with Westerners, Samoans differentiated between palagi (White person) illnesses as those that can be explained by health professionals and cured by Western medicine, and ma'i Samoa, which are illnesses that cannot be explained by Western medicine (Aitaoto et al., 2007).

Obesity is a major risk for cancer, accounting for the 35% of all cases in the US (Glanz, Croyle, Chollette, & Pinn, 2003). In American Samoa, cancer is the second-leading cause of death (PIHOA, 2002) and, in (Western) Samoa, cancers are a leading cause of death (WHO, 2008). For Samoan immigrants in Hawai'i, cancer deaths contribute to Samoan's having the lowest life expectancy in the state (Park CB & Braun K, 2008). Disparities in cancer control behaviors contribute to high cancer morbidity and mortality in Samoans (Glanz et al., 2003). Several qualitative studies have provided evidence of the cultural aspects of cancer control in Samoan populations.

Research by Mishra in 1996, continued by Hubble in 2005, and recently by Puaina in 2008, identified a lack of disease prevention concepts in traditional Samoan cultural ideology, contributing to low cancer screening rates among Samoans (Mishra et

al., 1996, Hubbell et al., 2005, Puaina et al., 2008). Low screening rates lead to high cancer mortality because cancers are identified at less treatable stages (Mishra, Luce-Aoelua, & Wilkens, 1996). However, these studies also identified strengths related to Samoan cancer perceptions including that cancer is believed to be caused by not following fa'a Samoa, and adopting Western diets and lifestyles (Hubbell et al., 2005). Participants suggested culturally appropriate interventions including the use of the "Matai", or chiefs, to model appropriate cancer control behaviors (Puaina, Aga, Pouesi, & Hubbell, 2008).

A recent study by Aitaoto and colleagues (2007) provides guidance about other Samoan cultural norms, and identified appropriate settings for cancer control interventions with migrant Samoans. This qualitative study was conducted with 66 American Samoans and (Western) Samoans in Hawai'i. The study identified churches in Hawai'i as a primary institution used by migrant Samoans (Aitaoto et al., 2007). For migrant Samoans, the churches supplant villages, and priests or pastors are perceived as similar to the role the Matai would possess in the Samoa. Participants confirmed that the church could be used as a setting for the delivery of health interventions, and suggested methods to incorporate traditional Samoan values into faith-based interventions.

Finally, a study by Brewis in 1998 about the perceptions of obesity and chronic disease in Samoans, provides information about current cultural norms regarding obesity (Brewis et al., 1998). Early observations by Westerners of Polynesian culture attributed obesity in individuals to social status. "Early European visitors to Polynesia noted the health and well-being of the people, and mentioned signs of overweight among high status individuals but not in the general population" (Keighley et al., 2007). Individual and group norms concerning obesity in Samoans were evaluated in 226 participants in (Western) Samoa, and with Samoan migrants living in New Zealand (Brewis et al., 1998).

The Brewis study (1998) used BMI measurements, combined with a survey about perceptions of normal body weights. Although participants displayed high rates of obesity, their concept of ideal body sizes were of individuals classified as slim (Brewis et al., 1998). Another finding was that the women had made several attempts to lose weight. Interestingly, these overweight women and men did not possess a diminished self-

perception about their current body size. This study contradicts the notion of a veneration of large body sizes among Polynesians. However, there is an absence of a strong negative view towards high body weight as characterized by the values of Western societies.

Discussion

The aim of this review was to synthesize a large body of research on factors contributing to the current obesity trends seen in Samoan populations, and to present possible strategies for continued research, and the development of effective interventions. Epidemiological studies with Samoan populations have been conducted since the 1970s when sharp increases in obesity rates first began to be noted (Keighley et al., 2007). The specification and refinement of this obesity research began in the 1990s and continues today. These studies have been conducted by group of research colleagues who have keen interest in identifying obesogenic factors in Samoans. This group has pursued investigations whereby questions posed by prior research, were used as the foundation for more contemporary analysis. This process has built a solid base of knowledge concerning the interactions of multiple determinants of obesity and chronic diseases in Samoans. These determinants have been framed in this review by use of the Social Ecological Model. Additionally, recent studies of Samoans incorporating qualitative designs have uncovered the cultural and behavioral processes leading to obesity and the consequent diseases.

Limitations in this body of research include several notable issues. While a great debt is owed to the cohort of researchers initiating studies with Samoan populations, caution must be taken. Investigator bias may be a factor in creating a base of knowledge bounded by the common interests among these researchers. For example, many study populations were derived from the larger cohort studies conducted between 1991 and 1995 (Keighley et al., 2007). This convenience sampling of participants originally selected to meet the aims of the initial studies may introduce bias into observations found in the latter research.

A second issue concerns studies evaluating biological factors. Much of this research was conducted in the early 2000s when scientific enthusiasm surrounded the Human Genome Project. These studies emphasized the identification of specific genetic patterns correlated with obesity in Samoans. While these studies have tremendous

scientific merit, caution must be taken. The intention of the researchers may be to identify possible targets for disease mitigation, however the discovery of genetic disease determinants have the potential to be misclassified, misinterpreted, and misused by nonscientific interests to substantiate discriminatory practices. The conclusions of the reviewed studies emphasize that genetic factors alone do not fully explain obesity in this population, substantiating a more comprehensive perspective towards understanding obesogenic determinants in Samoans.

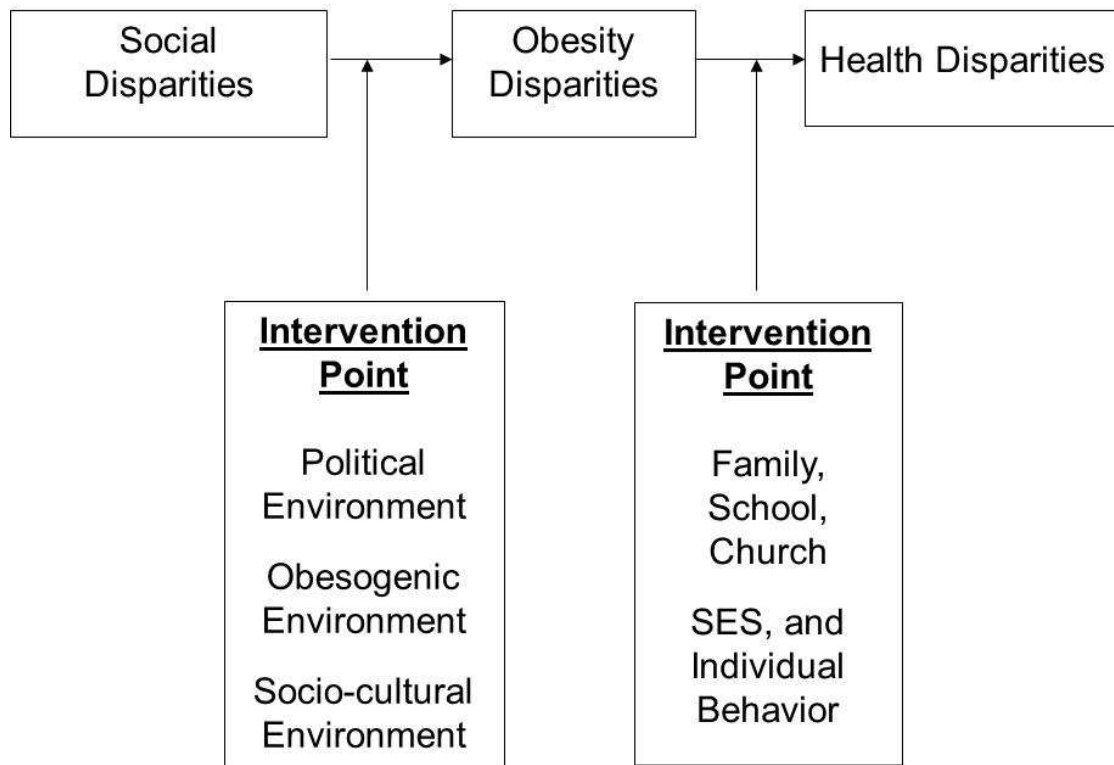
Finally, many studies examining obesity risks in Samoans populations have a deficiency-focus. No studies have evaluated populations in American or (Western) Samoa who do not demonstrate obesity and high risk profiles and who may be unaffected by the prevalent environmental, cultural, and biological obesogenic factors. Although 60% of men and 75% of women are considered obese in American Samoa, there remains 40% of men, and 25% of women maintain healthy body weights despite contrary environmental dynamics. Studies evaluating these individuals, or positive deviance may prove useful towards abetting obesity trends in Samoa.

Despite possible limitations, the strengths of the current research regarding obesity in Samoans abound and outweigh possible bias or shortcomings. Many studies offer guidance on the political and social context of Samoan obesity trends. The fit of the Social Ecological Model to this range of research is a tribute to its importance and the vision of the researchers. A review of these studies provides a clear understanding of the obesity determinants in Samoa and discloses possible intervention points (Figure 2.3), according to J. Kaholokula and K. Braun (personal communication, Nov. 2008). Targeting policy, institutional variables, and changing the socio-economic milieu affecting Samoan obesity rates can increase the likelihood of improving the health of this population.

Qualitative studies conducted with Samoans have helped our understanding of the cultural and individual obesogenic determinants and provided insights towards addressing these influences. Many studies describe the collectivist and hierarchal nature of Samoan culture as a characteristic that may provide opportunity to leverage interventions and facilitate changes in the health of Samoans. These studies describe the close-knit features of Samoan communities, and increasing affinity towards the adoption

of healthy traditional cultural practices, particularly concerning diet and physical activity (Aitaoto et al., 2007; Elstad et al., 2008; Hubbell et al., 2005). The studies describe the application of collectively focused strategies and the engagement of specific cultural institutions including the use of the traditional Matai system of governance and churches to address Samoan health (Aitaoto et al., 2007; Elstad et al., 2008; Hubbell et al., 2005).

Figure 2.3. Potential Intervention Leverage Points Using the Social-Ecological Model*
 *Note: J.K. Kaholokua and K. Braun (Personal communication, 17 Nov 2008)



Conclusions

The constructs of the Social Ecological Model were used to frame the research on obesity and the subsequent chronic diseases in Samoans because this model identifies factors within multiple levels of influence that contribute towards obesity risks. The analysis identified the specific contributions of political, socio-economic, cultural, and biological factors leading to increasing obesity in Samoans. Also, the review considers

opportunities for continued research on appropriate intervention methods to address obesity related health disparities experienced by Samoans.

Recommendations for future research include the development and implementation of health promotion policies and environmental interventions to address the political and socio-economic determinants of obesity the Samoan Archipelago. Research can identify protective factors among populations of Samoans who maintain healthy lifestyles. Research should also test culturally appropriate interventions using established cultural institutions to insure relevance and appropriateness for this unique ethnic population.

CHAPTER 3. SAMOAN BODY AND SOUL: ADAPTING AN EVIDENCE-BASED PROGRAM FOR USE IN SAMOAN CHURCHES IN HAWAI'I

Abstract

Social ecological factors contribute to rising obesity in Samoans, a group that maintains high rates of migration to the US. Culturally-appropriate interventions have been shown to improve diet and exercise in many US ethnic populations. However, there are limited research-tested interventions to improve the health of Samoans. This study describes research conducted with Samoans in Hawai'i to identify adaptable components of a faith-based intervention originally designed for African Americans. Samoans and African Americans share many cultural similarities including affinity with faith-based institutions, perceptions of body size, and obesity-related health risks. The study had three specific aims: 1) to understand Samoan culture; 2) to confirm the saliency of using a faith-based intervention to reach Samoans; 3) to identify the adaptable features of a potential intervention to suit Hawai'i's Samoans.

Qualitative research (key-informant interviews and focus groups) were used in this study. Data were collected from a total of 31 Samoan participants. Key-informant interview participants included a male and female non-church member, a male and female church member, and a church pastor. Focus group participants included six female church members ages 18-50, seven female church members over age 50, seven male church members ages 18-50, and six male church members over age 50. Focus groups were conducted by trained peers. Quantitative analysis based on Grounded theory was used to identify key themes (Charmaz, 2006).

The interview and focus group participants confirmed that the church was an appropriate setting to address obesity in Hawai'i's Samoans. The study identified specific strategies for the implementation of a faith-based intervention for Samoans including: leveraging use of Samoan social hierarchy, re-adoption of healthy traditional foods and preparation methods, and conducting intervention activities in group settings.

This study provided information precursory to the implementation of a health promotion program for Samoans in Hawai'i. The study's use of qualitative research methods built readiness for intervention implementation among Hawai'i's Samoan community.

Introduction

Socio-ecological factors contribute to rising obesity in Samoan populations. These factors work in concert and include the political, economic, cultural, biological, and behavioral aspects of Samoan life today. Currently 50% of (Western) Samoans and 70% of American Samoans are considered obese (Keighley, McGarvey, Quested, McCuddin, & Viali, 2007). Samoans maintain high migration rates to the United States (US), predominantly to Hawai‘i and California (CIA, 2008). Unfortunately, the high prevalence of obesity found in the jurisdictions of Samoa persists in these Samoan migrants. According to the 2007 Hawai‘i BRFSS, more than 90% of Samoans surveyed in Hawai‘i are overweight or obese (based on body mass index), and 80% reported having no exercise within the past 30 days (CDC, 2008). Obesity-related chronic diseases contribute to Samoans having the lowest life expectancy in Hawai‘i (Park, Braun, Horiuchi, & Onaka, 2009).

Culturally-appropriate interventions that can address obesogenic socio-ecological factors have been shown to improve nutrition, physical activity, and reduce chronic diseases in ethnic populations, including African Americans who experience similar obesity-related health risks as Samoans (Campbell et al., 1999; Resnicow et al., 2004; Resnicow et al., 2005). A promising evidence-based intervention that may work among Samoans is Body and Soul, a program of the National Cancer Institute (NCI) designed for implementation in African American churches. Body and Soul is a faith-based nutrition and physical activity intervention that incorporates African American community norms to address obesogenic factors on the behavioral, interpersonal, cultural, and institutional levels (Resnicow et al., 2004). The intervention also builds the faith-based community’s capacity to address the policy and economic determinants of obesity.

The Body and Soul program represents a synthesis of two randomized controlled research studies conducted with African American churches, the “Black Churches United for Better Health” trial, and the “Eat for Life Trial” (Resnicow et al., 2000). Components that were instrumental in improving nutrition and physical activity among participants were combined to create the current Body and Soul program. These components included support of the church pastor, changes in church dietary policies, church activities that

support physical activity, healthy eating, and peer-to peer support among program participants.

Body and Soul may suit Samoan communities in the US for several reasons. Samoans and African Americans have similar perceptions concerning personal self-image and body size. Although ideal body sizes in African American and Samoans are of slim individuals, these ethnic groups do not have the strong negative self-perceptions related to being overweight or obese as found in non-Hispanic Caucasians (Brewis et al., 1998; Duncan, Anton, Newton, & Perri, 2003; Okosun, Choi, Matamoros, & Dever, 2001). Additionally, the church is considered an important institution in both cultures, and churches have been identified as the primary social institution used by migrant Samoans in Hawai'i and California (Aitaoto et al., 2007; Bell et al., 2001; Levy-Storms & Wallace, 2003). Faith-based settings have been used successfully to improve breast cancer screening rates among Samoans in California (Levy-Storms & Wallace, 2003). In New Zealand, churches have been used to promote healthy nutrition and physical activity of migrant Samoans and Tongans (Bell et al., 2001; Simmons et al., 1998). However research on the use of faith-based intervention to address obesity among Samoans in the US and Hawai'i is lacking.

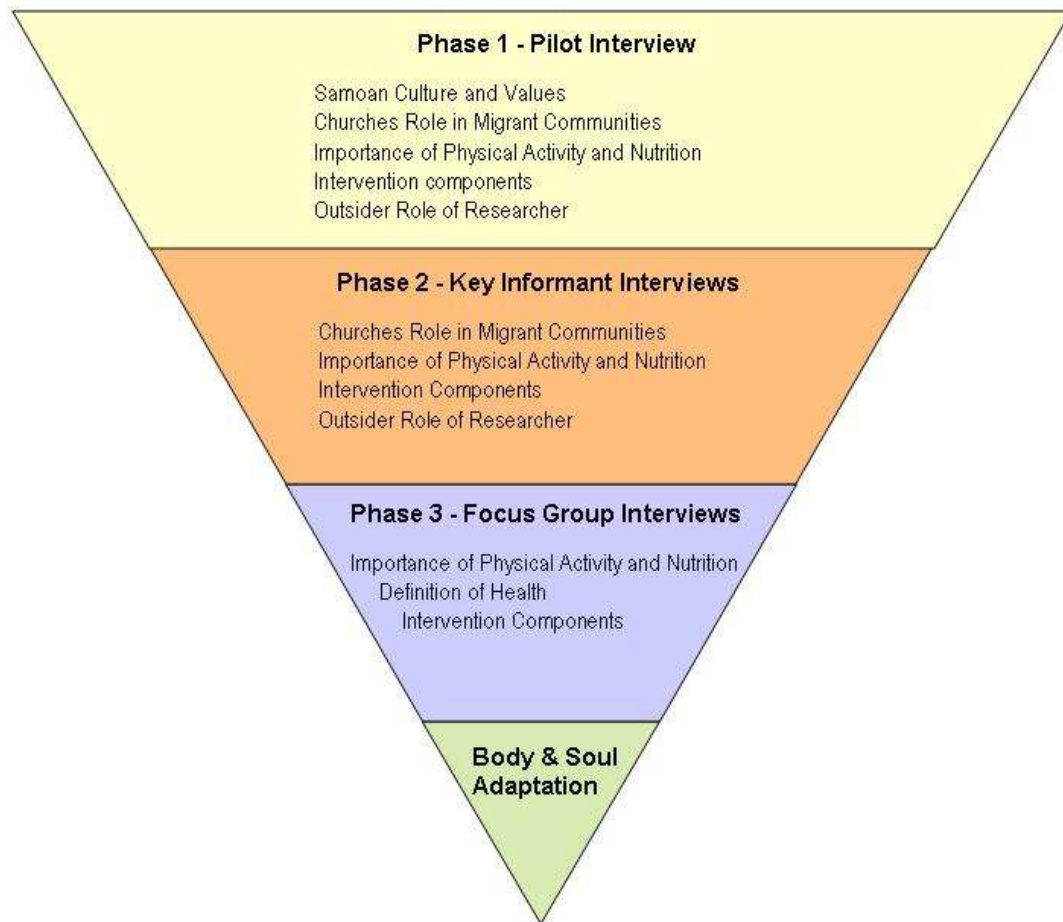
The three primary aims of this study were addressed in three distinct study phases and included: (a) Phase 1, to validate information found in the scientific literature suggesting the importance of socio-ecological factors, including cultural factors, related to obesity in Samoan populations; (b) Phase 2, to determine if the church is a viable setting to address healthy eating and physical activity for Samoans in Hawai'i; and (c) Phase 3, to identify the important features for adapting and culturally tailoring a church-based intervention to be suitable for Samoan populations in Hawai'i.

Methods

The research was conducted in Honolulu in 2010-2011. Qualitative research methods guided this inquiry, and included: a pilot interview with a Samoan pastor; interviews with four key-informants from Hawai'i's Samoan community; and focus groups conducted with members of a Samoan church in Hawai'i (Figure 3.1). The focus groups were led by church members who were trained by the researcher in qualitative interview methods. Additionally, these trained moderators assisted with the refinement

of the interview questions and the analysis of the focus group interview data. Qualitative research methods have the ability to incorporate community-based participatory research (CBPR) features by building knowledge and establishing collective research priorities that are meaningful to the participants (Minkler & Wallerstein, 2008). The use of these qualitative research methods was expected to increase community knowledge of and engagement with the issues, and to enhance the likelihood of community ownership and adoption of interventions derived from this research (Minkler & Wallerstein, 2008).

Figure 3.1. Overview of Study Design and Issues Addressed in Each Phase



Recruitment and Study Population Overview

The participants in all interview types were purposively selected relative to their perceived ability to provide information-rich, illuminative, in-depth data concerning each phase of the study. References from individuals working with Hawai‘i’s Samoan community were used to select Samoan community members in Hawai‘i. Grounded Theory was used to support the inquiry, whereby information obtained from the pilot key-informant interview was used to inform and refine the inquiry for the additional key-informant interviews, which in turn served to guide the questions posed to the focus group participants (Charmaz, 2006). The study was reviewed and approved by the University of Hawai‘i Institutional Review Board, and all participants provided written consent.

Phase 1 – Initial Interview: The primary objectives of the initial key-informant interview were to obtain a better understanding of Samoan cultural values and practices, and practical information concerning the Samoan church in Hawai‘i. Also, the etic perspective of this researcher, an African American male from the eastern coast of the continental United States, warranted efforts to obtain information about the investigator’s suitability for the study, and to learn, incorporate, and be responsive to Samoan social norms (Patton, 1990).

A 46-year-old Samoan pastor from a church consisting of approximately 200 members of Samoan ancestry, located in rural Honolulu was selected for the initial key-informant interview. Although born in American Samoa, he attended college in Honolulu, and had seminary training in (W) Samoa. This pastor had an established leadership role among other Samoan pastors, as the head of an ecumenical council of Samoan churches in Hawai‘i. It was expected that an interview with this particular key-informant could provide basic information about the potential for conducting a church-based health intervention like Body and Soul, and provide valuable cultural information relative to his experience with Samoans in Hawai‘i and both Samoan jurisdictions. Recruitment of this particular interviewee represented purposive, politically important sampling of an informant with positional influence within the Samoan community (Patton, 1990).

Phase 2 - The Key-informants: To determine if the church is an appropriate setting to broadly reach Samoans in Hawai‘i, interviews were conducted with two distinct types of key-informants, either self-described church members or non-church members. This quota sampling frame was used to obtain perspectives from these groups about using the church, or another community-based setting for the delivery of an intervention (Maxwell, 2005). To address potential gender-related differences, interviews were held with influential Samoan women and men in each setting. Key-informants included a 42-year-old non-church affiliated woman, a 46-year-old non-church affiliated man, a 69-year-old church affiliated woman, and a 50-year-old church affiliated man. All interviewees that were recruited to participate as key-informants were recommended by other Samoans as community leaders either by their vocations, or their participation in and leadership of Samoan organizations in Hawai‘i.

Phase - 3 Focus Group Participants: Focus group participants were recruited from the Samoan church led by the pastor from the initial interview. This setting was identified by key-informants as the most appropriate for reaching migrant Samoan populations in Hawai‘i to deliver a nutrition and physical activity intervention. The aim of this phase was to determine the church members’ perspectives on the importance of nutrition and physical activity and to identify components that may need to be culturally tailored to be suitable for Samoan populations in Hawai‘i. Participants were recruited using the church’s regular communications channels. The researcher provided an overview of the study and solicited church members to join during a regular church service. Other recruitment methods included the posting of print promotional materials in both English and Samoan in prominent locations at the church.

Four focus groups were held with a total of 26 participants (Table 3.1). Participants in these focus groups were stratified by age and gender to address cultural norms found to be important in the Samoan community (Aitaoto et al., 2007). This separation by gender and age created homogenous groups including a group of seven men ages 25-49, a group of six men over the age of 50, a group of six women ages 25-49, and a group of seven women over the age of 50. Based on participant preferences, two of the focus groups with younger adults were conducted in English, while focus groups with older participants were held in Samoan.

Table 3.1. Focus Group Demographics

	Group 1 Young Adult Females, n=6 n (%)	Group 2 Older Adult Females, n=7 n (%)	Group 3 Younger Adult Males, n=7 n (%)	Group 4 Older Adult Males, n=6 n (%)	Participant Totals n=26 n (%)
<i>Mean age, years</i>	37.1	64.8	36.8	63.5	50.6
20-29	1 (17)	-	1 (7)	-	2 (8)
30-39	2 (33)	-	3 (23)	-	5 (19)
40-49	3 (50)	-	3 (23)	-	6 (23)
50-59	-	2 (29)	-	3 (23)	5 (19)
60+	-	5 (71)	-	3 (23)	8 (31)
<i>Age range, years</i>	28-44	50-90	25-47	56-79	25-90

Six bilingual moderators (three males including an older man, and three females, including an older woman) were recruited for their ability to hold the groups in either Samoan or English. The recruited moderators were trained by the researcher to conduct focus group interviews as a component of qualitative research during a 3-hour training session held before the first set of focus groups. Each member of the moderating team had a distinct responsibility in facilitating the groups, either leading the discussion, audio taping the session, or taking written notes and collecting other documentation in support of the group.

Gender and age concordance were considered in assigning moderators to focus groups as this was found to be an important Samoan cultural norm in the literature and key-informant interviews (Aitaoto et al., 2007; Kruger & Casey, 2000). Additionally, the emic perspective of these moderators served to enhance disclosure among participants, who may have been reticent to share sensitive personal and cultural information with an outside researcher. All moderating team members signed non-disclosure agreements to protect the anonymity of focus group participants, and to prevent disclosure of confidential information by members of the moderating teams.

Interview Questions: The structured interview questions used across all research phases sought to obtain information about the relevance of health, physical activity, and nutrition in the Samoan community (See Table 3.2). The questions used for the pastor interview were specifically designed to provide information about Samoan culture, church functioning, and to confirm information found in the literature. The questions used in the subsequent key-informant interviews were designed to ascertain information about an appropriate intervention setting and to identify potential activities that would

support improved physical activity and nutrition. Focus group questions were aimed at confirming the use of the church for an intervention among church members, and soliciting more detailed information about the activities that church members would find useful to promote improved nutrition and physical activity.

Table 3.2. Questions for Pilot, Key Informant, and Focus Groups Interviews

Interview Questions	Study Phase		
	Pilot	Key Informant	Focus group
1. Did you migrate from Samoa or were you born in Hawaii?	X		
2. What is the migration status of your (community/church) members, are they predominantly locally born or migrated from Samoa?	X	X	
3. What does fa'aSamoa mean to you?	X		
4. As a person outside of the church, what aspects of fa'aSamoa are important for me to know?	X		
5. As a person from outside of the Samoan community what is important for me to know about working in the community?	X	X	
6. What types of activities do you use to support fa'aSamoa at church?	X		
7. As a (community /church) leader what types of activities do you consider, or use to support Samoan community members?		X	
8. What is your opinion about the success of the faaSamoa or community support activities?	X	X	
9. Does the migration status of your church members affect participation in activities that support fa'aSamoa.	X		
10. What aspects of fa'aSamoa promote good health, including physical activity and nutrition?	X		
11. What types of activities do church members do to promote health including physical activity and nutrition while at church?	X		
12. In your opinion are the Samoans who attend churches locally, very different than Samoans who do not?		X	
13. What is your opinion about the overall health of the Samoan community?	X	X	X
14. Do you believe physical activity and nutrition is an important issue?	X	X	X
15. What would be a good place to reach local Samoans regarding physical activity and nutrition education?		X	
16. What would be the important parts of a project promoting physical activity and nutrition in the Samoan church/community?		X	X
17. What does being healthy mean to you?			X
18. How important is your health to you?			X
19. What are the things you do to maintain a reasonably healthy lifestyle?			X
20. What does eating healthy mean to you?			X
21. What does physical activity mean to you?			X

Data Analysis

The taped responses of all interviews were transcribed by a professional transcriber. The two focus group interviews that were conducted in Samoan were first translated into English and then transcribed. The initial analysis of the transcribed interviews was conducted by the researcher to enhance the opportunity for cultural emersion. This analysis followed Grounded Theory methods and included a detailed examination of the transcription in a line by line fashion, allowing for the creation of a descriptive summation of the interviewee's responses, or codes (Charmaz, 2006). Situations where the respondent's own words provided the best explanation of these concepts were captured as "in-vivo" codes during this initial coding process (Bracht, 1988; Charmaz, 2006).

The second step of the data analysis was to apply a focused coding process (Charmaz, 2006). Patterns found within the initially coded data were combined and organized into concepts or themes that captured the essence of the interviewee's responses. This secondary data analysis included a "Situational Analysis", or the creation of a "map" of the relationships between the various interrelated concepts (Clarke, 2005). Also, an axial coding strategy was used, whereby the contrasts between opposing themes in the interviews were identified to reveal distinctions between some categories of coded responses.

A memo writing process was used to describe the data overall as it related to a conceptual model, which included components from the Social Ecological Model (Smedley & Syme, 2001). The use of the Social Ecological Model provided a data organizing framework, and allowed comparison of the concordance between the interview data across all research phases with information found in the scientific literature. Also, the use of this particular model served to support possible use of an intervention that utilizes socio-ecological approaches to address obesity, including the potential use of Body and Soul.

Two independent reviewers were recruited to code randomly selected transcripts. These independent reviews were compared with the researcher's coding to assess inter-rater reliability. There was a 90% concordance between themes found by the independent reviewers with the themes categorized by the researcher. All research findings were

reviewed with the five key-informants and six focus group moderators to insure the accuracy of these findings, and to provide additional insights. This member-checking process also supported the principles of CBPR specifically that research is done in a transparent fashion through open collaboration and communication among the participants and the researcher (Charmaz, 2006; Minkler & Wallerstein, 2003).

Finally, the emergent themes, as vetted with the interviewees and moderators were added as a coding framework for use in a qualitative data analysis software package (NVivo 8, QSR International). This qualitative data analysis software was used to complement and support the data analysis conducted by the researcher. The use of this software allowed for easy access to the data extracted from a variety of sources, and across multiple interview types.

Results

As hoped, the initial key-informant interview with a church pastor helped the researcher better understand Samoan cultural values, and the cultural protocols of the Samoan community in Hawai'i as related to nutrition and physical activity beyond the information found in the literature. The interviewee believed that socio-ecological factors including the economic, cultural, and behavioral were components associated with obesogenic trends currently found among Samoans. This interview also provided precursory information concerning the feasibility of using the Samoan church in Hawai'i to conduct an intervention promoting healthy diets and physical activity. Finally, this interview provided information about conducting this study in a culturally-aware manner.

The subsequent key-informant interviews with other community members determined that the church was the most appropriate setting to reach a broad number of Samoans in Hawai'i concerning physical activity and nutrition. These interviewees provided more detailed information about the social functioning of Samoan communities in Hawai'i across age and gender groups. These interviewees reinforced information concerning the adoption of Westernized dietary patterns as factors in the current trends towards obesity. Finally, these interviews provided preliminary suggestions about possible components of a culturally-appropriate diet and exercise program for use in Hawai'i's Samoan churches.

The focus group interviews served to determine the importance of nutrition and physical activity in representatives from a Samoan church in Hawai‘i. These interviewees confirmed that Samoan attitudes towards weight and body size were consistent with African American perspectives. Focus group participants also identified the important features for adapting and culturally-tailoring an intervention for Samoans in Hawai‘i. Although focus group participants varied in their own health promotion activities, all supported adopting activities in the church to promote healthy diet and exercise, and many had specific suggestions for the church-based programs.

Interview participants across all phases of this study provided useful information that could inform the adaption of a physical activity and nutrition program, including Body and Soul to fit Hawai‘i’s Samoan churches. This information was grouped into 9 themes: 1) relevance of Samoan culture (fa‘aSamoa); 2) conducting culturally-appropriate research; 3) Hawai‘i’s Samoan community norms; 4) social support and pressure; 5) the role of Samoan churches in Hawai‘i; 6) acculturation challenges; 7) perceptions of health among Hawai‘i’s Samoans; 8) perceptions of physical activity, and nutrition; and 9) features of a culturally-appropriate intervention.

Relevance of Samoan Culture - Fa‘aSamoa

A key Samoan cultural concept is fa‘aSamoa which literally means the Samoan way that includes the social, economic, and political system of the Samoan people, and extends to music and dance, and language (Aitaoto et al., 2007). The four major components of fa‘aSamoa are a strong belief in the spiritual, hierarchical social orientations, the importance of relationships and obligations, and the importance of the traditional Samoan lifestyle (Aitaoto et al., 2007). The pastor expressed that fa‘aSamoa is viewed as a form of respect rendered by providing service to the community as whole, consistent with a person’s social role. He states:

At an early age you are taught to respect your elders, but it is actually heightened as a person accepts more responsibilities within the village. In the village you have the young men’s and the women’s society, each level has very specific roles. You have to fulfill those roles. They all learn their roles by serving, and rendering service is a part of demonstrating respect.

The communal and hierarchal structure of Samoan society is embodied in a *matai* or chief system (Hubbell, Luce, & McMullin, 2005). Typically, the eldest member of a family or group of families is responsible for decision-making amongst family members. This hierarchal matai leadership structure extends to the community and village. Gender roles are also important in the Samoan community (Hubbell et al., 2005). The pastor stated, “For example in the family setting males have fa’avelave (a family gathering to address ‘trouble’), and the matai gives suggestions to the families that are under his tutelage, and we usually try to fulfill that suggestion.”

Conducting Culturally-appropriate Research

All key-informant interviewees provided insights on community perceptions and ways for an external researcher to navigate within the community in an appropriate manner. It is expected that an outsider or *palangi* be aware of some the aspects of fa’aSamoa, particularly those related to demonstrating respect. This includes an awareness of generational, gender, and status-related cultural norms. Outsiders are given some accommodation from the community on their limited knowledge of cultural practices, if the research demonstrates an overall attitude of respect for the community. The pastor stated, “And so that is probably the finer dynamics of the fa’aSamoa, which the underlying concept is respect, if you just respect your fellow human beings then you shouldn’t have any problems.” Another key-informant said:

It wouldn’t be a bad idea to know a little bit about our culture. You know, usually when we go to church you know where to sit [among elders, males, or females], and that you’re not going to go right up to the person’s face. And, well the respect, it’s usually common sense, you know, the respect that you would show other people -- it’s the same thing.

Hawai‘i’s Samoan Community Norms

Samoan communities in Hawai‘i were described by all key-informants as being part of the close-knit Samoan social networks established in Hawai‘i. Networks include informal communications through familial links, and are also established through attendance at social events including festivals, wedding, and funerals. Formal networks include a local language school, a high school alumni association, and various other

social and athletic groups. Migrant community members choose to remain socially and politically connected in Hawai‘i, and with their friends and relatives in the Samoan jurisdictions. A variety of communications channels are used within these networks. Communications technologies are widely used among migrant Samoans including the use of advanced cell phones and the internet. One key-informant stated:

I am involved with our Fagaitua [American Samoan] High School Alumni Association in Hawai‘i. We also have our own local golf club like a Samoan social group. You mingle then you get involved with someone you just met, at a wedding or something..., that’s how it works, just like a network... There is a lot of technology these days that we use to stay connected. Basically the number one technology is our phone. One of the tools is email, and computer networks. If you go online, it’s also Samoa news, to learn about things going on [in Samoa] these days.

Social Support and Pressure

The Samoan community networks found in Hawai‘i networks are imbued with systems to provide social support according to key-informants. A motivating factor within Samoan communities is social pressure. The extensive social connections and communications found among Samoans in Hawai‘i provide a vehicle for the increased scrutiny of individual and group behaviors. The networks and channels that support social connectivity also support the delivery of reinforcing or sanctioning feedback concerning these behaviors. Social pressure is exerted towards individuals and groups to build conformity with traditional practices, adherence with communal support systems, and regard for the community’s leadership structure. A key-informant stated:

Social pressure is very big in the Samoan community. It is like everything is constantly being watched everything is up for comment. There is kind of an ultra-concern about things appearing and looking good. So, there is shame that is attached if your family or your chief didn’t give a donation amount that is respectable or whatever.

Role of the Samoan Church in Hawai‘i

The church was described by all interviewees as an important setting for the articulation of cultural practices, and an institution used for teaching fa’aSamoa to young

people in migrant communities in Hawai‘i. Use of the Samoan language is part of Hawai‘i’s Samoan churches, providing opportunities for community members to converse and socialize in Samoan. The Samoan church pastor in Hawai‘i takes on the village matai role within their congregations (Aitaoto et al., 2007). However, there is conflict that is associated with this newfound role of the pastor as community leader, particularly when there is a difference between objectives related to Christian values, and those of community leadership.

The pastor stated:

We are trying to teach the younger generation, or their kids, about what the fa‘aSamoa is, and this is within the church setting. And so I think the church has taken upon that village setting outside of Samoa. It is like a village setting, you teach each aspect of the village, first that you need to serve in order to become a Matai. However, the church is different than the village setting, you have your hierarchy in the village, and the pastor has taken on the role as the high chief of the village, it does sometime conflict with the church’s role to promote spiritual values.

All key-informants, regardless of their membership status, described the church in Hawai‘i as the best setting to broadly reach the local Samoan community.

One key-informant stated:

Well with the church-based setting, if you really got it [an intervention] going you will have a kind-of a multiplier effect. You get that church to change, the churches are all part of a system and so you could really have some widespread change.

Agreement about using the church as an intervention setting resonated with focus group participants. A focus group participant states, “I think the church is the only common ground that we Samoans have together as a community.” A notable feature of the Samoan church in Hawai‘i is its use in traditional ceremonies hallmarking events including birthdays, weddings, and funerals. These ceremonies are typically attended by a range of Samoan community members in Hawai‘i, including those who may not be church members.

Acculturation Challenges

The interviews provided new insights about cultural practices among Hawai'i Samoans not immediately found in the scientific literature. The pastor and other key-informants described keen intra-generational challenges to traditional Samoan practices. These challenges represented a desire among Hawai'i's Samoan populations to negotiate the communal and hierarchal aspects of fa'aSamoa within the context of the individualist westernized cultures found in Hawai'i. These conflicts create a rift between older and younger generations of Samoans in Hawai'i that are often manifest during the activities in the church.

The pastor stated:

Overall everyone practices [fa'aSamoa] on a very basic level, but I'm speaking for the older generation, but those who are born and raised here, that is where we see the conflict, probably more generational than anything. For some the transition is difficult, only because those who are born and raised here they are questioning everything that [is] happening with the fa'aSamoa. Whereas in Samoa they just would go ahead and do it.

Perceptions of Health

All interviewees agreed that the traditional practice of fa'aSamoa historically involved health promotion features. People harvested foods from the land and sea to share among community members. The work was hard. Thus, health, physical activity and nutrition were integrated aspects of fa'aSamoa and were conceived as being part of overall personal and communal well-being. However, issues related to economics, migration, and acculturation has transformed traditional practices, particularly those protocols supporting familial and communal functions, or fa'alavelave. Typically, these functions that are part of fa'alavelave may involve bestowing gifts, and communal meals or tona'i (Puaina, Aga, Pouesi, & Hubbell, 2008).

Westernization of these cultural practices included the transformation of the traditional items used in the gift exchanges, and the foods that are served during communal meals.

An interviewee states:

Back then you fish, you hunt, or farm your foods - chicken and stuff like that, and that's what people used, the stuff from their land and the sea. Then you exercised when you do whatever outdoors as part of your physical activity. We don't see that now, especially outside of Samoa. Westernized ways and everything has been a big part of these new health issues.

A focus group participant stated:

Our brothers and sisters in [Western] Samoa are just so much different than us. I mean if you look at them, they're really well proportioned. You know, like, slim, healthy. I guess it's just the lifestyle – they do still live off the land. They have to earn what they eat. They fish. And then us being Americanized – we're so dependent on these benefits that we have that we kinda like forget who we are.

Focus group participants provided more detail on the perceptions of health among Hawai'i's Samoan church members. These participants reinforced key-informant disclosures that described lack of negative self-perceptions related to large body sizes and weight, similar to African Americans. One focus group participant stated, "Samoans are built for power not for speed."

However, across all interviews there was an acknowledgment that the current trends towards obesity is becoming a primary health concern among Samoans in Hawai'i. Another focus group participant states:

I have relatives that are sick from cancer and diabetes, and that have died. Because of that I've become more aware of the severity of being overweight. But I also think that culturally there is a perception especially for us Samoans that big is healthy. I know growing up, there's a healthy "bigness". I do believe that you can be big boned and healthy, but a lot of us are big or obese in an unhealthy way now.

Perceptions of Physical Activity and Nutrition

Although focus group participants acknowledged growing concerns in Hawai'i's Samoan community about the importance of exercise and diet, participants varied widely in their familial and personal strategies to promote healthy energy balance. Several participants in all four focus groups including the young male, young females, older males, and older females performed regular physical activity; the most common activity

was walking. Several members of the older male and female groups worked to maintain healthy diets. One interviewee states, “I take the effort to try and get up, go for a walk. People would just sit around at my house and eat, I kind of like to get up and just try and be active in any way I can.”

All focus group participants discussed the current challenges and barriers they faced as they began to recognize a need to improve their diets and increase exercise. These challenges were related to food costs and availabilities, time limitations, and lack of resources to help them exercise regularly. Work, family, and other obligations precluded their abilities to be physically active. A focus group participant states, “I would buy organic foods, but it is too expensive. The farmer’s markets are sometimes cheaper, but that’s when the convenience of time becomes a factor.” Another focus group member states, “I don’t have much time for exercise, I work through the evening. Basically my schedule during the week day is I get up, take my boys to school, then I come and see if the wife has any errands.”

Features of an Intervention

The pastor reported that cultural activities within his church did not currently support health as a major concern; however he was open to the idea of incorporating exercise and nutrition education programs into his church’s activities. Other key-informants and focus groups interviewees had specific suggestions about implementing a diet and exercise intervention in the church that adhered to their cultural values. They suggested that activities that promote health should be incorporated into cultural training for youth, and the traditional events and ceremonies held in the church. A focus group participant stated, “This [the church] is where we teach our kids the ‘ways of Samoa’. I like the idea about starting a church garden for the children and elders to participate in together and exercise.”

Social and peer-oriented activities should be part of an intervention and include opportunities for practice-based learning like cooking demonstrations. Finally, social pressure could be used in the intervention. Social pressure should be in the form of light competition among subgroups, women versus men etc., and not between individuals. A focus group participant states, “I think a treadmill would help me and the church be

active, and to spend time with my sisters. For me exercising, talking with my sisters and laughing is therapy for my health.”

Another focus group member said:

We could have a cooking day where we can learn how to cook our traditional comfort foods in a healthier way. Get everybody in the church involved so they can influence others to you know do the same thing and it can be like a chain.

Discussion

Qualitative research with key-informants and church members was conducted to determine the feasibility of adapting a national evidence-based physical activity and nutrition program designed for African-American churches, entitled Body and Soul, for use in Hawai‘i’s Samoan populations. Samoan populations have been described within the scientific literature as sharing similar trends in obesity, and chronic disease, perceptions of weight and body size, and affinities with churches as African Americans. This study validated information found in the literature concerning the potential of using the Samoan church in Hawai‘i as an intervention setting. The inquiry also identified challenges and supports to establishing programs to promote healthy nutrition and physical activity among Hawai‘i’s Samoans, and informants expressed readiness for improving diet and exercise patterns. Finally, Hawai‘i’s Samoan community and church members identified possible cultural and setting-appropriate activities that could be implemented in churches for this purpose.

Body and Soul incorporates a social-ecological approach to health promotion by concurrently addressing socio-cultural and behavioral factors to improve energy balance among participants. Interviews with Samoans in Hawai‘i identified a similar set of social-ecological factors as contributing towards the community’s obesogenic trends. All interview participants identified challenges such as the limited availability and the high costs of procuring healthy foods, the social cultural challenges associated with activities in the Samoan community that encourage poor nutrition, and the familial and other behavioral constraints that limit opportunities to engage in exercise and healthy eating.

There were several strengths of Hawai‘i’s Samoan community and churches that would support a community-based, socio-ecological approach to improve diet and exercise. The hierarchal and communal nature of the community and support could serve

to insure the uptake of any program among community members that has gained support of the matai or pastor. Peer support and pressure exerted among Samoan church and community members could be used to modify existing social norms concerning diet and exercise. Cultural training of youth that occurs in Hawai‘i’s Samoan churches may prove ideal for activities that support improved diet and nutrition including the re-adoption and use of traditional foods, and food preparation methods. This type of activity could also serve to address and bridge the current discord between the older and younger generations of Samoans living in Hawai‘i.

The essential elements of the Body and Soul program are suited to incorporate the strengths of the Hawai‘i’s Samoan communities and churches (Table 3.3). Church activities that can serve to fulfill the four key components of Body and Soul including, pastoral involvement, church activities to promote diet and exercise, peer support for improved diet and exercise among church members, and development of community and church policies to promote energy balance. These Body and Soul components directly address the suggestions of church members regarding an intervention. These were obtaining the support of leaders including the church pastor for healthy nutrition and exercise, training on traditional food acquisition and cooking demonstrations, peer supported exercise programs, development and enhancement of church/community gardens that would include elders and youth.

Body and Soul’s four key program components also allows the church flexibility in program implementation. Understanding the relevant cultural supports and challenges to healthy diets and improved physical activity faced by Samoans in Hawai‘i allows the program components to be tailored to directly address the church’s needs, preferences, and resources. For example, the church chosen for this interview is situated on prime agricultural land in Hawai‘i where grapefruit, coconut, and breadfruit trees abound. The church pastor can emphasis the importance of diet and physical activity as part of the spiritual health during a sermon, and challenge members to use traditional foods found on church property as part of church meals. This sole activity can serve to address all four program components while incorporating hierarchal communal norms, social connectivity and support, and traditional village modeling.

Table 3.3. Interview Themes and Concordance with Potential Intervention

Themes	Body and Soul Intervention					Comments
	Type *	Leader Modeling	Policy Change	Church Activity	Peer Support	
Samoan maintain communal and hierarchal norms	KI	X	X	X	X	Pastoral endorsement, policy changes in church functioning, church activities, and peer counseling are congruent with existing norms.
Samoan communities in Hawai'i are connected and supportive.	KI			X	X	Existing church activities and social structures can be modified to deliver intervention.
Churches model villages in Samoa for migrant Samoans	KI	X	X	X	X	Using churches for the intervention delivery has the capacity to reach church members and non-members in an appropriate manner
Samoan language is a cultural medium	KI			X	X	Intervention resources should be provided in both English and Samoan
Acculturation may be a source of intra-generational conflict	KI			X	X	Incorporating use of traditional and nontraditional dietary, physical activity training has the capacity to bridge multiple generations
Obesogenic dietary patterns are attributed to Western influence.	KI FG		X	X	X	Intervention should address traditional foods and food preparation techniques to promote both diet and physical activity
Health, physical activity, and nutrition are not primary but an important concern	KI FG	X	X	X	X	Intervention should build awareness of diet and physical activity as linking with overall health promotion, including spiritual health
Churches are the venue to reach Hawai'i's Samoans	KI FG	X	X	X	X	Using churches for the intervention delivery has the capacity to reach church members and non-members in an appropriate manner
Church members vary widely in health promotion activities	FG	X	X	X	X	Intervention pillars provides multiple opportunities to involve all congregation members in the interventions
All church members ready to support church-based nutrition and physical activity.	FG		X	X	X	Intervention can address economic, social and behavioral aspects of nutrition and exercise
Church members suggested diet and exercise activities	FG			X	X	Church member can incorporate their specific ideas and suggestion into the intervention components and activities

*Interview Type: KI = Key-informant, FG= Focus Group

There are several limitations in this research. First there was a lack of cultural concordance between the researcher and the community of interest. A second limitation is related to the recruitment of participants through quota sampling methods. This method may introduce response bias, as participants may be recruited who may have an affinity towards the research topic, or may have commonalities with each other on relevant factors related to the inquiry. The perspectives of the church population selected for the focus group interviews are not generalizable, and may not be representative of the majority of Samoan churches or church members in Hawai‘i. Also, social desirability bias may have been a factor during the focus group interviews. Focus group members may have deferred their comments to accommodate members of higher status in the community during these groups. Finally, the use of bilingual moderators who served a dual role as translators and transcribers is a limitation in that the translated copy may have been filtered by moderators to protect cultural decorum, and may not accurately reflect the true nature of the discussions among the focus group participants.

However, the rich detailed data provided by qualitative methodologies used in this study were useful to meet the exploratory purposes of this research (Clarke, 2005). During this investigation the researcher sought information from participants concerning the effect of being a community ‘outsider.’ It is believed that this research followed the Samoan community’s suggestions concerning adherence to cultural protocols while obtaining study data. The use of Grounded Theory to substantiate information from each phase of the research intended to address any limitations relative to the study’s sampling design. Finally, follow-up review sessions with interview participants and focus group moderators were used to minimize the any inaccuracy in translation and data analysis.

Conclusions

This study laid a foundation for the potential adaption of a proven faith-based health promotion program that appears to be suitable for use in Samoan churches in Hawai‘i. Future research can investigate the validity of this study’s finding with other Samoan churches in Hawai‘i, and the potential for broader dissemination to other Samoan communities globally. The methods used to determine the suitability of a cross-cultural adaption of an evidence-based program may inform processes used for other cross-cultural program adaptations. Finally, this research is intended to be precursory to

the actual implementation of a Body and Soul type program at the Samoan church in Hawai'i supporting this investigation. It is hoped that this type of program will be useful towards promoting improved health within this congregation.

EVALUATING THE MODERN SAMOAN DIET: A SECONDARY ANALYSIS OF THE SAMOAN DIET AND HEALTH STUDY'S FOOD FREQUENCY QUESTIONNAIRE DATA

Abstract

Samoans represent the 2nd largest population of Pacific Islanders in the US. Today, about 50% of (Western) Samoans and 70% of American Samoans are considered obese. The excessive prevalence of obesity persists among Samoans in the US, who experience the lowest life expectancy of the seven largest ethnic groups in Hawai'i. There have been limited assessments of Samoan diets that have contributed to obesogenic trends. This analysis intends to identify Samoan dietary patterns as a fundamental step in discerning healthy Samoan diets, dietary leverage points for use in interventions, and appropriate dietary indicators for this population.

This study employed two statistical approaches to analyze Food Frequency Questionnaire data from 1,368 Samoan participants -- 56% female, mean age 39.9 years (SD=14.5), mean BMI 32.2 kg/m² (SD=6.03) -- living in American Samoa, Hawai'i and Los Angeles. Principal Component Analysis identified dietary patterns within Samoan diets, and Reduced Rank Regression analysis examined Samoan food consumption linked to obesity.

The consumption of energy, in total or as percent from saturated fat, exceeded recommended USDA guidelines, with Samoans in the study consuming an average of 3,595 kcal/day (SD=2049) and 12% of calories from saturated fat. Four Samoan dietary patterns were identified including an omnivore, processed foods, fruit, and fish patterns. This structure implies that prudent dietary patterns may be embedded within Samoan diets, overwhelmed by the amount and range of foods now available and, thus, eaten.

The study identified dietary consumption patterns specific to Samoans that can be promoted, including fish, fruit and vegetable patterns, or discouraged, such as consumption of high fat meats, white rice, and processed traditional and Western items. This information will prove useful in the development of brief dietary assessment instruments to measure the effects of interventions with this population that should include Samoan foods, as well as some western foods recently incorporated into Samoan diets.

Introduction

Samoans represent the 2nd largest population of Pacific Islanders in the US, following Native Hawaiians (US Census, 2007). Today, about 50% of (Western) Samoans and 70% of American Samoans are considered obese (Keighley et al., 2007). The excessive prevalence of obesity persists in Samoan migrants to the US who experience the lowest life expectancy of the seven largest ethnic groups in the state of Hawai'i (Park et al., 2009). There are several standard indices used to assess eating patterns and healthy eating in many US ethnic populations, such as the NHANES Food Frequency Questionnaire, the Health Habits and History Questionnaire, and the Block Food Frequency Questionnaires (Thompson et al., 2007; Thompson & Subar, 2001; Thompson et al., 2002). However, these indices may not apply to Samoan population as they do not incorporate Samoan eating patterns. There is a need to develop and validate reliable indices that can measure diets that have contributed to recent obesogenic trends in Samoan populations. Identifying Samoan dietary patterns is a fundamental step in developing these appropriate dietary indicators, and in discerning or developing prudent or healthy Samoan dietary models. The measurement and promotion of healthy Samoan diets can be part of interventions designed to reduce obesity and chronic diseases in this population.

The adaptation of nutritional assessment instruments for use with Samoans requires the inclusion and measurement of foods that are common to Samoan diets, and are not represented in existing instruments. The mere inclusion of Samoan foods into existing dietary assessment instruments may not be a useful approach, because it would not address diet and ethnicity's complex effects on health outcomes (Schulze & Hoffmann, 2006). For example, while micro-nutrients in specific foods, such as beta carotene in carrots and vitamin D in milk, are known to be linked to health and disease (Willett, 1998), foods are eaten in combination and not as individual items, with many ethnic groups combining foods in particular patterns (Cunha, Almeida, & Pereira, 2010). The micro-nutrients in food consumption patterns tend to interact, influencing and modifying the bioavailability and absorption of the nutrients that impact health (Schulze & Hoffmann, 2006). Dietary pattern analysis is a method of inquiry that addresses the

cumulative and interactive effects of normal food consumption, and that has proven useful in identifying the relationships between diets and disease (Schulze & Hoffmann, 2006).

This study analyzed responses to a food frequency questionnaire administered to a large sample of 1439 adult Samoans in American Samoa, Hawai‘i and California. This analysis provided an overview of typical Samoan eating patterns in these three locations. This analysis intends to identify potential dietary leverage points that can be modified to reduce the prevalence of obesity in this population. Also, this dietary analysis is precursory to the development of a brief dietary assessment instrument specifically for use with Samoan populations. It is expected that this instrument will be able to reliably measure dietary changes achieved through interventions that are designed to improve nutrition in Samoans.

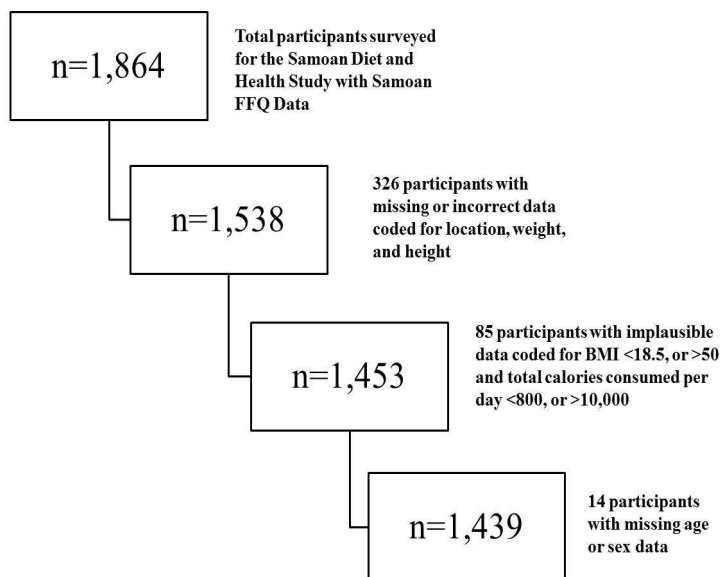
Methods

Study Sample

The current study uses data from the University of Hawai‘i Cancer Center’s (UHCC) “Samoan Diet and Health Study” of diet, cancer risks, and cancer control knowledge, attitudes, and behaviors among over 1,800 Samoans living in American Samoa, Hawai‘i, and California (Wilkins, 2010). The Samoan Diet and Health Study’s sampling frame consisted of a list of households with Samoan residents in each study location: 4,828 households in Los Angeles, 4,346 in Honolulu, and 8,898 in American Samoa. Household lists were abstracted from the Census data in American Samoa. In Hawai‘i and Los Angeles the household lists were obtained from Samoan churches and supplemented by lists from social service organizations, health care providers, and community-based organizations (Mishra, Hubbell, & Luce, 1997). A total of 1,903 households were randomly selected from these lists, and interviewers used a random selection procedure to choose one participant from among the eligible adult residents (Mishra et al., 1997). Up to three attempts were made to complete interviews with selected residents. Participation rates were high at 93.6% (n=625) in Los Angeles, 95.9% (n=620) in Oahu, and 99.8% (n=619) in American Samoa for the total of 1,864 participants.

This analysis is based on data from 1,439 participants representing 78% of the Samoan Diet and Health Study's original sample of 1,864. The remaining 425 either could not be definitely matched with non-dietary information collected at a different visit or had missing or implausible data on several variables of interest including weight and height. No significant differences were found in distributions between the original dataset (n=1,864), and the final data set (n=1,439) for age (t=.35 p=.72), BMI (t=.25 p=.80, among the n=1,611 with complete BMI data), and sex ($\chi^2=3.32$ p=.06). Details of sample losses are described in Figure 4.1. Body mass index (BMI) was calculated from participants' self-reported weight, measured in pounds, and self-reported height, measured in inches, using the formula $BMI = (\text{weight in pounds} * 703) / \text{height in inches}^2$ (CDC, 2011).

Figure 4.1. Loss of the Samoan Data Sample from Missing, or Implausible Data Obtained from the Samoan Diet and Health Study's Dataset.



Samoan FFQ Data

A food frequency questionnaire (FFQ) and corresponding food composition table (FCT) was developed for Samoans for the Samoan Diet and Health Study by UHCC Nutrition Support Shared Resource. The FFQ method is useful for obtaining information on the usual diets of large population-based samples (Thompson & Subar, 2001; Willett,

1998). As the first step in the development of the Samoan FFQ, 24-hour dietary recalls were collected by a trained dietitian from 100 Samoan households in Hawai'i and California in 1996. A list of foods consumed was created, and the minimum set of foods that contributed substantially to the consumption of major macro-and micro-nutrients was identified. The resulting 127-item Samoan FFQ was based on all foods contributing substantially to the Samoan diet, as well as any foods culturally important to Samoans.

Each item on the Samoan FFQ includes eight consumption frequency categories, ranging from “not eaten” to “two or more times a day” and three choices of portion sizes illustrated by photographs that complement the instrument. The Samoan FFQ was administered to the Samoan Diet and Health Study participants in either Samoan or English depending on their preferences. Trained bilingual interviewers who were residents in each of the study's respective communities administered the surveys. During the collection period the Samoan FFQ data were reviewed weekly for errors, including missing or implausible data.

The food composition databases maintained by the UHCC NSSR were supplemented with Samoan foods and recipes. Nutrient composition of individual foods was determined using commercial information and direct analysis. For each food item on the Samoan FFQ, the grams consumed per day were computed for each participant and converted, by applying the FCT, to 116 nutrients and food components, including energy intake (kcal/day), fat intake (grams/day), carbohydrate intake (grams/day), sodium intake (mg/day), percentage of energy from fat, protein intake (grams/day), and dietary fiber intake (grams/day).

Participant responses to the Samoan FFQ's food item selections were collapsed for this analysis into 12 food group categories using the United States Department of Agriculture (USDA) Food Patterns as a model (United States Department of Agriculture [USDA], 2010). This produced food groups consistent with existing dietary guidelines for US populations that synthesize knowledge about nutrients and foods into healthy eating recommendations (USDA, 2010). The food groups used for this analysis included: 1) vegetables, which combined all the sub-categories for dark-green, red orange, other and starchy vegetables; 2) fruits, including 100% fruit juices; 3) grains, including white rice and bread; 4) sugar, including candy, and syrup; 5) alcohol; and 6) fat, which

combined oils and solid fats; 7) dairy products (Note: the amount of dietary fat contained in dairy products was not determined in this study); 8) beans, which combined peas and legumes; 9) eggs; 10) red meat; 11) poultry and fish; and 12) coffee, tea, soda and other non-alcoholic beverages.

Consumption of each of the twelve food groups was computed by summing the daily grams consumed of each food assigned to that group. Composite foods or mixed dishes, including traditional Samoan dishes identified either by their Samoan names or were known to be commonly consumed in Samoa, that were composed of several food items were disaggregated into individual foods prior to assignment. For example palusami, a Samoan dish made of taro leaves, coconut milk, and canned corned beef contributed in appropriate proportions to the vegetable, fruit, and red meat food groups.

Select analyses considered only traditional Samoan FFQ food items, as identified by their Samoan names in the Samoan FFQ, or those foods known to be indigenous to Samoan jurisdictions. Additionally, other complementary food items such as nuts, beverages, alcohol, mayonnaise etc. were included as part of the traditional Samoan foods as these foods are normally eaten together with Samoan foods. Table 4.5 provides an abbreviated list of these foods.

Data Analysis

SAS Version 9.1 (SAS Institute Inc., Cary NC) was used for the data analysis. The purpose of the analysis was to identify dietary patterns with the Samoan diet, independent of and related to obesity. The amount of an individual's specific food group consumption is relative to the overall amount of food they consume (Willett, 1998). Also, adjustment for energy intake has been found to reduce the measurement error in dietary intakes from FFQs (Kipnis et al., 2002). For these reason, the newly created food group variables were adjusted by the density method (food group kcal/day / total kcal/day) to modulate participant's consumption of these specific food groups as a proportion of his/her total food consumption (Willett, 1998).

BMI is related to energy balance, the relationship between foods eaten (energy input) relative to the amount of physical activity performed and respiration (energy expenditures). Over time weight, and hence BMI, will decrease or increase as a result of any sustained imbalance between energy inputs and outputs (Vaughn, 2004).

Unfortunately, physical activity measures were not included as part of the original Samoan Diet and Health Study. All variables (dietary intakes and BMI) were adjusted for age and sex by the method of residuals to reduce the influence of the absence of physical activity measures. Adults' physical activity levels have been found to be correlated with age and sex, with older adults and females being generally less active than younger adults (CDC, 2010). Outliers for BMI and energy in kcal/day included BMIs less than 18.50 kg/m², or greater than 50.00 kg/m², and people who ate less than 800 kcal/day, or over 10,000 kcal/day, respectively. These 85 records were eliminated from the dataset (CDC, 2011b).

Principal Component Analysis: Principal component analysis (PCA) describes a larger set of observed variables by using a smaller set of hypothetical variables called components (Raykov & Marcoulides, 2008). PCA aims to explain as much variation as possible in the observed variables with this reduced set of uncorrelated components. These components serve to represent the structural relationships between the original variables. The components are inferred from correlations among the original variables and identified by use of characteristic equations that produce the unique optimal linear functions that characterize the correlation matrix of observed variables (Hatcher, 2006). The first component is the standardized linear function of the observed variables that accounts for as much of the variability in the data as possible. Each succeeding component explains the remaining variability in the data, while being uncorrelated any of the previously identified components (Raykov & Marcoulides, 2008). To determine the suitability of the data for component analysis the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA) was evaluated for all analyses. The MSA is an index (between 0 and 1) of the proportion of variance among the variables that might be common variance indicative of underlying or latent common factors. An MSA index \leq 0.50 indicates the correlation matrix is not suitable for factor / component analysis (Raykov & Marcoulides, 2008).

The Factor Procedure in SAS was used for component extraction from the data set relative to the 12 sex and age adjusted food group variables. These variables were found to reasonably meet the criteria for inclusion in PCA. This procedure identified components that accounted for the maximum variance of foods eaten within food groups

as reported in the Samoan FFQ. The resulting components can be interpreted as food group consumption patterns (Cunha et al., 2010). The analysis estimates eigenvalues or the standardized variance associated with a particular extracted component, and these eigenvalues are used to determine the proportion of total variance in the original data set explained by the extracted component. Components with eigenvalues greater than 1 were extracted, as suggested by the Kaiser-Guttman Rule (Raiche, Riopel, & Blais, 2006). The use of eigenvalues greater than one for this analysis provided a more inclusive component identification scheme to assess Samoan dietary patterns.

Extracted components from all analyses were orthogonally rotated using Kaiser's varimax criterion (varimax) procedure in order to improve the interpretability of the resulting data (Raykov & Marcoulides, 2008). The varimax procedure is a transformation of the component loadings that polarizes the loadings to be either high or low while maintaining the uncorrelated relationship between the components. The procedure allows for more identifiable associations between foods groups with a particular component. The procedure generated component loadings for each of the 12 defined food group variables. These loadings indicate the correlations between the newly identified components and the food group; negative loadings indicating an inverse relationship. The magnitude of loading values indicates a greater contribution of a particular food group towards a component. Factor loadings of .40 or greater were used as indicators of important foods group for that extracted component, and were used to help interpret the dietary patterns that best characterized the component (Raykov & Marcoulides, 2008).

Reduced Rank Regression Analysis: The SAS PLS procedure was used to implement the Reduced Rank Regression (RRR; also called maximum redundancy) analysis for this study. RRR is a multivariate statistical method that like PCA, that identifies linear combinations of hypothetical variables that best explain the variance of observed variables (Reinsel & Velu 1998; Hoffmann, Schulze, Schienkiewitz, Nothlings, & Boeing, 2004). Unlike PCA however, both predictor and response variable are used in RRR analyses, to identify components that describe the maximum variation in the observed response variables. The technique integrates use of observed data with current knowledge concerning the relationships between foods, nutrients, and diseases. In RRR the extracted linear functions of the response variables quantify the variance explained by

the corresponding linear functions of predictor or independent variables (Hoffmann et al., 2004). The hypothesized associations between a set of response variables and predictor variables can be assessed. RRR projects a linear function of responses or response scores onto the space of predictors to produce the linear functions of predictors or factor scores. In our analysis, the single response variable of BMI was used to identify food group predictors, therefore a single dietary pattern of foods groups was identified by RRR. In this study BMI was used as the response or dependent variable and the food groups were used as predictor or independent variables.

To provide a complete picture of Samoan dietary patterns, several PCA and RRR analyses were conducted including; 1) a PCA and RRR analysis of all participants, 2) a PCA and RRR analysis of participants by each location; 3) a PCA and RRR analysis using only traditional Samoan food items.

Contribution of foods to diet: The contribution of each food item to nutrients was computed for Samoans by location. It was calculated as the amount of that nutrient from the food item (summed over all individuals) divided by the total amount of that nutrient consumed by the population.

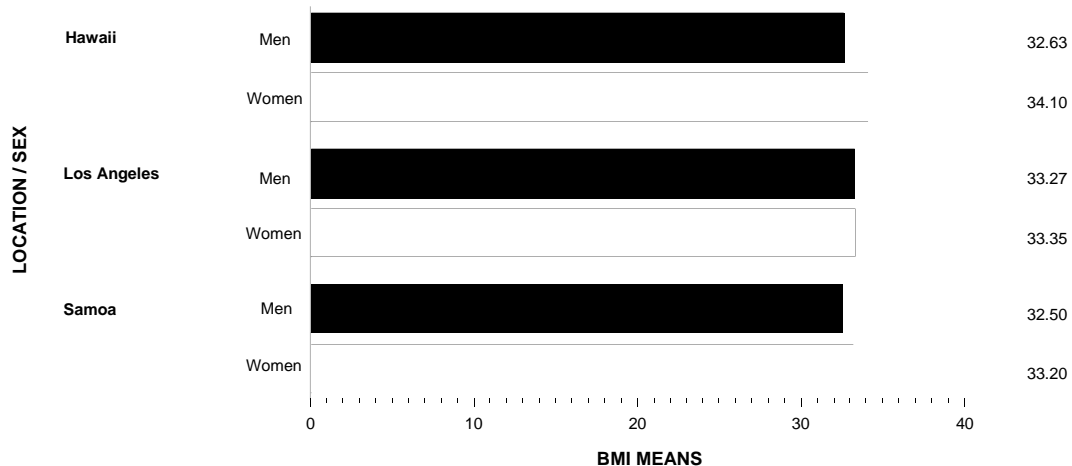
Results

The final sample for analysis consisted of 1,439 participants. Table 4.1 summarizes participants' demographics. The mean BMI of participants was 32.20 kg/m² (SD=6.03kg/m²). Participants were equally distributed by age and sex across sites, these distributions were tested using the using a chi square test for age ($\chi^2=6.25$, $p=.18$), =and sex ($\chi^2=2.43$, $p=.29$) (Table 4.1). Also, the mean BMIs in the three study locations were not found to be significantly different using an ANOVA model ($F=1.08$, $p=.32$) (Figure 4.2). The data were appropriate for factorability / component extraction with the $MSA=.75$.

Table 4.1. Sex and Age Distribution by Location of Participants

	Hawai'i	Los Angeles	Samoa	Total
Sex				
Females	280 (57%)	279 (54%)	253 (58%)	812 (56%)
Males	207 (43%)	240 (46%)	180 (42%)	627 (44%)
Totals	487 (100%)	519 (100%)	433 (100%)	1,439 (100%)
Age Group				
18-34	199 (41%)	194 (37%)	187 (43%)	580 (40%)
35-44	133 (27%)	132 (25%)	115 (27%)	380 (26%)
Over45	155 (32%)	193 (38%)	131 (30%)	479 (33%)
Totals	487 (100%)	519 (100%)	433 (100%)	1,439 (100%)

Figure 4.2. Participant Mean BMI by Sex and Location



The components or dietary patterns identified through the PCA are described in Table 4.2. The PCA indicated that four components should be retained. These components were: 1) an omnivore component (characterized by significant component loadings by the beans, eggs, dairy, red meat, fat, and alcohol groups); 2) a processed food component (characterized by significant component loadings by grains, sugar, and fat groups); 3) a fruit component (characterized by significant component loading by the fruit group); and 4) a fish component. Overall these four components explained 58% of the variance in participants' food consumption by the assigned food group variables. The specific percentage of variance for each of the assigned food groups explained by the combined components, was 9% vegetables, 55% fruit, 60% grain, 39% bean, 70% egg,

87% fish and chicken, 55% red meat, 74% dairy, 80% sugar, 60% fats, 45% alcohol, and 48% beverages.

Table 4.2. Food Group Loadings on Rotated PCA Component Patterns

Food group	Dietary Pattern			
	Omnivore	Processed	Fruit	Fish
Vegetable	-.03	.01	.13	-.28
Fruit	.07	.15	.72	-.11
Grain	.16	.75	.14	-.06
Beans	.58	.14	.01	-.19
Eggs	.73	.40	.02	.12
Fish/Poultry	-.08	-.01	.10	.92
Red Meat	.68	-.26	.11	-.08
Dairy	.85	.09	-.05	.09
Sugar	-.05	.89	.04	-.07
Fats	.52	.56	-.05	.12
Alcohol	.44	.38	.31	.16
Beverages	.01	.01	-.70	.02
Eigenvalue	3.23	1.50	1.09	1.03
%Explained Variance	27%	13%	9%	9%
% Cumulative Variance	27%	40%	49%	58%

Note: Bolded values indicate factor loadings of .40 or higher

To better understand any differences in the dietary patterns of participants relative to their location, the PCA was repeated by study location. The following numbers of participants were used in the location-specific analysis: 431 participants from American Samoa, 486 participants from Hawai‘i, and 518 participants in Los Angeles. Participant data from each location was adequate for factorability / component analysis with MSAs for American Samoa, Hawai‘i, and Los Angeles of .87, .50, .53, respectively. The analysis revealed a distinct set of components or dietary patterns for each location as shown in Table 4.3.

Table 4.3. Food Group Loadings on Rotated PCA Component Patterns by Location

Food group	American Samoa			Hawai'i					Los Angeles					
	Omni	Bev	Fish	Proc	Fat	Bean	Egg/ Bev	Fruit/ Alcohol	Proc	Egg	Bean	Fruit	Bev	Veg
Vegetable	-.05	-.16	-.68	.04	.01	-.09	-.56	-.20	.02	-.01	.08	.08	.02	.91
Fruit	.53	-.58	-.04	.31	-.34	-.10	-.05	.65	.08	.03	-.07	.82	.00	.06
Grain	.76	-.03	-.13	.85	-.08	-.12	.05	-.03	.80	-.04	-.14	.26	.01	-.04
Beans	.84	-.04	.08	-.10	.10	.88	-.06	-.03	-.17	-.20	.89	-.08	-.01	.06
Eggs	.89	-.12	.00	.11	.20	-.12	.60	-.08	.06	.68	-.18	-.13	-.01	.06
Fish/Poultry	-.08	-.14	.75	-.12	.38	-.46	.06	.09	.07	.09	-.25	-.21	-.67	.28
Red Meat	.67	-.12	.01	-.09	-.65	-.18	-.24	-.01	-.41	-.50	-.35	.24	-.14	-.02
Dairy	.90	-.03	.03	-.51	-.08	-.44	.05	-.31	-.50	-.01	-.38	-.37	.07	-.11
Sugar	.63	-.07	.07	.78	.37	.10	-.03	.02	.88	.12	.01	.03	-.02	-.06
Fats	.85	-.03	-.01	.15	.65	-.15	-.25	.03	.59	.09	-.15	-.27	-.15	.16
Alcohol	.86	-.20	.07	-.12	.26	.01	.03	.80	-.01	.77	-.06	.29	-.11	.03
Beverages	.05	.84	-.01	-.01	-.13	-.10	.66	-.12	-.05	.00	-.22	-.19	.76	.26
Eigenvalue	5.40	1.07	1.06	2.01	1.40	1.25	1.14	1.13	2.47	1.42	1.15	1.06	1.03	1.01
%Explained Variance	45%	9%	9%	16%	11%	10%	9%	9%	20%	11%	9%	8%	8%	8%
%Cumulative Variance	45%	54%	63%	16%	28%	38%	48%	58%	20%	32%	42%	51%	59%	68%

Note: abbreviations are defined as Omni= omnivore; Bev=beverages; Proc= processed foods; Veg=vegetables. Bolded values indicate factor loading of .40 or higher.

The American Samoa PCA indicated that three dietary components should be retained. These components were: 1) an omnivore component (characterized by significant component loadings by grain, beans, egg, dairy, red meat, dairy, sugar, fat, and alcohol groups); 2) a beverages component (characterized by significant component loadings by coffee, tea, and other non-alcoholic beverages); 3) a fish component. Overall these three components explained 63% of the variance in American Samoan participants' food consumption by the assigned food group variables. The specific percentage of variance for each of the assigned food groups explained by the components was 49% vegetables, 46% fruit, 60% grain, 71% bean, 81% egg, 59% fish and chicken, 46% red meat, 80% dairy, 41% sugar, 72% fat, 78% alcohol, and 71% beverages.

The Hawai'i PCA indicated that five dietary components should be retained. These components were: 1) a processed foods component (characterized by significant component loadings by grain and sugar groups); 2) a fat component; 3) a bean component; 4) an egg/beverage component (characterized by significant component loadings by egg and beverage groups); 5) a fruit/alcohol component (characterized by significant component loadings by fruit and alcohol). Overall these five components explained 58% of the variance in Hawai'i participants' food consumption by the assigned food group variables. The specific percentage of variance for each of the assigned food groups explained by the components, was 37% vegetables, 65% fruit, 74% grain, 79% bean, 44% egg, 38% fish and chicken, 52% red meat, 56% dairy, 75% sugar, 53% fat, 72% alcohol, and 48% beverages.

The Los Angeles PCA indicated that six dietary components should be retained. These components were: 1) a processed foods component (characterized by significant component loadings by grain, fat, and sugar groups); 2) an egg and alcohol component (characterized by significant component loadings by egg, and alcohol groups); 3) a bean component; 4) a fruit component; 5) a beverage component; and 6) a vegetable component (characterized by significant component loadings by vegetable group). Overall these six components explained 68% of the variance in Los Angeles participants' food consumption by the assigned food group variables. The specific percentage of variance for each of the assigned food groups explained by the components, was 85%

vegetables, 70% fruit, 74% grain, 86% bean, 50% egg, 64% fish and chicken, 62% red meat, 54% dairy, 80% sugar, 50% fat, 69% alcohol, and 73% beverages.

The RRR component accounted for nearly 7.6 % of the variance in BMI among participants, and 14% of the overall variance of predictors as correlated with BMI. The component concurrently identified high proportions of the specific variances in the beans, egg, dairy, red meat, alcohol, and fat food group predictors. These variances in predictors identified by this component included 40% of the dairy group, 32% of the egg group, 20% of the bean group, 20% of the meat group, 10% of the fats group, 11% of the alcohol group, 2% of the grain group, .4% of the fish group, .2% of the sugar group, .1% of the beverages group, and 0% of the vegetables group.

RRR analyses were also conducted for each location. The model for American Samoa explained the highest amount of variance in participants' BMI at 19.22%. This RRR component concurrently identified 20% of the overall variance in food group predictors of participants in American Samoa. The RRR's ability to identify predictor variance relative to response variance was lower in the model of the Hawai'i and Los Angeles locations. In the Hawai'i analysis, the RRR explained 6.27% of the variance in BMI concurrent with 9.28% of variance in food group predictors. In the Los Angeles analysis, the RRR explained 6.46% of the variance in BMI concurrent with 5.24% of variance in food group predictors.

Table 4.4 shows the Spearman Rho correlations of the study's food group variables with the components identified by each modeling method, PCA or RRR, with BMI for all locations. Typically, PCA does not address a response variable and is conducted to determine the structural aspects of data, or for data reduction. The correlation of the identified PCA components with participants' BMI measures provided an ad hoc comparability of these components with that of the RRR analysis. The table illustrates the ability of either the PCA or the RRR analysis to effectively explain the participant variances in BMI. The Rho with BMI was higher at 0.25 with the RRR component than with any of the PCA components, although the Rho with the first principal components was positive and substantial at 0.19.

Table 4.4. Spearman Correlations between Food Groups and PCA Components and RRR Predictor Scores with BMI

Food group	Component Extraction Method				
	Principal Component Analysis				Reduced Rank Regression
	Omnivore	Processed	Fruit	Fish	Predictor Score
Vegetable	-.02	.01	.13 ⁺	-.28 ⁺	-.11 ⁺
Fruit	.07 ⁺	.14 ⁺	.71 ⁺	-.11 ⁺	-.30 ⁺
Grain	.16 ⁺	.74 ⁺	.13 ⁺	-.06	-.07
Beans	.58 ⁺	.13 ⁺	.00	-.19 ⁺	-.44 ⁺
Eggs	.72 ⁺	.39 ⁺	.17	.12 ⁺	.01
Fish/Poultry	-.08 ⁺	-.01	.10 ⁺	.92 ⁺	.14 ⁺
Red Meat	.68 ⁺	-.25 ⁺	.11 ⁺	-.08 ⁺	-.02
Dairy	.85 ⁺	.08 ⁺	-.04	.09 ⁺	.31 ⁺
Sugar	-.05	.89 ⁺	.04	-.07 ⁺	.20 ⁺
Fats	.52 ⁺	.55 ⁺	-.05	.11 ⁺	.31 ⁺
Alcohol	.43 ⁺	.37 ⁺	.30 ⁺	.15 ⁺	.01
Beverages	.01	.01	-.69 ⁺	.02	.02
BMI	.19⁺	.01	-.02	.00	.25⁺

⁺Significant Correlations (p<.01)

A final PCA and RRR analysis was conducted using the 12 food groups using only traditional Samoan food items found in the Samoan FFQ data set. This analysis was conducted to determine the dietary structure by food groups, and the relative effect of traditional Samoan foods on BMI. The examination of traditional Samoan foods completes an overview of Samoan dietary patterns and propensities within the framework of the USDA Food Patterns, consistent with dietary guidelines for US populations. Table 4.5 provides an abbreviated list of these foods that were categorized using the previous 12 food group categories.

Table 4.5. Traditional Samoan Food Group Items Used in PCA

Food Groups	Select Samoan Traditional Food Items
1. Red Meat	pisupo (corned beef), mamoe (mutton flaps), Samoan sausage
2. Fish and Poultry	turkey tails, wahoo (tuna), chicken
3. Eggs	fuamoa (eggs any style)
4. Dairy	milk, cheese, yogurt
5. Beans	green beans, peanuts, peanut butter,
6. Fruits	bananas fa'i (green banana), pineapples, mangos , ulu (breadfruit), papaya, banana
7. Vegetables	talo (taro), umala (yams), lau pele (leafy greens), cabbage
8. Grains	rice, koko arisa (cocoa rice), panikeke (pancakes), sao (biscuits), vaisalo (tapioca)
9. Sugar	jam, honey
10. Fats	mayonnaise,
11. Alcohol	beer, liquor
12. Coffee and other Beverages	coffee, tea, soda

The data used for the traditional food PCA and RRR analysis was again appropriate for factorability, component extraction, the MSA=.83. Unlike previous analyses only two dietary patterns were indicated by PCA. These were: 1) an omnivore component (characterized by significant component loadings on 9 of the 12 foods including vegetables, grain, egg, dairy, red meat, fish, dairy, sugar, and fat groups); and 2) an added foods component (characterized by significant component loadings by non-alcoholic and alcohol beverages, and the bean food groups); Overall these two components explained 59% of the variance in participants' traditional food consumption. The specific percentage of variance for the food groups were 24% vegetables, 50% fruit, 78% grain, 45% bean, 61% egg, 49% fish and chicken, 70% red meat, 73% dairy, 84% sugar, 86% fat, 47% alcohol, and 38% beverages. Table 4.6 displays the results of the traditional foods PCA analysis.

Table 4.6. Traditional Samoan Foods Loadings on Rotated PCA Component Patterns

Food group	Dietary Pattern	
	Omnivore	Added Foods
Vegetable	.44	.23
Fruit	.66	-.25
Grain	.87	.31
Beans	.37	.56
Eggs	.71	.33
Fish/Poultry	.70	-.2
Red Meat	.83	.10
Dairy	.84	.18
Sugar	.88	.26
Fats	.89	.27
Alcohol	.31	.62
Beverages	.18	-.60
Eigenvalue	6.05	1.10
% Explained Variance	50%	9%
% Cumulative Variance	50%	59%

Note: Bolded values indicate factor loadings of .40 or higher for PCA.

The ability of the RRR to identify participants' BMI variance, relative to food group variance, using only traditional foods slightly improved the ability to explain the variance in BMI among participants to 8%, and the overall predictor variance to 24%. This indicates that traditional foods alone can serve as indicators of the obesogenic components of the Samoan diet. This component concurrently identified high proportions of variances in the fish (38%), fruit (15%), grain (28%), beans (18%), egg (30%), dairy (40%), red meat (34%), alcohol (10%), and fat (25%) food group predictors. Table 4.7 shows the Spearman correlations of the traditional Samoan food PCA and RRR analysis with BMI.

Table 4.7. Spearman Correlations between Traditional Samoan Food Groups, PCA Components and RRR Predictor Scores with BMI

Food group	Component Extraction Method		
	Principal Component Analysis		Reduced Rank Regression
	Omnivore	Added Foods	Predictor Score
Vegetable	.00	.13 ⁺	-.04
Fruit	-.13 ⁺	.10 ⁺	.06
Grain	.05	-.12 ⁺	-.07 ⁺
Beans	.17 ⁺	-.06	.07 ⁺
Eggs	.08 ⁺	.17 ⁺	-.06
Fish/Poultry	.49 ⁺	-.44 ⁺	.35 ⁺
Red Meat	.35 ⁺	-.34 ⁺	.16 ⁺
Dairy	.49 ⁺	-.48 ⁺	.18 ⁺
Sugar	.00	-.01	-.15 ⁺
Fats	-.01	-.01	-.13 ⁺
Alcohol	-.08 ⁺	.33 ⁺	-.09 ⁺
Beverages	.09 ⁺	-.17 ⁺	.05
BMI	.06	-.10⁺	.16⁺

⁺Significant Correlations (p<.01)

Finally, participants' consumption of food items were ranked according to contribution made to total daily calories consumed, and to total saturated fat eaten per day. Overall the mean calories consumed were 3,614 kcal/day (SD=2,049 kcal/day) for all participants, 3,758 kcal/day (SD=1,829 kcal/day) for men and 3,470 kcal/day (SD=2,294 kcal/day) for women. These amounts exceed by more than 1,000 kcal/day the USDA recommendations which are 2,000 - 2,600 kcal/day for moderately active adults ages 18 to 50 (USDA, 2010). The mean amount of saturated fat consumed per day by participants was 51 g/day (SD=34g/day) with saturated fats representing 12% of daily calories consumed (SD=3%). The USDA recommends reducing the percentage of saturated fats in diets to between 7% and 10% of daily calories consumed (USDA, 2010).

Ranking these specific high fat and high calorie foods within Samoan diets would identify foods items amenable for inclusion in a modified Samoan dietary screener. A list of the top 20 foods contributing to daily calories consumed and top 20 foods high in saturated fats eaten by participants in the study by location were created and are reported

in Table 4.8. The prominence of Samoan foods made with coconut milk is notable, including green banana and fish dishes. Also, the contribution of mutton meat and rice to the amount of overall daily calories eaten by participants in all locations is apparent.

Table 4.8. Rank of Foods Eaten by Total Daily Calories and Saturated Fat by Site

American Samoa		Hawai'i		Los Angeles	
Daily calories	Saturated Fat	Daily calories	Saturated Fat	Daily calories	Saturated Fat
1. mamoe (mutton)	green banana w/ coconut milk	1. mamoe (mutton)	fish with coconut milk	1. mamoe (mutton)	green banana w/ coconut milk
2. rice	fish with coconut milk	2. rice	green banana w/ coconut milk	2. green banana w/ coconut milk	ice cream
3. green banana w/ coconut milk	butter	3. fish w/coconut milk	short ribs	3. rice	milk
4. bread	pisupo	4. green banana w/ coconut milk	milk	4. beer	butter
5. huli chicken	ota raw fish w coconut milk	5. fried chicken	butter	5. panikeke	fish with coconut milk
6. choc milk	milk	6. bread	fried chicken	6. soda	short ribs
7. soda	ulu with coconut milk	7. soda	koko araisa	7. chicken sandwich	beef stew
8. saimin	fried chicken	8. choc milk	ota raw fish w coconut milk	8. fried chicken	ulu w coconut milk
9. cakes	spam	9. tuna	fried eggs	9. light beer	fried chicken
10. tuna	ice cream	10. koko araisa	vaisalo	10. saimin	chips
11. fish w/coconut milk	chocolate	11. mackerel	chocolate	11. turkey tail soup	koko araisa
12. green banana	koko araisa	12. turkey tail soup	pisupo	12. ice cream	Vienna sausage
13. mackerel	beef stew	13. potato salad	cereal and milk	13. bread	kopai
14. panikeke	chocolate milk	14. saimin	American cheese	14. koko araisa	chicken sandwich
15. koko araisa	vienna sausage	15. short ribs	beef stew	15. green banana	pisupo
16. turkey tail soup	fried eggs	16. fried eggs	roast pig	16. beef stew	spam
17. pisupo	chips	17. milk	chips	17. cake	turkey tail soup
18. potato salad	vaisalo	18. green banana	banana and coconut milk	18. kopai	sweet roll
19. egg salad	tuna	19. banana	ulu and coconut milk	19. chips	hot dogs
20. chicken sandwich	egg salad	20. chicken sandwich	mackerel	20. milk	fried eggs

Discussion

The purpose of this study was to explore Samoan dietary patterns to identify potential leverage points within these diets that can be modified to reduce obesogenic trends. Additionally, this analysis is precursory to the development of brief dietary assessment instruments, similar to those used with other population-based nutrition interventions, which can distinguish changes in diets among Samoans in the US. These instruments are intended to be used in conjunction with interventions designed to improve the health of Samoans.

Overall four primary dietary patterns emerged among all participants. Notable is the composition and order of these components. The omnivore pattern was first, followed

by processed foods, and ending with the fruit and fish patterns. This structure implies that prudent or healthy dietary patterns that are composed primarily of fruit and fish consumption may be a part of typical Samoan diets, regardless of location. Also, this structure indicates that these prudent dietary patterns are obscured by an omnivore pattern, depicting participants' consumption of a wide array of other regularly eaten foods, or by the high consumption of processed foods.

Although the PCA provided valuable information on this general structure of Samoan diets, this method does not explain variances in participants' BMI. The RRR analysis improved the ability of this study to link Samoan dietary patterns to BMI. Only the omnivore component of the four PCA patterns was significantly correlated with BMI, while the RRR component provided a more robust correlation between BMI and food group consumption. The factor scores represented by the RRR analysis of all participants provided the most inclusive assessment of BMI variances relative to food group consumption variances. The RRR found correlations in the expected direction between specific food group variances and BMI variances, including inverse BMI correlations with vegetables, fruit, grain, and bean groups, and positive BMI correlations with dairy, sugar, and fat groups.

The directions of these correlations are congruent with USDA dietary guidelines. Increased consumption of fruit, vegetables, whole grain, and beans are promoted in lieu of meat and dairy, and foods high in sugar and fat. An exception to this expected congruence was the directionality of the fish /poultry group, positively associated with the RRR predictor score and BMI. This effect may be explained by the analysis of fat and calories in Samoan food items. It was found that these fish and poultry food items are commonly consumed with coconut milk or prepared by frying. Overall, the RRR predictor scores may prove helpful in the weighting of the food groups to be used in brief screener instruments for Samoans.

The moderate correlations identified in this study between diet and BMI are common in dietary studies (Lissner et al., 2007). Systematic and non-systematic measurement error in food consumption reporting attenuates correlations between diets and anthropometric measures. Several studies describe the effects of differential and non-differential underreporting by participants of total energy consumed according to

their BMI or adiposity status, with those with low BMI over reporting, and those with high BMIs underreporting intake (Bellach & Kohlmeier, 1998; Lissner et al., 2007). Patterns of reporting errors may also be linked to the dietary assessment methods, including FFQs where over reporting of total calories consumed are common source of error. Generally, FFQs are meant to address only a portion of participants' total diets based upon the specific foods contained within the instrument (Bellach & Kohlmeier, 1998; Thompson & Subar, 2001). Studies that have used objective anthropometric and nutrient measures have identified comparable correlation coefficients ranging from $r=.12$ to $r=.25$ (Hasselbalch, Heitmann, Kyvik, & Sorensen, 2010; Keen, Thomas, Jarrett, & Fuller, 1979). We expect that the inclusion of physical activity measures as a part of any nutritional instrument would improve the potential to predict changes in participants' BMI and adiposity from an intervention.

The analysis of participants by location provided evidence that dietary patterns among Samoans are reflective of their location. The number of relevant dietary patterns found increased from three in Samoa, to five in Hawai'i and six in Los Angeles. This increase in components or dietary patterns is indicative of the participants' increasing dietary diversity, marked by consumption of an increasingly broader spectrum of foods as participants are found farther from American Samoa. Most notable is the transposition of the primary omnivore pattern found in American Samoa with the processed food patterns found to become predominant among participants in Hawai'i and Los Angeles. Also, beverages in American Samoa are replaced by consumption of high fat foods in Hawai'i as a secondary dietary pattern. Finally, Samoans in Hawai'i and Los Angeles differ from their counterparts in American Samoa in fish consumption. The fish consumption pattern found in American Samoa is no longer apparent in Hawai'i's and Los Angeles' Samoans and may be related to increased cost and reduced availability.

The analysis of increasingly westernized participants in locations east of American Samoa, found that fruit and vegetable consumption patterns were identified in diets of Samoans in these locations. However, this trend is overwhelmed by the prominence of processed foods, denoted by high intakes of the grain, sugar, and fats. The consumption of eggs and bean products also accounted for high proportions of the dietary variance in among Samoans living in Hawai'i and Los Angeles. In both locations, either

the fruit, or the vegetable consumption patterns ranked last among diet types. However, the sole fruit dietary pattern ranked higher in Los Angeles' participants than the component comprised of fruit and alcohol among their counterparts Hawai'i.

The traditional Samoan food analysis provided important information on the basic consumption of Samoan foods. Limiting the analysis to these specific foods served to illustrate the consistency of consumption of these foods by Samoans across locations. This also revealed the lowest number of dietary patterns, two, of any analysis. These two components delineated a specific Samoan food omnivore pattern, and an additional foods pattern particularly comprised of beverages; which included coffee, tea, soda, and other non-alcoholic beverages. There were no other relevant dietary patterns found. This is an important structural feature of Samoan diets, useful towards considering dietary changes appropriate for this population. It emphasizes a distinct propensity among Samoans to eat culturally relevant foods. Using solely traditional foods to conduct an RRR analysis did not reduce the ability to account for BMI variation.

Finally, ranking the overall food items eaten by participants by location identified specific foods that are predominant in Samoan diets and comprise the highest magnitudes of energy and saturated fat eaten per day. These items should be prominent in dietary screeners used to assess fat and energy consumption characteristics for Samoans. Across all localities, mutton flaps or mamoe was consistently identified as a primary source of calories per day in the Samoan diets, along with white rice, fish, and green banana with coconut milk. These food items can be considered key foods within the Samoan FFQ dataset, with items that contain coconut milk contributing to the highest amounts of daily saturated fats eaten per day. Previous research has employed the use of brief dietary assessment instruments including dietary energy, fat, and fruit and vegetable screeners that can be self-administered with guidance, in lieu of full FFQs to reduce the associated costs, and burden on respondents (Campbell et al., 1999). Abbreviated dietary assessment instruments are found to be nearly as reliable and valid as full length FFQs in assessing study participants' overall food consumption (Campbell et al., 1999; Thompson et al., 2000).

In Samoan populations outside of American Samoa the increasing role of western foods can also be observed. Western foods are being incorporated into the typical

Samoan diets including high fat items such as ice cream, short ribs, and beer. Most notable in the ranking assessment is the identification of food items that would normally be considered healthy when eaten alone such as green banana, fish, and breadfruit; these are transformed into high fat foods through the addition of coconut milk. The coconut milk added to these items may have been obtained from prepared canned coconut milk products that contain as much 50-70% saturated fat (USDA, 2010). This is distinct from the traditional methods used to prepare coconut milk, which involves a labor intensive process (climbing trees, husking and opening the nut, grating the coconut meat, and squeezing the grated meat, pulp and fluids to extract the milk), which requires high levels of energy expenditure. This may be an important dietary behavioral distinction to identify in the future, that could lend towards promoting use of traditional food preparation methods as an appropriate dietary leverage point for interventions.

Use of coconut milk is common to many jurisdictions throughout Asia including the Philippines and Thailand. In the Pacific Basin coconut products are also favored but notably, are used in larger quantities than in Asia (WHO, 2003). The historic consumption of coconut products, naturally high in saturated fats, has recently been combined with the increases in the consumption of imported animal fats among individuals living in the Pacific including Hawai'i, French Polynesia, and Papua New Guinea. The trends toward the increased consumption of dietary saturated fats from coconut milk along with saturated fat from animal products also follow decreasing trends in physical activity in these populations (WHO, 2003). This is a feature of Western dietary transitions in these countries, resulting in increases in obesity and obesity-related diseases.

The Western dietary transitions that are evident among Samoans and across the Pacific are also common in developing nations and ethnic populations worldwide, including those in the China, Chile, Cuba, India, Iran, Mexico, South Korea, Tanzania, Tunisia, and Inuit populations (Bersamin, Zidenberg-Cherr, Stern, & Luick, 2007; Ezeamama et al., 2006; Uusitalo, Pietinen, & Puska, 2002). Dietary transitions are the result of socio-ecological shifts in developing societies from agrarian to industrial economies, and the resulting increases in capital-intensive urban areas within these societies (Ezeamama et al., 2006; Uusitalo et al., 2002). According to the WHO, Western

dietary transitions are apparent through the increased availability and use of vegetable fats, salt, sugars, and refined carbohydrate foods. Traditional staple foods in many cultures are increasing in costs, while the costs of processed foods are decreasing. Starchy root vegetables or other cultural food staples are being replaced by globally-available and highly promoted foods including refined rice and wheat products (Uusitalo et al., 2002).

Understanding the nature of Samoans food consumption patterns can help determine culturally appropriate dietary modifications designed to create healthy diets for this group. The study identified Samoan consumption patterns ranging from the monotonic traditional pattern to the multi-faceted patterns found in Los Angeles; however modification of the four component pattern identified from overall analysis may have the broadest applicability.

An ideal strategy would be to focus efforts on lowering the overall daily calories and percentage of saturated fat consumed by participants. This could be accomplished by working to transpose the dietary prominence of processed foods, including refined rice and wheat products, by encouraging consumption of whole grain rice and other whole grain products and increasing consumptions of fruit and fish products. This is a common dietary improvement method used for many US populations, and is a component of the faith-based intervention expected to be implemented with Samoans in Hawai'i (Resnicow et al., 2004; USDA, 2010). However it is equally important to have knowledge of how fruit and fish products are prepared and consumed within Samoan culture. For example, when promoting increased fruit and fish consumption with Samoans, participants would need to know that adding coconut milk greatly increases the calories and fat in the meal.

An alternate strategy could be to encourage use of traditional and traditionally prepared foods including the preparation of coconut milk and taro using processes that require energy expenditure commensurate with the added calories and fat provided by these items. Other food preparation changes could include training on culinary techniques that would reduce the amount of fat in foods, for example trimming, or draining fat after cooking mamoe or mutton flap meat (24% mean fat content) or substituting this cut with leaner cuts of lamb meat (USDA, 2010; Wyber, Wilson, & Baker, 2009).

Encouraging the re-adoption of modified traditional diets has been shown to be an effective strategy in counteracting the unhealthy nutrition patterns linked with the globalization of Western dietary patterns. Voster (2002) suggests that there is a stage in the dietary transition from traditional diets, which can frequently be nutritionally inadequate, to westernized diets as they become more diverse and include consumption of optimal levels of whole grain, vegetable, beans, and moderate amounts of animal fats (Vorster, 2002). Such a strategy would combine healthy features of traditional Samoan diets with the adoption of the healthy components of Western diets. South Korea began such a campaign in the 1980, promoting the traditional Korean diet, which is low fat and high in vegetable consumption, and promoting the traditional Korean preparation of Western meat products (wrapped in vegetables or in soups containing numerous vegetables), while admonishing complete adoption of Western eating habits (Uusitalo et al., 2002).

Recently studies of dietary diversity in both developed and developing countries have found direct correlations between diets that include a range of foods and improved health outcomes (Ruel, 2003). These findings are attributed to the fact that diverse diets have an increased likelihood of containing the recommended levels of nutrients that support improved health (Drewnowski, Henderson, Driscoll, & Rolls, 1997). It was noted among several of these studies that diversity as measured by food group variety was better able to assess the benefits of dietary diversity, as opposed to food item variety (Drewnowski et al., 1997; Kant, Schatzkin, Harris, Ziegler, & Block, 1993). Newer dietary diversity indices, such as the Healthy Food Diversity Index, are being developed that are directly correlated to dietary recommendations that can distinguish the increased promotion of the specific shares of diverse foods in grouping such as plant foods found to contain high levels of required nutrients, while minimizing those with health risk due to excess consumption such as fat and cholesterol (Drescher, Thiele, & Mensink, 2007).

Measuring the effects of any dietary intervention with Samoans requires the development of assessment instruments. The use of food records, 24 hour dietary recalls, food frequency questionnaires, and diet histories are options; however these methods are costly when used in conjunction with interventions (Thompson & Subar, 2001). Additionally, these dietary assessment methods are burdensome for respondents and may

affect intervention compliance and retention (Thompson & Subar, 2001). Brief dietary assessment instruments such as vegetable, fruit, and dietary fat screeners are a reliable and valid alternative approach (Resnicow et al., 2000; Thompson et al., 2000; Thompson et al., 2007; Thompson & Subar, 2001). This method has been effectively used in several culturally appropriate dietary interventions, and has the additional benefit of activating participant interest concerning the intervention (Thompson et al., 2000).

Features of this analysis can be used to guide development of brief dietary screeners modified for use with Samoan populations. Due to the transitional nature of Samoan diets and the broad range of foods eaten by Samoans, these brief screeners should include detailed fat and energy food screeners created to track both high fat and high calorie Samoan foods including key foods such as mutton, turkey tails, and pisupo. Western foods that have become prominent in Samoan diets such as corned beef, spam, rice, short ribs, fried chicken, and ice cream should also be included as part of the calorie and fat screeners. Vegetable and fruit screeners for Samoans should include vegetable and fruit items common in both Western and Samoan diets including tropical fruits such as pineapple, mango, green bananas, and starchy vegetables, such as breadfruit, taro, as well as foods uncommonly eaten by Samoan such as tomatoes, lettuce, spinach, and other green vegetables. Additionally, all screeners including the vegetable and fruit screeners should be modified to assess food preparation behaviors, especially inclusion of coconut milk, breadfruit, or taro used in certain dishes.

There are several limitations to the current study. First is the potential for error in participants' self-reported measures of food consumption, body weight and height. Social desirability may have influenced these self-reports causing under-reporting of the amounts and frequencies of foods eaten, participants' weight, and overestimation of height. However, the measurement is likely to underestimate the association of the dietary patterns with BMI. Second, the cross-sectional nature of the original study cannot lead to an inference that participants' dietary patterns are antecedent and causative of BMI measures, particularly in the absence of physical activity and metabolic measures of participants in this study. Third, the diets were assessed in the mid-90's and may not reflect diets of Samoans currently if changes in diets have occurred. However, based on

data collected among Samoans in focus groups and on observation, the key elements of the Samoan diets appear to be represented in this analysis.

However, the identification of Samoan dietary patterns provides novel information on Samoan nutrition that can be used in interventions to support healthy lifestyles. The strength of this study is the large number of participants from Samoan populations representing three locations that provided the precursory information needed to create dietary interventions and measurement instruments for this population. The original study used standardized nutritional research methodologies to create a high quality, analyzable data set, including the use of trained interviewers to administer the Samoan FFQ.

Conclusions

The analysis of the Samoan FFQ data served to provide a comprehensive overview of the dietary patterns of Samoans participating in the Samoan Diet and Health Study. The analysis was useful in understanding the relationships between various Samoan food consumption patterns including variations in the consumptions of processed foods, fruit, vegetables and fish relative to location, and the impact of these Samoan dietary patterns on BMI. The study identified dietary consumption patterns specific to Samoans that can be promoted, including fish, and fruit patterns, or discouraged, including consumption of high fat meats, white rice, and processed traditional and Western foods. This information will prove useful in the developing brief dietary assessment instruments for Samoans that are capable of measuring the effects of interventions to improve healthy nutrition in this population.

CHAPTER 5. DISCUSSION AND CONCLUSIONS

Trends toward obesity in Samoan populations is a public health concern, particularly in Hawai'i, where obesity-related diseases contribute to high mortality rates in this group (Park et al., 2009). This dissertation sought to identify the salient institutional, cultural, behavioral factors contributing to Samoan obesity prevalence and to verify the relevance of these factors for Samoans living in Hawai'i. This dissertation served to provide a foundation for adapting an evidence-based dietary intervention to help reduce obesity among Hawai'i's Samoans. Additionally, prerequisite research was conducted to inform the development of potential measures to assess Samoan dietary behaviors, and the effectiveness of potential interventions.

Summary of Main Findings

Chapter two described a current review of the scientific literature on obesity determinates in Samoans. Western colonial influences in the Samoan archipelago and the arbitrary political division Samoan society were found to have resulted in economic transitions in American Samoa and (Western) Samoa (Finau et al., 2002). These changes created two distinct economies, agrarian in (Western) Samoa, and industrial in American Samoa, which reduced the availability of traditional dietary resources for Samoans (Ezeamama et al., 2006). Calorie-dense foods, including baked goods, and highly salted, canned foods gained social and dietary prominence in Samoa life (Keighley et al., 2007).

Samoan cultural norms also contribute to epidemic increases in obesity in Samoan populations. Hierarchical relationships and the importance of maintaining these relationships through sharing food, and other subsistence needs are features of Samoan cultural values that add to the obesogenic effects of newly adopted Western dietary patterns (Baker et al., 1986). Mutual, freely-given support is a cultural value quantified during cultural ceremonies through contributions of food (Aitaoto et al., 2007). Transitions from uses of traditional food sources to Western foods are prominent in these ceremonies, and exacerbate the obesogenic effects of Western foods.

Finally, phenotypical characteristics were found to compound the obesogenic effects related to the uptake of Western dietary patterns by Samoans. Samoans are descendants of people who migrated via canoes over open oceans (McGarvey et al., 2002). Survivorship required for migration favored individuals with efficient

metabolisms. Samoan physiology reflects this efficient metabolic profile (Keighley et al., 2007). However, the biological components of Samoan obesogenic traits, are amenable to personal behavior modification, including improved nutrition, and physical activity which can inhibit this potential predisposition (Dai et al., 2007).

Chapter three supported the validity and relevance of Samoan obesity determinants with members of Hawai‘i’s Samoan community. Qualitative interviews with and conducted by community members confirmed that political, socio-economic, cultural, and behavioral factors led to dietary transitions that contribute strongly to obesogenic trends in Samoans in the jurisdictions, and in Hawai‘i. These included changes in the vocational structure of Samoan society, combined with influences due to migration/acculturation into Western societies, modifying cultural norms surrounding the adoption of Westernized diets and the prominence of Western foods within cultural practices.

Faith-based interventions have shown promise in addressing health issues with Samoan populations (Aitaoto et al., 2007; Bell et al., 2001; Levy-Storms & Wallace, 2003). Chapter three also corroborated this evidence with community members, and found that churches may be an ideal setting to conduct a diet and exercise intervention with Samoans in Hawai‘i. Focus groups conducted with members of a Samoan church in Hawai‘i found that this congregation was receptive to the idea of an intervention, and provided suggestions on ways to embed Samoan cultural values. These suggestions included leveraging use of Samoan social hierarchy, re-adoption of healthy traditional foods and preparation methods, and conducting intervention activities in group settings.

Chapter four analyzed dietary data obtained from over 1,400 Samoans living in American Samoa, Hawai‘i, and California to identify features of Samoan diets, and dietary patterns that are linked to obesity (Mishra et al., 2000). Analysis of Samoan diets in this study clearly identified increases in the number and composition of dietary patterns in Samoan populations outside of the Samoan jurisdictions. The identification of two to three additional Samoan dietary patterns, including a specific pattern related to the consumption of processed food in participants located in Hawai‘i and California suggests that increasing dietary diversity may be an effect of acculturation of Samoans in these locations, that has both positive (fruit) and negative (processed foods) components for

obesity. Irrespective of location, participants' diets indicated high daily calorie intakes, particularly of foods high in saturated fats.

This analysis also revealed some promising information concerning Samoan diets, namely healthy dietary patterns were found to be embedded within the overall Samoans dietary patterns identified in this study. Healthy patterns included predominant fish and fruit food group consumption, which may be obscured by Samoan's expansion in dietary diversity in more westernized settings (healthy acculturation). These findings support the need to encourage the dietary diversity found among Samoans by promoting consumption of healthy food groups, such as fish and plant-based foods, while minimizing adoption of those with health risks due to excess consumption, such as foods high in fat and cholesterol (Uusitalo et al., 2002).

The purpose of this dissertation was to provide a foundation for adapting an evidence-based dietary intervention to help reduce obesity prevalence among Hawai'i's Samoans. Additionally, the study sought describe Samoan diets to help facilitate the development of the measures to assess the effectiveness of interventions to improve the diets of Samoans in Hawai'i.

Recommendations for the Adaptation of an Intervention, and Components Needed to Address Obesity Trends Among Samoans in Hawai'i

Based on the findings from this dissertation research, the following are recommended for the adaptation of an intervention for Samoans in Hawai'i:

- (1) Interventions that incorporate multi-level multi-component features influencing the social-ecological aspects of Samoan obesity should be used as the root intervention for adaptation, as indicated in chapters two and three. Prospective interventions, including Body and Soul, may be ideal for adaptation due to the program's multi-focal ecological approach (Campbell et al., 1999). The program provides intervention activities for the institution (social), uses peer support mechanisms (cultural), and provides for personal behavioral modification activities (Resnicow et al., 2004).
- (2) Community-based participatory methods should be included in the intervention's adaptation processes, and should also be a component of the intervention. Chapter three emphasized the importance of Samoan cultural

values. Embedding Samoan cultural values within an intervention is impossible without the use of a community-participatory approach (Minkler & Wallerstein, 2003). This approach should involve community members to design the refitting of program components, thereby providing the intervention with the ability to utilize the deep structure of Samoan culture obtainable only from community members (Harvey, 2003). Linguistic adaptation of the intervention may be an ideal mechanism for this purpose. The collectivist, hierarchical nature of Hawai'i's Samoan community is a strength that can be applied through use of participatory intervention approaches, building community buy-in and facilitating broad intervention adoption. Community members should be utilized to deliver the core components of the intervention, this approach would use existing social leaders including pastors, and lay leaders to demonstrate support for the program, and model the behaviors intended to be adopted by the community.

- (3) The intervention should use the existing established social institutions, and networks within Hawai'i's Samoan community (Aitaoto et al., 2007). This recommendation from chapter three emphasizes the ability of Samoan church to influence not only church members, but also the capacity of this institution to dovetail with informal community support and communications networks to reach non-church members of Hawai'i's Samoan community. The church should serve as the focal point for conducting intervention activities; however other components should be created such as print materials that may have applicability for use in other settings.
- (4) Intervention components should incorporate training on the use and re-adoption of traditional Samoan foods and food preparation methods. This was found to be important among community members in chapter three. Key foods such as taro, breadfruit, tropical fruits, and fish are important in Samoan diets. Dietary training should emphasize healthy culinary preparation methods, and promote the development of community gardens to build use of traditional food acquisition methods. Cultural training for Samoans living outside of the jurisdictions is part of the work of the Samoan church. Imbedding re-adoption

of healthy traditional food choices, and preparation methods can complement this purpose. This training should include the behavioral aspects of dietary management including training on building healthy dietary diversity, reduction of total calorie intakes, and reducing the fat content of both traditional and western foods (USDA, 2010; Wyber et al., 2009).

- (5) Assessments developed to evaluate Samoan diets and the effects of an intervention should be flexible and inclusive. Any developed dietary assessment tool for Samoans should measure key Samoan foods, as well as Western foods prominent in Samoan culture as identified in chapter four. Additionally, these measures can include cues to support healthy dietary diversity by including healthy Western food choices such as whole grain products, like brown rice, and plant-based foods as substitutes for adopted foods (Drescher et al., 2007).
- (6) Finally food preparation behaviors should be included in Samoan dietary measures. First it would be important to know if consumed healthy foods (like vegetables, fruits, and fish) are prepared with coconut milk, which greatly increases calories and fat. Second, it would be important to promote traditional food acquisition and preparation if coconut milk (for example) is absolutely required for the dish, as traditional food acquisition and preparation is labor intensive, and physically demanding. Including this as part of dietary measures can serve to promote this approach as part of the intervention, and provide an additional assessment of energy outputs. Reasonable changes in food preparation such as trimming mutton meat or substituting use of leaner cuts should be part of these measures, and can also serve as cues to action for the intervention participants (USDA, 2010).

Future Research

Results from the dissertation studies indicated the need for additional research in these areas:

- (1) Validated instruments need to be developed to evaluate diet and physical activity among Samoans. These instruments should also include measures of acculturation among Samoans. Instruments that are designed to assess Samoan

diet and physical activity will assist in evaluating potential health benefits of interventions improving energy balance and health in this population.

- (2) Assessment of physical activity norms and culturally-appropriate exercise behaviors should be conducted through use of qualitative and quantitative research methods to address the energy output practices and potential areas for improvement and intervention among Samoans. Effort should be made to include positive dissident models, or individuals who have maintained health body weights despite obesogenic influences.
- (3) Descriptive research on how interventions are adapted for use with different ethnic and medically-underserved populations, including research on understanding the potential for research-tested programs to be cross-cultural adapted and disseminated. Identifying the key processes used for cross-cultural adaption of interventions may serve to inform the rapid development and implementation of proven health promotion interventions for effective use in minority and medically-underserved populations.
- (4) Research on the comparative effectiveness of adapted interventions with their root interventions to address health outcomes in different populations. This would include comparing the fidelity of the newly adapted intervention with the original intervention.

Conclusions

Western colonization within the Samoan archipelago resulted in economic, cultural, and behavioral transitions leading to increases obesity among Samoans over the past 40 years (Baker et al., 1986). Samoans maintain high rates of migration, with nearly one third of Samoans living in US (US Census, 2007). Obesity persists in these migrants, obesity-related disease contributes to Samoans having the lowest life expectancy of any ethnic group in Hawai'i (Park et al., 2009). Interventions have addressed obesity in Samoans (Afele-Fa'amuli, 2009; Bell et al., 2001; Simmons et al., 1998). However there are few reported interventions tackling obesity with Samoans living in Hawai'i.

The purpose of this dissertation was to identify and verify the salient institutional, cultural, behavioral supports and barriers towards adapting an intervention to improve the dietary behaviors of Samoan populations living in Hawai'i. Additionally, this dissertation

research aimed to identify an appropriate setting for the delivery of a potential intervention, and conduct the prerequisite research to be used towards the creation of indices to measure the effects of dietary intervention.

A review of the current scientific literature on studies conducted with Samoans, and identified the salient political, institutional, cultural, behavioral obesogenic factors, including the introduction of market economies, changes in vocations, prominence of processed foods, and transitions from agrarian to urban lifestyles. Constructs from the Social Ecological Model of Health (SEM) provided an important organizing framework for the knowledge on Samoan diet and health, and informed hypothesized intervention targets within the model components.

Many Samoans living in Hawai‘i supported the relevance of information found in the scientific literature on Samoan obesogenic factors during interviews with community key-informant and focus groups. Samoan churches in Hawai‘i were identified as appropriate settings to reach Hawai‘i’s Samoans. Interviewees also suggested strategies for culturally-appropriate interventions with Samoans. The suggestions for interventions by Hawai‘i’s Samoan community members also signifies the community’s readiness for the implementation of an intervention.

Samoan dietary data obtained from more than 1,400 Samoans living in American Samoa, Hawai‘i, and California served to identify the nutritional aspects of trends towards obesity in Samoans. Samoan diets were characterized by high daily intakes of calories, and saturated fat. Samoan dietary patterns also suggest an increase in dietary diversity with acculturation. This knowledge of the obesogenic features of Samoan diets will inform specific dietary changes as part of an intervention that can reduce obesogenic trends. Also this information can inform the creation of dietary assessment instruments for Samoans that are consistent with the current knowledge concerning the relationships between diet and disease and health.

In summary, with the support of Hawai‘i’s Samoan community members, the information within this dissertation will be directly applicable towards further research, as well as the adaption and testing of an intervention to address the current burden of obesity related chronic diseases.

APPENDIX A. KEY-INFORMANT AND FOCUS GROUP CONSENT FORMS

University of Hawai'i Department of Public Health Studies

General Consent Form for

The Tailoring Of A Community-Based Program for Samoans In Hawai'i Study

Primary Investigators:

Kevin D. Cassel, MPH (564-6916 or 284-9097)

Claudio Nigg, Ph.D. (956-2862)

Purpose and Benefits

This study will examine the influence of the Samoan church among Samoan migrants in Hawai'i. The study also hopes to have church members inform possible strategies for developing a church-based nutrition and physical activity program designed to reduce t chronic diseases among Samoan in Hawai'i using Samoan cultural beliefs, values, and practices.

Procedures

If you agree to participate in this study, you will participate in a group discussion (talk-story) session for approximately 2-3 hours. The session will consist of a group discussion of questions about opinions concerning the influence of the local church in Samoans, and the development of a health promotion project with the support of the church. With your permission the discussion will be audio recorded for accurate data collection purposes. During the discussion session, we will have several breaks to have refreshments and to support opportunities for fellowship among the group. You can choose to stop participating in the session at any time and withdraw your consent. You are free to refuse to answer any questions that you do not want to answer. Your participation is strictly voluntary.

Risks, Stress, or Discomfort

A possible risk of the study may be that answering certain questions may be uncomfortable. Please let the researcher or discussion moderator know at any time if you do not understand a question, if you need clarification, chose to not answer a particular question, or if you would like to stop.

Confidentiality

The information you provide during the discussion sessions will be handled with strict confidentiality. All audio recordings will be used to insure accurate data collection. All data collection materials will be locked in a cabinet and only the primary investigators will have access to them. No identities will be used to collect the information, and you will be assigned a code to shield your identity with in the written notes or data collected, on the typed transcriptions, in any report, or in any publication resulting from this study. All personell leading the discussion sessions have signed agreements that they will not disclose any information you have provided as part of the discussion with anyone outside of the research team, and that the information you provided will be solely used within the context of this research project.

Other Information

The results of this study may be used for the purpose of preparing information to conduct a larger study with others like yourself who may provide similar information on this topic. The findings from this study will be shared with you when completed to obtain your feedback and input about the accuracy of the information.

Again your participation is voluntary, and there are no adverse consequences should you choose not to participate.

Signature of the Interviewer

Date

Participant's Statement:

The study described above has been explained to me by _____, who has satisfactorily answered my questions concerning the study purpose, procedures, risks, confidentiality and rights. I also understand that I may withdraw my consent, and stop participation at any time. I understand that the primary investigator can be reached at 564-5916 or 284-9097, if I have any further questions.

I voluntarily consent to participate in this study, with the understanding that such consent does not waive any of my legal rights, nor does it release the principal investigator or the institution or any employee or agent thereof from liability for negligence.

I have had an opportunity to ask questions, and understand that future questions I may have about this research or about my rights as a participant will be answered as indicated above.

Signature of the Participant

Date

(If you were unable to get satisfactory answers to your questions, or have comments or complaints about your treatment in the study, contact: Committee on Human Studies, University of Hawai'i, 2540 Maile Way, Honolulu, HI. 96822)

APPENDIX B. KEY-INFORMANT INTERVIEW GUIDE

Interview Questions

Introductory Information:

I apologize beforehand for any rudeness in beginning this research project. I am asking for your help to guide me. I am conducting a study to examine the potential influence of the Samoan church among Samoan migrants in Hawai'i. I hope to be able to use results of this study to develop additional questions that may help build a nutrition and physical activity program for Samoans in Hawai'i. These programs may reduce obesity and the burden of chronic diseases experienced by Samoans. This interview is meant to be informal. I will audio record our conversation so that I can make sure that I accurately capture your statements. I will not write down detailed notes on what you say; but I will only make brief notes to myself to help me keep track of our conversation when I listen to the tape.

Questions

1. As a person from outside of the Samoan community what is important for me to know about working in the community?
2. In your opinion, what is the migration status of your (community/church) members, are they predominantly locally born or migrated from Samoa?
3. In your opinion are the Samoans who attend churches locally, very different than Samoans who do not?
4. As a (community /church) leader what types of activities do you consider, or use to support Samoan community members?
5. What is your opinion about the outcomes of these activities?
6. What is your opinion about the overall health of the Samoan community?
7. Do you believe physical activity and nutrition is an important issue?

8. What would be a good place to reach local Samoans regarding physical activity and nutrition education?
9. What would be the important parts of a project promoting physical activity and nutrition in the Samoan church/community?
10. What else do I need to know that I have asked?

Demographic Data Questions:

Age:

Residence:

Migration Status:

Occupation/s:

Years at Occupation:

Educational Level:

Marital Status:

APPENDIX C. FOCUS GROUP INTERVIEW GUIDE

The Tailoring Of A Community-based Program for Samoans In Hawai'i Study Group Interview Guide

Research Question: *Are churches a viable setting to address healthy eating and physical activity for Samoans living in Hawai'i. What are the important features of a church based Intervention?*

introduction:

Aloha. Thank you for joining our group today. We plan to talk about your views on diet and exercise ways we can support ourselves and others in staying healthy.

Ground rules;

1. There is no right or wrong interpretations.
2. Be courteous; allow people a chance to fully express their views
3. We need you voice; please speak out even if it goes against the other opinions

Opening questions:

Just to get us started, and to help us get to know each other better.

1. Please tell us your name, and some you like to do that is fun for you.

Introductory questions:

1. Recent studies show that our obesity rate is one of the highest in the world. Obesity is a major risk factor for diabetes mellitus, cardiovascular diseases, high blood pressure, cancer and so forth. Do you agree with this finding?
2. What does being healthy mean to you? Probe: With your definition of 'healthy', do you consider your health as excellent, very good, good, fair, and poor? Why?
3. How important is your health to you? Probe: How does your health affect others close to you?

Transitions questions:

1. What are the things you do to maintain a reasonably healthy lifestyle?
Probe: What are some things that make it hard?

2. What does eating healthy mean to you?

Probes: What makes it easier to eat healthy? What makes it difficult to eat healthy?

3. What does physical activity mean to you? What types of physical activities that you do?

Probes: How often? Why they appeal to you? What makes it difficult for you to do these activities?

Key questions:

1. What kinds of services, programs or environmental supports to encourage healthy eating and physical activity amongst you and your family members would you recommend?

2. Where would be a good place to promote physical activity and healthy eating?

3. Are there any other plausible explanations for these findings?

Refining question

1. What would the challenges to promoting health in this setting?

Ending question

1. What additional ideas do you have about services, programs, or environmental supports to encourage healthy eating and physical activity amongst you and your family members would you recommend??

Closing

Thank you for your time and sharing your knowledge with us today. We would like to meet with you again, or contact you in a few weeks to review the thing we talked about today with all of you.

Please remember that we would like to respect the opinions of one another, and we would ask that you not discuss the opinions given in this room by others with those outside of this group.

APPENDIX D. MODERATORS NON-DISCLOSURE AGREEMENT

Tailoring Of A Community-Based Program for Samoans In Hawai'i Study Moderators' Non Disclosure Agreement

I, _____ hereby agree to maintain the confidentiality of information disclosed during focus group entitled, **“The Tailoring Of A Community-Based Program for Samoans In Hawai'i Study”**, observed live, recorded, or in any other manner as follows:

- 1) Definition - For purposes hereof, “Confidential Information” shall mean information or material obtained or observed while attending the focus group session. Confidential Information includes
 - a) Any information about any participant in the focus group that is not currently in the public domain or readily available to the public.
 - b) Also included as confidential is any participant’s Personally Identifiable Information (“PII”). PII shall mean a person’s identity or information that might reasonably allow identification of the person.
- 2) I shall at all times hold in trust, keep confidential and not disclose to any third party or make any use of the Confidential Information.
- 3) I shall at all times hold in trust, keep confidential and not disclose to any third party or make any use of the identity or PII of any participant involved in the focus group.
- 4) I will use commercially reasonable efforts to keep the PII secure from any third party access.
- 5) I will comply with all state, federal, and international statutes and regulations governing privacy, data security and the use of PII. I will use this information only in the manner consented to by the participant, and not for non-research purposes unless explicit permission has been previously obtained from the participant.
- 6) All notes, reference materials, memoranda, documentation and records in any way incorporating or reflecting any of the Confidential Information shall belong exclusively to Principal Investigators, and the undersigned agrees to turn over all copies of such materials in the undersigned’s possession to the Principal Investigators upon request.

The undersigned agrees to the above terms of this agreement.

Signed _____ Date _____

Printed _____

APPENDIX E. FOCUS GROUP RECRUITMENT MESSAGES

1. Church members are needed to participate in a discussion group to help develop a church-based nutrition and physical activity program.
2. These discussion groups are part of a research project conducted by a University of Hawai'i doctoral student and this church.
3. The overall goal of the project is to get your opinion about how to incorporate Samoan value and practices into this potential health promotion project.
4. Groups will be conducted in both English and Samoan; participants can choose their preference for attending a group in either language.
5. Men and women over the age of 18 are eligible to join the groups.
6. The discussion groups are expected to last 2-3 hours.
7. The information you provide in these groups will remain confidential.
8. Refreshments, as well as a small token of appreciation will be provided.
9. For more information contact the researchers at 564-5916 or 284-9097.
10. You can also contact the church administrator 259-9522.

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