3891

BODY SIZE AND COMPOSITION,

LIFESTYLE AND HEALTH

AMONG NATIVE SAMOAN WOMEN

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DEDICATIONS

I dedicate the following thesis to Kristin Lindsey-Dudley, Glen Butcher and my parents. Without their love and support this would not have been possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

Obesity and related diseases have reached near-epidemic proportions in both the United States and portions of the wider international community (Davis et al., 2004; NIH, NHLBI, & NIDDKD, 1998; NIH & NIDDK, 2004). The causes of this global crisis appear to be a selective but growing abundance of high fat processed foods, lack of exercise and changing lifestyles. Small-scale studies indicate that obesity, type 2 diabetes and cardiovascular disease prevalence is even greater among American and Alaska Indians and Pacific and Islander Americans compared to Caucasians (CDC, 2000; CDC, 2002). The explanations for this predicament for these populations are multifaceted, from dramatic changes in lifestyle, hunter-gatherer to sedentary, patterns of food procurement and choices, to limited access to preventative healthcare and nutritional education.

Body size measures for overweight and obesity classification in clinical and epidemiologic settings include BMI, (weight in kilograms/ height in meters squared) and waist circumference (NIH et al., 1998; NIH, NHLBI, & North American Association for the Study of Obesity, 2000). In the clinical setting, BMI and waist circumference measurements are used to categorize individual risk for chronic disease. For epidemiologic studies, BMI and waist circumference measurements estimate incidence and prevalence of obesity and risk for obesity-related disease. BMI is based on the proportion of overall body weight to height and thus, negates body composition variations in body fat, muscle and bone mass (Pan et al., 2004; WHO, 2004).

This study was conducted to understand the current body size and composition patterns in relation to nationally-defined cut-points, lifestyle and health risk indicators among native Samoan women age 18 to 28 living on Oahu. The findings from this study will contribute pilot baseline data necessary for larger scale preventative endeavors for these populations.

1.1 OBESITY

The conditions of "overweight" and "obesity" are defined by a body mass (BMI) index of 25-29.9 kg/m^2 and > 30 kg/m^2, respectively. Obesity cut-points for waist circumference are 102 cm (>40 in) and 88 cm (>35 in) for men and women respectively (CDC, 2002; NIH et al., 2000; WHO, 2004). Overweight and obese individuals are at high risk for the development of obesity-related morbidities or diseases such as type 2 diabetes, cardiovascular disease, hypertension, and high blood cholesterol (NIH et al., 1998; WHO, 2004).

Obesity and overweight account for over 300,000 deaths in the United States, where the prevalence of obesity and overweight combined reached 64% between the time-frame of 1960 to 2000 among adults age 20 to 74 (USDHHS, 2000; WHO, 2004). The Third National Health and Examination Survey (NHANES III) reported that 59.4 % of men and 50.7% of women in the United States are overweight or obese (NIH et al., 2004; WHO, 2004).

Asian and Pacific Islanders are experiencing an even more drastic rise in the prevalence of obesity and related disease compared to Caucasians (CDC, 2000; Coyne, 2000; Davis et al., 2004; WHO, 2004). Over 65 percent of Pacific Islanders in Hawaii are overweight or obese, compared to 50% of Filipinos, 46% of Caucasians, and 30% of Chinese (DOH, 2001).

1.2 TYPE 2 DIABETES

Type 2 diabetes is defined by the WHO and the National Diabetes Data Group (NDDG) by the presence of elevated plasma glucose levels >200 mg/dl following an oral glucose tolerance test and fasting plasma glucose levels >126 mg/dl (ADA, 1969; ADA, 1997). Impaired fasting glucose (IFT) and impaired glucose tolerance (IGT) are pre-diabetic conditions in which blood glucose levels are elevated between 110-125 mg/dl and 140-199 mg/ dl respectively, but not high enough to be classified as diabetes (ADA, 1969; ADA, 1997).

Type 2 diabetes affects 150 million people worldwide and accounts for about 90 to 95 % of all diagnosed cases of diabetes (NIH et al., 2004). Approximately 300 million people are expected to suffer from diabetes by the year 2025, with the majority of cases being type 2 diabetes (Van Tilburg, Van Haeften, Pearson, & Wijmenga, 2001). Direct and indirect costs of diabetes exceed $44 billion and $54 billion respectively (NHIS NHANES, 2000; WHO, 1985).

The number of people in the Asia Pacific region with type 2 diabetes is 30 million and estimated to reach 130 million by the year 2010 (Inoue & Zimmet, 2000). Pacific Islander populations have among the highest prevalence of diabetes, obesity and cardiovascular disease in the world (Collins et al., 1994; Coyne, 2000; Davis et al., 2004; Inoue et al., 2000). Samoans in particular, have experienced rapid transition in diet and accompanied chronic diseases, such as obesity and type 2 diabetes which are attributed to the modernization process (Bindon & Zansky, 1986; Bindon, 1988; Zimmet et al., 1996) (Coyne, 2000).

Type 2 diabetes is associated with insulin resistance in the peripheral target tissue and involves impaired GLUT 4 receptor translocation, function or uptake (Groff & Gropper, 2000; Harris, 2002; Shils, Olson, Shike, & Ross, 1999). In the muscle, insulin resistance is associated with decreased glucose transporter activity at the cell surface and subsequent failure in vesicle translocation. Within adipose, insulin resistance and type 2 diabetes are marked by decreased mRNA that encodes the GLUT 4 transporter, which results in a pre translational reduction of the intracellular stores of the protein.

Major risk factors for diabetes include obesity, ethnicity, family history, diet and physical activity, all of which are data easily obtained and recommended as screening criteria for undiagnosed type 2 diabetes (ADA, 1997; Franz et al., 2002; NIDDK, 2002; NIDDK & NIH, 2004).

Modifiable factors associated with both type 2 diabetes and obesity risk include diet, physical activity, and lifestyle. The degree to which hereditary factors contribute to type 2 diabetes risk (Kekalainen, Pyorala, Sarlund, & Laasko, 2004; Tsai et al., 2001; Van Tilburg et al., 2001) and given that gene pools shift slowly over time, the present rapid onset diabetes epidemic clearly reflects lifestyle changes (McGarvey, 2002; Zimmet et al., 1996).

Although clinical trials demonstrate that moderate weight loss and increased regular physical activity reduce blood glucose levels, the independent relationship between these factors and among indigenous populations with differing muscle and fat distributions deserves additional research.

1.3 PHYSICAL ACTIVITY

Historically, the isolation and remoteness of traditional island populations served to insulate them from many diseases (Baker, Hanna, & Baker, 1986; Coyne, 2000; McGarvey, Levinson, Bausserman, & Galanis, 1993).To date there is no record of the pre-colonial prevalence of chronic obesity or diabetes (Bindon, 1988; Kirch, 2000; McGarvey et al., 1993).

The indigenous lifestyle and subsistence practices of Pacific Islanders required and valued a robust and physically active lifestyle. However, the process of modernization has shifted traditional Pacific Island work life from activities involving plantation and irrigation development, marine fishing and hunting to more sedentary office-based occupations with a drastic reduction in physical activity (Coyne, 2000).

Physical activity and aerobic fitness are key preventive measures for the development and treatment of diabetes type 2 and obesity(DOH, 2001; Leonard, 2001). During exercise the most significant stimulants for increased glucose uptake are muscle contraction and insulin release (Boushard, Shepard, & Stephens, 1994; Boushard & Rankinen, 2001). Following an acute bout of exercise skeletal muscle glucose uptake remains above baseline as replenishment of glycogen stores occurs.

Similarly, long- term exercise leads to improved insulin stimulated glucose uptake (Williams, 2002). Longitudinal and cross sectional studies demonstrate that physical inactivity and low cardiovascular fitness level are associated with development of diabetes and obesity, through increased body fat percent, decreased energy expenditure and insulin stimulated glucose metabolism (Hu et al., 1999; Kelley & Goodpaster, 2001).

Current physical activity guidelines recommend 60 minutes of daily moderate physical activity in order to prevent weight gain, diabetes, obesity and cardiovascular disease (Kelley et al., 2001; National Academy of Sciences, 2002). According to the American College of Sports Medicine, 30 minutes per day of physical activity is adequate for both health promotion and the prevention of obesity and related disease (ACSM, 1998).

Two leading health indicators from Healthy People 2010, aimed to decrease health risks associated with lack of physical activity, overweight and obesity (CDC, 2002; DOH, 2001). Frank et al., (1999) found that regular physical activity such as walking and, more significantly, rigorous walking were associated with a decreased risk for type 2 diabetes among women during an 8 year follow up (Frank et al., 1999). Similarly, men who participated in moderate physical activity for over 30 minutes per day had lower glucose tolerance levels compared to those without these activities when adjusting for diet, age, diabetes, BMI and smoking (Van Dam, Schuit, Feskens, Seidell, & Kromhout, 2002).

With or without dietary modification, physical activity is a proven preventive measure for all chronic disease (Inoue et al., 2000; Kelley et al., 2001; Leonard, 2001; National Academy of Sciences, 2002; NIH et al., 2000; Van Dam et al., 2002). Furthermore, the effects of decreased physical activity among indigenous populations such as American and Alaskan Indians demonstrate that changes in lifestyle namely physical activity and diet, have resulted in the drastic rise in and increased type 2 diabetes and obesity and a new major public health crisis among young American Indians and Alaska Natives (Kriska, Hanley, Harris, & Zinman, 2001; Gray & Smith, 2003; Acton et al., 2002).

1.4 DIET

Diet alone exerts a significant effect on weight loss and improved glucose tolerance independently of physical activity (Franz et al., 2002; Frank et al., 1999; DOH, 2001). Specific nutrients associated with increased obesity and related diseases include dietary fat and fatty acids and refined carbohydrates (Institutes of Medicine of the National Academies, 2002; Bray et al., 2002). Refined carbohydrates are currently under investigation as a primary reason for the rise in type 2 diabetes among American Indians and Pacific Islander Americans (Shintani, 1999; Grandinetti et al., 2002; Galanis, McGarvey, Sobal, Bausserman, & Levinson, 1995).

Several studies demonstrate significant reduction in dietary energy from native foods such as taro, fruit, native plants and fish among Samoans living in more urban settings compared to those in rural settings (Collins et al., 1994; Bindon, 1988; Baker et al., 1986). For example, Sparling et al. (1999) found energy and macronutrient consumption to be significantly higher in American Samoa versus Western Samoa for carbohydrate (47% vs. 44%), protein (18% vs. 13%) and less as fat (36% vs.46%) (Sparling, 1997).

1.5 SAMOANS

There are no records of the pre-colonial prevalence of obesity, cardiovascular disease or diabetes (Bindon, 1988). The Polynesian population of the Samoan islands has been well- suited to study the biological effects of both modernization and migration due to the differing levels of their rural and urban subsistence (Baker et al., 1986).

In the year 2000, the prevalence of obesity was over 64% for both males and females in Samoa (American and Western) and the age standardized prevalence of obesity among Samoan women from Hawaii, American Samoa and Samoa age 25 to 69 years reached 75% (Inoue et al., 2000; Coyne, 2000). Among preadolescents, age 6-11 years, Bindon et al. (1988) found similar trends and significant differences in weight and weight for height among Samoan migrants in Hawaii compared to those in American and Western Samoa (Bindon, 1988). Studies conducted in the 1970's showed that Samoans living in Hawaii and California were among the populations at greatest risk for obesity in the world (McGarvey et al., 1993). However, current data on obesity, type 2 diabetes, cardiovascular disease and lifestyle are limited for these groups (USDHHS, 2000; NIH et al., 2004; CDC, 2002; Acton et al., 2002).

1.6 PACIFIC ISLANDER WOMEN

Among Pacific Islander women in the United States, obesity and related disease mortality data are fragmented and nonexistent. Recently, Grandinetti et al. (1999) reported a combined prevalence of both overweight and obesity rural Hawaiian women of 81.5% compared to a national prevalence of 52.6 % and a greater prevalence of obesity among women than men, 51.3% and 46.26% respectively (Grandinetti et al., 1999). Moreover, Native Hawaiian women had significantly greater occurrence of impaired glucose tolerance levels compared to Hawaiian males (18.7% women, 10.8% men) (Grandinetti et al., 1999).

Over 70% of Samoan women living in Samoa are considered obese {WHO 1985 40 /id}. Studies among Samoans conducted by McGarvey et al., found 91% of women within the age group of 35-44 years old were overweight according to US standards (BMI >25) and the average BMI among American Samoan women was 33.8 (McGarvey et al., 1993; McGarvey, 1995). The high average BMI and associated risk factors for diabetes and cardiovascular diseases substantiates the need to further investigate the relationship between these BMI cut-points, cardiovascular and diabetes risk level among Samoans.

1.7 BMI AND BODY COMPOSITION

Validation studies comparing percent body fat and BMI among different ethnic groups demonstrate that body fat percentages and BMI levels are significantly different among ethnic groups. For example, Deurenberg (1998) compared BMI and body fat among Tongan and Caucasian females and found that while Tongan females (BMI, 34.2) were heavier than their Caucasian counterparts (BMI, 26.2), the differences in total body percent fat, 41.9 and 38.7, respectively, were less than expected (Deurenberg, Yap, & Staveren, 1998). The study concluded that significant body composition variations existed between the Tongans and Americans. Moreover, mean BMI among Polynesians in particular is extremely high compared to those of European descent (Swinburn, Craig, Strauss, & Daniel, 1995; Swinburn, Ley, Carmichael, & Plank, 1999)

Swinburn et al., (1999) reported that Samoan women had higher mean fat mass and percentage of body fat than the Europeans. However, their corresponding body fat level at higher BMI values was significantly lower than for the Europeans (Swinburn et al., 1999). The study concluded that there were significant differences in body composition between Europeans and Polynesians with a BMI over 25 kg/m^2 where Samoans have more fat-free mass and less fat mass than Europeans at equivalent BMI levels. Therefore, the cut off values for obesity used among Caucasian individuals may not be appropriate for other ethnic groups.

The current World Health Organization BMI classifications of overweight and obesity are intended for international use and reflect risk for obesity-related diseases such as type 2 diabetes and cardiovascular disease (Zimmet et al., 1996; Inoue et al., 2000).

However, the absolute prevalence and incidence of type 2 diabetes and obesity varies greatly among different ethnic groups such as American and Alaskan Indians and Asian and Pacific Islander Americans (Davis et al., 2004; Craig, Samarus, Halavatau, & Campbell, 2003). The above definitions of overweight and obesity are based on data collected among populations of European descent. Thus, the interpretation of BMI among Pacific Islanders in the United States United States-affiliated countries and territories remains in question.

Further quantification of body size and body composition in relation to obesity and chronic disease risk among Pacific Islander and, in particular, Pacific Islander Americans necessitates examination.

1.8 PROBLEM STATEMENT

Body size is an indicator of health. Clinical measures used to define "healthy" cut-points for body size include BMI and waist circumference (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004).Overweight and obesity are significantly associated with increased risk for type 2 diabetes and cardiovascular disease (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004). Heredity and lifestyle characteristics are known factors related to the onset and progression of obesity and related diseases. The extent to which these characteristics apply to diverse ethnic populations is not well understood.

The aims of this study are to understand the relationship between BMI and waist circumference in young Samoan and to establish risk measures for type 2 diabetes and cardiovascular disease. Secondary aims are to observe the associations between young Samoan women's nutrition and lifestyle patterns and risk measures for type 2 diabetes, cardiovascular disease and obesity.

RESEARCH QUESTIONS

I. What is the relationship between BMI and waist circumference and health risk indicators among the Samoan women in this study?

a. What is the relationship between BMI and blood glucose and lipid levels?

b. What is the relationship between BMI and DEXA body fat percent?

c. How do reference BMI levels relate to risk for abnormal glucose and lipid levels?

II. What is the relationship between lifestyle factors and health risk indicators among the Samoan women in this study?

a. What is the relationship between diet and blood glucose and lipid levels?

b. What is the relationship between physical activity and blood glucose and lipid levels?

III. What are the main factors associated with BMI, waist circumference and body fat percent among the Samoan women in this study?

CHAPTER 2. METHODS

2.1 INTRODUCTION

The Samoan Women's Health Assessment Project (Principal Investigator, Rachel Novotny, Grant Number CRC 0216) was funded through the Kapiolani Clinical Research Center, National Institutes of Health and the National Center for Research Resources (Grant Number CRC 0216) at the University of Hawaii. The purpose of the study was to investigate the relationship among physical activity, diet, body composition and clinical measures of body size, risk for type 2 diabetes and cardiovascular disease.

2.2 DESIGN

The study design was cross sectional. The **Samoan Women's Health Assessment** project involved human subjects and received approval from the Hawaii Pacific Health Institutional Review Board (IRB) and the University of Hawaii, Kapiolani Clinical Research Center.

Inclusion criteria for the Samoan Women's Health Assessment Project included the following; female, Age 18 to 28 years, at least 50% native Samoan ethnicity, non-pregnant, non-lactating, weight less than 300 pounds and no previous cardiovascular or diabetes diagnosis.

2.3 MEASURES

Questionnaires

All participants provided written informed consent and Health Insurance Portability and Accountability Act (HIPAA) authorization prior to completing questionnaires distributed during recruitment meeting and clinic visits at the Kapiolani Clinical Research Center.

Questionnaires included:

1. Background Questionnaire
2. Health Questionnaire
3. Physical Activity Questionnaire
4. Diet Records

Background Questionnaire and Health Questionnaire

The Background Questionnaire (Appendix A) was completed by 55 participants and contained information about the participant's family background, parents' and participants' birthplace, ethnicity, demographics, education, birth-weight and breastfeeding history. Participants completed the Health Questionnaire (Appendix A) that asked about menstrual history, birth control practices, smoking, pregnancy and lactation history, medications and history of broken bones.

Physical Activity Rating Questionnaire (PAR-Q)

The NASA Physical Activity Rating Questionnaire (PAR-Q) (Appendix B) (Ross & Jackson, 1990) assessed individual physical activity levels. The PAR-Q requires subjects to respond to an activity rating that best describes their present level of regular activity. The questionnaire includes 8 activity levels that rate physical activity for the previous month. The rating scale ranges from 0, representing the lowest level of activity, and 7 greatest.

After reading through questionnaire instructions, participants were asked to select the number that best represented their physical activity level for the previous 4 weeks. The study coordinator reviewed instructions and clarified questions for each participant. The values from the questionnaire were used to estimate physical activity level and amount of time and type of activity for each participant. Examples of activity corresponding to each level were provided in the questionnaire.

Diet Records

Participants were asked to record their dietary intake for the Sunday, Monday and Tuesday prior to their clinic visit. The Diet Record form (Appendix C) included a detailed example of a day's diet and participants were given measuring cups and spoons to help estimate the amount of food that was eaten and portions were described. The study coordinator probed the diet records with participants during clinic visits to clarify ingredients, servings and portions.

Physical Fitness

Physical Activity Rating numbers from the NASA PAR-Q (Ross et al., 1990) were used to assess each subject's physical fitness level. The PAR for each participant was applied to the following non-exercise multiple regression equation to estimate physical fitness level equivalent to maximum oxygen consumption, $V0_{2\,peak}$ (ml 0_2/kg/min). Prediction of functional aerobic capacity without exercise testing, a non-exercise model established by Jackson et al., (1990) $V0_2$ peak = 56.363 + 1.921 (PAR) – 0.382 (Age) – 0.754 (BMI) (Jackson et al., 1990) yields estimates of $V0_{2\,peak}$ that are similar in accuracy to models that utilize sub-maximal exercise responses to predict $V0_{2\,peak}$ (Jackson et al., 1990).

2.4 CLINICAL MEASURES

Blood Testing

Participants fasted for 10 hours prior to clinical lab testing. Fasting glucose, 2-hour oral glucose tolerance, and blood lipid tests were taken at the Kapiolani Hospital for Women and Children and performed by laboratory technicians (Clinical Laboratories of Hawaii). Blood tests included fasting serum glucose (Hitachi 911- 450058 1127887R1), two- hour glucose tolerance testing (100 grams oral glucose solution), triglycerides (Hitachi 911-1488899), and cholesterol (Hitachi 911-450061).

The oral glucose tolerance test determines efficiency of blood glucose clearance. Impaired glucose tolerance (IGT) is a condition where blood glucose levels are elevated (between 140 mg/dl and 199 mg/dl after a 2 hour glucose tolerance test), but not high enough to be classified as diabetic (ADA, 1969; ADA, 1997). Impaired Fasting Glucose (IFG) as defined by the National Institutes of Health (NIH), National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Diabetes Data Group (NDDG) is a condition where fasting plasma glucose levels are elevated (> 70- 110 mg/dl) but not high enough to be classified as diabetic (ADA, 1969; ADA, 1997).

Lipoproteins (LDL, HDL) are risk factor measures for coronary heart disease and were used to assess individual “Lipid profiles” and cardiac risk level. Lipid profile outcomes including LDL, HDL, total cholesterol, and triglycerides were be measured in mg/dl and compared to normal references values; HDL > 55mg/dL; LDL 60-180 mg/dl; Total Cholesterol <200 (mg/dl); Total Cholesterol/HDL; <3.5; Total Triglycerides <150 (mg/dl) (National Cholesterol Education Program (NCEP), 1988)

Anthropometry

Anthropometric measurements taken during clinic visits at the Kapiolani Clinical Research Center included weight measured with a digital scale (Seca) in kilograms, height and sitting height measured using a digital stadiometer (Measurement Concepts, North Bend WA).

Circumferences of shoulder, waist, hip and calf were measured in centimeters by a tape measure (Hoechstmass Rolifix, 150 cm). Two measurements were taken to the nearest 0.1 centimeter. If the difference between measurements was greater than 0.2 cm, the average of the two closest measurements was used in analyses.

A standardized measurer (Yihe Daida) trained and standardized the project coordinator (Vanessa Nabokov) on all of the anthropometric measurements according to Lohman et al., (1988) (Lohman, Roche, & Martorell, 1988).Two Samoan women volunteers were used to practice and standardize the project coordinator with the standardized measurer.

DEXA Body Composition

Whole Body Dual Energy X-Ray Absorptiometry DEXA (GE Lunar Prodigy) scans were performed to measure bone mineral, fat and fat free soft tissue and used to estimate regional and total body percent fat. A certified radiographic technician (Jane Yakuma) was trained by the Lunar Corporation and operated the Lunar Prodigy DEXA according to standard procedures. All participants were screened for pregnancy (Accu-check, Quick-Vue) prior to having their DEXA- body scans. One participant screened positive for pregnancy and was not measured by DEXA.

Ethnicity

Participants were asked to identify the ethnicity of their biologic mother and father. Given the multiethnic characteristic of the Hawaii population and Samoan ethnicity required for this study, each participant was required to be at least 50 percent native Samoan. For example, a participant with a pure Samoan mother and a pure Caucasian father would be 0.5 Samoan and 0.5 Caucasian. One participant did not complete the background questionnaire. The ethnicity of each participant was determined from the question below in the Background questionnaire:

What is the ethnicity of your biologic mother and father?

	Father %	Mother %
Samoan	______	______
Tongan	______	______
Hawaiian	______	______
White	______	______
Japanese	______	______
Chinese	______	______
Filipino	______	______
Other	______	______

2.5 PROTOCOLS

Before Visit

All recruitment procedures and recruitment sites were approved by the Straub and Kapiolani Committee for Human Subjects, Institutional Review Boards. Participants were recruited through the University of Hawaii Manoa, Kapiolani, Windward and Honolulu Community Colleges, Hawaii Pacific University, Chaminade University and Remington College. Prior to recruitment, the Project Coordinator contacted school administrators, teachers and Samoan club leaders to identify appropriate recruitment venues.

Recruitment began with flyer distribution on college campuses. Recruitment flyers outlined the purpose of the study, eligibility criteria and recruitment meeting date and location. Family and friends of university students were invited to attend meetings and participate in the study if they were eligible.

Recruitment Meetings

Each recruitment meeting was directed by the Project Coordinator. Recruitment meetings took place on University and community college campuses. Individual recruitment occurred when interested women were unable to attend meetings. During recruitment meetings, the study coordinator explained in detail the purpose and procedures of the study, eligibility criteria and participant involvement.

Eligibility checklists (Appendix D) were distributed to interested individuals. Eligibility checklist questions included:

- Are you at least 50 percent native Samoan ethnicity?
- Are you female?
- Are you between the ages of 18 to 28 years?
- Are you non-pregnant?
- Are you non-lactating?
- Are you less than 300 pounds?
- Do you have any previous diabetes or cardiovascular disease diagnosis?

At the end of recruitment meetings, the Project Coordinator answered questions and reviewed the consent and HIPAA forms with the group. The consent form outlined the procedures and duration of participant involvement; three-day diet record, background and health questionnaires, physical activity questionnaires, pregnancy screening test, blood glucose and lipids tests, 10 hour overnight fast, DEXA scans, and anthropometry measures. The Project Coordinator distributed 2 copies of the consent form to each interested individuals. Following the informed consent process, participants signed two copies of the consent form. The Project Coordinator asked if there were questions before and after the consent process. The Project Coordinator then distributed background and health questionnaires and diet records and reviewed the instructions for the diet records. Participant clinic visits were scheduled at the end of the recruitment meeting.

The Project Coordinator confirmed available appointment slots with the receptionist at Kapiolani Clinical Research Center and scheduled participants accordingly. Scheduled participants were offered a reminder call prior to their clinic visit and were asked for permission to be contacted by the project coordinator regarding modifications in the appointment dates and times. The Project Coordinator notified the receptionist at Kapiolani Clinical Research Center following each recruitment meeting to confirm appointments and to obtain a schedule of available appointment slots for the following weeks.

Participants were given fasting instructions (Appendix E), which included a contact number for the study nurse in case of adverse effects from fasting. Background and Health questionnaires and diet record forms were provided for participants to record their diets for the Sunday, Monday and Tuesday and complete these forms prior to their scheduled clinic visits. The Project Coordinator provided a copy of the signed consent form to participants and kept one copy for the Kapiolani Clinical Research Center charts.

During Clinic Visit

Clinic visits were scheduled for the morning because participants were fasting for their blood tests. Upon arrival at the Kapiolani Clinical Research Center the Project Coordinator verified that the participant consent forms were on file and checked the fasting status of participants. Participants completed patient intake and medical release forms with the receptionist. The Project Coordinator or the Project Nurse reviewed the consent and HIPAA forms to verify that they were signed. After each study procedure, participants were given the opportunity to ask questions in private. Reimbursement vouchers were provided to each participant and parking validation was offered.

Following the pregnancy screening tests, the Project Coordinator walked each participant to the Kapiolani clinical laboratory for fasting blood glucose test and to drink the 75 gram oral glucose solution (CMS Glucose Tolerance Beverage) (ADA, 1969). The Project Coordinator also took each participant to the Kapiolani cashier's office where reimbursement vouchers were exchanged for $50 cash.

Participants were then provided a gown and taken to the examination room to change and opened the door when they were ready. The Project Coordinator performed anthropometric measurements according to standard procedure (Lohman et al., 1988) in the following order:

- Height (cm)
- Sitting height (cm)
- Calf Circumference (cm)
- Shoulder Circumference (cm)
- Abdomen Circumference (cm)
- Hip Circumference (cm)
- Weight (kg)

DEXA scans were performed by the DEXA technician (Jane Yakuma). Following each participant's DEXA scan, the Project Coordinator reviewed the background and health questionnaires with participants and probed three-day diet records to check portions, specific foods and clarify individual questions. The Project Coordinator then administered the Physical Activity Rating Questionnaire (PAR-Q) with participants.

Two hours after participants consumed the 75-gram oral glucose (CMS Glucose Tolerance Test) (ADA, 1969) solution, they returned to the Kapiolani Clinical Laboratory for their second blood glucose test. After the Oral Glucose Tolerance Test, participants returned to the Clinical Research Center. To ensure that participants were feeling well and to prevent adverse events, the Project Nurse or the Kapiolani On-Call Nurse checked each participant's vital signs and overall status in the examination room prior to completion of the study visit.

Each participant was checked for:

- Hypoglycemia
- Nausea
- Headache
- Weakness
- Shakiness
- Blood Pressure
- Pulse rate

After each participant was checked by the Project Nurse or the Kapiolani On-Call Nurse, the Project Coordinator provided a snack and drink prior to their leaving the Kapiolani Clinical Research Center.

After Visit

All data and questionnaires remained at the Kapiolani Clinical Research Center throughout the data collection period. The project coordinator entered all data into the database at the Kapiolani Clinical Research Center. When data entry was complete, original charts were taken to the University of Hawaii and copies given to Kapiolani. All data were kept locked at both locations.

Diet Records

Copies of diet records were given to the Cancer Research Center (Hawaii) for data entry and nutrient analysis. Photocopies of diet records were given to the Kapiolani Clinical Research Center to include in the patient charts and originals were kept at the University of Hawaii. The Cancer Research Center retained an electronic copy of the diet records with identities. This thesis reports on data for 48 participants who completed diet records.

Blood Laboratory Results

Fasting glucose, two- hour glucose tolerance, cholesterol, triglycerides, HDL, LDL, and Cholesterol/HDL laboratory results were delivered to the Project Coordinator and/or the Project Nurse at Kapiolani Clinical Research Center for initial review. The Project Coordinator brought lab results and copies of participant contact information to the Project Physician (Chris Derauf, MD).

The Project Physician checked each lab printout and called participants with results that were out of range. The Project Physician referred participants at risk with and provided them with appropriate medical advice and answered questions. Fifty-six participants completed all blood laboratory testing.

Mailed Results

At the end of data collection and data entry, the Project Coordinator copied laboratory results for each participant. Each participant was mailed a copy of their glucose and lipid blood laboratory values, DEXA % body fat and DEXA Bone Mineral Density result. Explanation letters for DEXA results and blood laboratory results were sent along with the study physician's (Chris Derauf, MD) contact information in the mailed packets.

Department of Health pamphlets for nutrition and exercise were approved by the IRB and included in the mail out packets. The Project Coordinator also compiled a list of clinics on Oahu for those individuals without insurance or a Primary Care Physician.

Mailed Results:

- Blood lab results slip
- Blood lab results letter
- DEXA % fat
- DEXA Bone Mineral Density
- DEXA results letter
- Oahu Clinic Referral List
- Nutrition Pamphlet
- Exercise Pamphlet

A total of 57 women came to scheduled clinic appointments at the Kapiolani Clinical Research Center. One participant was unable to complete the DEXA due to positive pregnancy test. One participant did not bring or mail in the background and health questionnaire and did not provide documentation of Samoan ethnicity. Data were complete for 48 participants. This thesis reports on 55 complete background, health, physical activity questionnaires and 48 complete clinical measures and dietary data.

Data Analysis

Clinical Measures

The Project Coordinator entered all data for the study at the Kapiolani Clinical Research Center. Data for all questionnaires, clinical measures and laboratory results were entered using a database developed using Microsoft Access (Redmond, WA) program. The database was developed at Kapiolani Clinical Research Center by Mike Wieneke. All data (including records and questionnaires) were double entered and verified by Joanne Mor. Data analysis was performed at the Kapiolani Clinical Research Center Gold Bond Building and the University of Hawaii using SPSS version 12.0 (Chicago, IL) and the SAS System for Windows version 8.0.

Dietary Data

The Food Composition Table Manager was used to analyze the diet records. This computerized nutrient analysis program is comprised of the USDA Nutrient Database for Standard Reference, Release 13 (1999) and the local Pacific recipes developed by the Cancer Research Center of Hawai'i, which contain 132 nutrients and other food components for 2200 foods and 1500 dietary supplements. Diets were entered in duplicate by two different people. The nutritionist examined entries for discrepancies and the Project Coordinator researched Samoan food recipes and ingredients not in the database.

Data Cleaning

Questionnaires

The first level of data cleaning compared discrepancies between entry one and entry two. A printout was obtained with the identity and questionnaire answer for clarification. The Project Coordinator verified with the original charts and corrected mis-entered data.

The second level of data cleaning checked for missing questionnaires and entries. When data were missing from the database, the Project Coordinator checked the original chart and corrected the entry in question. The third level checked for outliers by calculating the frequencies, means, maximum and minimum values of every continuous variable. Data were checked for normality. To achieve approximate normality, the logarithm of total blood triglycerides was calculated. Means and standard deviations were calculated for groups. Calculated variables included weight, height, body mass index (BMI), ethnicity, physical fitness $V0_{2peak}$ and log blood triglycerides (Table 1).

Ethnicity

Ethnic background of the parents was screened in the background questionnaire. Based on the inclusion criteria, each participant was at least 50 percent native Samoan. This thesis contains data for 55 completed clinical measures, background, health and physical activity questionnaires.

Calculated Variables

Table 1. Calculated Variables for Weight, Height, Body Mass Index (BMI), Ethnicity, Physical Fitness $V0_{2peak}$ and Log Triglycerides

Calculated variable	**Formula**	Units
Weight	Weight in kilograms (weight (lbs)/ 2.2)	kg
Height	Height in cm (Height (inches) * 2.54)	cm
BMI	Weight (Kg)/(Height in m)^2	kg/m^2
Ethnicity **Pure Samoan** **Blended Samoan**	(Mother's percent ethnicity/2) + (Father's percent ethnicity/2) 100 Percent Samoan 51-99 Percent Samoan	% % %
DEXA Fat Tissue Percent	Fat Mass (g)/ (Fat (g) + Lean (g)) * 100	%
DEXA Fat Region Percent	Fat Mass/ (Fat (g) + Lean (g) + Bone (g)) * 100	%
DEXA Lean Tissue Percent	Lean Mass (g)/ (Fat (g) + Lean (g)) * 100	%
Fitness Level	$V0_2$ peak = 56.363 + 1.921 (PAR) - 0.382 (Age)-0.754 (BMI)	ml/kg/min
Log Blood Triglycerides	Log (Blood Triglycerides)	mg/dl
Percent Calories From Fat, Protein, Carbohydrate	Kcal of Fat, Protein, Carbohydrate/Total Kcal * 100	%

CHAPTER 3. RESULTS

3.1 BASIC CHARACTERISTICS OF PARTICIPANTS

Age, Percent Ethnicity and Education

This section contains the descriptive statistics of 55 participants with a complete set of clinical measures. Ethnicity was categorized as pure Samoan or blended Samoan but ($\geq$ 50% Native Samoan Ethnicity). Table 2 describes the basic characteristics including age, percentage of Samoan ethnicity and education for the 55 Samoan participants. The mean age of participants was 22 and the mean number of years of education was 14. The average percentage of pure Samoan ethnicity among all participants was 84.

Table 2. Basic Characteristics of Samoan Participants

Variable	N	Mean	Standard Deviation	Range
Age (yrs)	55	22	2.5	18 -28
Samoan Ethnicity (%)	55	84	18	51-100
Pure Samoan (%)	20	100	0	100-100
Blended Samoan (%)	35	72	16	51-99
Education (yrs)	55	14	2	12-18

Age frequency distribution for Samoan participants between the ages of 18 to 28 years.

The mean age of Samoan women in this study was 21.8 years as shown in Table 3

Table 3. Age of Participants (N= 55)

Age (yrs)	**Frequency**	**Percent**
18	5	9.1
19	5	9.1
20	10	18.2
21	5	9.1
22	12	21.8
23	9	16.4
24	2	3.6
25	1	1.8
26	2	3.6
27	2	3.6
28	2	3.6

Anthropometry and Body Mass Index (BMI)

Table 4 summarizes the anthropometric data for participants. The mean weight and height of participants were 87.2 kg (192 lbs) and 166.6 cm (5ft 5 in) respectively. The average BMI was 31.3 kg/m^2.

Table 4. Anthropometric Characteristics of Samoan Women (N=55)

Variable	N	Mean	SD	Min	Max
Weight (kg)	55	87.2[1]	20.1	49.1	137.2
Height (cm)	55	166.6[2]	6.5	154.2	181.6
BMI (kg/m^2)	55	31.3	6.5	18.3	43.5
Sitting Height (cm)	54	126.0	6.7	117.0	168.7
Shoulder Circumference (cm)	54	120.9	12.4	94.0	141.1
Waist Circumference (cm)	55	92.0	13.1	69.5	118.6
Hip Circumference (cm)	55	115.7	12.8	86.6	145.2
Calf Circumference (cm)	55	43.0	5.3	25.5	54.5

[1]192 lbs
[2]5 ft 5 in

Body Mass Index (BMI), Weight, Waist Circumference and DEXA Total Body Fat Percent by Ethnicity

Table 5 examines the differences in weight, waist circumference, Body Mass Index (BMI) and DEXA total body fat percent between pure Samoans (100%) and blended Samoans. A T-test was conducted to compare waist circumference, BMI and DEXA total body fat percent between the two groups. Samoan blends included combinations of Samoan and Caucasian, Samoan and Asian, Samoan and Pacific Islander, and Samoan and Native American.

Weight, waist circumference and BMI were all significantly different when comparing pure Samoans with blended Samoan blends where pure Samoans were larger. DEXA body fat percent was not significantly different between pure Samoans and blended Samoans.

Table 5. Anthropometry and DEXA Body Fat Percent by Ethnicity T-test[1]

Variables	**Pure Samoan (N=20) Mean ± SD**	**Blended Samoans (N=35) Mean ± SD**	**T Value**	**P Value**
Weight (kg)	*95.2 ± 18.2	82.3 ± 20.0	-2.30	0.03
Waist (cm)	*97.4 ± 11.7	87.7 ± 13.5	-2.69	0.01
BMI (kg/m^2)	*33.8 ± 6.0	30.0 ± 6.6	-2.14	0.04
DEXA Fat (%)	42.5 ± 5.5	40.6 ± 7.0	1.00	0.31

* $P < 0.05$ significantly greater among pure Samoans

[1] Comparison between ethnic groups

Blood Lipids and Blood Glucose by Ethnicity

Table 6 examines the differences in blood lipids and glucose levels by ethnicity between pure Samoans (100%) and blended Samoans with a minimum of 50% Samoan ethnicity. A T-test was conducted to compare the difference in blood lipids and glucose levels between the two groups. Samoan blends included combinations of Samoan and Caucasian, Samoan and Asian, Samoan and Pacific Islander, and Samoan and Native American.

There were no significant differences in blood lipid and cholesterol levels between pure Samoans (100%) and blended Samoans with a minimum of 50% Samoan ethnicity.

Table 6. Blood Lipids and Glucose levels by Ethnicity T-test[1]

Variables	**Pure Samoan (N=20) Mean ± SD**	**Samoan Blends (N=35) Mean ± SD**	**T Value**	**P Value**
Fasting Glucose (mg/dl)	93.45 ± 11.89	91.43 ± 6.94	0.70	0.49
Two-Hr OGTT (%)	102.48 ± 34.01	98.69 ± 25.30	0.43	0.67
Triglycerides (mg/dl)	156.35 ± 27.14	162.34 ± 30.60	-0.75	0.46
Log Triglycerides (mg/dl)	4.41 ± 0.42	4.46 ± 0.50	-0.37	0.72
Total Cholesterol (mg/dl)	89.30 ± 36.00	98.63 ± 58.85	-0.73	0.47
LDL Cholesterol (mg/dl)	87.25 ± 25.20	89.83 ± 28.00	-0.35	0.73
HDL Cholesterol (mg/dl)	51.40 ± 11.53	52.83 ± 12.51	-0.43	0.67
Total Chol/HDL (mg/dl)	3.18 ± 0.88	3.25 ± 0.99	-0.26	0.79

National BMI Categories for Normal, Overweight and Obese

Table 7 shows the Body Mass Index (BMI) characteristics of Samoan participants compared to the current national and international cut-points established by the NIH and the WHO. Eighty percent of the women were overweight or obese according to national and NIH obesity cut-points. Combining obesity class I, II and III results in 58 percent of women classified as obese according to the National Institutes of Health (NIH) (NIH et al., 2000; CDC, 2002).

Table 7. Body Mass Index by National Cut-Points[1] (N=55)

Category	**BMI (kg/m^2)**	**Frequency (N)**	**Percent (%)**
Underweight	< 18.5	1	2
Normal	18.5-24.9	10	18
Overweight	25 -29.9	12	22
Obese Class I	30 -34.9	15	27
Obese Class II	35 -39.9	10	18
Obese Class III	$\geq$ 40.0	7	13

[1](NIH et al., 2000; CDC, 2002)

Waist Circumference Characteristics of Participants

Waist circumference is used to estimate a patient's abdominal fat and often provides an independent prediction of risk above that of BMI (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004; CDC, 2002). Table 8 shows the results of waist circumference measurements in comparison to the NIH categories.

A waist circumference of greater than 88.0 cm is defined as high risk for diabetes and cardiovascular disease. There were 36 (65.4%) participants with a waist circumference greater than 88.0 cm, and therefore at high risk for type 2 diabetes and cardiovascular disease according to the NIH (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004; CDC, 2002).

Table 8. Waist Circumference Compared to National[1] Cut-points (N=55)

Waist Circumference Cut-Point	**Frequency (N)**	**Percent (%)**
≤ 88.0 cm	20	36.4
>88.0 cm	36	65.6

[1](NIH et al., 1998; NIH et al., 2000; NIH et al., 2004; CDC, 2002)

DEXA Body Composition

Whole Body Dual-Energy X-ray Absorptiometry (DEXA) body composition results are shown in Table 9. Total body fat and lean tissue were defined based on the Lunar Prodigy DEXA criteria. Regional Percent Fat is defined as regional body fat mass (g) divided by the sum of fat mass (g), lean mass (g) and bone mass (g) multiplied by 100.

Table 9. DEXA Tissue Fat[1], Region Fat[2] and Lean Percent and Bone Density (N=55)

Variable	**N**	**Mean**	**SD**	**Min**	**Max**
Total Body Tissue Fat (%)	55	42.75	6.58	26.96	57.68
Total Body Region Fat (%)	55	41.30	6.51	25.77	55.57
Total Body Lean Tissue Percent (%)	55	57.25	6.58	42.32	73.04
Bone Density (g/cm^2)	55	1.23	0.08	1.06	1.39

[1] Calculated from fat and lean tissue mass (fat (g)/ (fat (g) + lean (g)) * 100
[2] Calculated from fat, lean tissue and bone mass (fat (g)/ (fat (g) + lean (g) + bone (g)) * 100
[3] Calculated from fat and lean tissue mass (lean (g)/ (fat (g) + lean (g)) * 100

Physical Activity

Table 10 shows physical activity level from the NASA Physical Activity Rating questionnaire (PAR-Q) (Ross et al., 1990).

The mean physical activity rating for participants was 2.7, approximately 10 to 60 minutes per week of recreation or work requiring moderate physical activity (Ross et al., 1990). Forty seven percent of participants reported little or no regular physical activity according to the NASA PAR-Q (Ross et al., 1990).

Table 10. Physical Activity Rating Questionnaire Results and Corresponding Physical Activity Level[1] (N=55)

PAR Level	**Time (min/wk)**	**Definition of Activity Level**	**N**	**%**
0-1		*Do not participate regularly in programmed recreation sport or heavy physical activity*	26	47.3
2	10-60	*Participate regularly in recreation or work requiring moderate physical activity such as golf, weight lifting, yard-work, table tennis, bowling*	3	5.5
3	> 60		10	18.2
4	<30	*Participate regularly in physical exercise such as running, jogging, swimming, cycling, rowing, tennis, basketball*	3	5.5
5	30-60		3	5.5
6	60-180		6	10.9
7	>180		4	7.3

[1](Ross et al., 1990)

Physical Fitness

Cardiorespiratory fitness level ($V0^2_{peak}$), also referred to as the maximum oxygen uptake was assessed with a non-exercise based prediction formula (Jackson et al., 1990) and reported as $V0^2_{peak}$ (ml/kg/min). The prediction model uses known factors that are determinants of physical condition such as age, BMI and physical activity ranking from the Physical Activity Rating questionnaire (PAR-Q) developed by NASA (Ross et al., 1990).

Physical fitness levels results are shown in Table 11. Physical Activity Rating, BMI and age were applied to the prediction equation and were used to predict aerobic capacity for participants. A healthy range for physical fitness $V0_{2peak}$ among women age 20-29 years is considered to be approximately 33.0-36.9 (ml/kg/min) (Curtis, 2004).

Table 11. Physical Fitness $V0_{2peak}$[1] (values ml/kg/min) (N=55)

Variable	**N**	**Mean**	**SD**	**Range**	**Reference Range**[2]
$V0^2_{peak}$ (ml/kg/min)	55	29.4	8.1	16.8- 44.7	33.0-36.9

[1] $V0_2$ peak = 56.363 + 1.921 (PA-R) - 0.382 (Age)-0.754 (BMI) (Jackson et al., 1990)
[2] Adapted from (Curtis, 2004)healthy for women 20 to 29 years of age

Nutrient Intakes from Three-Day Diet Records

Forty-eight participants out of the total of 55 completed three-day diet records after recording their diets for Sunday, Monday and Tuesday prior to the clinic visit. Nutrient intake results from the three-day diet record averaged over three days are shown below in Table 12.

The mean and standard deviation of total caloric intake was 2323.0 $\pm$ 992.4 kcal/day. Percent of total calories from protein was 13.8 $\pm$ 3.2 %. The mean percent of total calories from fat was 38.1 $\pm$ 6.3 % and mean percent of calories from carbohydrate was 47.9 $\pm$ 7.3 %.

Table 12. Daily Nutrient Intake Averages for Participants (N=48)

Variable	N	Mean	SD	Min	Max	Reference[1]
Total Calories (kcal)	48	2323.0	992.4	712.1	5848.9	2368
Total Protein (g)	48	78.4	30.6	20.4	141.2	46
Total Fat (g)	48	97.6	46.0	40.7	285.2	30
Carbohydrate (g)	48	280.4	130.9	68.6	696.0	130
Total Fiber (g)	48	11.7	5.4	4.0	25.8	25
Percent Calories from Protein (%)	48	13.8	3.2	8.0	20.8	10 -15 %
Calories from Fat (%)	48	38.1	6.3	25.4	51.5	25 -30%
Calories from Carbohydrates (%)	48	47.9	7.3	34.0	63.3	55-60%

[1] (Institutes of Medicine of the National Academies, 2002)

Blood Glucose, Lipid and Cholesterol Test Results

Results for fasting blood glucose, two-hour glucose tolerance test, blood lipids and cholesterol tests are presented in Table 13. The mean fasting and post-prandial glucose levels were within normal range compared to clinical guidelines.

The average total cholesterol level was 160.2 mg/dl corresponding to the normal cholesterol range. Mean LDL, HDL and total cholesterol to HDL cholesterol ratio levels were also within the normal range according to standard guidelines (National Cholesterol Education Program (NCEP), 1988).

Table 13. Fasting, Oral Glucose Tolerance Test, and Blood Lipids[1] (N=55)

Variable	**N**	**Mean**	**SD**	**Min**	**Max**
Fasting glucose (mg/dl)	55	92.2	9.0	67	122
2-Hour glucose (mg/dl)	55	100.1	28.5	58	178
Cholesterol (mg/dl)	55	160.2	29.3	103	241
Triglycerides (mg/dl)	55	95.2	51.5	32	280
HDL-Cholesterol (mg/dl)	55	52.3	12.0	32	81
LDL-Cholesterol (mg/dl)	55	88.9	26.8	34	141
Total Cholesterol/HDL-Cholesterol	55	3.2	.94	1.57	5.43

[1](National Cholesterol Education Program (NCEP), 1988)

Fasting blood glucose and two- hour oral glucose tolerance test results are presented according to laboratory reference values in Table 14. Diagnostic criteria are indicated according to clinical guidelines (ADA, 1969; ADA, 1997).

Current recommendations from the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus of the American Diabetes Association are a diagnosis of diabetes based on fasting plasma glucose levels $\geq$ 126 mg/dl and Oral Glucose Tolerance Test level OGTT $\geq$200 mg/dl (ADA, 1997).

Table 14. Fasting Blood Glucose and Glucose Tolerance Test Outcomes by Diagnostic Category[1] (N=55)

Diagnostic Criteria	**Low** (mg/dl)	**Normal** (mg/dl)	**High** (mg/dl)
Fasting Glucose Test	<70	70-110	>110
Frequency (N)	1	51	3
Percent (%)	2	93	5
Oral Glucose Tolerance Test	<70	70-140	> 140
Frequency (N)	5	42	8
Percent (%)	9	76	15

[1](ADA, 1997)

Blood Lipids and Cholesterol and Clinical Reference Ranges

Total triglyceride and cholesterol profiles (total cholesterol, LDL cholesterol, HDL cholesterol and total-cholesterol/HDL-cholesterol results by clinical diagnostic criteria according to clinical guidelines (National Cholesterol Education Program (NCEP), 1988)are shown in Table 15.

Table 15. Blood Cholesterol and Lipid Outcomes by Diagnostic Category[1] (N=55)

	Normal	Borderline High	High
Cholesterol (mg/dl)	<200	200-240	≥ 240
Frequency (N)	49	5	1
Percent (%)	89	9	2
	Normal	Borderline High	High
Triglycerides (mg/dl)	<150	150-200	> 200
Frequency (N)	48	4	3
Percent (%)	87	7	5
	Normal	Low	High
HDL (mg/dl)	> 39	40-60	≥ 60
Frequency (N)	30	6	19
Percent (%)	55	11	34
	Optimal	Above Optimal	High
LDL (mg/dl)	<100	100-130	>130
Frequency (N)	35	17	3
Percent (%)	61	34	5
	Ideal	Average Risk	≥ Average Risk
Cholesterol/HDL Ratio (mg/dl)	<3.5	3.5-4.5	> 4.5
Frequency (N)	34	15	6
Percent (%)	62	27	11

[1](National Cholesterol Education Program (NCEP), 1988)

Total triglyceride and cholesterol profiles according to clinical diagnostic criteria (National Cholesterol Education Program (NCEP), 1988) and BMI, weight and waist circumference are shown in Table 16.

Table 16. Blood Lipid and Cholesterol Results by Diagnostic Criteria and BMI, Waist, Circumference and Weight [1]

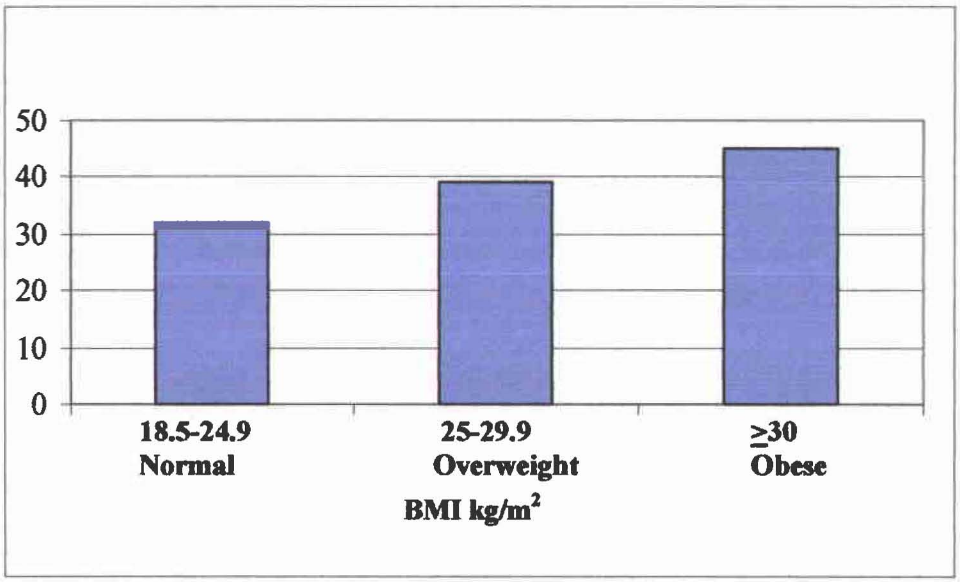
Lipids by Category	**N**	**%**	**BMI (kg/m^2) mean ± SD**	**Waist (cm) mean ± SD**	**Weight (kg) mean ± SD**
Triglycerides (mg/dl)					
Normal < 150	48	87	30.8 ± 6.7	89.5 ± 13.4	85.1 ± 20.2
Borderline High 150-200	4	7	35.8 ± 2.1	106.4 ± 9.6	106.1 ± 11.3
High ≥ 200	3	5	34.6 ± 4.9	98.4 ± 7.8	95.6 ± 15.2
Cholesterol (mg/dl)					
Normal < 200	49	89	31.2 ± 6.5	91.2 ± 14	86.7 ± 19.3
Borderline High 200-240	5	9	33.0 ± 8.3	91.5 ± 13.1	94.3 ± 30.0
High ≥ 240	1	2	29.3 ± 0	89.7 ± 0	81.4 ± 0
LDL (mg/dl)					
Optimal < 100	35	61	30.1 ± 6.5	90.3 ± 13.4	83.4 ± 19.4
Above optimal 100-130	17	34	33.2 ± 6.1	92.9 ± 14.8	93.4 ± 17.9
High >130	3	5	35.0 ± 8.5	92.6 ± 12.1	96.5 ± 37.3
HDL (mg/dl)					
Normal > 39	30	55	32.4 ± 6.0	93.2 ± 13.3	90.1 ± 18.5
Low <40	6	11	35.6 ± 6.0	100.6 ± 12.0	96.2 ± 14.4
High ≥ 60	19	34	28.3 ± 3.0	85.1 ± 12.5	79.9 ± 22.5
Cholesterol/HDL (mg/dl)					
Ideal <3.5	34	52	29.3 ± 6.3	87.0 ± 13.6	81.1 ± 19.2
Average Risk 3.5-4.5	15	27	34.0 ± 6.0	97.7 ± 11.4	96.7 ± 19.5
> Average Risk > 4.5	6	11	36.6 ± 4.4	99.3 ± 9.8	98.3 ± 13.5

[1](National Cholesterol Education Program (NCEP), 1988)

3.2 BODY SIZE MEASURES AND DEXA BODY COMPOSITION

The graph in figure 1 shows the relationship between BMI by category (x-axis) and DEXA body fat percent (y-axis). Obesity classes I, II, and III were combined in order to create groups based on normal, overweight and obese classifications.. These results show an increase in percentage of body fat with increased elevations in BMI category according to the current national and international cut-points.

Figure 1 BMI[1] Categories by DEXA Total Body Percent[2]

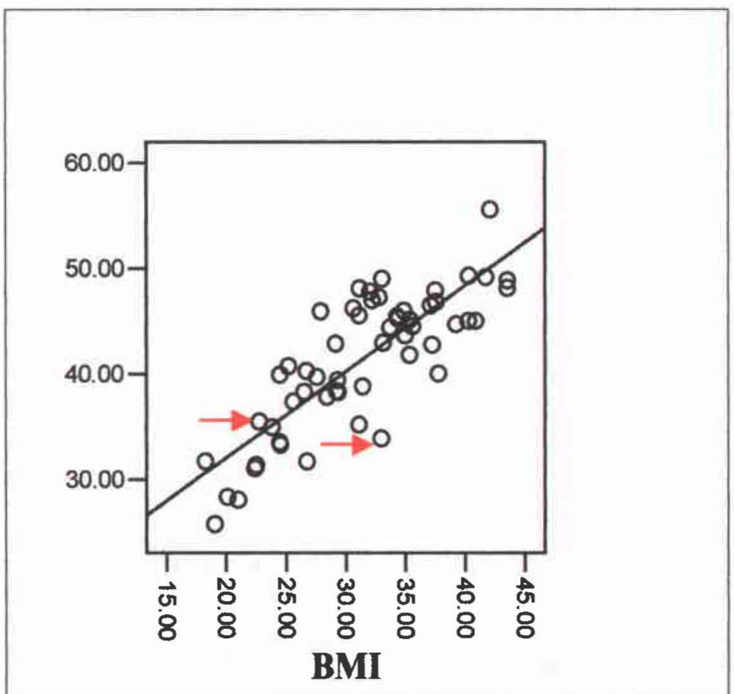


[1]X-Axis, BMI (kg/m2) Categories for Normal BMI, 18.5-24.9, overweight BMI 25-29.9, obese BMI ≥ 30 (NIH et al., 2000)
[2]Y-Axis, DEXA body fat percent: (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100

Figure 2 presents a scatter-plot with BMI range represented on the x-axis and DEXA total body fat percent on the y-axis for Samoan participants age 18 to 28. Each BMI value and corresponding body fat percentage are presented in order to examine the relationship between BMI and body fat percent values that are specific to each individual.

The scatter-plot shown in figure 2 demonstrates an increasing trend in percentage of total body fat with higher BMI values (R-Squared, 0.672). However, its is important to note each individual plot, as there are participants that have substantially lower BMI values with higher body fat percent. Similarly there are participants with higher BMI values and lower body fat percentage (BMI).

Figure 2. Scatter-plot of BMI[1] range and DEXA Total Body Fat Percent[2]



[1]X-Axis, BMI (kg/m^2) body mass index rang
[2]Y-Axis, DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100

Body size measures that are currently used in clinical settings in order to categorize healthy weights and associated risk for chronic disease include BMI and waist circumference (NIH et al., 2000). In this study, DEXA body fat percentage was also measured in order to compare the study population with present "healthy body size" assessment methods.

Table 17 presents the correlation matrix of different body size and composition measures among Samoan women participants. All body size measures were significantly correlated. BMI was highly significantly related to DEXA total body fat percent (r = 0.82) and abdominal circumference (r = 0.93). DEXA total body fat percent was also highly positively significantly related to waist circumference (r = 0.75). Waist circumference was the only body size measure marginally significant and positive in relation to age (r = 0.29).

Table 17. Correlations of BMI, Waist Circumference and DEXA Total Body Fat Percent[1] (N=55)

Variable	BMI (kg/m^2)	Total Body Fat (%)	Waist Circumference (cm)	Age (yrs)
BMI (kg/m^2)	1.00			
Total Body Fat (%)	0.82***	1.00		
Waist Circumference (cm)	0.93***	0.75***	1.00	
Age (yrs)	0.24	0.076	0.29*	1.00

[1] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
***$P \leq 0.0001$
*$P \leq 0.05$

Nutrient Intake, BMI, Waist Circumference and DEXA Total Body Fat Percent

Correlations between nutrient values and BMI, waist circumference and DEXA total body fat percent from 48 participants were calculated from three-day diet records. Mean total protein intake was the only nutrient variable significantly positively related to BMI and waist circumference both at $r = 0.31$.

There were no significant relationships between total calories, fat, carbohydrate and BMI, waist circumference and DEXA total body fat percent. There were also no significant relationships between percentage of total calories from fat, protein and carbohydrate and BMI, waist circumference and DEXA total body fat percent.

The correlations between mean total calcium, fiber and starch intake were also examined in relation to BMI, waist circumference and DEXA total body fat percent. However there were no significant relationships between these pairs of variables.

3.3 ASSOCIATIONS BETWEEN VARIABLES

BMI, weight, waist circumference, DEXA total body fat percent and Total Triglycerides

To examine the relationship between body size and health indicators, simple linear regression analysis was used to test the association between body mass index, body weight and abdominal circumference on total triglyceride and cholesterol levels (mg/dl). Total triglyceride level results were not normally distributed and therefore the log triglyceride was computed and used in analysis.

Table 18 presents the results from simple linear regression used to test the relationship between BMI and total triglyceride levels. In this regression model, BMI was independently and positively related to the log of total triglyceride levels. Body weight was independently positively related the log blood triglyceride levels.

Simple linear regression analysis between waist circumference and log blood triglyceride levels demonstrated that waist circumference was significantly positively related to the log of blood triglyceride levels (Table 19). However, DEXA total body fat percent was not significantly related to the log of total triglycerides.

Table 19. Simple Linear Regression of Log Triglyceride on (mg/dl)[2] BMI, Weight, Waist Circumference[1] and DEXA Total Body Fat Percent[3] (N=55)

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**T Value**	**Adjusted R-Square**
Model 1	**BMI (kg/m^2)**	0.02*	0.010	2.13	0.61
Model 2	**Weight (kg)**	0.007*	0.003	2.29	0.73
Model 3	**Waist Circumference (cm)**	0.011*	0.005	2.32	0.75
Model 4	**DEXA body fat (%)**	0.008	0 .010	0.84	0.008

[1] Weight, waist in kg and cm average of anthropometry measurements
[2] Dependent Variable: Log of blood triglycerides (mg/dl)
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
*$P \leq 0.05$

BMI, weight, waist circumference, DEXA total body fat percent and total cholesterol

Simple linear regression analysis was used to test the relationship between BMI and total cholesterol levels (Table 20). BMI was not significantly related to total cholesterol levels. However, total body weight and waist circumference were significantly positively related to total cholesterol levels (mg/dl) among Samoan women participants age 18 to 28 years.

DEXA total body fat percent was not significantly related to levels of total cholesterol (mg/dl) with simple linear regression analysis as shown in Table 20. However, body fat percent was positively related to total cholesterol levels.

Table 20. Simple linear Regression of Total Cholesterol[2] on BMI, Weight, Waist Circumference[1], DEXA Total Body Fat Percent[3] (N=55)

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	**BMI (kg/m^2)**	2.03	1.05	0.49
Model 2	**Weight (kg)**	0.718*	0.338	0.06
Model 3	**Waist Circumference (cm)**	1.094*	0.518	0.06
Model 4	**DEXA total body fat (%)**	0.95	0.55	-0.09

[1] Weight in kg and waist in cm, average of anthropometry measurements
[2] Dependent Variable: Total cholesterol levels (mg/dl)
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
*$P \leq 0.05$

BMI, weight, waist circumference, DEXA total body fat percent and LDL cholesterol

Table 21 shows the results of simple linear regression with BMI and LDL cholesterol. In Model 1 BMI was highly positively significantly related to LDL cholesterol levels among Samoan participants age 18 to 28 years ($P \leq 0.007$).

Total body weight, waist circumference and DEXA total body fat percent were not significantly related to LDL cholesterol levels Total body weight, waist circumference and DEXA total body fat percent were not significantly related to LDL cholesterol levels as shown in Table 21, Models 1,2 and 3 respectively.

Table 21. Simple Linear Regression of LDL Cholesterol[2] on BMI, Weight, Waist Circumference[1], DEXA Total Body Fat Percent[3] with Linear Regression (N=55)

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	**BMI (kg/m^2)**	1.47**	0.52	0.11
Model 2	**Weight (kg)**	0.40	0.17	0.07
Model 3	**Waist Circumference (cm)**	0.46	0.27	0.03
Model 4	**DEXA total body fat (%)**	0.96	0.55	0.04

[1] Weight, waist in kg and cm average of anthropometry measurements
[2] Dependent Variable: LDL cholesterol levels (mg/dl)
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
*$P \leq 0.05$
***$P \leq 0.001$

BMI, weight, waist circumference, DEXA total body fat percent and HDL cholesterol

HDL cholesterol levels are influenced by total body weight and waist circumference. Simple linear regression analysis was used to test the relationship between body size measures such as BMI, weight and waist circumference among Samoan participants age 18 to 28 years.

Table 22 shows the results of simple linear regression with BMI and HDL cholesterol, total body weight and HDL cholesterol, and waist circumference and HDL cholesterol. BMI total body weight, waist circumference and DEXA total body fat percent were all highly significantly negatively associated with HDL cholesterol levels.

Table 22. Simple Linear Regression of HDL Cholesterol[2] on BMI, Weight, Waist Circumference[1], DEXA Total Body Fat Percent[3] (N=55)

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	**BMI (kg/m^2)**	-0.92***	0.22	0.23
Model 2	**Weight (kg)**	-0.24**	0.08	0.15
Model 3	**Waist Circumference (cm)**	-0.72**	0.24	0.25
Model 4	**DEXA total body fat (%)**	-0.72**	0.23	0.13

[1] Weight, waist in kg and cm average of anthropometry measurements
[2] Dependent Variable: HDL cholesterol levels (mg/dl)
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
*$P \leq 0.05$
**$P \leq 0.001$
***$P \leq 0.0001$

BMI, weight, waist circumference, DEXA total body fat percent and Total Cholesterol to HDL cholesterol ratio

The ratio of Total cholesterol to HDL cholesterol is an important indicator used in the clinical setting to diagnose risk for cardiovascular disease. Elevated total cholesterol is known risk factor for coronary heart disease, whereas HDL cholesterol levels are inversely related to coronary heart disease.

Table 23 shows the results from simple linear regression of BMI and the ratio of total blood cholesterol to HDL Cholesterol levels among Samoan participants. In this model, BMI was very highly significantly and positively related to the ratio of total cholesterol to HDL cholesterol levels ($P \leq 0.0001$).

Models 2 and 3 in Table 23 show that total body weight and waist circumference measures were independently highly significantly and positively related to total cholesterol /HDL cholesterol ratio ($P \leq 0.0009$ and $P \leq 0.0007$), respectively.

Simple linear regression analysis with DEXA total body fat percent and the ratio of total cholesterol/HDL cholesterol levels are shown in Model 4 of Table 23. In this linear regression model, DEXA total body fat percent was not significantly related to total cholesterol/HDL ratio.

Table 23. Simple Linear Regression of Total Cholesterol/HDL Cholesterol[2] on BMI, Weight, Waist Circumference[1], DEXA Total Body Fat Percent[3] (N=55)

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	**BMI (kg/m^2)**	0.07***	0.02	0.25
Model 2	**Weight (kg)**	0.02**	0.01	0.17
Model 3	**Waist Circumference (cm)**	0.03**	0.01	0.18
Model 4	**DEXA total body fat (%)**	0.95	0.55	0.04

[1] Weight, waist in kg and cm average of anthropometry measurements
[2] Dependent Variable: Total cholesterol/HDL cholesterol
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
*$P \leq 0.05$
**$P \leq 0.001$
***$P \leq 0.0001$

BMI, weight, waist circumference and fasting blood glucose levels among Samoan participants

Simple linear regression analysis was used in order to examine the relationship between BMI, total body weight, waist circumference and DEXA total body fat percentage and fasting blood glucose (Table 24).

Model 1 shows the results of simple linear regression analysis of BMI and fasting glucose levels where BMI was marginally positively significantly related to fasting glucose (P=0.051). Weight, waist circumference and DEXA total body fat were not significant indicators of glucose levels. However all factors were independently positively related to fasting glucose levels among Samoan participants.

Table 24. Simple Linear Regression of and Fasting Blood Glucose[3] on BMI, Weight, Waist Circumference[1], and Total Body Fat[2] (mg/dl).

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	**BMI (kg/m2)**	0.36	0.18	0.05
Model 2	**Weight (kg)**	0.12	0.06	0.05
Model 3	**Waist Circumference (cm)**	0.13	0.09	0.02
Model 4	**DEXA total body fat (%)**	0.22	0.19	0.01

[1] Weight, waist in kg and cm average of anthropometry measurements
[2] Dependent Variable: Fasting Blood Glucose (mg/dl)
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100

BMI, weight, waist circumference and post-prandial blood glucose levels among Samoan participants

Simple linear regression analyses were used in order to test the association between body size and composition among Samoan women participants (Table 25). BMI, weight and waist circumference were all significantly positively related to 2 hour post-prandial glucose tolerance levels (mg/dl). DEXA total body fat percent was not significantly related to 2 Hour post-prandial glucose tolerance levels (mg/dl).

Table 25. Simple Linear Regression Analyses of Two-hour Post Prandial Glucose[3] (mg/dl on BMI, Weight, Waist Circumference[1], DEXA Total Body Fat[2]

Linear Regression Model	**Independent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	**BMI (kg/m2)**	1.29*	0.57	.071
Model 2	**Weight (kg)**	0.43*	0.19	.073
Model 3	**Waist Circumference (cm)**	0.63*	0.29	.068
Model 4	**DEXA total body fat percent (%)**	0.69	0.59	.007

[1] Weight, waist in kg and cm average of anthropometry measurements
[2] Dependent Variable: Two-Hr Post-prandial glucose (mg/dl)
[3] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100

Physical Activity and Body Size and Composition

Simple linear regression analysis was used to evaluate the associations between physical activity level, BMI, abdominal circumference and DEXA total body regional percent fat among Samoan women in this study.

Table 26 presents the results of simple regression analysis with physical activity rating level from the NASA (PAR-Q) (Ross et al., 1990) and BMI, waist circumference and DEXA total body fat percent.

Physical activity level was highly significantly and negatively related to BMI, waist circumference and DEXA total body fat percent. With each increase in physical activity level, BMI decreased by 1.29 kg/m^2. Waist circumference and DEXA total body fat percent decreased by 2.47 cm and 1.42 percent, respectively with each increase in physical activity level.

Table 26. Simple Linear Regression of BMI (kg/m^2),Waist Circumference (cm) and DEXA Body Fat Percent

Regression Model	**Dependent Variable**	**Regression Coefficient**	**SE**
Model 1	BMI	-1.29	0.366***
Model 2	Waist Circumference (cm)	-2.47	0.741**
Model 3	DEXA Body Fat (%)	-1.42	0.354***

[1]Physical Activity Rating Level (0-7) (Ross et al., 1990)
** $P \leq 0.005$
*** $P \leq 0.0005$

Physical Activity Blood Glucose, Total Triglyceride and Cholesterol levels

Multiple linear regression analysis was used to test the relationship between physical activity level assessed with the Physical Activity Rating Questionnaire (PAR-Q) (Ross et al., 1990) and blood lipid levels among Samoan participants age 18 to 28 years. BMI was included in each model to control for the effects of body size.

Table 27 shows the results of multiple linear regression analysis of log triglycerides, total, LDL and HDL cholesterol and total cholesterol to HDL cholesterol ratio on physical activity level and BMI. Physical activity was significantly negatively associated with the log of blood triglyceride and total cholesterol levels. However there was not a significant association between physical activity and LDL and HDL cholesterol (Model 3 and Model 4). Physical activity was significantly related to the ratio of total cholesterol to HDL cholesterol.

Table 27. Log Triglycerides, Total Cholesterol, LDL Cholesterol, HDL Cholesterol and Total Cholesterol/HDL Cholesterol on Physical Activity[1] and BMI, Multiple Regression

Regression Model	Dependent Variable	Independent Variables	Regression Coefficient	SE	Adj. R-Sq.
Model 1	Log Triglycerides	PAR	-0.07*	0.03	0.14
		BMI	0.01	0.01	
Model 2	Total Cholesterol (mg/dl)	PAR	-7.23	3.32	0.11
		BMI	0.96*	1.12	
Model 3	LDL Cholesterol (mg/dl)	PAR	-2.58	1.70	0.24
		BMI	1.09	0.58	
Model 4	HDL Cholesterol (mg/dl)	PAR	0.77	0.72	0.13
		BMI	-0.81**	0.24	
Model 5	Total Cholesterol/HDL Cholesterol	PAR	-0.11*	0.05	0.29
		BMI	0.06**	0.02	

[1]Physical Activity Rating Level (0-7) (Ross et al., 1990)

*$P \leq 0.05$

**$P \leq 0.005$

Physical Activity and Blood Glucose

Multiple linear regression analysis with physical activity and BMI and glucose levels are presented in Table 28. Physical activity level, assessed with the NASA PAR-Q (Ross et al., 1990), was not significantly related to fasting blood glucose or 2 hour post-prandial glucose levels as shown in Models 1 and 2.

Table 28. Fasting and Two- hour Post-Prandial Glucose levels on Physical Activity[1] and BMI, Multiple Regression

Regression Model	**Dependent Variable**	**Independent Variables**	**Regression Coefficient**	**SE**	**Adj. R-Sq.**
Model 1	Fasting Blood Glucose (mg/dl)	PAR	0.10	0.60	0.03
		BMI	0.38	0.20	
Model 2	Two- hour Post Prandial Glucose (mg/dl)	PAR	-2.67	1.86	0.09
		BMI	0.90	0.63	

[1]Physical Activity Rating Level (0-7)(Ross et al., 1990)

Physical Fitness and Blood Lipids

Simple linear regression analysis of log triglycerides, total, LDL and HDL cholesterol and total cholesterol to HDL cholesterol ratio on calculated physical fitness (Jackson et al., 1990) among Samoan women participants in this study age 18 to 28 years (Table 29).

Physical fitness level was negatively significantly related to total cholesterol levels and highly significantly negatively related to blood levels of LDL. Physical fitness was highly significantly and positively related to HDL cholesterol and highly significantly and positively related to the ratio of total cholesterol to HDL cholesterol.

Table 29. Log Triglycerides, Total Cholesterol, LDL, HDL and Total /HDL Cholesterol on Physical Fitness[1], Simple Linear Regression

Regression Model	**Dependent Variable**	**Regression Coefficient**	**SE**	**Adjusted R-Square**
Model 1	Log Triglycerides	-0.02**	0.01	0.13
Model 2	Total Cholesterol (mg/dl)	-2.26**	0.82	0.11
Model 3	LDL Cholesterol (mg/dl)	-0.42	1.35	0.15
Model 4	HDL Cholesterol (mg/dl)	0.75***	0.18	0.24
Model 5	Total Cholesterol/HDL Cholesterol	-0.07***	0.01	0.30

[1]Physical fitness estimation based on NASA PAR-Q non-exercise regression model (Jackson et al., 1990)
*P≤ 0.05
**P≤ 0.005
***P≤ 0.0005

Physical Fitness and Blood Glucose

Physical fitness levels and fasting blood glucose with simple linear regression analysis are shown in Table 30. Physical fitness was not significantly related to fasting blood glucose and two- hour post-prandial glucose levels among Samoan participants in this study.

Table 30. Fasting Blood Glucose and Two- hour Post-Prandial Glucose on Physical Fitness[1], Simple Linear Regression

Regression Model	**Dependent Variable**	**Regression Coefficient**	**SE**	**Adj. R-Sq.**
Model 1	Fasting Blood Glucose (mg/dl)	-0.26	0.15	0.04
Model 2	Two-hour Post Prandial Glucose (mg/dl)	-1.26	0.46	0.11

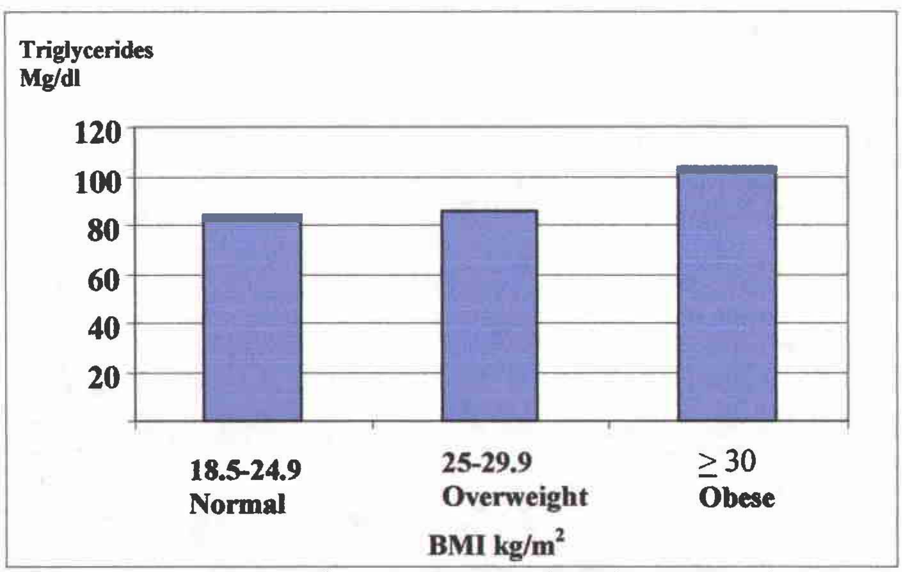
[1]Physical fitness estimation based on NASA PAR-Q non-exercise regression model (Jackson et al., 1990)

BMI Categories and Blood Lipids

BMI categories (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004) are utilized to predict risk for diabetes and cardiovascular disease. However the relationship between these categories and specific blood lipid levels among diverse ethnicities, and young Pacific Islander Americans is not well documented. BMI categories and blood lipids are presented in the following figures.

Figures 3 through 6 demonstrate changes in lipid levels with respect to BMI categories of normal (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2) and obese (BMI $\geq$ 30.0 kg/m^2). Figure 3 presents lipid outcomes for Samoan participants age 18 to 28 and living on Oahu.

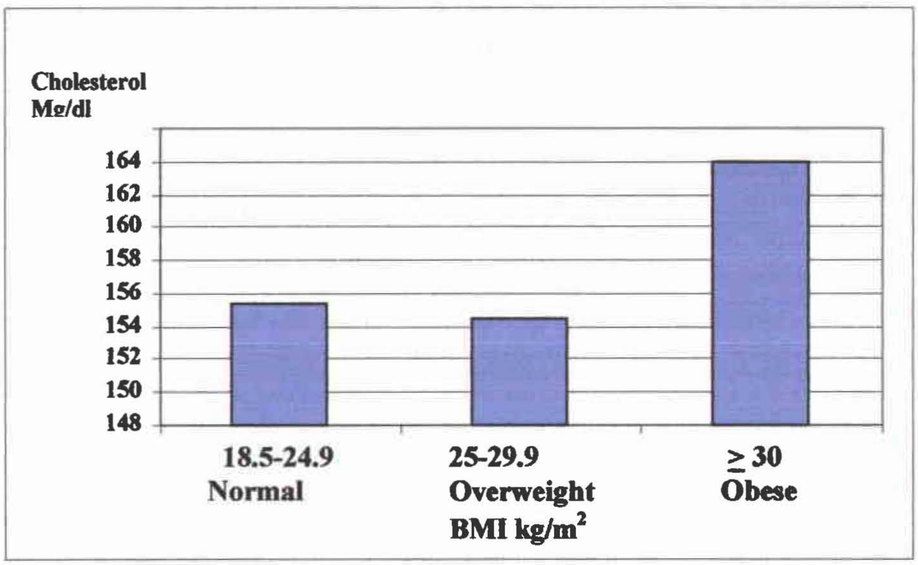
Figure 3. Categories for Normal BMI, Overweight BMI, and Obese BMI
And Total Blood Triglyceride Levels



BMI Categories, (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)

Results for total Cholesterol and BMI by category (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004) are shown below. Figure 4 demonstrates that blood cholesterol levels increased from approximately 154 mg/dl to 164 mg/dl between the overweight BMI category and the obese BMI category.

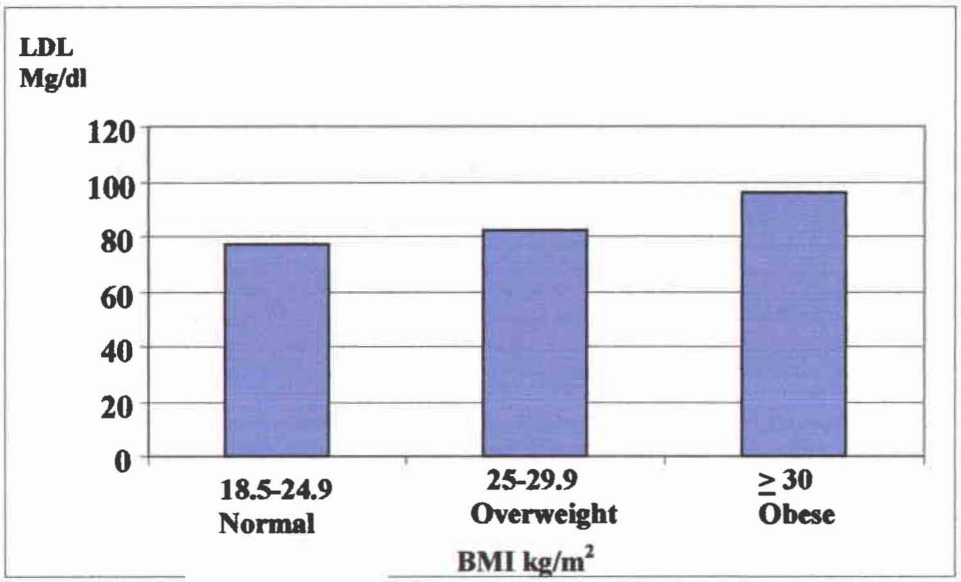
Figure 4. Categories for Normal BMI, Overweight BMI, and Obese BMI
And Total Blood Cholesterol (mg/dl)



BMI Categories, (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)

LDL cholesterol levels increased by approximately 5 mg/dl from normal BMI to overweight BMI and 18 mg/dl from the overweight BMI category to the obese category as shown in Figure 5.

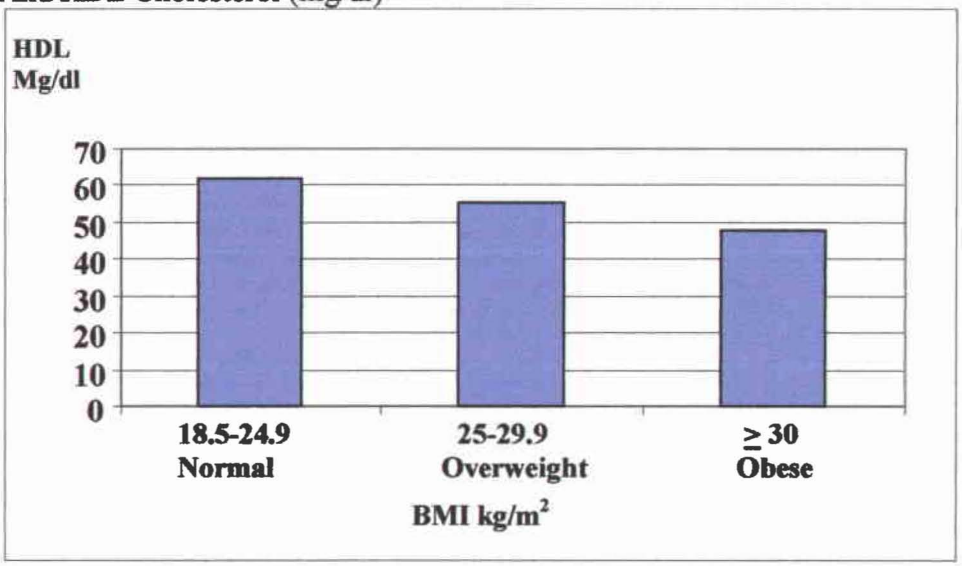
Figure 5. Categories for Normal BMI, Overweight BMI, and Obese BMI
And LDL Cholesterol (mg/dl)



BMI Categories, (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)

HDL cholesterol levels decreased by approximately 8 mg/dl from the normal to the BMI overweight BMI category and 8 mg/dl between overweight and obese (Figure 6).

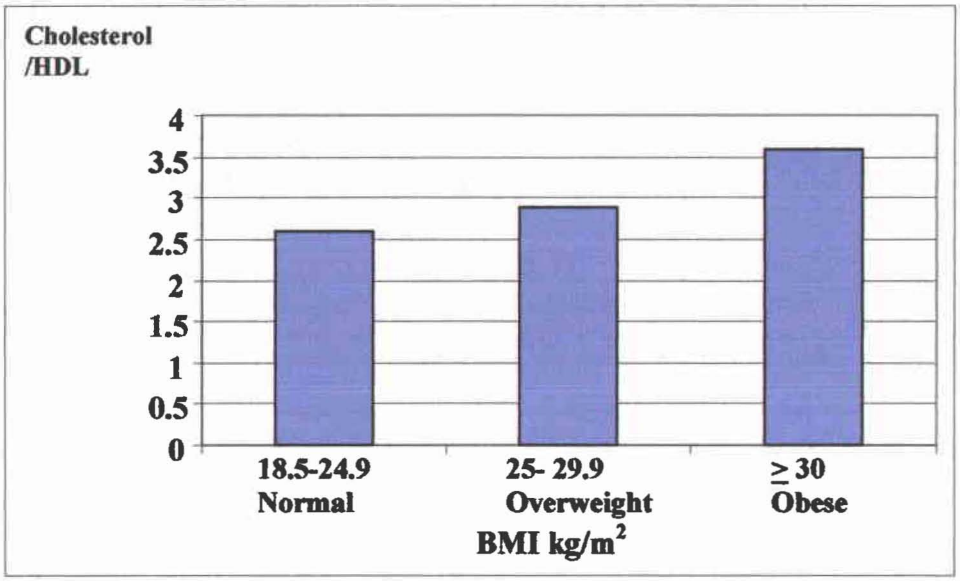
Figure 6. Categories for Normal BMI, Overweight BMI, and Obese BMI And HDL Cholesterol (mg/dl)



BMI Categories, (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)

Figure 7 graphs BMI categories for normal, overweight and obese and the total cholesterol to HDL cholesterol ratios. Between the overweight and obese categories, the total cholesterol to HDL cholesterol ratio increased by approximately 0.9.

Figure 7. Categories for Normal BMI, Overweight BMI, and Obese BMI And Total Cholesterol/HDL Cholesterol



BMI Categories, (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)

3.4 NIH AND WHO BMI AND WAIST CIRCUMFERENCE CATEGORIES BY DEXA TOTAL BODY FAT PERCENT, LIPID AND GLUCOSE

All overweight and obese adults age 18 years or older with a BMI of > 25.0 kg/m^2 are considered at risk for the development of morbidities or diseases such as hypertension, high blood cholesterol, type 2 diabetes and cardiovascular diseases (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004). Waist circumference cut-offs are used to identify increased relative risk for the development of obesity-associated risk factors in most adults.

This section examines the relationship between of current BMI and waist circumference cut-offs and body fat percent and blood lipids and glucose levels among Samoan women age 18 to 28 years.

Results from Analysis of Co-variance (ANCOVA) with BMI categories for normal, overweight and obese by key outcomes are presented in Tables 31 through 38. Age was adjusted for in all analyses. Dependent variables include DEXA total body fat percent, total triglycerides, total, LDL and HDL cholesterol and glucose levels. BMI categories for normal, overweight and obese used for analysis were BMI of 18.5-24.9 kg/m^{2,} 25-29.9 kg/m^2 and $\geq$ 30 kg/m$^{2.}$ Waist circumference of > 88.0 cm (>35 in) was defined as obese and therefore high-risk for cardiovascular disease and type 2 diabetes.

DEXA Total Body Fat Percent and BMI by Category

Table 31 presents the results of DEXA body fat percent by BMI category among Samoan participants age 18 to 28 years with ANCOVA. DEXA body fat percent was significantly greater with increasing BMI categories for normal, overweight and obese.

Table 31. ANCOVA of DEXA Total Body Fat Percent[1] by BMI Categories[2] (N=55)

	Normal-Overweight BMI 18.5-24.9 kg/m²	**Normal-Obese BMI 25-29.9 kg/m²**	**Obese-Overweight BMI $\geq$ 30 kg/m²**
Total Body Fat (%)			
Mean Percent Fat (%)	31.70 $\pm$ 1.18	38.85 $\pm$ 1.13	45.53 $\pm$ 0.70
Change in Percent Fat (%)	7.17 $\pm$ 1.61 ***	13.84 $\pm$ 1.39 ***	6.67 $\pm$ 1.34 ***

[1] DEXA Body Fat (%) = (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
[2] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)
$P \leq 0.0001$***

Table 32 presents differences in body fat percent by each BMI category for normal, overweight and obese in order to demonstrate the changes in body fat percentage with respect to current global BMI cut-offs among Samoan women in this study. DEXA body fat percentage changes were all highly significant and increased by 22.6%, 43.8% and 17.17% between normal to overweight, normal to obese and overweight to obese categories respectively.

Table 32. BMI Categories Normal, Overweight and Obese[2] and Percent Difference in DEXA Total Body Fat Percent[1] ANCOVA (N=55)

	Normal-Overweight BMI 18.5-24.9 kg/m²	**Normal-Obese BMI 25-29.9 kg/m²**	**Obese-Overweight BMI ≥ 30 kg/m²**
Change in Body Fat (%)	22.6% ***	43.8% ***	17.17% ***
Standard Error (SE)	5.1%	4.39%	3.46%

[1] DEXA Body Fat (%) = (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
[2] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)
$P \leq 0.0001$***

DEXA Total Body Fat and Waist Circumference by Category

Age adjusted ANCOVA results for waist circumference changes by category and DEXA total body fat percentage are presented in Tables 33 and 34. These results demonstrate highly significant increases in DEXA body fat percentage are associated with concurrent changes from normal risk waist circumference ($\leq$ 88.0, 35 in) to high risk waist circumference (> 88.0 cm, 35 in) categories (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004) ($P < 0.0001$) among Samoan women in this study. The mean DEXA fat percent in the normal waist circumference category was 35.03 and increased to 44.88 for those with a waist circumference greater than 88.0 cm.

Table 33. Waist Circumference by Categories for Normal and High Risk[1] And DEXA Total Body Fat Percent[2] ANCOVA (N=55)

	Normal to High Risk Categories $\leq$ 88.0 cm (35 in) to > 88.0 cm (35 in) Increase
DEXA Total Body Fat (%)	9.85 $\pm$ 1.31***

[1] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)
[2] DEXA total body fat (%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
*** $P \leq 0.0001$.

Table 34 presents the difference in body fat percent by waist circumference definitions for normal and high risk. Age-adjusted DEXA body fat increased by 28 %from normal waist circumference to high risk waist circumference and was highly significant when adjusted for age ($P \leq 0.0001$).

Table 34. Percent Change in Waist Circumference by Categories Normal and High Risk[1] and DEXA Total Body Fat Percent[2] ANCOVA (N=55)

	Normal to High Risk Categories $\leq$ 88.0 cm (35 in) to > 88.0 cm (35 in)
Change in DEXA Body fat Percent	28.1 % ***
Standard Error (SE)	3.75%

[1] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)
[2] DEXA total body fat(%), (fat tissue mass (g)/ (fat tissue (g) + Lean Tissue (g) + Bone (g)) * 100
$P \leq 0.0001$***

Differences in Total Triglycerides, Log of total Triglycerides and Total, LDL and HDL Cholesterol levels by BMI Categories

Results from Analysis of Covariance (ANCOVA) with the differences in triglycerides and cholesterol levels by BMI categories are presented in Table 35. LDL cholesterol levels were significantly different between normal and obese ($P \leq 0.05$). Differences in HDL levels were highly significant and lowered by 14.56 mg/dl in normal compared to the obese categories ($P \leq 0.0005$). Similarly, significant increases in the ratio of total cholesterol to HDL cholesterol were found from normal to overweight and overweight to obese categories ($P < 0.005$ and $P < 0.05$), respectively.

Table 35 presents results of blood lipid level differences in mg/dl by BMI category normal, overweight and obese among Samoan participants age 18 to 28 years with ANCOVA. Age of participants was adjusted for in all of the models.

Table 35. Difference in Blood Lipids by National BMI Categories[1] ANCOVA (N=55)

Blood Lipids and Cholesterol	**Normal-Overweight BMI 18.5-24.9 kg/m^2**	**Normal-Obese BMI 25-29.9 kg/m^2**	**Obese-Overweight BMI ≥ 30 kg/m^2**
Log Total Triglycerides			
Mean ± SD (mg/dl)	4.33 ± 0.14[2]	4.28 ± 0.14[3]	4.54 ± 0.08[4]
Difference in Log TGL (mg/dl)	-0.05 ± 0.19	0.21 ± 0.17	0.26 ± 0.164
Change ± SE (%)	1.15 ± 4.39	4.75 ± 3.93	6.08 ± 3.88
Total Triglycerides (mg/dl)			
Mean ± SD (mg/dl)	154.88 ± 9.13[2]	154.26 ± 8.70[3]	164.19 ± 5.37[4]
Difference in TGL (mg/dl)	-0.62 ± 12.41	9.31 ± 10.77	-9.93 ± 10.37
Change ± SE (%)	0.41 ± 8.11	6.01 ± 6.95	-6.05 ± 6.32
Total Cholesterol (mg/dl)			
Mean ± SD (mg/dl)	81.44 ± 34.01[2]	84.81 ± 15.21[3]	103.93 ± 9.40[4]
Difference in Cholesterol (mg/dl)	3.47 ± 21.73	22.59 ± 18.84	19.13 ± 18.15
Change ± SE (%)	3.27 ± 4.27	27.77 ± 23.28	22.51 ± 21.40
LDL Cholesterol (mg/dl)			
Mean ± SD (mg/dl)	76.40 ± 8.03[2]	82.10 ± 65.01[3]	95.73 ± 4.73[4]
Difference in LDL (mg/dl)	5.71 ± 10.92	19.54 ± 9.47*	13.62 ± 9.13
Change ± SE (%)	7.47 ± 14.29	26.32 ± 12.41*	16.20 ±11.21
HDL Cholesterol (mg/dl)			
Mean ± SD (mg/dl)	62.36 ± 3.31[2]	55.10 ± 3.38[3]	47.81 ± 1.95[4]
Difference in HDL (mg/dl)	-7.26 ± 4.50	-14.56 ± 3.90 ***	-7.30 ± 3.76
Change ± SE (%)	-11.64 ± 7.21	-23.01 ± 6.25 ***	-15.21 ± 7.86
Total Cholesterol/HDL (mg/dl)			
Mean ± SD (mg/dl)			
Difference in Total/HDL Cholesterol	2.56 ± 0.26[2]	2.88 ± 0.25[3]	3.58 ± 0.15[4]
(mg/dl)	0.33 ± 0.36	1.02 ± 0.31 **	0.7 ± 0.30 *
Change ± SE (%)	12.72 ± 13.91	40.21 ± 12.21 **	24.40 ± 10.41

[1] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)[2] Mean for normal BMI level
[3] Mean for overweight BMI level
[4] Mean for Obese BMI level
* P ≤ 0.05
**P ≤ 0.005
***P≤ 0.0005

Differences in Total Triglycerides, Log of total Triglycerides and Total, LDL and HDL Cholesterol levels by Waist Circumference Cut-points

Differences in lipid levels from normal waist circumference cut-point ($\leq$ 88 cm) to obese/high risk waist circumference cut-point (> 88 cm) are presented in Table 36. After adjusting for age, the log triglyceride ($P \leq 0.005$), total cholesterol ($P \leq 0.005$), LDL cholesterol ($P \leq 0.05$), HDL cholesterol ($P \leq 0.0005$), and the ratio of total cholesterol to HDL cholesterol ($P \leq 0.0005$), were all significantly higher in the high risk waist circumference category (> 88 cm).

Table 36. Differences in Blood Lipids and Cholesterol by National Waist Circumference Cut-Points[1] ANCOVA (N=55)

Blood Lipids and Cholesterol	**Waist (>88 cm)**
Log Total Triglycerides	
Log TGL (mg/dl)	0.38 ± 0.13**
Percent ± SE (%)	9.07 ± 3.10
Total Triglycerides (mg/dl)	
TGL (mg/dl)	11.52 ± 8.39
Percent ± SE (%)	7.54 ± 5.49
Total Cholesterol (mg/dl)	
Total Cholesterol (mg/dl)	37.82 ± 14.11**
Percent ± SE (%)	53.14 ± 0.20
LDL Cholesterol (mg/dl)	
LDL Cholesterol (mg/dl)	16.62 ± 7.43*
Percent ± SE (%)	21.22 ± 8.92
HDL Cholesterol (mg/dl)	
HDL Cholesterol (mg/dl)	12.81 ± 2.98***
Percent ± SE (%)	21.19 ± 4.93
Total Cholesterol/HDL (mg/dl)	
Total-Cholesterol/HDL (mg/dl)	1.01 ± 0.23 ***
Percent ± SE (%)	39.15 ± 8.91

[1] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)

* $P \leq 0.05$

**$P \leq 0.005$

Differences in Fasting and Post-prandial Glucose levels by BMI Categories

Fasting and two hour oral glucose tolerance levels by NIH and WHO categories for normal, overweight and obese with ANCOVA (Table 37). In this model, two hour post-prandial glucose was significantly higher among obese participants with a BMI of ≥ 30 kg/m^2 compared to those in the normal BMI category (18.5 – 24.9 kg/m^2).

Table 37. Differences in Blood Glucose by National BMI Categories[1] ANCOVA (N=55)

Blood Glucose	**Normal-Overweight BMI 18.5-24.9 kg/m^2**	**Normal-Obese BMI 25-29.9 kg/m^2**	**Obese-Overweight BMI $\geq$ 30 kg/m^2**
Fasting Glucose (mg/dl)			
Mean $\pm$ SD (mg/dl)	88.02 $\pm$ 2.70[2]	91.55 $\pm$ 2.57[3]	93.81 $\pm$ 1.89[4]
Difference in Fasting Blood Glucose (mg/dl)	3.53 $\pm$ 3.67	5.80 $\pm$ 3.18	2.27 $\pm$ 3.06
Percent Change $\pm$ SE (%)	4.07 $\pm$ 3.61	6.59 $\pm$ 3.61	2.48 $\pm$ 1.57
Two-hour OGTT (mg/dl)			
Mean $\pm$ SD (mg/dl)	86.30 $\pm$ 8.55[2]	94.15 $\pm$ 8.14[3]	107.00 $\pm$ 5.03[4]
Difference in Two-Hour OGTT (mg/dl)	7.85 $\pm$ 11.62	20.69 $\pm$ 10.09 *	12.84 $\pm$ 9.72
Percent $\pm$ SE (%)	9.10 $\pm$ 13.46	23.10 $\pm$ 11.69	13.64 $\pm$ 10.31

[1] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)[2] Mean for normal BMI level
[3] Mean for overweight BMI level
[4] Mean for Obese BMI level
* $P \leq 0.05$

Differences in Fasting and Post-prandial Glucose levels by Waist Circumference Cut-Points

Excess abdominal fat is an independent predictor of risk factors for obesity related morbidities and is positively correlated with abdominal fat content (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004). Furthermore, increased abdominal circumference is a known risk factor associated with impaired glucose tolerance and type 2 diabetes and obesity.

Table 38 shows the differences in fasting and two-hour post-prandial glucose levels from among Samoan participants from normal waist circumference to high risk (>88 cm) waist circumference. Two hour glucose tolerance levels were significant higher among participants in the high risk waist circumference category compared to normal risk (P<0.005).

Table 38. Differences in Blood Glucose by National Waist Circumference Cut-Points[1] ANCOVA (N=55)

Blood Glucose	**High Risk Waist Circumference (>88 cm)**
Fasting Glucose (mg/dl)	
Difference in Fasting Glucose (mg/dl)	3.89 ± 2.52
Percent Change ± SE (%)	4.34 ± 2.81
Two-hour OGTT (mg/dl)	
Difference in Two-Hr OGTT (mg/dl)	24.43 ± 7.54 **
Percent Change ± SE (%)	28.91 ± 8.92

[1] (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004)
**$P \leq 0.005$

3.5 CORE REGRESSION MODELS

Ethnicity, Physical Activity, Diet and DEXA Total Body Fat Percent

Multiple linear regression analysis was used to test the role of physical activity, total energy, dietary fat, calcium intake, percent Samoan ethnicity and age on DEXA total body fat percent and BMI among Samoan women age 18 to 28 years. Table 39 shows the results of multiple linear regression with DEXA body fat percent as the dependent variable.

In this model, physical activity was significantly negatively related to DEXA total body fat percent ($P<0.005$). Percent of Samoan ethnicity was also significant and positively related to DEXA total body fat percent ($P<0.01$). Total energy intake, dietary calcium and mean total fat intake were not related to DEXA total fat percent.

Table 39. Multiple Linear Regression[1] Dependent Variable: DEXA Fat Percent

Independent Variables	**Regression Coefficient**	**SE**	**T Value**	**P Value**
Physical Activity (PAR)	-1.48	0.44	-3.36	0.001**
Calories (kcal)	0.001	0.002	0.56	0.58
Total Fat (g)	-0.03	0.05	-0.71	0.48
Total Calcium (mg)	0.0007	0.004	0.16	0.87
Samoan (%)	12.35	4.72	2.61	0.01*
Age (yrs)	-0.01	0.32	-0.03	0.98

** $P\leq 0.001$
* $P\leq 0.01$
[1]Adjusted R-square = 0.28

Ethnicity, Physical Activity, Diet and BMI

Multiple linear regression analysis was used to test the role of physical activity, total energy, dietary fat, calcium intake, percent Samoan ethnicity and age on body mass index (BMI). In this model, physical activity was significantly negatively related to BMI. In addition Samoan ethnicity was also significant and positively related to BMI when age was included in the model as shown in Table 40.

Table 40. Multiple Linear Regression[1] Dependent Variable: BMI (kg/m^2)

Independent Variables	Regression Coefficient	SE	T Value	P Value
Physical Activity (PAR)	-1.40	0.41	-3.44	0.001***
Calories (kcal)	0.001	0.002	0.57	0.57
Total Fat (g)	-0.04	0.045	-0.85	0.39
Total Calcium (mg)	0.003	0.004	0.92	0.37
Samoan (%)	14.32	4.39	3.26	0.002**
Age (yrs)	0.44	0.30	1.48	0.14

** $P \leq 0.005$
*** $P \leq 0.001$
[1]Adjusted R-square = 0.014

Blood Lipids and Glucose, Waist Circumference and DEXA Total Body Fat Percent

Multiple linear regression analysis was used to examine the influence of total body fat percent and waist circumference on blood triglycerides, lipids and two-hour post-prandial glucose. Both waist circumference and DEXA total body fat were included in the model as independent variables to examine the independent relationship of these variables on lipids and glucose.

Table 41 shows that waist circumference was positively significant in relation to the log triglycerides, total cholesterol, and the ratio of total cholesterol to HDL cholesterol when total body fat was included in the model. Waist circumference was highly negatively significantly related to HDL cholesterol.

Table 41. Blood Lipids and Blood Glucose on DEXA Body Fat Percent and Waist Circumference, Multiple Linear Regression, N=55

Dependent Variable	Independent Variables	Regression Coefficient	SE	Adj. R-Sq
Two-hour OGTT (mg/dl)	Body Fat (%)	-0.60	0.87	0.59
	Waist Circumference (cm)	0.86	0.43	
Log Triglycerides	Body Fat (%)	0.02	0.01	0.87
	Waist Circumference (cm)	0.02*	0.007	
Total Cholesterol (mg/dl)	Body Fat (%)	2.03	1.57	0.07
	Waist Circumference (cm)	1.15*	0.77	
HDL Cholesterol (mg/dl)	Body Fat (%)	-0.03	0.33	0.23
	Waist Circumference (cm)	-0.46**	0.17	
LDL Cholesterol (mg/dl)	Body Fat (%)	0.58	0.83	0.24
	Waist Circumference (cm)	0.25	0.41	
Total /HDL Cholesterol	Body Fat (%)	0.008	0.03	0.17
	Waist Circumference (cm)	0.03*	0.01	

* $P \leq 0.05$
** $P \leq 0.005$

Summary of Significant Findings

Table 42. Summary of Significant Associations

	BMI	**Waist (cm)**	**DEXA Body Fat %**	**Log Triglycerides (mg/dl)**	**Total Cholesterol (mg/dl)**	**LDL Cholesterol (mg/dl)**	**HDL Total Cholesterol (mg/dl)**	**Total /HDL cholesterol (mg/dl)**	**Two-hour OGTT (mg/dl)**
BMI				* Positive Association		** Positive Association	*** Negative Association	*** Positive Association	* Positive Association
Weight	*** Positive Association			* Positive Association	* Positive Association		** Negative Association	** Positive Association	* Positive Association
Waist (cm)	*** Positive Association		*** Positive Association	* Positive Association	* Positive Association		** Negative Association	** Positive Association	* Positive Association
DEXA Fat (%)	*** Positive Association						** Negative Association		
Physical Activity	*** Negative Association	*** Negative Association		* Negative Association	* Negative Association				
Physical Fitness				** Negative Association	* Negative Association	** Negative Association	*** Positive Association	*** Negative Association	*** Negative Association

***P≤0.0005
** P≤0.005
** P≤0.05

CHAPTER 4. DISCUSSION

BODY SIZE REFERENCE VALUES IN RELATION TO OUTCOMES AMONG SAMOAN WOMEN IN THIS STUDY

BMI and Waist Circumference

The current global definitions for overweight and obesity are BMI of $\geq$ 25.0 kg/m^2 and > 30.0 kg/m^2, respectively (NIH et al., 1998; NIH et al., 2000; NIH et al., 2004; CDC, 2000; CDC, 2002). According to these criteria, 81% of the Samoan women in this study were overweight or obese and 58 percent were obese. Recent National Health and Nutrition Examination Survey (NHANES) 1999-2000 reported that 64% of US adults age 20 to 74 also met these criteria (NHIS NHANES, 2000; CDC, 2000). Therefore, there appears to be a 17 percent greater prevalence of these defined categories among the Samoan women age 18 to 28 years in this study compared to the national average of men and women with a larger and older age range.

Furthermore, in this study, 64 % of Samoan women were classified as obese (waist > 88.0 cm) according to the NIH definitions based on waist circumference (NIH et al., 1998; NIH et al., 2000). Therefore, according to national waist circumference cut points, 64 percent of the women were obese and at high risk for the development of type 2 diabetes and cardiovascular disease.

Studies conducted in American Samoa by McGarvey et al., 1995 reported an overweight prevalence of 73 percent among Samoan women age 25 to 34 years in 1990 which was significantly greater than 1976- 1978 ($P<0.03$) where overweight prevalence reached 63 percent (McGarvey, 1995). Other studies have also described the continued increase in overweight and obesity among modern Samoans living in California, Hawaii, American Samoa and Samoa (Bindon et al., 1986; Bindon, 1988; Pawson & Janes, 1981).

The combined findings of previous studies and this present research clearly demonstrate that obesity is a major health issue among Samoans and young Samoan women in particular. Moreover, appropriate action is necessary in order to decrease the further progression of this identified concern.

BODY SIZE REFERENCE VALUES IN RELATION TO DEXA BODY COMPOSITION

BMI, Waist Circumference and DEXA total Body Fat Percent

In this study of Samoan women age 18 to 28, DEXA total body fat among women of normal, overweight and obese BMI categories was 32 %, 36 % and 46 % respectively. These differences in percent body fat by DEXA were highly significant ($P \leq 0.0001$) and increased across all National Institutes of Health (NIH) categories (CDC, 2002; NIH et al., 2000; Pawson et al., 1981).

Similarly, DEXA body fat was significantly greater ($P \leq 0.0001$) among women with a waist circumference over 88.0 cm and increased from 35 to 44 percent from the normal to NIH obese/high-risk waist circumference category (CDC, 2002; NIH et al., 2000; Pawson et al., 1981). Thus, increased BMI by category was not due to an increase in percentage of muscle mass among the Samoan women in this study.

However, Figure 2 demonstrates the variation in the range of BMI with DEXA total body fat percent compared to the BMI categories. Clearly, there are individuals classified with a "normal" BMI of less than 25 kg/m^2 that have DEXA measured body fat greater than some individuals classified as "obese" class I and II. Hence, BMI classifications are beneficial instruments by which to assess body fat, although further study of misclassification of the predictive value of BMI is desirable.

BODY SIZE REFERENCE VALUES IN RELATION TO HEALTH RISK INDICATORS

BMI Categories, Blood Glucose and Blood Lipids

To evaluate the effectiveness of BMI categories in relation to risk for type 2 diabetes and cardiovascular disease, National Institutes of Health cut-points for normal, overweight, and obese BMI (CDC, 2002; NIH et al., 2000; Pawson et al., 1981) were graphed by blood lipid and glucose outcomes as shown in Figures 3 through 7. According to these categories, blood glucose tolerance levels increased with each increase in BMI category.

Blood lipids including total triglycerides, LDL-cholesterol and the ratio of total cholesterol to HDL-cholesterol also showed an increasing trend with each elevation in BMI by category. Two hour post-prandial glucose levels were significantly greater in the obese BMI (≥ 30 kg/m^2) category compared to the normal BMI category (18.5-29.9 kg/m^2) ($P \leq 0.05$).

These results demonstrate that total lipid and cholesterol levels increased with each BMI category and that national BMI cut-points are useful tolls to estimate increase in risk for the development of cardiovascular disease measured by blood lipid levels.

Differences in Blood Glucose and Blood Lipids by BMI Categories

ANCOVA of lipid levels by BMI category confirm that significant differences in LDL cholesterol, HDL cholesterol, and total cholesterol/HDL ratio levels from normal to obese and overweight to obese categories were evident. Similarly, post-prandial blood glucose levels were significantly higher among persons classified as obese compared to normal BMI category. These findings support the utilization of current national BMI cut-points as appropriate measures related to health risk indicators among the Samoan women in this study. However, further investigation of the predictive ability of these categories is necessary.

Waist Circumference Categories and Blood Lipids and Blood Glucose

Waist circumference is a significant predictor of impaired glucose tolerance and increased risk for type 2 diabetes (ADA, 1997; CDC, 2002; NIH et al., 2000; WHO, 2004). Janssen et al., (2004) found that waist circumference rather than BMI explained obesity-related co-morbidities, namely type 2 diabetes and cardiovascular disease (Janssen, Katzmarzyk, & Ross, 2004).

Sixty four percent of the Samoan women age 18 to 28 in this study were classified as obese according to the NIH definition for waist circumference > 88.0 cm (Aluli, 1991; Inoue et al., 2000; NIH et al., 2004) and, "high risk" for type 2 diabetes and CVD (Aluli, 1991; Inoue et al., 2000; NIH et al., 2004) a slightly higher number then the 58 percent identified as obese using BMI.

Differences in Blood Glucose and Blood Lipids by BMI Categories

Waist circumference classifications for normal (<88.0cm) and obese (> 88 cm) by lipids and glucose with ANCOVA were significantly positively associated with an increase in blood triglycerides, total cholesterol, LDL cholesterol, ratio of cholesterol to HDL and blood glucose (P<0.0001). Waist circumference classifications for normal (<88.0cm) and obese (> 88 cm) were highly significantly associated with decreased mean HDL cholesterol levels among Samoan women in this study (P<0.0001). Two-hour post prandial glucose levels were also significantly greater among those classified as obese, waist circumference > 88.0 cm compared to those classified as normal with a waist circumference ≤ 88.0 cm.

These results suggest that national waist circumference cut-points were positively related to an increase in health risk indicator levels measured in this study and according to national waist circumference cut points, over 60 percent of the women in this study are obese and at "high risk" for the development of type 2 diabetes and cardiovascular disease. Furthermore, waist circumference cut-points for normal and obese appeared to be as adequate as BMI in relation to health risk indicators measured in this study.

Therefore, waist circumference categories may be a more practical means than BMI for assessment of obesity related health risk indicators. Moreover, waist circumference has been found to be more related to impaired glucose tolerance and risk for type 2 diabetes (Janssen et al., 2004; Kissebah & Peiris, 1989) than BMI due to the small sample size in this study. Waist circumference, having only 2 categories, gains statistical power over BMI.

SAMOAN ETHNICITY, BODY SIZE AND HEALTH RISK INDICATORS

BMI, Waist Circumference and Ethnicity

BMI, weight and waist circumference were all significantly different between pure Samoan women and blended Samoans in our study, where pure Samoan women had higher measurements compared to Samoan blends. Coyne et al, found that 75 % of Samoan women were overweight or obese, and that these rates were among the highest in the world (Coyne, 2000; NIH et al., 2004). Similarly, studies conducted by (NIH et al., 2004; Swinburn et al., 1995; Swinburn et al., 1999) comparing BMI between Europeans, Maori and Samoans, reported an average BMI of 33.3 kg/m^2 among Samoan women compares to 25.1 kg/m^2 among European women age 20 to 70 years.

Multiple linear regression showed that percent Samoan ethnicity was significant and positively associated with DEXA total body fat percent ($P \leq 0.05$) and BMI ($P \leq 0.005$) respectively, when age was included in the model. Moreover, DEXA body fat percent increased by over 12 percent as percentage of Samoan ethnicity increased from 50 to 100 percent pure Samoan. BMI increased by 14 percent as Samoan ethnicity increased from 50 to 100 percent pure Samoan. Thus, DEXA total body fat and BMI were positively significantly related to percentage of Native Samoan ethnicity.

These findings support the possible racial or ethnic influence on body size among Samoan women age 18 to 28 years in this study. However, DEXA total body fat was not significantly different comparing pure Samoan women to Samoan blended women. Further study is necessary to elucidate whether the differences detected are due to genetic variation or unmeasured lifestyle factors influencing body size.

BMI, Waist Circumference Ethnicity and Health Risk Indicators

All 55 Samoan women participants in this study were age 18 to 28 years and recruited from varied settings. Therefore the variability was somewhat widespread, considering the small population size. However, pure Samoan women were larger with respect to BMI, total body weight and waist circumference. These findings in conjunction with other studies suggest that Samoan ethnicity may be a key factor related to the increase in overweight and obesity among Samoan women.

In contrast, the significant differences in most blood lipids and two-hour post-prandial glucose across BMI and waist circumference categories demonstrate that health risk indicators increased with body size and were not significantly different among pure Samoans compared to Blended Samoans. Thus, while ethnicity appears to influence the physiology of Samoan women, BMI and waist circumference measures were related to health risk indicators for obesity related diseases for the majority of the women in this study.

LIFESTYLE PATTERNS IN RELATION TO BODY SIZE MEASURES AND HEALTH RISK INDICATORS

Physical Activity and Current Guidelines

The mean physical activity rating (PAR) was 2.7 from the NASA PAR -Q. This activity level corresponds to approximately 10 to 60 minutes per week, or less than 10 minutes per day of recreation or work that requires moderate physical activity (Ross et al., 1990). The average PAL among adults reported in the 2002 DRI was approximately 1.6, which reflects a physical activity habit of walking 5 to 7 miles per day at an approximate speed of 3 to 4 miles per hour (Institutes of Medicine of the National Academies, 2002a; National Academy of Sciences, 2002). Sparling (1997) reported and average physical activity level of 1.3 (0-4), a level corresponding to a sedentary lifestyle among Samoan women living in Samoa (Sparling, 1997).

Thus, compared to the current Dietary Reference Intake 2002 recommendation of 60 minute per day, the mean physical activity level in this study was approximately 50 minutes per day or 5 hours per week less than the current DRI recommendations (Institutes of Medicine of the National Academies, 2002a; National Academy of Sciences, 2002). American College of Sport Medicine currently recommends 30 minutes per day of moderate physical activity and questions the practicality of the DRI's 60 minute per day recommendations (ACSM, 1998). The opportunity for improvement and implementation of increased physical activity among the Samoan women in this study is evident.

Physical Activity, BMI, Total Body Fat Percent and Waist Circumference

In order to examine the relationship between physical activity and body size, PAR level results from the NASA PAR-Q in this study were examined in relation to body size and composition measures. Physical activity was significantly and highly negatively associated with BMI ($P \leq 0.0009$) and DEXA total body percent fat ($P \leq 0.0002$) and waist circumference ($P \leq 0.0002$) with simple linear regression.

Multiple regression analysis showed that physical activity level among Samoan women in this study from the NASA PAR-Q was very highly significant and negatively related to DEXA total body fat percent ($P \leq 0.001$) controlling for age, total calories, fat, calcium, age and percent Samoan were included in the model. Similarly, PAR level was very highly significant and negatively related to body mass index outcomes ($P \leq 0.001$).

There were no significant associations between physical activity and BMI among Samoan women and men living in Samoa as reported by Sparling (1997). The tool used to measure physical activity was different in this study and thus may explain the differences in associations (Sparling, 1997). However, among the Samoan women age 18 to 28 years in this study, regular physical activity in this study was associated with a decreased risk for the development of overweight and obesity as well as improving total body fat percentage, even when total energy is held constant.

Physical activity level was highly significantly and negatively associated with both DEXA body fat percent and BMI as shown in Tables 38 and 39. These multiple regression models were adjusted for age, total energy, dietary fat and percentage of Samoan ethnicity. The physical activity results from this study suggest that physical activity clearly is beneficial in decreasing total body fat percent and BMI despite high intake of total dietary energy and macronutrients.

Physical Activity and Health Risk Indicators

Physical Activity Rating was negatively and significantly related to log triglycerides, total cholesterol and the ratio of total cholesterol to HDL cholesterol when BMI was included in the model. However there were not significant relationships between HDL cholesterol, fasting and post-prandial glucose levels. These results suggest that physical activity may favorably influence blood triglycerides, total cholesterol and LDL cholesterol levels independently of BMI. However the effects of physical activity on HDL cholesterol may occur through a decrease in BMI, percentage of total body fat and abdominal circumferences.

Multiple linear regression analysis with physical activity, age, total calories, fat, calcium, age and percent Samoan included in the model showed that physical activity levels were highly significant and negative in relation to the ratio of total cholesterol to HDL cholesterol ($P \leq 0.01$) and positively associated to HDL cholesterol ($P \leq 0.01$). Therefore physical activity is a potential modifiable factor in relation to body size, improved blood lipid and cholesterol profiles and glucose tolerance and may function independently from the effects of diet and total energy.

Physical Fitness and Health Risk Indicators

The fitness variable ($V0^2_{peak}$) in this study (ml 0^2/kg/min) was highly significantly associated with log triglycerides ($P \leq 0.005$), total cholesterol ($P \leq 0.01$), LDL cholesterol ($P \leq 0.005$), HDL (0.001) and the ratio of total cholesterol to HDL cholesterol levels ($P \leq 0.0001$). In relation to blood glucose outcomes, physical fitness level ($V0^2_{peak}$) was significantly related to two-hour post-prandial glucose levels ($P \leq 0.01$) but not fasting blood glucose.

The variable used ($V0^2_{peak}$) to estimate fitness level, includes BMI, age and physical activity rating (PAR-Q) levels in the prediction model. Calculated physical fitness was highly significantly and negatively related to all of the blood lipids measured and two- hour post-prandial glucose levels among Samoan women in this study. The physical fitness tool used was the best proxy indicator of risk for the development of overweight, obesity and related diseases examined in this study.

Physical Fitness and Current Guidelines

The mean physical fitness level or aerobic capacity was 29.4 ($V0^2_{peak}$) as predicted from the non-exercise prediction equation (Jackson et al., 1990; Ross et al., 1990).Therefore, the average maximum capacity for oxygen consumed per minute was approximately 30 ml/kg/minute. This amount corresponds to an approximate 8.4 METs (Metabolic Energy Equivalents), where 1 MET is the equivalent of 3.5 ($V0^2_{peak}$). The prediction equation used in this study was validated among sedentary women with < 9 MET fitness criterion, and no significant difference was found between actual and predicted mean $V0^2_{peak}$ in the sample (Jackson et al., 1990; Williford et al., 1996). The same study concluded that the non-exercise based prediction equation provided an estimate of $V0^2_{peak}$ that was similar to other tests employing actual sub maximal testing.

Jackson et al., (1990) reported that one of the main limitations of the non- exercise based physical fitness assessment models was the inaccurate predictions of $V0^2_{peak}$ among highly fit individuals because the PAR-Q scale highest value is the equivalent of running over 10 miles per week and that highly fit individuals would exceed this (Jackson et al., 1990). However, the mean PAR-Q rating in this study was 2.7. Therefore the PAR-Q physical activity level scale and prediction equation were an appropriate assessment tools for this population and the physical fitness level results from this study indicate that the women in this study were in "fair" physical condition compared to reference values (Curtis, 2004).

Nutrient Intake and Current Guidelines

Dietary intake in this study was assessed with three day diet records for the Sunday, Monday and Tuesday prior to clinical visits. The mean daily total calories, protein, fat and carbohydrate in this study were 2323 kcal, 78.4 (g), 97.6 (g), and 280.4 (g), respectively. The mean percentages of daily total calories from protein, fat and carbohydrate were 13.8%, 38.1% and 47.9 % respectively.

Compared to the current DRI of 30-35 grams of protein, 25-30 grams of fat and 130 grams carbohydrate, the average intake was twice the current DRI recommendation for protein and carbohydrate and approximately three-times the DRI recommendation for total daily fat intake (Institutes of Medicine of the National Academies, 2002; Institutes of Medicine of the National Academies, 2002; National Academy of Sciences, 2002).

Nutrient Intake, BMI, Total Body Fat Percent and Waist Circumference

In relation to body size and composition, Pearson partial correlation analysis results showed that total calories, total fat grams, carbohydrate grams were not significantly related to BMI, DEXA total body fat percent or abdominal circumference. Mean total protein intake (g) was however, significantly related to both BMI and waist circumference. These results suggest that among the Samoan women age 18 to 28 years, the direct relationship of dietary intake and body size was only significant for total protein intake.

This deserves further investigation as the small sample size for diet records (N=48) and error in dietary measurement is high. Baker et al., (1986) conducted cross-sectional studies among Samoans and found significantly positive associations between total energy and all macronutrients and BMI among Samoan migrant adolescents and adults in Hawaii (Baker et al., 1986; Bindon et al., 1986). Cross-sectional studies by Bindon et al., (1986) also found positively significant elevations in BMI and blood pressure among Samoan migrants in Hawaii compared to those in American Samoa and Samoa (Bindon et al., 1986; Bindon, 1988).

However, it is important to note that the long-term effects of this diet may not be captured among women of younger ages as in this study.

4.2 LIMITATIONS

Cross-sectional Design

This study was cross-sectional and therefore does not show causal effects of an intervention on behavior. However, this study provides potential hypotheses regarding contributory relationships between independent and dependent variables that warrant future research. Clearly, future longitudinal studies examining the relationship between lifestyle factors such as lifestyle, obesity, cardiovascular disease and type 2 diabetes Samoan women and other Pacific Islanders are necessary.

Population

This study was conducted among Samoan women living on Oahu and does not represent those Samoan women living on other Hawaiian islands, American Samoa, Samoa, and the U.S. Mainland. Women were students, friends or family and affiliated with the Universities on Oahu and therefore may not represent all levels of education. Participants already aware of their health may have participated and may be already more physically fit or have healthier dietary habits or those seeking information about their health who suspected risk.

Diet Records

Under-reporting in diet records and in particular total energy intake is common (Little et al., 1999). The mean caloric intake reported in study was approximately 2300 kcal/day. This number, along with other nutrient results for women may be lower than actual intake values. Diet records often under report total energy intake. In addition, mixed dishes that are reported in diet records may differ from the individual foods within the nutrient database. Furthermore, there were only 48 total diet records analyzed. Therefore, the sample size lacked statistical power for diet analysis and therefore did not show significant relationships.

Physical Activity Questionnaire

The NASA Physical Activity Rating Questionnaire (PAR-Q) (Ross et al., 1990) that was used in this study contains 8 levels for participants to select ranging from 0 to 7. The physical activity level selected is then applied to the non-exercise based physical fitness assessment equation in order to estimate physical fitness level. The NASA PAR-Q was originally validated among a population of sedentary women (Ross et al., 1990). However, this questionnaire was not validated among women of Pacific Islander heritage and may not be representative of the types of physical activity among this population.

The results from this study are based on 55 Native Samoan women living on Oahu and 48 completed diet records. Therefore, the applicability of findings from this study for the Samoan population as a whole remains in question. Similarly, women were age 18 to 28 years and recruited through college settings and relatives of college students. Thus the population in this study may not be representative of the Samoan population.

Background and Health Questionnaires

The background and health questionnaires were used to assess family background and ethnicity information for participants. Ethnicity was self reported and therefore may have errors in calculation of each parent and child ethnicity.

4.3 FUTURE STUDIES

The aim of this study was to examine the current physical activity, nutrient intake and lifestyle patterns among Samoan women living on Oahu. Samoan women are currently experiencing among the greatest rises in obesity, type 2 diabetes and cardiovascular disease in the world. In addition, this study examined the relationships between body size measures and body composition with Dual Energy X-Ray Absorptiometry (DEXA).

An ideal study would follow changes in lifestyle factors such as body size, body composition and risk for type 2 diabetes and cardiovascular disease. A lifestyle intervention design and implementation of culturally appropriate physical activity would be beneficial for the Samoan community and other Pacific Islanders.

CHAPTER 5.CONCLUSION

Current BMI and Waist Circumference Cut-Points

This study found that both BMI and waist circumference were significantly related to DEXA total body fat percent. When BMI values were categorized based on current national and international cut-points, there was an increase in DEXA total body fat percent, although over the range of BMI there were not consistent increases in DEXA total body fat percent for all individuals.

BMI and waist circumference measurements categorized according to national reference values were significantly related to an increase in DEXA total body fat percent, blood lipids and cholesterol and glucose levels among Samoan women in this study. Therefore, the national BMI reference values appear to be appropriate for estimating health risk indicators among the Samoan women in this study.

Ethnicity, Body Size and Composition

Pure Samoan women demonstrated higher BMI and body fat percent by DEXA than blended Samoan women in this study. Whether this is due to a genetic or unmeasured lifestyle factor remains to be determined.

National data and results from this study clearly demonstrate that obesity prevalence is extremely high and appears across ethnicities. Therefore, culturally appropriate measures are necessary in order to prevent the increase in obesity and obesity-related diseases.

Appendix A. Background and Health Questionnaire

Samoan Women's Health Assessment
University of Hawaii, Kapiolani Clinical Research Center

Background Questionnaire

Today's date:___________ /__________ /__________
(Month) (Day) (Year)

What is your full name:
(Last)__________________ (first)__________________(Middle) ________________
Home Phone Number: ____________________________
Cell Phone: ___________________________
Business: ___________________________
Pager: ______________________________
Email address: ____________________________

If you attend college, what is the name of the university or college that you attend?
____

I. Birth History

What is **your** age? ________ years

Where were **you** born

American Samoa ____ Samoa_____ Hawaii _____ Other (write in) _________

Where were **your mother and father** born?

Mother
American Samoa ____ Samoa_____ Hawaii _____Other (write in) __________

Father
American Samoa ____ Samoa_____ Hawaii _____Other (write in) __________

What was **your** birth weight _______**(grams)**

How were **you** fed after you were born? Please pick 1.

Breast How many weeks_________

Bottle (formula) How many weeks_________

6. At what age was formula introduced?

Weeks______ or months_________or never__________

II. Education

How many years of education have you completed?

_____Years

What is the your last level of education obtained?

____ Did not complete high school
____ Completed high school
____ Completed post high school training, excluding college (trade school or business school)
____ Completed some college/community college
____ Graduated from a four-year college or university
____ Attended and/or completed graduate school
____ Other (specify): ______________________________________

III. Ethnicity

What is your ethnicity

Samoan _____

Other 1 ______(write in)

Other 2 ______(write in)

Other 3 _____(write in)

What is the ethnicity of your biologic **mother** and **father**?

	Mother	Father
Samoan	______	______
Tongan	______	______
Hawaiian	______	______
White	______	______
Japanese	______	______
Chinese	______	______
Filipino	______	______

Other (please specify): ____

Health Questionnaire

I. Menstrual history

11. When was the first day of your last menstrual period?

Month / Day / Year

12. Are you presently using birth control?

YES /NO/ DONT KNOW

a. If yes, how long have you been taking birth control pills?
_______ **Months**

b. What brand of birth control pills are you currently using?

____

c. Have you taken any other brand?

YES /NO/ DONT KNOW

d. If so, please name the other brand:

____

13. If you do **NOT** take birth control pills:

How would you describe your menstrual periods?

________ Very regular (you could always predict when they would start within 3 days)
________ Regular
________ Irregular
________ No periods

If you are **CURRENTLY** taking birth control pills:

How would you describe your menstrual periods 12 months before taking birth control pills?

________ Very regular (always predict when would start within 3 days)
________ Regular
________ Irregular
________ No periods

14. Have you ever been pregnant?

YES / NO

If yes, was it a live birth?

YES / NO

15. Have you ever breastfed?

YES / NO

16. Do you smoke?

YES / NO

a. How long have you been smoking?

_________ Years _________ months

b. How many cigarettes do you smoke per day?

17. Do you take any medications for asthma?

YES / NO

18. If YES, please describe the medicines you take for asthma.

19. Are you currently taking any medication?
If yes please name the medication and reason for taking
Name _________________
Reason_______________________

21. Have you ever broken any bones?

YES / NO

22. If Yes, when and which bone(s) have you broken?

Bone	Month and year broken
	________ **Month** ________ **Year**
	________ **Month** ________ **Year**
	________ **Month** ________ **Year**
	________ **Month** ________ **Year**
	________ **Month** ________ **Year**
	________ **Month** ________ **Year**

Comments: ____

Initials:__________ **Date Reviewed:** ______________

Appendix B. Physical Activity Rating Questionnaire (PAR-Q)

Physical Activity Rating Questionnaire
Use the appropriate number (0-7) which BEST DESCRIBES your general ACTIVITY LEVEL for the PREVIOUS MONTH:

DO NOT PARTICIPATE REGULARLY IN PROGRAMMED RECREATION SPORT OR HEAVY PHYSICAL ACTIVITIY

0 = Avoid walking or exertion (always use elevator, drive instead of walking)

1 = Walk for pleasure, routinely use stairs, occasionally exercise sufficiently to cause heavy breathing or perspiration

PARTICIPATE REGULARLY IN RECREATION OR WORK REQUIRING MODEST PHYSICAL ACTIVITY, SUCH AS GOLF, HORSEBACK RIDING, CALISTHENICS, GYMNASTICS, TABLE TENNIS, BOWLING, WEIGHT LIFTING, YARDWORK.

2 = 10 to 60 minutes per week.

3 = Over one hour per week.

PARTICIPATE REGULARLY IN HEAVY PHYSICAL EXERCISE SUCH AS RUNNING OR JOGGING, SWIMMING, CYCLING ROWING, SKIPPING ROPE, RUNNING IN PLACE OR ENGAGING IN VIGOROUS AEROBIC ACTIVITY TYPE EXERCISE SUCH AS TENNIS BASKETBALL OR HANDBALL

4 = Run less than 1 mile per week OR spend less than 30 minutes per week in comparable activity such as running

5 = Run 1 mile to less than 5 miles per week OR spend 30 to 60 minutes per week participating in comparable physical activity.

6 = Run 5 miles to less than 10 miles per week OR spend 1 hour to 3 hours per week participating in comparable physical activity.

7 = Run over 10 miles per week OR spend over 3 hours per week participating in comparable physical activity.

YOUR OVERALL LEVEL OF ACTIVITY:______

Appendix C. Diet Record

Diet Record Form Date: ______________ DAY OF WEEK: __________

Who is this for?	✓ You! Please complete this Diet Record.
When & Where?	✓ List foods immediately after you eat them for the dates shown above. ✓ Keep this form with you at all times so that you can record your intake whenever you eat. ✓ Record one food item per line.
What did you eat?	✓ Write down everything that you eat and drink throughout your assigned days and nights (4 a.m. to 4 a.m. the next day).
Describe it accurately.	✓ Be as specific as possible. ✓ Include cooking method used to prepare food e.g. baked, broiled, fried, canned, fresh, frozen. ✓ Include brand names whenever possible. ✓ Describe liquid included in canned foods e.g. tuna in water, sliced peaches in heavy syrup. ✓ Include additions such as sugar drink or milk.
How much did you eat?	✓ Record only the portions that you ate. ✓ Estimate amount using collapsible cup and ruler attached to the back of the Diet Record Forms. ✓ Record the amount of oil added in cooking.

We are interested in finding out what you normally eat. Please do not change your eating habits during the diet-recording period.

Example:

TIME	**PLACE**	PREPARED BY	**WHAT YOU ATE**	**DESCRIPTIONS OF WHAT YOU ATE**	**AMOUNT**
8:30 am	Kitchen	Self	Scrambled eggs	2 large, white eggs, 1 Tablespoon canola oil, 1/8 cup onions and 1 Tablespoon ketchup	3/4 Cup
8:30 am	Kitchen	**Self**	**Banana**	Apple Banana, 3 inches	1 Banana
8:30 am	Kitchen	**Self**	**Milk**	4% Milk, Viva brand, Vitamin A fortified	1 Cup
12:30 pm	Campus	**Paradise Palms**	**Rice**	White, medium-grain rice	1 & 1/2 cups
12:30 pm	Campus	**Paradise Palms**	**Chicken Stir fry**	1 cup chicken, without Skin, ½ cup bean sprouts, ½ cup mixed veggies (carrot, celery), 2 Tablespoons Canola oil	2 & 1/4 cups
12:30 pm	Campus	**Starbucks**	**Cookie**	Chocolate Chip	1 Large
12:30 pm	Campus	**Paradise Palms**	**Sprite**	Medium with 1 Cup Ice	2 Cups
12:30 pm	Campus	**Paradise Palms**	**Water**	Plain	1 Cup
3.00 pm	Friend's house	**Self -served**	**Coke**	Regular, with 1 Cup Ice	2 Cups
3.00 pm	Friend's house	**Self**	**Potato Chips**	Lays Sour Cream and Onion	1 Cup
7:00 pm	Home	**Self**	**Apple**	Medium Granny Smith	1 Medium
7:00 pm	Home	**Self**	**Pasta**	Spaghetti Noodles, Marinara Sauce, Parmesan Cheese,	2 Cups noodles, ½ Cup sauce, 1 Tablespoon cheese
7:00 pm	Home	**Self**	**Garlic Bread**	2 Pieces, 2 Tablespoon Butter, ¼ Teaspoon garlic	2 Pieces
7:00 pm	Home	**Self**	**Water**	Plain	12 Oz

Comments:____

Date: ________________ Day: ______________________ ID #: ____________________

TIME	***PLACE***	PREPARED BY	WHAT YOU ATE	DESCRIPTIONS OF WHAT YOU ATE	AMOUNT

Appendix D. Eligibility Checklist

Samoan Women's Health Assessment Study University of Hawaii, Kapiolani Clinical Research Center

Dear Participant,
Thank you for your interest in participating in the Samoan Women's Health Assessment study at the Kapiolani Clinical Research Center!
It is important for you to read over and answer the eligibility checklist below.
Please feel free to ASK if you have ANY questions.

Eligibility Checklist

$\geq$ 50 percent native Samoan heritage? Yes ___ No ___

Example:
Biological mother is 50 % Samoan (1/2 Samoan)
Biological Father is 50% Samoan (1/2 Samoan)

1. *Divide mother's % Samoan by 2*

$\frac{50\%}{2} = 25\%$

2. *Divide father's % Samoan by 2*

50%
= 25%

3. *Add each to obtain total ethnicity*

Your % Samoan = 25% + 25% = *50%*

Living on Oahu?	Yes ___ No ___
Female?	Yes ___ No ___
Age between 18 and 28 years?	Yes___ No___
Weight less than 300 pounds	Yes___ No___
Non- pregnant?	Yes___ No___
Non-lactating?	Yes___ No___
No previous diabetes diagnosis?	Yes___ No___
Available for a clinic visit that will last approximately 2.5 hours?	Yes____No___

If you are interested please contact Vanessa at nabokov@hawaii.edu or 271-1634

Last Name:____________________ First Name:____________________
Signature:____________________________ Date:______________
Home Phone:_____________Cell Phone:____________________ Email:______
Address:____
Street City

Appendix E. Fasting Guidelines

Samoan Women's Health Assessment Study
University of Hawaii, Kapiolani Clinical Research Center

Name of participant: ______________________

Your clinic visit is scheduled for: ________________________

FASTING PROCEDURE

PLEASE **DO NOT** EAT ANY FOOD OR DRINK ANY LIOUIDS **EXCEPT** WATER FOR **10 HOURS**

No food or drink after ___________________
AT_________: ________

If you feel any severe symptoms of low blood sugar while you are fasting, immediately drink a glass of orange juice (more than 8 ounces) and eat some food such as a peanut butter and jelly sandwich.

Please call the research nurse at 983-6251 or pager 288-6244 the morning of your clinic visit to reschedule.

Some symptoms of low blood sugar are headache, dizziness, faintness, nausea, vomiting, and blurred vision.

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