

ANALYSIS OF METHODS TO ASSESS FRUIT AND VEGETABLE INTAKE
AMONG AN ETHNICALLY DIVERSE SAMPLE IN HAWAI'I

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Abstract

Background

Studies indicate that the vast majority of adult Americans do not regularly consume recommended daily servings of fruits and vegetables. One major issue with research in this area is how to measure fruit and vegetable intake, especially in ethnically diverse populations.

Objectives

The specific aims of the study were to a) compare the percentage of participants categorized as regularly consuming five or more ('5 or more') daily servings of fruits and vegetables using two commonly used instruments, b) assess if percentages varied by race/ethnicity, and c) assess if the different instruments interacted with race/ethnicity.

Methods

The source for the current study was the Healthy Hawai'i Initiative (HHI) which collected baseline data from adult residents of Hawai'i in 2002. The data used in this study are baseline data from the HHI longitudinal study. 'Five or more' was calculated using two instruments: a single question instrument and a multi-item food frequency questionnaire (FFQ) 19-item instrument. The latter allowed for variations in how '5 or more' was calculated (e.g. not including fried potatoes). Percentages were compared overall and by race/ethnicity.

Results

The percentage meeting '5 or more' criteria varied greatly depending on how '5 or more' was calculated ranging from 20.9% with the single question instrument to 60.8% when all items on the multi-item FFQ instrument were used. Caucasians were

significantly more likely to consume '5 or more' than were Japanese and Filipinos. With the single question instrument the results for Filipinos were exceedingly low and inconsistent with results using the multi-item FFQ and with State of Hawai'i survey data for 2002. Female gender and older age were also associated with '5 or more' while education was not. No specific food items explained differences by race/ethnicity.

Conclusions

The percentage of participants meeting '5 or more' criteria varied significantly depending on how '5 or more' was calculated. Race/ethnicity was significantly associated with '5 or more'. The single question method for determining '5 or more' categorization appeared to interact with race/ethnicity, greatly underestimating intake for some groups relative to Caucasians and therefore it should not be used in studies in Hawai'i.

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CHAPTER 1 - INTRODUCTION TO THE STUDY

Introduction

As is the case with most adults in the United States, the vast majority of adults living in Hawai‘i do not regularly eat the recommended number of daily servings of fruits and vegetables, often quantified as five or more servings of fruits and vegetables on a daily basis (Maddock, Marshall, Nigg, & Barnett, 2003). Fruit and vegetable intake has received national attention in recent years because of studies showing that high intake is associated with decreased risk for most chronic diseases, and national campaigns have been implemented to try and increase the percentage of American adults who regularly consume at least 5 servings or more of fruits and vegetables on a daily basis (Casagrande, Wang, Anderson, & Gary, 2007). Unfortunately, recent data indicate these efforts have been largely unsuccessful (Casagrande, et al., 2007).

In order to determine current intake of fruits and vegetables and what factors are associated with such intake (the latter information needed to help develop strategies to increase such intake) large, population-based studies of representative samples of American adults are imperative. A major potential issue with population-based studies of fruit and vegetable intake is regarding how to determine such intake. Large studies generally require assessment methods that involve only asking participants a limited number of questions regarding their fruit and vegetable intake. Fruit and vegetable intake assessment instruments that are most often used in such studies usually contain 16 or fewer items with some containing only 1 or 2 items (Bogers, van Assema, Kester, Westerterp, & Dagnelle, 2004). While many of these instruments have been reported to be somewhat accurate (compared with 24-hour dietary recall) in assessing fruit and

vegetable intake in mostly Caucasian populations, it is unclear if they are equally effective in assessing fruit and vegetable intake across ethnic groups. Wolfe, Frongillo, and Cassano (2001) reported that the accuracy of such instruments may vary with ethnicity partially due to differences in interpretation of items in the instruments. Their study compared Caucasians, African Americans, and Hispanic ethnic groups. There are few if any studies that have evaluated this issue among the highly diverse Asian/Pacific Islander ethnic groups that make up the majority of the population of Hawai'i.

Race/ethnicity might also interact with fruit and vegetable intake assessment methods depending on what criteria are used when determining categories of intake and depending on what food items are or are not included when assessing intake. An example of the former is that some studies categorize participants as either regularly consuming or not consuming five or more servings of fruits and vegetables a day, the Healthy People 2000 criterion, while others employ a stricter criterion of at least two servings of fruit and at least three servings of vegetables, with at least one-third of vegetable servings being from dark green or orange vegetables, the Healthy People 2010 criterion (NIH, 2006). It might be that ethnic differences in intake might produce different findings by ethnicity depending on which criterion is used. An example of the latter is potato intake, which is often, but not always, included when calculating vegetable consumption. Potatoes are common in Caucasian diets where they are often considered a starch, but in many Asian populations, rice is the primary starch in the diet. In order to evaluate current levels of fruit and vegetable intake among this diverse population, and to further identify factors associated with such intake as a prelude to developing interventions to increase such intake, it is first important to make sure the instruments,

definitions, and criteria being used to assess intake are accurate and consistent across ethnic groups.

Problem Statement and Study Aims

This study will evaluate if two commonly used fruit and vegetable intake assessment instruments are consistent in assessing fruit and vegetable intake across the ethnically diverse population found in Hawai‘i. This will include looking at if varying criteria for goal fruit and vegetable intake using results from the instruments interacts with ethnicity. The overall aims of the study are (1) to assess and compare various approaches for calculating fruit and vegetable intake among adults living in the ethnically diverse population of Hawai‘i, and (2) to identify factors associated with such intake that might provide the basis for development of effective interventions to increase intake across all groups living in Hawai‘i. The specific aims of the study are to a) compare the percentage of participants categorized as regularly consuming five or more (‘5 or more’) daily servings of fruits and vegetables using two commonly used instruments, b) assess if percentages vary by race/ethnicity, and c) assess if the instruments and criteria interact with race/ethnicity.

A secondary aim is to assess if any specific food types explain differences in ‘5 or more’ by ethnicity if such differences are present. The hypotheses for the study are: (1) *The percentage of participants categorized as regularly consuming five or more daily servings of fruit and vegetables will be significantly lower using the single question instrument compared with using the multi-item instrument. Percentages will also be significantly lower for the stricter criteria using the multi-item instrument.* (2) *There will be differences in ‘5 or more’ intake by race/ethnicity but no specific hypotheses*

regarding those differences with differences remaining stable across the various methods used for determining '5 or more' categorization. (3) Differences in intake by race/ethnicity will remain stable when the mean number of daily servings of fruits and vegetables is used as the outcome measure instead of the categorical variable '5 or more'. (4) Caucasians will consume significantly more daily servings of potatoes compared with the other ethnic groups.

Concepts Used in the Study

The general concept of interest is fruit and vegetable intake, and more specifically, the primary concept of interest is '5 or more' which is defined as regularly consuming 5 or more servings of fruits and vegetables on a daily basis by a given individual. In addition to how to accurately measure intake using a simple intake assessment instrument, another issue is what to include and not include as constituting a fruit or a vegetable when calculating intake. Beans, such as pinto and black beans, while technically not a fruit or a vegetable are almost always counted when calculating fruit and vegetable intake. Potatoes, especially fried potatoes, which are a starchy vegetable, are sometimes not counted in calculating fruit and vegetable intake.

Significance and Rationale for the Study

Hawai'i contains a unique, ethnically diverse population with a large percentage of persons with Asian/Pacific Islander backgrounds. Few if any studies have evaluated the validity of using short fruit and vegetable intake instruments in persons of Asian/Pacific Islander backgrounds. One recent national study that consisted of a primarily Caucasian study population and no specific Asian/Pacific Islander groups (or

group) reported that one quarter to nearly one third of vegetable intake for adults comes from potatoes (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009). However, while potatoes are a major source of starch for many Caucasians, rice is a major source of starch for many Asians. It is possible that methods that count potatoes in calculating fruit and vegetable intake may produce results where Asians appear to eat fewer servings of fruits and vegetables than Caucasians merely because they eat rice instead of potatoes. This would be significant since it might lead to erroneous outcomes and conclusions in fruit and vegetable intake studies that might lead to improper or unnecessary interventions.

Theoretical Model

The current study is concerned with the possibility that commonly used methods for assessing fruit and vegetable consumption are not as accurate among non-Caucasian ethnic groups as they are among Caucasians. This issue is important because of the broader issue of health disparities by ethnicity in the United States. Flaskerud and Winslow (1998) have proposed a model that might help explain the association between ethnicity and fruit and vegetable intake as well as the larger issue of health disparities. Their model, the “Vulnerable Populations Conceptual Model”, proposes that resource availability, relative risk, and health status are interrelated and that ‘vulnerable populations’, which include ethnic minorities, have decreased resource availability (socioeconomic and environmental), which results in increased relative risk, which in turn results in overall poorer health status compared with less vulnerable populations (e.g. Caucasians). Increased relative risk and poor health status can feedback and further inhibit resource availability. Relating this model to the issue of fruit and vegetable

intake, ethnic minorities, because of decreased socioeconomic status and decreased environmental resources relative to Caucasians, have less access to healthy foods such as fruit and vegetables and thus their consumption of fruits and vegetables is lower. This in turn increases their risk for chronic diseases and other health disparities that have been noted between Caucasians and ethnic minorities in the United States.

Implications for Nursing

Nursing takes a broad view of health. Treatment of diseases and related symptoms and treatment of human responses to diseases are of course very important to nursing. Additionally, disease prevention, health promotion, and optimization of health are also very important goals to nursing. Nursing is also concerned with the health of populations in addition to the health of specific individuals and their families. Thus, a primary area of concern for nursing is preventing disease and promoting health at the population level. The current research can help identify populations at risk for poor nutrition and factors associated with poor nutrition which can in turn inform nursing research and practice to develop interventions to improve nutrition, specifically increasing fruit and vegetable intake to optimal levels, to help prevent disease and promote optimal health at both the population and individual levels.

CHAPTER 2 - REVIEW OF THE LITERATURE

Chronic Diseases and Fruit and Vegetable Intake

Burden Associated with Chronic Diseases

Chronic diseases are increasing in prevalence worldwide, including in underdeveloped countries where infectious diseases have traditionally been the primary health concerns. Nearly a third of deaths worldwide are from cardiovascular disease (Yusuf, S., Reddy, S., Ourtpuu, S., & Anand, S., 2001) and it is estimated that by 2025, nearly 30% of the adult population in the world will have hypertension (Kearney, P. M. et al., 2005). The worldwide prevalence of overweight and obesity (World Health Organization [WHO], 2007a) and of diabetes (Boyle, J. P. et al., 2001) are increasing at epidemic rates with the prevalence of diabetes expected to more than double to 366 million persons worldwide by 2030 (WHO, 2007b).

Chronic diseases are the primary cause of death and disability in the United States with cardiovascular disease and cancer being the two leading causes of death (Hung, et al., 2004). Other chronic diseases such as diabetes, hypertension, hyperlipidemia, and obesity are also major causes of morbidity and mortality, both directly and by being risk factors for the development of cardiovascular disease. In the United States, approximately 90 million persons suffer from at least one chronic disease with 7 of every 10 deaths attributable to chronic diseases. It is estimated that the annual medical costs associated with chronic diseases exceeds \$1 trillion (Centers for Disease Control and Prevention [CDC], 2008). While the incidence for both coronary artery disease and many cancers have stabilized and in some instances even decreased in recent years, the

recent rapid increases in the prevalence of obesity and diabetes indicate these gains may be short lived. Over 30% of adults in the United States are obese (WHO, 2007a). The prevalence of diabetes in the United States is projected to increase from 17 million Americans in 2000 to over 30 million Americans in 2030 (WHO, 2007a). Identification of modifiable risk factors for chronic diseases and development of interventions that can help prevent, delay the onset of, or lessen the severity of chronic diseases are thus extremely desirable.

Modifiable Risk Factors for Chronic Diseases

Tobacco use, physical inactivity, and poor nutrition all contribute to the development of and interfere with the control of many chronic diseases. Tobacco use is the number one leading cause of preventable morbidity and mortality in the United States, primarily because of its association with the development of lung cancer and chronic obstructive pulmonary disease, but also because of its association with development of other types of cancer and cardiovascular disease (CDC, 2004).

The second leading cause of preventable morbidity and mortality in the US is the combination of physical inactivity and poor nutrition. In addition to coronary heart disease, some cancers, and type 2 diabetes, nutritional factors are also associated with stroke. Thus, dietary factors play a role in 4 of the top 10 leading causes of death in the US (National Center for Health Statistics [NCHS], 1997). Additionally, dietary factors play a major role in the development of osteoporosis, a major cause of disability among postmenopausal women and the elderly (National Institutes for Health [NIH], 1994).

While many dietary components contribute to good nutrition and health, much focus has been placed on a few specific areas of concern with respect to diet in the United

States: consumption of too much saturated fats and too many total calories, consumption of too little complex carbohydrates and dietary fiber, and consumption of too few daily servings of fruits and vegetables (NIH, 2006).

Fruit and Vegetable Intake as a Risk Factor

Studies are increasingly showing that low levels of fruit and vegetable intake are associated with the development of major chronic diseases. Early epidemiologic studies indicated that higher intakes of certain dietary nutrients that are abundant in fruits and vegetables are associated with lower incidence in mortality from stroke and from coronary heart disease (Khaw & Barrett-Connor, 1987; Morrison, Schaubel, Desmeules, & Wigle, 1996). More recent studies have switched to looking specifically at fruit and vegetable intake in relation to chronic diseases, both because it is easier to assess fruit and vegetable intake than specific nutrient intake, and because it is easier for persons “to understand and follow nutritional recommendations when phrased in terms of foods rather than nutrients” (Bazzano, et al., 2002) when designing interventions to increase such intake.

Hung, et al. (2004), using data from two large databases, the Nurses’ Health Study and the Health Professionals’ Follow-up Study, reported that fruit and vegetable consumption was inversely related to development of cardiovascular disease specifically and major chronic diseases overall. Bazzano, et al. (2002), using data from the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study, reported that there was an inverse relationship between fruit and vegetable intake and risk of cardiovascular disease and all-cause mortality. Two studies, one evaluating the population of Europe (Pomerleau, Lock, and McKee, 2006) and one evaluating the

population of New Zealand (Tobias et al., 2006) reported that low fruit and vegetable intake was associated with increased burden from cardiovascular disease, and that small increases in fruit and vegetable intake at the population level could significantly reduce such burden.

There is also much evidence that high rates of fruit and vegetable consumption help prevent the development of many, if not all, types of cancer (Van Duyn & Pivonka, 2000). One review reported that high intake of fruits and vegetables on a daily basis was associated with over a 70% decreased risk for developing cancer of any type (World Cancer Research Fund, 1997). Prentice, et al. (2007), in a randomized controlled trial that evaluated a dietary modification intervention designed to increase fruit and vegetable consumption, reported lower rates of ovarian cancer and total invasive cancers among postmenopausal women assigned to the intervention group compared with the control group. In a multiethnic case-control study, increased intake of yellow-orange and cruciferous vegetables was associated with decreased risk for prostate cancer (Kolonel, L. N., et al., 2000).

Fruit and vegetable intake also appears to be associated with other chronic diseases and risk factors for chronic diseases. He, Nowson, and MacGregor (2006), in a meta-analysis of prospective cohort studies, found that the risk for stroke was significantly lower for those with high levels of fruit and vegetable intake. Ford and Mokdad (2001) reported that among women, the risk for developing diabetes was significantly lower for those reporting intakes of 5 or more servings of fruits and vegetables per day. McNaughton, Mishra, Stephen, and Wadsworth (2007) reported higher fruit and vegetable intake was associated with lower blood pressure, BMI, and

waist circumference among women. In a cross-sectional study of adults living in Spain, increased fruit and vegetable consumption was associated with less weight gain over the prior 5 years among men (Bes-Rastrollo, Martinez-Gonzalez, Sanchez-Villegas, de la Fuente Arrillaga, & Martinez, 2006). A number of studies have reported that high intakes of fruit and vegetables are associated with lower blood pressure (Bazzono, 2006) and that dietary changes that include increasing daily servings of fruit and vegetables can reduce blood pressure in those with hypertension (Appel, L. J. et al, 1997).

Several studies have evaluated the association between fruit and vegetable intake and chronic diseases specifically among residents of Hawai'i. Meng, Maskarinec, Lee, and Kolonel (1999) developed a composite risk index that included fruit and vegetable consumption as a component of the index. Data used for the index originally were obtained from over 30,000 residents of Hawai'i between 1975 and 1980. Index scores were compared with presence or absence of various chronic diseases in these subjects that developed through 1994. Overall, as risk scores increased so did mortality rates for cancer, heart disease, and stroke. Galanis, Kolonel, Lee, and Nomura (1998) reported an inverse relationship between fruit and raw vegetable intake and risk for gastric cancer among a cohort of Hawai'i residents of Japanese ancestry. Maskarinec, et al. (2006) pooled data from 18 epidemiologic studies conducted in Hawai'i and found that among all ethnic groups, fruit and vegetable intake was inversely associated with weight. Maskarinec, Novotny, and Tasaki (2000) reported that among a multiethnic cohort of women in Hawai'i, dietary patterns of "vegetable" and "cold foods", the latter with high intakes of fruit and fruit juice, were both associated with lower BMIs.

The overall conclusion that can be drawn from current research is that consistent low intake of fruits and vegetables is associated with increased risk for many chronic diseases, risk factors for chronic diseases, and overall poor health. The association between low intake and poor health is found across diverse ethnic populations. Increasing intake of fruits and vegetables among persons with consistently low intake levels should be a major public health focus.

Fruit and Vegetable Intake in the United States

Current Intake and Established Future Goals Nationally

Healthy People 2010, which sets out health goals for the United States to be accomplished by 2010, has set as two of its major objectives to increase the percentage of persons who consume at least 2 daily servings of fruits and to increase the percentage of persons who consume at least 3 daily servings of vegetables including at least one-third or more of servings being dark green or orange vegetables with the other two-thirds from any type of vegetables including potatoes, fried potatoes, beans, peas, soybeans, and tofu (NIH, 2006). These two objectives are part of a group of objectives designed to address nutrition and overweight issues among the population with the overall goal of the objectives to “promote health and reduce chronic disease associated with diet and weight” (NIH, 2006). While the target for the vegetable guidelines is 50 percent of the population, less than 10% of the adult population in the United States currently meets this objective (NIH, 2006). Similarly, fewer than 10% of Americans meet calorie-specific recommendations for fruit and vegetable intake established by the MyPyramid program (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009). In looking at specific components of vegetable intake, potatoes, especially fried potatoes, are the main

contributor to reported fruit and vegetable intake, accounting for up to nearly a third of vegetable intake for most Americans, while dark green and orange vegetables and legumes are minor contributors to intake (Kimmons, et al., 2009).

‘5 or More’ as a Goal

Most often in research and intervention settings the two goals (2 servings of fruit and 3 servings of vegetables without the specification of a third consisting of dark green or orange vegetables) have been combined such that the standard measure of healthy eating and the standard goal of nutritional interventions is that persons consume 5 or more servings of fruits and vegetables per day (Casagrande, Wang, Anderson, & Gary, 2007). In fact, the Healthy People 2000 objective regarding fruit and vegetable intake was 5 or more daily servings for fruits and vegetables combined which was the basis for a major national campaign, the 5-A-Day Program for Better Health, initiated in 1991, that included public education and advertising campaigns, and school and workplace interventions, and whose goal was to increase the percentage of Americans who consume 5 or more servings of fruits and vegetables on a daily basis (Casagrande, Wang, Anderson, & Gary, 2007). Survey data used to develop Healthy People 2000 guidelines indicated that among American adults, 32% met the objective at baseline. However, when more specific guidelines were used regarding subgroups of fruits and vegetables only 12% of adults met intake objectives (Krebs-Smith, Cook, Subar, Cleveland, & Friday, 1995). Unfortunately the 5-A-Day Program for Better Health appears to have had little if any positive effect on fruit and vegetable intake. Currently, it is estimated that only 11% of the general population of Americans consume the recommended two or more servings of fruits and three or more servings of vegetables on a daily basis

(Casagrande, et al., 2007). When vegetables are considered alone, consumption has actually decreased in recent years (Casagrande, et al., 2007). The overall picture is that few Americans eat five or more servings of fruits and vegetables on a daily basis and that efforts to increase consumption have so far had little positive effect. It should also be noted that the 5 or more servings objective is a minimum guideline for adults and that persons with higher caloric needs (most men and very active women) should actually eat 9 or more servings (4 servings of fruits and 5 servings of vegetables) per day, a level that very few American adults achieve (Krebs-Smith, et al., 1995). In a recent national study where intake was assessed using multiple 24-hour dietary recalls, and where intake criteria were based on an individual's age, gender, and physical activity level, fewer than 5% of American adults were considered to be consuming adequate daily servings of fruits and vegetables (Kimmons, et al., 2009).

Ethnicity and Fruit and Vegetable Intake

While the prevalence of poor nutrition and the related issue of obesity are of concern with respect to the entire population of the United States, the concern is even greater with respect to minority populations (Bhargava & Hays, 2004). The prevalence of obesity is now epidemic in the United States and is contributing to the rapid increase in the prevalence of diabetes and other chronic diseases. While the increase in obesity prevalence is affecting the entire population, the absolute levels and rate of increase in levels of overweight and obesity are higher among most minority groups compared with Caucasians (Yancey, et al., 2004), and are especially high among Hispanic, African American, Native American, and Pacific Islander women (NIH, 2006). Minority populations also have higher rates of chronic diseases compared with Caucasians, a fact

that is thought partially attributable to generally poorer nutrition in most minority populations (Yancey, et al., 2004). African Americans have the highest incidence rate for all cancer sites combined compared with other racial/ethnic groups in the United States (National Cancer Institute [NCI], 2005).

In baseline data used for Healthy People 2000, compared with Caucasians, Hispanics had a lower mean intake of fruits and vegetables on daily basis, and African Americans had an even lower mean intake (Krebs-Smith, et al., 1995). These disparities have continued, especially the lower mean intake of fruit and vegetables among African Americans compared with other groups (Casagrande, et al., 2007). In one population-based sample of African Americans, only 16% of subjects reported eating 3 or more servings of vegetables each day and only 8% reported eating 2 or more servings of fruits each day (Gary, et al., 2004).

There are almost no studies that have evaluated fruit and vegetable intake, specifically '5 or more', among minority groups in the United States other than African Americans. The study that reported baseline data for Healthy People 2000 divided the entire population into only four groups by race/ethnicity: Non-Hispanic White, Non-Hispanic Black, Hispanic, and Other (Krebs-Smith et al., 1995). A more recent study of national trends also had only four groups, but the Hispanic group was replaced with Mexican American, and presumably all other Hispanics were included in the "Other" grouping (Casagrande, et al., 2007). One study that evaluated ethnicity and nutrition among adolescent girls in Hawai'i did not find any differences in fruit and vegetable intake by ethnicity (Daida, Novotny, Grove, Acharya, & Vogt, 2006). However, that study divided the diverse population of Hawai'i into only 3 groups: White, Asian, and

Mixed Ethnicity. Takata, Maskarinec, Franke, Nagata, and Shimizu (2003) compared fruit and vegetable intake among women of Caucasian ethnicity living in Hawai'i, women of Japanese ethnicity living in Hawai'i, and women of Japanese ethnicity living in Japan. Intake was adjusted to grams per 1000 kcal energy intake. Overall fruit and vegetable intake was higher for women of Caucasian ethnicity compared with women of Japanese ethnicity living in Hawai'i. Overall intake was comparable for Caucasian women and Japanese women living in Japan. However, when fruit intake and vegetable intake were looked at separately, fruit intake was much higher for the Caucasian women while vegetable intake was much higher for the Japanese women living in Japan.

Other Demographic Factors and Fruit and Vegetable Intake

Other demographic factors also appear to be associated with fruit and vegetable intake among Americans. Baseline data from the *Five A Day for Better Health Program* indicated that increasing education, higher income, and increasing age were all associated with higher daily fruit and vegetable intake, as was nonsmoking status (versus current or former smoker) and female gender (Subar, et al., 1995). In a more recent survey, increasing age, education, and income were each associated with higher daily fruit and vegetable intake (Casagrande, et al., 2007). Education used as a marker for socioeconomic status, was also significantly associated with '5 A Day' among middle-aged French adults (Estaquio, et al., 2008). In a study of older Mexican-American women, being more acculturated was associated with decreased fruit and vegetable consumption, while increasing education and not smoking were associated with increased consumption (Gregory-Mercado, et al., 2006).

Theoretical Model for Explaining Differences in Intake by Demographics

Compared with Caucasians, other ethnic/racial groups in the United States have higher rates of many chronic diseases, especially cancer, cardiovascular disease, diabetes, and obesity, with generally poorer nutritional habits among non-Caucasians thought to be a major contributing factor to such disparities (Yancey, et al., 2004). In general, at least for the mainland United States, income and education levels are generally higher for Caucasians compared with other ethnic groups and as just discussed, many mainland studies have reported that ethnicity, education, and income are associated with fruit and vegetable intake with Caucasian ethnicity, higher levels of education and higher income associated with increased intake (Krebs-Smith, et al., 1995; Casagrande, et al., 2007).

Flaskerud and Winslow (1998) have proposed a model that might help explain the association between ethnicity and fruit and vegetable intake as well as the association of socioeconomic factors and fruit and vegetable intake with relationships between ethnicity and socioeconomic factors and ethnicity. Their model also is potentially important for understanding the larger issue of health disparities by ethnicity in the United States. Their model, the “Vulnerable Populations Conceptual Model”, proposes that resource availability, relative risk, and health status are interrelated and that ‘vulnerable populations’, which include ethnic minorities, have decreased resource availability (socioeconomic and environmental), which results in increased relative risk, which in turn results in overall poorer health status compared with non-vulnerable populations (e.g. Caucasians). Increased relative risk and poor health status can feedback and further inhibit resource availability. Relating this model to the issue of fruit and vegetable intake, ethnic minorities, because of decreased socioeconomic status and decreased environmental resources relative to Caucasians, have less access to healthy foods such as

fruit and vegetables and thus their consumption of fruits and vegetables is lower. This in turn increases their risk for chronic diseases and other health disparities that have been noted between Caucasians and ethnic minorities in the United States. Poorer health can in turn further reduce resource availability.

Leight (2003) applied this model to another vulnerable population, persons residing in rural areas (rural dwellers). Using available demographic data, she reported that compared with urban, non-inner city dwellers, rural dwellers had generally lower resource availability including lower incomes, less education, and less access to health care resources, jobs and housing. With respect to relative risk, rural dwellers had poorer nutritional habits, engaged in less physical activity, and were less likely to engage in preventive health behaviors (e.g immunizations) compared with urban, non-inner city dwellers. Finally, rates of chronic diseases were noted to be higher among rural dwellers. This application is equally applicable to ethnic minorities in relation to Caucasians, at least on the mainland United States. It is not clear that this is also true in Hawai'i.

Interventions and Use of Health Behavior Theories

to Increase Fruit and Vegetable Intake

Overview

The overall implication of the previous discussion is that effective interventions are needed that will lead to a substantial increase in the percentage of adults whose daily consumption of fruits and vegetables is at least 5 servings per day, and preferably 8 or 9 servings per day for most men and active women. While the entire population needs to be the target of these interventions, most minority populations, who have even lower

intakes of fruits and vegetables and who have higher rates of chronic diseases compared with Caucasians, require specific targeting. In the United States, as well as worldwide, a number of initiatives to promote increased fruit and vegetable consumption have been established.

Pomerleau, Lock, Knai, and McKee, (2005) conducted a comprehensive review of published studies of interventions designed to increase fruit and vegetable intake among adults. They reviewed the available literature in a number of languages and databases covering the period through April 2004. A total of 44 articles met inclusion criteria. While many of the studies reported that the interventions designed to promote increased fruit and vegetable consumption were somewhat effective in the short term, the effect sizes were generally quite small and increases in intakes most often occurred in subjects who were already at high risk for disease (Pomerleau, et al., 2005). Overall the results were disappointing and none of the evaluated interventions appeared likely candidates for population-level efforts to increase fruit and vegetable intake. Importantly, it appeared from the review that few of the interventions were based on theoretical models of health behavior change.

More recent intervention studies have evaluated interventions that were theory-based. Nitzke, et al. (2007) evaluated a stage-tailored intervention designed to increase fruit and vegetable intake among low-income young adults. The intervention group received a series of mailed materials and educational calls based on baseline stage of change while the control group received a mailed pamphlet. At follow-up, intake was significantly higher for the intervention group, but was a relatively small third of a serving higher compared with the control group. Resnicow, et al. (2008) also evaluated a

tailored intervention for increasing fruit and vegetable intake among African American adults. Participants in both study groups received three newsletters designed to increase fruit and vegetable intake, with each newsletter tailored to each participant based on demographics, food preferences, and several constructs from social cognitive theory. One group also had their newsletters tailored based on constructs from self-determination theory and motivational interviewing. In both groups, intakes increased moderately from one half to one serving per day depending on how intake was assessed. More importantly, within each intervention group, the effectiveness of the intervention was associated with communication style which was assessed at baseline indicating the need to tailor interventions by personal characteristics. However, Park, et al. (2008), while reporting that an internet-based intervention showed promising results in increasing fruit and vegetable intake among young adults, also found that the intervention was equally as effective when it was not tailored using health behavior theories as when it was tailored using stage of change. This study was quite small and involved only one internet-delivered nutrition module.

Interventions Targeting Minority Groups

As stated previously, minority populations generally have higher rates of chronic diseases and lower intakes of fruits and vegetables compared with non-Hispanic whites. Yancey, et al. (2004) reviewed population-based interventions designed to encourage obesity-related lifestyle changes, including studies designed to change eating habits, among targeted minority populations in the United States. Only 23 studies met inclusion criteria and most did not include outcome evaluation data. The authors concluded that there was a distressing lack of evidence on this topic among minority populations.

Kreuter, et al. (2005) reported a small increase in intake of fruit and vegetable intake among African-American women where the intervention consisted of culturally tailored magazines that promoted fruit and vegetable intake. A small study in Hawai‘i among mostly Asian women indicated that an intervention consisting of individual counseling and group activities could lead to large increases of fruit and vegetable consumption among “motivated” women (Maskarinec, Chan, Meng, Franke, & Cooney, 1999).

Conclusion

Dietary behavior is an extremely complex behavior and thus developing effective interventions to target this behavior is quite challenging, as is the case with most health behaviors. Also, from a public health perspective, interventions must not only be effective in changing individual behavior, they must also be readily transmittable such that exposure and behavior change will occur at the population level (Dzewaltowski, Estabrooks, & Glasgow, 2004). The development of effective interventions of health behavior change requires using theories and conceptual models of health behavior change.

Research Issues With Assessing Fruit and Vegetable Intake

As discussed already in detail, research has increasingly indicated that persons whose average daily intake of fruits and vegetables is low are at increased risk for a variety of chronic diseases and health issues (Hung, et al., 2004; Bazzano, et al., 2002). Research has also indicated that most Americans do not eat enough servings of fruits and vegetables on a daily basis. A number of interventions have been developed and implemented to try and remedy this situation, but so far these efforts have had little success (Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008). There are a number

of methodological issues that can affect any study where fruit and vegetable intake is a variable which can affect results of a given study and comparison of results between studies. Three of the primary methodological challenges in this area are (1) what criterion to use if categorizing subjects by intake, (2) how to accurately measure actual intake of fruit and vegetables, and (3) what to include or not include when assessing fruit and vegetable intake for research purposes.

Varying Goals for Fruit and Vegetable Intake

Over the past few decades researchers, because of the apparent association between fruit and vegetable intake and health and disease, have sought to evaluate current intakes of fruit and vegetables among various populations, and changes in consumption following interventions designed to increase such intake. In the 1990s, those involved in developing Healthy People 2000 objectives recognized the importance of fruit and vegetable intake in the daily diet and created the Healthy People 2000 objective regarding fruit and vegetable intake which was that individuals should consume at least 5 or more servings of fruits and vegetables combined on a daily basis (Krebs-Smith, et al., 1995). Also, a major national campaign, the 5-A-Day Program for Better Health, was initiated in 1991 that included public education and advertising campaigns, and school and workplace interventions, and whose goal was to increase the percentage of Americans who consumed at least 5 or more servings of fruits and vegetables on a daily basis (Casagrande, et al., 2007). Survey data used to develop Healthy People 2000 guidelines indicated that among American adults, only 32% met the 5 or more objective at baseline. When the data were analyzed with respect to more specific guidelines similar to those recommended by the US Department of Agriculture in the *Dietary Guidelines for*

Americans (1990) which specified at least 2 servings of the fruit and at least 3 servings of vegetables only 12% of adults met intake objectives (Krebs-Smith, et al., 1995).

Healthy People 2010, which sets out health goals for the United States to be accomplished by 2010, has set even more stringent objectives for what defines minimally adequate daily fruit and vegetable intakes for individuals with the goal being at least 2 daily servings of fruits and at least 3 daily servings of vegetables including at least one-third or more of servings being dark green or orange vegetables (NIH, 2006). The US Department of Health and Human Services and the US Department of Agriculture have set an even higher bar in their *Dietary Guidelines for Americans 2005* (2004). Those guidelines recommend that fruit and vegetable intake increase with increasing caloric needs and thus many persons would need to eat nine or more servings per day to meet recommendations. In an even more recent study where the criteria for meeting fruit and vegetable intake were even more stringent, with adequate level of intake being tied to gender, age, and level of activity, fewer than 5% of American adults met the recommended levels of fruit and vegetable intake (Kimmons, et al, 2009).

The varying criteria for what is considered “desirable” intake of fruits and vegetables certainly affects what results are obtained in any given study and the lack of consistent criteria makes it difficult to compare studies. An example is the previously mentioned study by Krebs-Smith, et al. (1995) where the percentage of subjects meeting intake criteria decreased from 32% to 12% merely by changing criteria from 5 or more servings of fruit and vegetables per day to the more specific 2 or more servings of fruit and 3 or more servings of vegetables per day. Depending on the study and the criteria

used, the percentage of American adults who regularly consume adequate servings of fruits and vegetables ranges from over 30% to less than 5%.

Issues with Defining and Measuring Intake

Beyond the issue of the variable criteria of what constitutes desirable intake of fruit and vegetables there are some more basic issues in this area of research that threaten the accuracy and comparability of results and thus could affect determination of the criteria that should be used to define adequate intake. The first issue is how to accurately measure fruit and vegetable intake. While the 24-hour dietary recall is considered the gold standard for assessing quantitatively actual consumption of fruits and vegetables by a subject during a given period of time it is prohibitively resource-intensive for most research settings and purposes. Various food frequency questionnaires and brief food intake surveys have been developed and utilized, but their absolute accuracy in assessing intake is questionable, with some appearing to greatly underestimate actual intake and others appearing to greatly overestimate actual intake.

The second is regarding the definition of what counts as a fruit or a vegetable for intake purposes in the research setting. For example, many studies do not include fried potatoes in their definition of what constitutes fruit and vegetable intake while other studies do count fried potatoes. Some studies consider potatoes to be part of the grains and starch category and do not count them as contributing to vegetable intake. On the other hand legumes and beans, which are not by definition vegetables, are usually counted toward vegetable intake. Condiments such as ketchup or a slice of onion on a sandwich count toward fruit and vegetable intake in some studies but not in others. Again, the definition of what food intakes count toward fruit and vegetable intake varies

from study to study. From a research standpoint these issues make it difficult to compare results between studies, etc. and also make it difficult to determine what recommendations should actually be for fruit and vegetable intake.

Issue 1 - How Do You Accurately Measure Fruit and Vegetable Intake?

There are 3 main categories of methods used for obtaining fruit and vegetable intake data from subjects: dietary recall, food frequency questionnaires (FFQs), and short screeners. For the latter two categories, there are many different instruments that have been developed and used to evaluate fruit and vegetable intake. Regardless of which method is used for collecting data, the desired end result is an accurate calculation of how many servings of fruits and vegetables are typically consumed on a daily basis.

The first method, usually considered the 'gold standard', is the dietary recall method. This method typically involves having a subject report everything eaten within a very recent 24 hour time period. While the specific methods for obtaining this information from subjects varies somewhat, the NHANES II survey approach illustrates a typical methodology. In that survey, trained interviewers obtained the data from subjects and helped subjects with such issues as portions sizes by using 3-D models, dishes, and glassware, in order to obtain accurate data. The subjects were asked to provide information on everything consumed in the 24-hour period before the interview. The data were then translated using computer analyses into grams consumed of each food then the grams consumed were converted to servings of fruits and vegetables using a food guidance system (Patterson, Block, Rosenberger, Pee, & Kahle, 1990). The data analysis process is often quite complex in this approach but the end result is that all foods ingested are accounted for and included in the assessment and that calculated intake is highly

accurate. However, there are a number of issues with this approach that limits its use. First and foremost is the intensive nature of this type of data collection. Both the data collection process and the data analysis process are highly resource intensive and thus this method is only practical for small studies or a few very well funded large studies (Kristal, et al., 2000). Another limitation is that individual dietary intakes tend to vary greatly from day to day so that a single 24-hour dietary recall is usually not representative of an individual's typical intake and therefore multiple recalls are required if individual intakes is an important aspect of the study (Buzzard, 1998). The definition issue of what constitutes a fruit and vegetable is overcome for subjects since they report everything eaten and do not have to self categorize. One study did report that it is important to specify what exactly is meant by the 24 hour period to be reported on (Wolfe, Frongillo, & Cassano, 2001). Overall while the dietary recall method is considered the most accurate method for obtaining actual fruit and vegetable intake data from subjects, in reality it is generally only suitable for use in small clinical studies or validation studies (Kristal, et al., 2000).

A second methodological approach for gathering data on fruit and vegetable intake is the food frequency questionnaire (FFQ). FFQ's typically consist of a precoded form containing a large list (60-120) of specific food items that assess frequency with which each item is consumed and often the usual portion size when consumed. Any given food item may consist of a single food or a group of highly similar foods (Teufel, 1997). In their review of the development and use of FFQ's, Cade, Thompson, Burley, and Warm (2002) used the following as a definition of a FFQ:

A questionnaire in which the respondent is presented with a list of foods and is required to say how often each is eaten in broad terms such as x times per day/per week/per month, etc. Foods chosen are usually chosen for specific purposes of a study and may not assess total diet. (p. 567)

This approach is less resource intensive compared with the dietary recall approach and does not require multiple administrations to assess an individual's usual intake. However, the questionnaires do tend to be quite long and not practical for large-scale use and while this method is appropriate for epidemiological studies, it is often still too resource intensive for large, population-level surveillance studies (Kristal, et al., 2000; Teufel, 1997). Also, studies indicate that FFQ results, while accurate in ranking individuals by intake, are usually inaccurate in assessing true intake. FFQs tend to consistently underestimate or overestimate true intake, depending on the given FFQ, with underestimation often occurring when the number of items is low and overestimation often a problem when the number of items is high (Kristal, et al., 2000).

Finally, the third general methodological approach for assessing fruit and vegetable intake is through the use of short screeners. These are typically food frequency questionnaires with 16 or fewer questions that ask about frequency of intake of various categories of fruits and vegetables over a given period of time (Bogers, van Assema, Kester, Westerterp, & Dagnelle, 2004). From a research standpoint, a short screener that is highly accurate in both ranking fruit and vegetable intake and in assessing actual intake is highly desirable since short screeners can be easily administered to large populations at a relatively low cost (Peterson, et al., 2008).

Many short screeners do not define or ask about portion sizes and they usually do not provide definitions beyond what is included in the questions themselves. A widely used example is the Behavioral Risk Factor Surveillance System (BRFSS) module on fruit and vegetable intake. The BRFSS is a continuous telephone survey conducted in all states that is designed to obtain data on a representative sample of the US adult population. The module on fruit and vegetable intake consists of six questions that ask respondents to report how frequently they consume different categories of fruits and vegetables. Some are quite specific such as asking how often the subject eats carrots and others are quite broad such as asking how often the subject eats fruit, excepting juice. Fried potatoes are explicitly excluded and legumes are not explicitly included and no definition of serving sizes is given (Blanck, et al., 2008).

The obvious benefit of the short screener is its ease of use and limited need for resources. Large numbers of subjects can be quickly screened and data quickly analyzed with this approach. However, similar to longer FFQ's, studies indicate most screeners are accurate in ranking individuals by intake but they are not accurate in assessing actual intakes (Kim & Holowty, 2003). Kristal, et al. (2000) directly compared the accuracy in ranking and accuracy in assessing actual intake of a short screener consisting of 7 items and longer FFQ's with over 100 items with 24-h dietary recall data as the standard. Consistent with other studies, results indicated both the short screener and the long FFQ's were equally precise in ranking individuals with respect to fruit and vegetable intake. However, with respect to actual intake, the short screener significantly underestimated intake and the longer FFQ's overestimated intake, also consistent with other studies.

The previously discussed BRFSS module is a widely used short screener. Smith-Warner, Elmer, Fosdick, Tharp, and Randall (1997) compared intakes calculated using the BRFSS module with those obtained using a 153-item FFQ and dietary recalls. Results showed that the BRFSS module, while good at assessing rank of intake, significantly underestimated actual intake by over 30%. In another study looking at national trends in consumption that used BRFSS data, the estimated average daily intake of fruit and vegetables among adults was 3.37 servings/day. As a comparison, results from another national survey that used 24-hour recall data showed average daily intakes of 4.9 servings/day for the period 1994-1996 (Serdula, et al., 2004). A primary reason the BRFSS module is thought to consistently underestimate actual intake is that it is insensitive to serving size (Serdula, et al., 2004) as it assesses frequency with which foods are eaten not servings consumed (Li, et al., 2000). It also does not include in calculations intake from French fries and fried potatoes (Serdula, et al., 2004).

More recently, Peterson et al. (2008) assessed the accuracy and precision of two screeners in assessing fruit and vegetable intake. The first screener was the National Cancer Institute 19-item Fruit and Vegetable Screener (FVS) and the second was a 1-item screener consisting of a single question asking how many servings of fruits and vegetables the subject typically consumed on a daily basis. Results indicated the longer FVS screener significantly overestimated actual intake while the 1-item screener significantly underestimated actual intake. The authors concluded that the multiple 24-h dietary recall method remains the gold standard for assessing fruit and vegetable intake and that further research is needed regarding developing and validating screeners that can accurately assess for such intake.

Another concern with assessing fruit and vegetable intake using short screeners where number of servings of fruits and vegetables without reference to portion size is the focus is that portion sizes may vary too greatly between individuals. Thus, encouraging persons to increase frequency of servings of fruits and vegetables and then assessing intake based on frequency without information of portion size may result in erroneous findings of success regarding intake results when a substantial percentage of those reporting the recommended numbers of servings actually have inadequate intakes because their portion sizes are too small. Ashfield-Watt, Welch, Day, & Bingham (2003), in evaluating the United Kingdom's "5-a-day" recommendations, specifically addressed the issue of if focusing on frequency of servings rather than portion sizes was an appropriate focus. Their results indicated that average portion sizes were fairly uniform across subjects, regardless of reported frequency of intake, and that average reported serving sizes were similar to recommended sizes, and thus that frequency was the better distinguishing factor of actual intake and thus the better focus on interventions. On the other hand, Bensley, Van Eenwyk, and Bruemmer (2003) in evaluating the '5 A Day' recommendations in the United States reported that when standard definitions of serving size were included in data collection surveys in addition to questions regarding frequency of intake, the percentage of subjects who met "5 A Day" criteria increased from 26% to 50%, indicating that portion size did matter. The latter study did not evaluate if there was consistency across subjects in increase in intakes when calculated adding in portion size data.

While it is clear that there is a need for short screeners that can quickly and accurately assess fruit and vegetable intake in a large population, it is also clear that the

short screeners that have been used have significant limitations and there needs to be a focus on improving such screeners (Kristal, et al., 2000). A number of researchers have sought to improve the accuracy of short screeners by refining the questions asked and/or by including asking about portion sizes in addition to frequency. Thompson, et al. (2000) evaluated if screener accuracy could be improved by dividing a day into 3 periods and having respondents answer intake questions on the screener for each of the 3 periods rather than for the entire day as one. A standard screener was also evaluated in this study. Results indicated that both screeners significantly underestimated actual intake. The screener that divided the day into 3 periods was only slightly more accurate than the all day screener.

The National Cancer Institute revised its Fruit and Vegetable Screener (FVS) in 1998 to include questions regarding portion size. The FVS now consists of 19 items that ask about frequency of consumption of 10 categories of fruits and vegetables over the past month with questions on portion sizes for 9 items (Greene, et al., 2008). However, when the revised FVS was assessed against repeat 24-hour dietary recalls in a diverse study group, the FVS significantly overestimated true intake for both males and females. Bogers, et al. (2004) developed an eight-item food frequency questionnaire that asked both how often in the past month certain types of foods were eaten and how much was eaten when it was consumed. Their results indicated that the questionnaire was effective for ranking individuals by intake, but not necessarily accurate in assessing true intake.

Field, et al. (1998) compared 4 brief questionnaires: Youth Risk Behavior Surveillance System questionnaire consisting of 4 questions regarding intake the previous day, the BRFSS questionnaire modified into 2 self-administered versions with the same 6

questions as on the traditional BRFSS. The difference between the two versions was that one asked about intake the previous day and the other regarding intake during the past year, and the Harvard Food Frequency Questionnaire which includes 27 questions and asks about intake during the previous year. Three 24-hour dietary recalls were also conducted with study subjects to provide a ‘gold standard’. Results indicated that although all 4 questionnaires accurately ranked subjects with respect to actual intake, they were less accurate in estimating true intake. Questionnaires that asked about frequencies of intake over the past year were slightly better in assessing actual intake compared with those that asked about intake the previous day. This approach was revisited in a study that involved 2 revised versions of the BRFSS module. Revisions were based on data obtained from qualitative interviews regarding understanding of BRFSS module questions. The revised versions were similar with respect to questions but differed in that one asked about all-day consumption and the other asked about consumption by each meal. Results showed that both screeners equally effective but correlations to actual intake were only moderate (Thompson, et al., 2002). This study also included a FFQ with over 120 items and consistent with other studies it overestimated actual intake.

A related issue is that assessment tools might also be understood differently because of ethnic/cultural differences of those being assessed. One study evaluated ways to improve subjects’ understanding of assessment tools specifically in relation to what the tools means to include and not include in defining what constitutes fruit and vegetable intake (Thompson, et al., 2002). For example, when queried about a question asking about “100% fruit juice” intake, many subjects did not understand the question and

mistakenly included fruit-flavored drinks when reporting intake. In a similar type of study, Wolfe, Frongillo, and Cassano (2001) conducted cognitive testing with subjects regarding understanding of questions using the BRFSS module and a newly created screener as the source of the questions. A number of questions were found to be frequently misinterpreted and there were often ethnic/cultural differences in how a question was interpreted. For example, many Whites when asked what they considered to be a 'bean' only included green beans, while many Hispanics and African Americans only included legumes.

Issue 2 – What Counts Toward Fruit and Vegetable Intake?

The second issue relates to what is defined as being included in fruit and vegetable intake when intake is assessed, specifically what items that are consumed by humans will be categorized as contributing to fruit and vegetable intake. In order to estimate fruit and vegetable intake a definition must specify what plant foods count toward such intake and what quantity corresponds to a serving if servings are being calculated (Smith-Warner, et al., 2004). The former would seem pretty straightforward as it would seem that it is clear what foods are in the category "fruits and vegetables". However, that term covers a highly heterogeneous group of foods, especially across cultures and geographic locales (Pomerleau, Lock, McKee, & Altmann, 2005). Also, researchers often will exclude certain foods from their definitions even though those foods are technically a fruit or a vegetable, either through inadvertent omission or through purposeful omission, or include foods that are not technically fruits and vegetables.

An example is the definition that was initially used to calculate fruit and vegetable intake for *Healthy People 2000*. The *Healthy People 2000* baseline data on fruit and vegetable intake were revised in part because in the original baseline data analyses, fruits and vegetables that subjects had consumed that were part of a mixed food (e.g. a stew containing meat and vegetables) were not counted in calculating fruit and vegetable intake because mixed foods had not been included in the original definition of fruits and vegetables (Krebs-Smith, et al., 1995). This omission apparently related to the fact that estimating fruit and vegetable intake was not a purpose of the original data set when it was collected. Many food items that humans prepare and consume contain a combination of vegetables, grains, and meat or seafood, and thus not counting the fruits and vegetables contained in such foods could lead to significant underestimation of fruit and vegetable consumption. Another example of not counting vegetables toward vegetable intake that illustrates cultural differences in what counts toward fruit and vegetable intake is that studies of fruit and vegetable intake in Japan use the Japanese system for categorizing foods. In that system, potatoes, which are by definition starchy vegetables, are counted in servings of grains, not in servings of vegetables (Takata, et al., 2003).

Conversely, legumes (dried beans and peas), which are not by definition fruits or vegetables, are almost always included in definitions of what is included in calculating fruit and vegetable intake in research studies. In the USDAs “My Pyramid”, legumes are considered to both be part of the group that includes high-protein foods such as meat and eggs and as part of the vegetable group, and legumes are specifically one of the subgroups of the vegetable group in the *Dietary Guidelines for Americans 2005*. Legumes potentially present a definition problem when assessment methodologies do not

specifically indicate in some way to subjects that legumes are to be considered in the fruit and vegetable category. For example, the widely used BRFSS survey asks 6 questions regarding frequency of intake of fruits and vegetables. Legumes are not specifically mentioned in the questions nor are subjects told that legumes are considered vegetables so it is left to the subject's own definition of fruit and vegetable whether or not they count legume intake in the question that asks about "other vegetables".

Researchers often specifically omit from their definitions certain foods that are technically part of the fruit and vegetable category. Even when methodologies for measuring intake are used where all intake can be accurately counted in the results, the method for coding may disallow certain food items that contain fruits and vegetables. Some researchers use epidemiologic coding for dietary recall data and any fruit or vegetable intake from any source is counted. Other researchers use behavioral coding and specifically exclude certain potential sources of fruit and vegetable intake. In the latter approach, some sources of fruits and vegetables (such as French fries) have high caloric contents in relation to nutritive value and are considered not appropriate to count toward intake (Cullen, Baranowski, Baranowski, Hebert, & de Moor, 1999). How much the behavioral approach affects results depends on what food items are not counted. Cullen, et al. (1999) compared these two coding approaches using the same data sets and found that the intakes with the behavioral approach were 5% to 15% below that with the epidemiologic approach.

What foods that are technically fruits and vegetables are excluded from a definition and the rationale for such exclusions is quite variable. A few studies have excluded salads such as coleslaw because they are considered to be served in too small a

serving size and the nature of the assessment tool cannot account for such small portions, or because of their high fat content they are deemed too nutritionally poor in relation to calories to count (Ashfield-Watt, et al., 2003). Condiments such as ketchup, and even sandwich toppings, such as lettuce and tomatoes, are also often excluded in the definition of fruit and vegetable intake when servings are directly assessed. In this case the rationale usually given is that the amounts are too small to constitute a serving or even half a serving and that the assessment method is based on number of servings rather than actual weights of everything consumed that is then converted into servings (Ashfield-Watt, et al., 2003). Depending on specifically what is being excluded, this appears to be more an issue related to assessment methodology rather than pure definition as certainly lettuce and tomatoes are counted in all studies if they are consumed in larger portions such as in a salad. The logic in excluding condiments is that they may be frequently eaten yet their portion size is so small that to exclude them would have little effect on estimated intake whereas including them could lead to large overestimates of intake.

Fried potatoes, especially French fries and potato chips, are often specifically excluded by researchers as counting toward fruit and vegetable intake (Blanck, et al., 2008). A potato is a starchy vegetable but the rationale usually given for excluding fried potatoes from calculations is that the fat from frying increases the caloric content so greatly in relation to nutritional contribution that they should not be counted toward fruit and vegetable intake (Thompson, et al., 1999). This can have a substantial impact on results as one study showed that French fries accounted for approximately 11% of total vegetables consumed and 8% of total fruits and vegetables consumed on a daily basis in that study population (Krebs-Smith, et al., 1995).

Sometimes even non-fried potatoes are not counted toward vegetable intake. As was previously discussed, the Japanese system for classifying foods puts potatoes in the grain category along with rice and other grains and not in the vegetable category (Takata, et al., 2003). In the United Kingdom's '5-a-day' program all servings of potatoes are excluded when calculating fruit and vegetable intake (Ashfield-Watt, et al., 2003). Since the end goal of increasing fruit and vegetable intake is to improve human health it might be logical to exclude certain foods that are technically fruits and vegetables if their consumption is actually counterproductive to that goal. Conversely, the reason the broad category of fruits and vegetables is the target for assessment and intervention rather than specific fruits and vegetables or specific nutrients found in fruits and vegetables is that science has yet to clearly identify which components found in fruits and vegetables are crucial to human health (Pomerleau, Lock, McKee, & Altmann, 2005). Perhaps that is also one of reasons that recommendations are becoming more and more specific in specifying the need to consistently eat a variety of categories of fruits and vegetables.

In the context of variety of intake of fruits and vegetables being the goal and therefore the focus of assessment and intervention, excluding French fries and fried potatoes may make theoretical sense. In a recent national study that used repeated 24-dietary recalls to accurately measure regular intake of specific fruits and vegetables reported that potatoes of any type contributed nearly a quarter to a third of daily vegetable intake among American adults (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009). It would appear that increasing intake of potatoes is neither indicated nor desirable from an intervention standpoint.

A possibly important issue with respect to including potatoes in fruit and vegetable intake is its potential effect on differences in fruit and vegetable intake by ethnicity or cultural background. The Kimmons, et al. (2009) study participants were mostly Caucasian and African American with no Asian/Pacific Islander category. While potatoes are a traditional staple for many Caucasian groups, they are not a staple for many Asian/Pacific Islander groups. Conversely, rice is a staple for the latter and not the former. In a study of older adults (aged 45-75 years) living in Hawai'i or the Los Angeles area, average daily servings of grains was much higher for persons who identified as Hawai'ian or Japanese compared with those who identified as Caucasian (Park, et al., 2005). Potatoes were counted as contributing to fruit and vegetable intake, not grain intake, in this study. Rice was identified as the primary reason that grain intake was so much higher for those from Hawai'ian and Japanese backgrounds compared with Caucasian backgrounds. A similar result was reported when diets of Japanese and Caucasian women living in Hawai'i were compared (Takata, et al., 2003). In that study, the Japanese classification system was used where potatoes were included in the grain category rather than the vegetable category. Japanese women in Hawai'i consumed significantly more grains in grams per 1000 kilocalories compared with the Caucasian women, with rice being the primary reason for the difference. A recent study that evaluated rice consumption among various ethnic groups in the United States reported that Caucasians were least likely to be regular consumers of rice and that a category that combined ethnic groups but mainly consisted of persons of Asian or Pacific Islander backgrounds were most likely to be regular consumers of rice. African Americans and Hispanics were in the middle (Batres-Marquez, Jensen, & Upton, 2009). The implication

of these results is that in populations where rice consumption is high and potato consumption is low, such as most Asian and Pacific Islander groups, differences in estimated fruit and vegetable intakes may occur by ethnicity in comparison to Caucasians, where potato consumption is high and rice consumption is low and where potatoes are counted toward fruit and vegetable intake.

The issue of how potato versus rice intake might affect fruit and vegetable intake results with respect to ethnicity has not been evaluated specifically. There are some studies where this issue was indirectly evaluated, but results are conflicting. In the study where diets of Caucasian and Japanese women living in Hawai'i were compared, rice consumption was significantly higher for the Japanese women while vegetable consumption was significantly higher for the Caucasian women. What makes the latter finding even more significant is that in this study, potatoes were not counted as vegetables, but rather as grains (Takata, et al., 2003). It is likely the difference in vegetable intake would have been even greater if potatoes, as they usually are in American studies, had been counted toward vegetable intake. Conversely, in a national study of rice consumers, while rice consumers as expected consumed less potatoes compared with non-consumers, they consumed more vegetables (Batres-Marquez, et al., 2009). However, in this study, potatoes were also excluded from the vegetable category and it was not addressed what effect including potatoes in vegetable consumption might have had on results. Also, the results were not differentiated by ethnicity. Thus the consumer and non-consumer categories consisted of subjects from all ethnic backgrounds. Finally, fruit and vegetable consumption was assessed in a study of persons aged 45-75 from Hawai'ian, Japanese, or Caucasian ethnicities living in Hawai'i

or the Los Angeles area. There were no differences between persons of Caucasian background and persons of Japanese background in either vegetable intake or fruit intake. Intakes of both were higher for persons of Hawai‘ian background (Park, et al., 2005). Unlike the previous two studies, potatoes did count toward vegetable intake in this study. While it is clear that in general rice consumption is higher and potato consumption is lower among persons from Asian and Pacific Islander backgrounds compared with persons from Caucasian backgrounds, it is not clear if including potatoes or not including potatoes when assessing fruit and vegetable intake results in variable results when looking at differences in intake by ethnicity. If it does, then studies examining ethnic differences in fruit and vegetable intake cannot be compared if they use different definitions of what to include in determining such intake. It would also mean the interpretations, implications, and resulting interventions would need to consider if differences by ethnicity are solely the result of whether or not potato intake were included when assessing vegetable intake. It might also mean that assessment tools might have to be altered for different ethnic groups and that interventions developed to increase fruit and vegetable intake might have to vary depending on ethnicity.

In summary this brief overview demonstrates some of the issues that surround both how to define fruit and vegetable intake and how to measure fruit and vegetable intake for research and intervention development purposes. Currently, both what constitutes fruit and vegetable intake, and how it is measured, varies, often greatly, from study to study. Obviously this makes it difficult to compare results between studies. In addition to the absolute differences in intake the varying definitions and methods

produce, there is also a question regarding their relative value in evaluating intake, particularly among minority groups

Conclusions

Poor nutritional habits are a major modifiable risk factor for most chronic diseases. Improving dietary habits, especially significantly increasing fruit and vegetable intake, is an important goal if we are to reverse the rapid increases in the rates of obesity, diabetes, and related chronic diseases that are occurring in this country, especially among minority groups. Currently, few Americans eat five or more servings of fruits and vegetables on a daily basis, the minimal recommendation. Efforts to increase such intake so far have only been mildly successful. In order to change complex behaviors such as eating habits, it is important to find theories that can explain such behaviors and that can provide a basis for developing successful interventions.

CHAPTER 3-METHODOLOGY

Purpose of the Study

The overall purpose of this study is to explore if using different instruments and criteria for categorizing persons as regularly consuming or not consuming five or more servings of fruits and vegetables on a daily basis ('5 or more') affects results in an ethnically diverse population and if ethnicity interacts with the different instruments and criteria.

Specific Aims and Study Hypotheses

1. Assess the difference, if any, in overall percentages of participants who meet criteria for consuming '5 or more' daily servings of fruits and vegetables using a single question measurement instrument and a multi-item FFQ measurement instrument, with varying criteria using the latter (Table 1).
 - a. Hypothesis: The percentage of participants categorized as regularly consuming five or more daily servings of fruit and vegetables will be significantly lower using the single question instrument compared with using the multi-item instrument. Percentages will also be significantly lower for the stricter criteria using the multi-item instrument.
2. Assess the differences, if any, by race/ethnicity in percentages of participants categorized as consuming '5 or more' daily servings of fruits and vegetables and if such differences remain stable across the two instruments and varying criteria use for determining '5 or more' in this study.

- a. Hypothesis: There will be differences in ‘5 or more’ intake by race/ethnicity but no specific hypotheses regarding those differences. The differences in ‘5 or more’ intake by race/ethnicity will remain stable across the various methods used for determining ‘5 or more’ categorization.
3. Assess if the differences by race/ethnicity, if any, remain consistent when the outcome measure is mean number of daily servings of fruits and vegetables rather than ‘5 or more’ categorization.
 - a. Hypothesis: Differences in intake by race/ethnicity will remain stable when the mean number of daily servings of fruits and vegetables is used as the outcome measure instead of the categorical variable ‘5 or more’.
 4. Assess if there are differences by race/ethnicity for mean daily servings of specific fruit and vegetable categories.
 - a. Hypothesis: Caucasians will consume significantly more daily servings of potatoes compared with the other ethnic groups. No hypothesis regarding the other specific fruit and vegetable categories.

Study Design

This study utilized a descriptive design with data previously collected from the baseline Healthy Hawai‘i Initiative Longitudinal Study that was conducted in Hawai‘i during 2002.

Background of Healthy Hawai'i Initiative (Parent Study)

The current study is a study using data previously collected for the Healthy Hawai'i Initiative (HHI). In 1999, the state of Hawai'i decided to use part of the monies received from the tobacco settlement to develop disease prevention programs targeting tobacco, physical activity, and nutrition. The Healthy Hawai'i Initiative is the program that was developed with this money. The overall stated goal of the HHI is to “increase the years of healthy life for all people of Hawai'i and reduce existing health disparities among ethnic groups in Hawai'i” (Maddock, et al., 2006). Prior to development of the HHI, survey data indicated that less than 20% of persons in Hawai'i consumed five or more servings of fruits and vegetables per day, the minimum amount that is often recommended, and that obesity rates were increasing rapidly (Maddock, et al., 2006).

Data Collection for Parent Study

Baseline surveillance data were obtained in 2002. A cross-sectional survey of non-institutionalized adult residents of Hawai'i was conducted in the spring (February through April) of 2002. The survey was conducted using random digit dialing procedures. Participant randomization was attained by choosing the person over age 18 in the household who had the last birthday. Informed consent was first obtained followed by conduction of a short telephone survey. Interviewers received extensive training prior to the actual interviews. Each of Hawai'i's four counties was sampled equally in an attempt to get a representative sample of the population. All procedures were approved prior to conduction of the surveys by the University of Hawai'i Committee on Human Participants. During the initial data collection for the baseline cross-sectional survey

conducted in February through April, 2002, a total of 62,237 telephone numbers were attempted. Of these, 43,168 were either non-residential numbers or were disconnected or there was no answer despite multiple attempts. A total of 19,069 persons were contacted of whom 12,605 refused to participate. Of the remaining 6464 persons, 1758 either did not speak English or were under age 18 leaving 4706 participants for the initial baseline cross-sectional survey of the HHI.

During collection of data for the initial baseline cross-sectional survey conducted in February through April, 2002, participants were asked to enroll in a longitudinal survey that would involve undergoing repeat interviews at yearly intervals. Data would include updated demographic data and follow-up data regarding selected behaviors such as fruit and vegetable intake and theoretical variables related to these behaviors such as stages of change in relation to fruit and vegetable intake. The names, addresses, and telephone numbers of participants who agreed to partake in the longitudinal survey were obtained.

Interviewer training for parent study

All interviewers were given classroom training on the general background and purpose of the survey and were walked through each question and any special instructions for each question. They were also reminded about interviewing techniques regarding probing when respondent answers are incomplete or vague. They were trained in trying to avoid refusals both during the screening process as well as during the regular interview. They were taught how to handle respondents who refuse individual questions or the entire interview. Interviewers were told that they would be observed on a sub-

sample of their interviews for quality control and where necessary would be retrained on specific techniques or items as needed. Part of the training sessions included practice interviewing, first with dummy respondents and then with live respondents to assure interviewer competence prior to actually beginning their interviewing work. The classroom portion of the initial training for each of the questionnaires (i.e. cross-sectional and longitudinal) required about two hours plus an additional one to two hours of practice interviewing. Follow-up training time depended upon the content and was tailored to each interviewer's need. Virtually all interviewers were observed during the project and all received supplementary training during the field collection period. Supplemental training focused on both techniques of interviewing as well as following correct procedures and obtaining and entering correct and complete data.

Quality control for parent study

Quality control was an important part of the data collection process. There were several procedures used to assure the highest quality of data. The first is the training of interviewers. The training sessions themselves initially were designed to assure interviewer knowledge and skills in calling, screening and in conducting interviews. The CATI program screened answers for appropriateness and completeness, requiring interviewers to enter answers within given ranges, and making sure that all appropriate/required questions were answered. In addition, a sub-sample of interviews was monitored for quality by the supervisor. A sub-sample of interviews were monitored during each interviewing session and based on the outcome, interviewers were alerted to areas that required additional follow-up training.

Survey protocol methodology for parent study

The sample for the short/cross-sectional sample from which the current longitudinal sample was obtained was a disproportionate stratified sample, with islands as strata. The sample was drawn randomly (RDD) by island (stratified) or statewide (proportional). Telephone numbers were entered into the WinCATI data system where interviewers could have controlled access to them in conducting the surveys. Interviewers made at least five attempts to contact the assigned sample telephone numbers. The calling center included 20 CATI stations and two supervisor stations. The interviewing schedule was 9AM until 9PM daily. Morning calling yielded fewer completed interviews but was better to screen out business and other non-working numbers so that afternoon and evening callbacks could be more productive. Daily reports by completion code were kept and a weekly summary was transmitted to the HHI Evaluation Survey Project Office at UH (JABSOM). Survey interviewing for the final longitudinal sample (4th wave) began the third week of March, 2004 and continued until completed during the second week of June 2004.

Error correction methodology for parent study

Many errors were averted because the CATI programming permitted the checking of interviewer responses for specific codes or ranges of codes as well as for consistency with previous responses. Skips were automatically accomplished so that interviewers could not ask inappropriate questions. Answers were required for most questions, which meant that in order to continue, an answer to each appropriate question was required.

After the completion of the data collection and merging of files was done, frequency runs of each data file were run to manually check for erroneous codes. When identified, the erroneous codes were corrected, if possible. The correction procedure checked related responses to assure the correction was consistent. If the error could not be corrected, it was coded unknown. No data attribution program was used to fill in missing or incomplete data.

Types of data obtained for parent study

Data obtained during the interviews included demographic data (age, gender, marital status, race/ethnicity, income, education, height, weight), data on the three health behaviors of interest (fruit and vegetable intake, physical activity, and smoking status), and various psychosocial measures including stages of change in relation to each health behavior being assessed, measures related to the Theory of Reasoned Action (TRA)/Theory of Planned Behavior (TRB), self-efficacy in relation to each health behavior being assessed, and environmental factors possibly associated with the behaviors. Nutrition information, specifically fruit and vegetable intake, was assessed in two ways. First, by asking a single question regarding average number of daily servings of fruits and vegetables consumed, and second, by using a short “all day” assessment developed by the National Cancer Institute that asks about regular consumption of 10 different categories of fruits and vegetables with results from these questions used to calculate average daily servings of fruits and vegetables (Thompson et al., 2002).

Population and Sample for Current Study

The population for the study was non-institutionalized adult residents of Hawai‘i. The sample for the current analyses include those HHI longitudinal study participants who provided data both at baseline in 2002 and at the final follow-up survey conducted in 2004 with the current analyses focusing on the baseline data collected in 2002. All of the 4706 participants who completed the initial baseline cross-sectional survey were asked if they would also participate in the longitudinal study which would require being contacted again at one year and two year follow-up. A total of 3533 participants agreed to the longitudinal study at baseline and 1350 of the 3533 (38%) completed both the baseline survey in 2002 and the follow-up survey two years later in 2004 (Table 2).

Measures used for the Current Study

Demographic variables

For the current study, the variables “gender” (female or male) and “education” (years of educations) were self-reported data. “Age” was calculated using self-reported year of birth. “Race/ethnicity” was based on self-report when asked about “ethnic identification” and that included options of “mixed” ethnicities when given 15 categories and a separate question asking if the participants considered themselves Hispanic. Based on responses participants were then categorized into one of five ethnicity categories (Caucasian, Japanese, Hawai‘ian/part Hawai‘ian, Filipino, Other). These categorizations are consistent with U.S. Census Bureau (2000) data for Hawai‘i which indicate that other than those 4 specific ethnic groups, other ethnic groups comprise very small proportions of Hawai‘i’s adult population. These categories are also consistent with BRFSS fruit and vegetable intake data for Hawai‘i (State of Hawai‘i, 2007).

Outcome measures

The variable “Five or More”, which categorizes participants as either meeting the goal of regularly consuming 5 or more servings of fruits and vegetables on a daily basis or not, was calculated based on self-reported response to a single question regarding average daily servings of fruits and vegetables consumed (Table 1). For the analyses comparing alternative methods for calculating this variable, ‘5 or more’ was also calculated using responses to the multi-item food frequency questionnaire (FFQ) administered as part of the survey. This FFQ contained questions that asked about 10 specific categories of fruits and vegetables and amount and frequency of consumption within each category (fruit juice, fruit, lettuce salad, French fries/fried potatoes, other potatoes, dried beans, tomato sauce, vegetable soups, mixtures including vegetables, and other vegetables). Responses to the FFQ were used to calculate actual daily servings for each item in the FFQ which were then summed for overall daily servings of fruits and vegetables. Both methods have been validated against 24-hour dietary recalls, but only among predominately Caucasian subject populations (Thompson, et al., 2002).

The first alternative method for determining if participants met ‘5 or more’ criteria involved using the sum of daily serving of fruits and vegetables as calculated using responses to all sets of questions that asked about consumption of specific categories of fruits and vegetables. If the summed intake was 5.0 or greater, then the participants were classified as meeting criteria, and if the summed intake was less than 5.0, then the participants were classified as not meeting criteria. The second method was the same as the first except that the category “French fries/fried potatoes” was not included in calculating consumption of fruits and vegetables. The third method was the

same as the second method with the additional exclusion of any potatoes from calculating intake. The fourth method used all items like the first method but with the additional requirement that at least 2 servings had to be from the fruit and fruit juice categories (sum of 2.0 or greater) and at least 3 servings had to be from the vegetable categories (sum of 3.0 or greater) (Table 1).

Human Subjects

In the parent study from which the data for the current study were obtained, all procedures for the telephone survey and the method for obtaining informed consent were first reviewed and approved by the University of Hawai'i Committee on Human Participants. For each subject contacted by telephone who agreed to participate in the study, informed consent was obtained first before survey administration. An application for new approval of a study involving human subjects was made to the University of Hawai'i Committee on Human Studies for the current study. The study was approved and a certificate of exemption was obtained (Assurance Identification No. F3526, IRB Registration No. IORG0000169, expires 09/15/2011).

Data Analysis

Data were analyzed using SPSS 17.0. First, descriptive analyses of demographic data for the overall sample and for each of the race/ethnicity categories using percentages for nominal data and means and SD for interval and ratio data were conducted. Then, in chi-square analyses for the categorical variable "gender", and in ANOVA analyses for the continuous variables "age" and "education", overall differences in each demographic variable by race/ethnicity were assessed. Post hoc analyses with "Caucasian" as the

referent group were then conducted for each demographic variable where the result in the overall analyses was statistically significant. For the categorical variable “gender”, a logistic regression analysis was conducted. For the continuous variables “age” and “education”, post hoc analyses using Tukey’s HSD to correct for multiple comparisons were conducted. For each of the analyses, the level of significance was set at $p < .05$. Analyses specific for each study hypothesis are discussed below with each hypothesis.

Hypothesis 1 – The percentage of participants categorized as regularly consuming five or more daily servings of fruit and vegetables will be significantly lower using the single question instrument compared with using the multi-item instrument. Percentages will also be significantly lower for the stricter criteria using the multi-item instrument.

To evaluate hypothesis 1, ‘5 or more’ percentages were calculated using the five methods previously described with results first compared descriptively as percentages of participants meeting ‘5 or more’ criteria for each method, and then in chi-square analyses with ‘5 or more’ calculated using all 10 FFQ items as the standard for comparison against which the other 4 methods used to calculate ‘5 or more’ were compared. To reduce the risk for error in doing 4 pair-wise comparisons, the significance level was adjusted using a *Bonferroni correction* resulting in a significance level of $p < .0125$ for each comparison ($.05/4 = .0125$).

Hypothesis 2 – There will be differences in ‘5 or more’ intake by race/ethnicity but no specific hypotheses regarding those differences. The differences in ‘5 or

more' intake by race/ethnicity will remain stable across the various methods used for determining '5 or more' categorization.

To evaluate hypothesis 2, for each method for determining '5 or more', the association between '5 or more' and race/ethnicity will be evaluated in logistic regression analyses along with gender, age, and education, demographic factors often found associated with fruit and vegetable intake in mainland US studies, to see both if the relative order of intake by ethnicity remains the same across definitions, and if the differences by race/ethnicity as well as for the other demographic factors that are statistically significant remain so across the five methods. For ethnicity, 'Caucasian' will be used as the referent group. In order to reduce the risk for error in doing five analyses, the significance level will be adjusted using a *Bonferroni correction* ($.05/5 = p < .01$).

Hypothesis 3 – Differences in intake by race/ethnicity will remain stable when the mean number of daily servings of fruits and vegetables is used as the outcome measure instead of the categorical variable '5 or more'.

To evaluate hypothesis 3 the overall mean intake of usual daily servings of fruits and vegetables for each ethnic groups was calculated using responses to all items on the multi-item FFQ. Then, an ANCOVA analysis was performed using mean overall intake of fruits and vegetables with race/ethnicity as the variable of interest and age, gender, and education as the covariates to be controlled, to assess if mean intake differed significantly by race/ethnicity. For the overall F test evaluating the effect of ethnic identify, the level of significance was $p < .05$. Pairwise comparisons were then performed with the level of

significance for each comparison set at $p < .05$ after Bonferroni adjustment for multiple comparisons.

Hypothesis 4 –Caucasians will consume significantly more daily servings of potatoes compared with the other ethnic groups. No hypothesis regarding the other specific fruit and vegetable categories.

To evaluate hypothesis 4, mean intakes for each fruit and vegetable item in the multi-item FFQ by race/ethnicity were calculated. Then, ANCOVA analyses were performed for each outcome measure (mean intake of each food group) with race/ethnicity being the independent variable of interest and age, gender, and education the covariates to be controlled, to see if mean intake for any of the items differed significantly by race/ethnicity. For the overall F test evaluating the effect of ethnic identify, the level of significance was $p < .05$. Pairwise comparisons were then performed with the level of significance for each comparison set at $p < .05$ after Bonferroni adjustment for multiple comparisons.

CHAPTER 4 - RESULTS

Sample Demographics

The sample was comprised of the 1350 participants who completed the longitudinal study survey at baseline and the follow-up survey 2 years later with the current analyses focusing on the baseline data. Ethnically the sample was diverse with slightly more than a third of the sample identifying as Caucasian, nearly a quarter identifying as Japanese, and one-sixth identifying as Hawai‘ian or part-Hawai‘ian. Mean age was 50.8 years and mean education was 15.2 years. By gender, 63.7% of participants were female and 36.6% were male. When participants were grouped by race/ethnicity (Caucasian, Japanese, Hawai‘ian, Filipino, and other), there were significant differences by race/ethnicity with respect to the other demographic variables (gender, age, education). Gender was significantly associated with race/ethnicity in chi-square analyses (Pearson chi-square 12.504, df 4, $p = .014$). In logistic regression analyses with Caucasian as the referent group, a significantly higher percentage of participants who identified as being Hawai‘ian (Exp(B) 1.68 CI 1.19-2.35, $p = .003$) or as Japanese (Exp(B) 1.42 CI 1.06-1.91, $p = .021$) were female. Age was significantly associated with race/ethnicity in ANOVA analyses ($F(4, 1340) 16.026, p < .001$). In post hoc analyses using Tukey’s HSD to correct for multiple comparisons, compared with participants who identified as Caucasian, the mean age was younger for those identifying as Hawai‘ian (mean difference 6.15 CI 2.83-9.47 $p < .001$), Filipino (mean difference 8.64 CI 4.19-13.09 $p < .001$), and Other (mean difference 4.62 CI 1.23-8.00 $p = .002$). Years of education was significantly associated with race/ethnicity in ANOVA analyses ($F(4,$

1340) 21.22, $p < .001$). In post hoc analyses using Tukey's HSD to correct for multiple comparisons, compared with participants who identified as Caucasian, the mean years of education was significantly lower for those identifying as Hawai'ian (mean difference 2.10 CI 1.42-2.78 $p < .001$), Japanese (Mean difference .88 CI .27-1.49 $p = .001$), Filipino (mean difference 1.85 CI .94-2.76, $p < .001$, and Other (mean difference .79 CI .10-1.48, $p = .016$). Demographic characteristics by race/ethnicity are presented in Table 3.

Overall Percentages Meeting '5 or more' Criteria

Hypothesis 1 – The percentage of participants categorized as regularly consuming five or more daily servings of fruit and vegetables will be significantly lower using the single question instrument compared with using the multi-item instrument. Percentages will also be significantly lower for the stricter criteria using the multi-item instrument.

The percentage of participants reporting regularly eating '5 or more' daily servings of fruits and vegetables varied greatly with how '5 or more' categorization was calculated (Table 4). When all items on the multi-item FFQ were used to calculate intake, the percentage reporting '5 or more' increased to 60.8%. When servings of French fries/fried potatoes were not included in calculating '5 or more', the percentage dropped to 56.7%, and it dropped to 46.4% when all potatoes were excluded. When '5 or more' was calculated using the FFQ responses and where the requirement specified at least two servings of fruits and at least three servings of vegetables in order to meet criteria, the percentage meeting '5 or more' criteria dropped to 30.8%. When participants

were asked a single question regarding average number daily servings of fruits and vegetables, only 20.9% of participants reported eating '5 or more' on a daily basis. In chi-square analyses comparing the method where '5 or more' was calculated using all items on the multi-item FFQ, the method which produced the highest percentage of participants meeting '5 or more' criteria, against each of the other four methods, the percentage of participants meeting '5 or more' criteria was significantly lower for those four methods (Multi-item FFQ not including fried potatoes, Pearson chi square 1129.93, $p < .001$; Multi-item FFQ not including any potatoes, Pearson chi square 745.99, $p < .001$; Multi-item FFQ with requirement of at least 2 servings of fruit and at least 3 servings of vegetables, Pearson chi square 302.38, $p < .001$; Single question, Pearson chi square 85.71, $p < .001$).

Ethnicity and Variations in '5 or more' Criteria

Hypothesis 2 – There will be differences in '5 or more' intake by race/ethnicity but no specific hypotheses regarding those differences. The differences in '5 or more' intake by race/ethnicity will remain stable across the various methods used for determining '5 or more' categorization.

Descriptive results

For all ethnic groups, the method using all 10 items on the FFQ produced the highest percentage of participants meeting '5 or more' criteria while the single question method for determining '5 or more' produced the lowest percentage (Table 5). As the criteria when using the multi-item FFQ became more restrictive, the percentages decreased for all groups. When the criteria was at least 2 servings of fruit and at least 3

servings of vegetables daily, percentages were closer to those obtained with the single item method than to the method using all 10 FFQ items. For all methods used to determine '5 or more' categorization, the highest percentage of participants meeting '5 or more' criteria by ethnicity was for Caucasians. For other ethnic groups, relative positions of the percentage of participants meeting '5 or more' criteria were generally the same across methods. However, for participants identifying as Filipino, the single item method led to an extremely small percentage meeting criteria, well below that of any other ethnic group, but this was not the case when the multi-item FFQ was used to determine '5 or more'.

Logistic regression results overall

Age in years and education in years as continuous variables, gender, and race/ethnicity, with 'Caucasian' as the referent group, were then evaluated for association with '5 or more' in logistic regression analyses for each of the five methods used to determine '5 or more' (Tables 6-10). For all methods used for determining '5 or more', race/ethnicity was significantly associated with outcomes. Specifically, as compared with Caucasian participants, Japanese participants and Filipino participants were significantly less likely to meet '5 or more' with all definitions (Japanese participants) or all but one definition (Filipino participants). Gender (females more than males) was significantly associated with '5 or more' for all methods evaluated with the exception of the method requiring at least two daily servings of fruit and at least three daily servings of vegetables. Age was not associated with '5 or more' for any method evaluated except for the single question method.

Logistic regression results multi-item screener method

For the '5 or more' method using all items on the multi-item FFQ, compared with Caucasians, those identifying as Japanese were significantly less likely to meet '5 or more' criteria (Exp(B) .45 CI .34-.61, $p < .001$). Age, education, and gender were not significantly associated with '5 or more' with this method (Table 6).

Logistic regression results multi-item screener method excluding fried potatoes

For the '5 or more' method using the multi-item FFQ except for fried potatoes, compared with Caucasians, those identifying as Filipino or Japanese were significantly less likely to meet '5 or more' criteria (Exp(B) .47 CI .30-.73, $p = .001$ and Exp(B) .43 CI .32-.58, $p < .001$, respectively). For the other demographic variables, males were significantly less likely than females to meet '5 or more' criteria (Exp(B) .73 CI .58-.92, $p = .007$). Age and education were not significantly associated with '5 or more' with this method for determining '5 or more' (Table 7).

Logistic regression results multi-item screener method excluding all potatoes

For the '5 or more' method using the multi-item FFQ except for all potatoes, compared with Caucasians, those identifying as Filipino or Japanese were significantly less likely to meet '5 or more' criteria (Exp(B) .55 CI .35-.86, $p = .008$ and Exp(B) .50 CI .37-.67, $p < .001$, respectively). For the other demographic variables, males were significantly less likely than females to meet '5 or more' criteria (Exp(B) .68 CI .54-.86, $p = .001$). Age and education were not significantly associated with '5 or more' with this method for determining '5 or more' (Table 8).

Logistic regression results multi-item screener method requiring at least 2 servings of fruit and at least three servings of vegetables

For the ‘5 or more’ method using the multi-item FFQ using all items but with the requirement of at least two servings of fruit and at least three servings of vegetables, compared with Caucasians, those identifying as Filipino or Japanese were significantly less likely to meet ‘5 or more’ criteria (Exp(B) .52 CI .32-.86, $p = .010$ and Exp(B) .39 CI .28-.55, $p < .001$, respectively). For the other demographic variables, gender, age and education were not significantly associated with ‘5 or more’ with this method for determining ‘5 or more’ (Table 9).

Logistic regression results single question method

For the ‘5 or more’ method using a single question, compared with Caucasians, those identifying as Filipino or Japanese were significantly less likely to meet ‘5 or more’ criteria (Exp(B) .25 CI .12-.53, $p < .001$ and Exp(B) .44 CI .30-.63, $p < .001$, respectively). In comparison to Caucasians, those identifying as Hawai‘ian or as Other tended to be less likely to meet ‘5 or more’ criteria with this method with results approaching statistical significance (Exp(B) .61 CI .41-.93, $p = .020$, n.s. and Exp(B) .63 CI .42-.94, $p = .023$, n.s., respectively). For the other demographic variables, males were significantly less likely than females to meet ‘5 or more’ criteria (Exp(B) .50 CI .37-.68, $p < .001$). Age and education were also significantly associated with ‘5 or more’ with this method for determining ‘5 or more’ with a greater likelihood of meeting ‘5 or more’ criteria with increasing age (Exp(B) 1.02 CI 1.01-1.03, $p < .001$ and with increasing years of education (Exp(B) 1.07 CI 1.02-1.11, $p < .001$)(Table 10).

Mean Daily Servings and Ethnicity

Hypothesis 3 – Differences in intake by race/ethnicity will remain stable when the mean number of daily servings of fruits and vegetables is used as the outcome measure instead of the categorical variable ‘5 or more’.

Mean daily servings of fruits and vegetables instead of the categorical variable ‘5 or more’ were then evaluated in ANCOVA analyses with age and gender controlled for and race/ethnicity the variable of interest. The average number of daily servings was 6.8-7 servings for all ethnic groups except Japanese, which was an average of 5.5 servings. Race/ethnicity was significantly associated with total mean daily servings of fruits and vegetables (F 5.54 df 4 $p < .001$). In pairwise comparisons with Bonferroni adjustment for multiple comparisons, the mean daily servings of fruits and vegetables was significantly lower for participants identifying as Japanese compared with Caucasians (mean difference 1.35 CI .43-2.28 $p < .001$). To evaluate this difference further, total servings of fruit/fruit juices and total servings of vegetables were then evaluated separately. Mean daily servings of fruit/fruit juices by race/ethnicity ranged from 2.7 – 3.3. In ANCOVA analyses, race/ethnicity was not significantly associated with mean daily servings of fruit/fruit juices. Mean daily servings of vegetables ranged from 2.8 – 3.9. In ANCOVA analyses, race/ethnicity was significantly associated with mean daily servings of vegetables (F 7.81 df 4 $p < .001$). In pairwise comparisons with Bonferroni adjustment for multiple comparisons, the mean daily servings of vegetables was significantly lower for participants identifying as Japanese compared with Caucasians (mean difference 1.01 CI .46-1.59 $p < .001$) (Table 11).

Mean Daily Servings of Specific Food Items and Ethnicity

Hypothesis 4 – Caucasians will consume significantly more daily servings of potatoes compared with the other ethnic groups. No hypothesis regarding the other specific fruit and vegetable categories.

Since overall vegetable intake was associated with race/ethnicity, mean servings of specific vegetable items were then evaluated for association with race/ethnicity in ANCOVA analyses controlling for gender and age with pairwise comparisons with Bonferroni adjustment for multiple comparisons (Table 12). Compared with Caucasians, participants identifying as Japanese ate significantly fewer mean daily servings of non-fried potatoes (mean difference .21 CI .11-.31, $p < .001$), beans (mean difference .17 CI .06-.29, $p < .001$), and mixed/other vegetables (mean difference .40 CI .09-.72, $p = .004$). Compared with Caucasians, participants identifying as Filipino consumed more daily servings of fried potatoes (mean difference -.21 CI -.40--01, $p = .026$) and more daily servings of vegetables in soups (mean difference -.27 CI -.39--015, $p < .001$).

CHAPTER 5 - DISCUSSION

Summary of Findings

This study evaluated if race/ethnicity is associated with fruit and vegetable intake, specifically intake of the commonly used '5 or more' servings per day, among adults in Hawai'i, using two instruments to measure intake and varying criteria for what defines '5 or more' intake. Of specific concern was evaluating if differences associated with race/ethnicity, if present, remained consistent across the different ways in which '5 or more' categorization was calculated. The results indicated that regardless of instrument used or criteria used for determining '5 or more' that there were significant differences in fruit and vegetable intake by race/ethnicity. However, for at least some ethnic groups, results were inconsistent depending on how '5 or more' categorization was calculated. This study also evaluated if the reason Caucasians, who in most studies have a higher percentage of participants meeting '5 or more' criteria compared with other ethnic groups, is at least partially the result of consumption of more servings of potatoes. In the current study, removing potatoes when determining '5 or more' percentages did not alter results with relative differences by race/ethnicity remaining consistent with Caucasians continuing to have significantly higher percentages of participants meeting '5 or more' criteria and Japanese and Filipino participants continuing to have the lowest percentages.

Overall Percentages Meeting '5 or more' Criteria

Overall, the percentage of participants who met criteria for '5 or more' fruit and vegetable intake ranged from a low of 20.9% when a single question instrument was used

to determine intake to a high of 60.8% when all items on a multi-item FFQ instrument were used to determine intake. As would be expected, percentages decreased using the multi-item FFQ as criteria became more stringent such as not including consumption of fried potatoes in calculating vegetable intake. When the criteria for ‘5 or more’ categorization using the multi-item FFQ was at least 2 daily servings of fruit and at least daily 3 servings of vegetables, a goal similar to but not as specific as the Healthy People 2010 goal, the percentage considered to have adequate intake of fruits and vegetables declined to 30.8%. These differences are not surprising as studies from the mainland of the US also report a wide range of adults as meeting goal levels of fruit and vegetable intake depending on how intake is assessed and/or what is or is not included when determining intake with reported percentages for adults ranging from less than 5% (Kimmons, et al., 2009) to nearly 60% (Guenther, Dodd, Reedy, & Krebs-Smith, 2006) depending on age, gender, and ethnicity.

In the current study, use of the single question method for determining ‘5 or more’ produced the lowest percentage of participants meeting criteria for desired intake. As discussed previously, studies have reported that this single-item instrument (Peterson, et al., 2008) and other very brief instruments, such as the BRFSS (Serdula, et al., 2004; Smith-Warner, et al., 1997), underestimate actual intake although they appear to be good at ranking intake. The results using the single question are very similar to BRFSS results for the state of Hawai‘i for 2002. The BRFSS data indicated that overall, 20.4% of adults in Hawai‘i met ‘5 or more’ criteria (Hawai‘i Department of Health, 2007) while results from the current study were that overall 20.9% of participants met ‘5 or more’ criteria.

In the current study, when all items on the multi-item FFQ were used to determine '5 or more' categorization, nearly 61% of participants met criteria. This is a higher percentage than reported in most other studies that have evaluated '5 or more'. However, Guenther, et al. (2006), using 24-hr dietary recall data to determine '5 or more' among a nationally representative sample of adults reported that approximately 50% of adults met '5 or more' criteria, and among subgroups of adults by age and gender, up to 60% met criteria, levels nearly as high as our findings. Additionally, previous studies have shown that the multi-item FFQ instrument that the instrument in the current study was based on, and other instruments that include even more items, tend to overestimate actual intake compared with 24-hour recall data (Petersen, et al., 2008; Thompson, et al., 2002). Previous studies that have looked specifically at '5 or more' generally have used either BRFSS data or have used 24-hour dietary recall to determine '5 or more' so the higher percentages we found using the multi-item FFQ are not surprising. Overall then although the current study did not have 24-hour recall data to compare our results to, results are consistent with previous studies and as expected, the percentage of participants meeting '5 or more' criteria based on response to the single item question was significantly lower than the percentage of participants meeting '5 or more' criteria based on responses to the multi-item FFQ. The obvious question is then if screeners do not accurately measure actual intake, should they even be used? The fact that short screeners significantly overestimate or underestimate true intake of fruits and vegetables does not mean they have no value in studying such intake. Although the previously mentioned studies have reported that screeners are not good for determining absolute intake, they have also reported that the screeners are good at ranking participants by intake and are good for

evaluating factors associated with intake and thus by implication can be good at evaluating interventions designed to increase such intake. The caveat is that those studies have generally involved primarily Caucasian subjects and it has not been established that such screeners are also good at ranking subjects from other ethnic groups.

Ethnicity and Variations in ‘5 or more’ Criteria and Overall Mean Servings

There were significant differences in ‘5 or more’ percentages by race/ethnicity in the current analyses. For all methods used for determining ‘5 or more’ the highest percentages of ‘5 or more’ by race/ethnicity were for Caucasians and the lowest, significantly lower than Caucasians, were for Japanese and Filipinos. Studies from the mainland have consistently reported that Caucasians are more likely to meet fruit and vegetable intake goals compared with African Americans (Casagrande, et al., 2007; Krebs-Smith, et al., 1995). The same appears true for Caucasians compared with Hispanics although studies have varied in defining Hispanic with some studies grouping all Hispanics into one category and others specifying Mexican Americans versus Americans from other Hispanic backgrounds with results varying depending on such categorization (Casagrande, et al., 2007; Krebs-Smith, et al., 1995). There are no national studies that have looked at specific Asian groups and in most studies that even include categories other than Caucasian, African American, and Hispanic, all persons from Asian and Pacific Islander backgrounds are included into the category ‘other’ along with diverse ethnic groups (Casagrande, et al., 2007; Krebs-Smith, et al., 1995).

There are some small studies that have looked at specific ethnic categories beyond what is included in national studies. Park, et al. (2005) looked at fruit and vegetable

intake among older persons living in Hawai‘i and the Los Angeles area and included specific ethnic categories that included Hawai‘ian ethnicity and Japanese ethnicity in addition to Caucasian ethnicity, Hispanic ethnicity, and African American ethnicity. Their study evaluated average daily intake of fruits and vegetables in servings per day rather than grouping participants by ‘5 or more’. In their study, average servings per day of fruits and vegetables was significantly higher for Hawai‘ian compared with Caucasians or Japanese, with no significant differences between the latter two groups. This conflicts with results of the current study regarding ‘5 or more’ in which Caucasians had the highest intake of fruits and vegetables followed by Hawai‘ians then Japanese. However, in the current study when absolute servings per day of fruits and vegetables rather than the category ‘5 or more’ was evaluated, Hawai‘ians also had higher, but not significantly so, intake than did Caucasians. One possible explanation for this is that average energy consumption is higher and more variable for Hawai‘ians compared with Caucasians and thus a small but significant percentage of Hawai‘ian participants have very high daily servings of fruits and vegetables because of very high energy intakes, which significantly affects average servings per day but not categorization in to ‘5 or more’. Although the current study did not evaluate energy intake, Park, et al. (2005) did and in their results, the average daily energy intake for Hawai‘ians was more than 20% higher than that for Caucasians and Japanese. Regardless of how the current study evaluated intake and regardless of whether the current study looked at ‘5 or more’ or average daily servings of fruits and vegetables, persons from Japanese backgrounds had significantly lower intakes compared with Caucasians, a finding that conflicts with that of Park, et al. (2005). There were two major differences between the two studies though.

First, the current study exclusively included residents of Hawai‘i while their study also included residents of the Los Angeles area. Second, the current study included adults of all ages while their study was specifically limited to adults aged 45-75 years. While the current results regarding higher intakes of fruits and vegetables by Caucasians compared with Japanese are inconsistent with Park, et al. (2005), they are consistent with a study that compared fruit and vegetable intake specifically among adult women in Hawai‘i from Caucasian and Japanese ethnic backgrounds as well as Japanese women living in Japan (Takata, et al., 2003). In that study, Caucasian women consumed significantly more servings of vegetables and fruit per day than did Japanese women in Hawai‘i. Importantly, in that study, potatoes were not included in calculating vegetable intake which is consistent with the Japanese system of classifying foods. It might be expected that potatoes would play a more prominent role in diets of Caucasians than Japanese and thus excluding them might erase differences in vegetable intake between the two groups, but that did not happen. In findings from the current study, excluding potatoes also did not erase such differences, an issue to be discussed later. Findings from the current study regarding ethnicity, at least with respect to Caucasians, Hawai‘ians, and Japanese, are also consistent with findings from the 2002 BRFSS survey in Hawai‘i (Hawai‘i Department of Health, 2007). In those findings, Caucasians had the highest percentage meeting ‘5 or more’ criteria and Japanese had the lowest percentage with Hawai‘ians in between.

There was one definite inconsistency, both within the current study between methods for determining ‘5 or more’ and between the current study findings and the BRFSS findings, and that was regarding results for Filipinos. In the BRFSS findings, the

percentage of Filipinos meeting the ‘5 or more’ standard was nearly as high as the percentage of Caucasians meeting the standard and was higher than Hawai‘ians and Japanese. In the current study, the percentage of Filipinos meeting the ‘5 or more’ standard was significantly lower than the percentage of Caucasians meeting it, and comparable to or lower than Japanese, depending on which method was used for determining ‘5 or more’. When the single question method was used, Filipinos had an extremely low percentage meeting ‘5 or more criteria’, much lower than any other ethnic group including Japanese. While other results in the current study using the single question were similar to the BRFSS findings, this particular result was pronouncedly different. Conversely, when all 10 items on the FFQ were used to calculate ‘5 or more’, the percentages for Filipinos were higher than those for Japanese, and nearly as high as for Hawai‘ians. With respect to relative rankings as opposed to absolute values, rankings in the current study of ‘5 or more’ by ethnicity were most consistent with BRFSS data when ‘5 or more’ was calculated using all items on the multi-item FFQ and were least like it when ‘5 or more’ was calculated using the single question. Rankings by ethnicity also changed when the multi-item FFQ was used but when more specific criteria for calculating ‘5 or more’ were used. When fried potatoes and when all potatoes were not included in determining ‘5 or more’, Filipinos and Japanese had approximately the same percentages and both were significantly lower compared with Caucasians. The inconsistency in findings for Filipinos across methods for determining ‘5 or more’ did not occur for any other ethnic group. Why this was the case with respect to the single question method is unclear but it does indicate that the single question method for determining ‘5 or more’ should probably not be used, at least in studies in Hawai‘i.

Interestingly, as was the case with Hawai‘ians, when the current study looked at average daily servings of fruits and vegetables as opposed to ‘5 or more’ categorization, there was no significant difference between Caucasians and Filipinos in intake. It could be speculated that this is for the same reasons as discussed regarding Hawai‘ians, that average daily energy intakes are significantly higher, but unlike Hawai‘ians, no reports that this is actually the case have been reported. It should also be noted that for the race/ethnicity groups “Hawai‘ian” and “Other”, when the single question method was used to determine ‘5 or more’, there would have been a statistically significant difference between each group and Caucasians if the level of significance had not been lowered to .01 to adjust for the multiple logistic regression analyses performed. This was not the case with any of the methods using the multi-item FFQ. Again, while not as dramatic as with Filipinos, the single item method appears to have more effect on results for non-Caucasians, further raising the question of using it in a population such as is found in Hawai‘i. A possible explanation is that with the single question method, non-Caucasians are more likely to not include foods that count toward vegetable consumption but might not be thought of as vegetables unless specifically prompted to include them such as beans, tofu, and possibly even potatoes. Of course, in order to fully evaluate these issues it would be necessary to have 24-hour dietary recall data.

The current findings illustrate the importance of how choice of fruit and vegetable screener might impact results and the importance of first validating any fruit and vegetable screener across ethnic groups. As previously discussed, the ‘gold standard’ for determining individual’s fruit and vegetable intake is the 24-hour dietary recall, but for most large, population-based studies, obtaining fruit and vegetable intake data using 24-

hour dietary recall is too time and too resource intensive to be feasible so fruit and vegetable screeners must be used. However, as also previously discussed, there are many such screeners, the screeners overestimate or underestimate actual intake, generally with brief screeners underestimating and long screeners overestimating, and their ability to accurately rank participants has not been established in non-Caucasians. In order to identify factors associated with fruit and vegetable intake and in order to evaluate the effectiveness of interventions designed to increase such intake, the method for evaluating such intake must first be established in the population of interest. Studies then are needed that evaluate fruit and vegetable screeners against 24-hour dietary recall among diverse populations, such as is found in Hawai'i, before they are employed for use in such populations.

Mean Daily Servings of Specific Food Items and Ethnicity

The current study also looked at ethnic differences in intake of specific categories of fruits and vegetables. It first looked at all servings of fruit and all servings of vegetables separately. With respect to average daily servings of fruit, there were no significant differences between the ethnic groups, including Japanese. However, for servings of vegetables, Japanese did eat significantly fewer daily servings compared with Caucasians. When specific vegetable categories were evaluated, the difference in vegetable intake was specifically attributable to lower intake by Japanese of non-fried potatoes, beans, and mixed foods containing vegetables.

A secondary area of interest in the current study was to evaluate if potato versus rice consumption might play a role in percentages meeting '5 or more' criteria in relation

to ethnicity. In a recent national study, Caucasians had the lowest percentage of persons considered to be ‘rice consumers’ defined as eating one fourth a cup or more of rice per day at 14.2%. The highest percentage at 45.7% was the group called “other” which primarily consisted of persons reporting Asian, Pacific Islander, or Native Alaskan backgrounds (Batres-Marquez, et al., 2009). This finding is not surprising since it is general knowledge that Asian populations consume high quantities of rice. What was surprising in this study was that rice consumers ate more servings of vegetables each day compared with non-consumers. However, in calculating vegetable intake, potatoes were not included, a factor that might have more of an impact on non-consumers of rice who were likely mostly Caucasians than on consumers of rice. But, in the Takata et al. (2003) study of Japanese and Caucasian women in Hawai‘i, while rice intake was much higher among Japanese women, Caucasian women had higher intakes of vegetables even when potatoes were not included in calculating vegetable intake, so this it might be an incorrect assumption to think that rice and potato intake are inversely correlated.

While the current study did not evaluate rice intake, it did look at intake of potatoes, with potato consumption divided into two categories, fried potatoes and non-fried potatoes. The average intake in servings per day for non-fried potatoes was similar for all ethnic groups except for Japanese who had significantly lower intake. However, Japanese, in comparison to Caucasians, did not have significantly lower intake of fried potatoes. Filipinos, conversely, had significantly higher intake of fried potatoes compared with Caucasians. In fact, potatoes accounted for nearly one fourth of vegetable intake for Filipinos. In a recent national study using 24-hour dietary recall, more than 25% of daily servings of vegetables among adults were attributable to fried and non-fried

potatoes (Kimmons, et al., 2009). In the current sample, only Filipinos had such a high percentage of vegetable intake from potatoes. The other ethnic groups in our study had especially low intakes of fried potatoes when compared with the national sample. These results tend to refute the idea that higher intakes of fruits and vegetables for Caucasians are the result of higher intake of potatoes by Caucasians and higher rice intake with associated lower potato intake for Asians. While Japanese in the current study did consume significantly fewer daily servings of non-fried potatoes compared with Caucasians, this was not the case for other ethnic groups, and it was not the case with fried potatoes for any group. More importantly, when potatoes were not included in determining '5 or more' categorization, results did not change, with the percentage of Caucasians meeting '5 or more' criteria remaining significantly higher than that for Japanese. Thus, the issue of rice versus potatoes appears to be a nonissue with respect to fruit and vegetable intake, at least in Hawai'i. This may be unique to Hawai'i as it is likely that Caucasians in Hawai'i differ from Caucasians on the mainland and that the former have adopted diets that include less potatoes and more rice and are more consistent with the more numerous Asian population found in Hawai'i. It would also have been interesting to specifically compare tofu intake between these two groups but tofu intake was not specifically assessed. Tofu is considered to count toward vegetable consumption (NIH, 2006) so it might be important in future studies to assess for it specifically or specifically identify it as being included in vegetable consumption since participants may not think of it as being a vegetable. Tofu may not contribute much to vegetable consumption in the general population of Caucasians but it might in the general population of Japanese in Hawai'i.

In addition to looking at what happened to ‘5 or more’ results when potatoes were excluded from calculations, which was primarily to evaluate the ‘rice versus potatoes’ issue, the current study also looked at what happened to ‘5 or more’ results when only fried potatoes were excluded from calculations, and also we looked at what happened to ‘5 or more’ results when at least two servings had to come from fruit and at least three from vegetables in order to be categorized as ‘5 or more’, similar to the Healthy People 2010 goal. While these restrictions as expected reduced absolute percentages of participants meeting the ‘5 or more’ goal in comparison to using all items on the FFQ, they had little if any effect on the relative rankings by ethnicity and they had little effect on what demographic variables were, or were not, associated with ‘5 or more’. While beyond the scope of discussion of this paper, what the specific goals that individuals should strive for in relation to fruit and vegetable intake are constantly being revised and made more stringent. While ‘5 or more’ was the oft cited goal in the past, Healthy People 2010, as already stated, set the more stringent goal of at least two servings of fruit and at least three servings of vegetables with specific goals for various types of vegetables. In the latest national study, goals for desirable daily intake of servings of fruits and vegetables were tied to estimated caloric needs based on gender, age, and activity level (Kimmons, et al., 2009). This approach means that for almost all adults, in order to meet goal daily servings of fruits and vegetables, they must consume six, seven, or even more daily servings.

It was interesting that Filipinos reported such high intake of potatoes, particularly fried potatoes. That could possibly partially explain the very low percentage of Filipinos who met ‘5 or more’ criteria when responses to the single question regarding fruit and

vegetable intake were used to calculate '5 or more'. If participants, especially Filipino participants, did not consider potato intake, especially fried potato intake, when reporting daily servings of fruits and vegetables, then not only would the overall percentage meeting '5 or more' criteria be lower compared with other methods, which was the case, but it would also especially affect Filipinos. This would need to be examined further and more specifically, again using 24-hour dietary recall results for comparison. But, as stated previously, the current results indicate that the single item instrument should not be used in the ethnically diverse population of Hawai'i because it is inconsistent across ethnic groups in determining fruit and vegetable intake.

Other Demographic Variables

Although not a specific purpose of the current study, it also looked at how gender, age, and education related to '5 or more'. In the current study females were more likely than males to report five or more with the difference being significant for four of the methods for determining '5 or more' and approaching significance for the method where the requirement was at least 2 servings of fruit and at least 3 servings of vegetables each day. This is consistent with the BRFSS data for Hawai'i for 2002 (Hawai'i Department of Health, 2007) and with earlier studies conducted on the mainland using BRFSS data (Serdula, et al., 1995). However, in a number of more recent studies where 24-hour dietary recall was used to assess intake, intake was actually greater for males or there was no difference by gender (Casagrande, et al., 2007; Guenther, et al., 2006; Krebs-Smith, et al., 1995). In the most recent study using national 24-hr dietary recall data, women were slightly more likely to meet criteria compared with men where intake goals were adjusted to caloric requirements based on gender, age, and activity level (Kimmons, et al., 2009).

One likely possibility is that women eat fruits and vegetables more frequently than men, but serving sizes are significantly smaller. While the BRFSS and many screeners, including the single question used in our study, ask frequency of consumption of fruits and vegetables, they do not assess amount consumed, so that really they are not assessing servings per day, but frequency of consumption per day. Since caloric needs for women are generally much less than those for men, servings sizes are likely to be much small so even if women eat more servings of fruits and vegetables per day, the actual amount consumed is likely less for women compared with men. It would be interesting to assess gender differences using both the BRFSS instrument and the multi-item FFQ instrument with 24-hr dietary recall among the Hawai‘ian adult population to further assess gender and fruit and vegetable intake. Perhaps more importantly, it points to the need to vary fruit and vegetable intake goals by gender as is the case with the recent study by Kimmons, et al. (2009).

In the current study, age was variably associated with fruit and vegetable intake depending on how fruit and vegetable intake was measured and defined. When ‘5 or more’ was calculated using responses to the single question regarding intake, there was a significant association between increasing age and ‘5 or more’. However, when ‘5 or more’ was calculated using responses to the multi-item FFQ, there was not a significant association between increasing age and ‘5 or more’ for the four ways in which ‘5 or more’ was calculated using those responses. As with gender, current results using a single question tool and studies using the BRFSS tool had similar findings with increasing age being associated with higher intake of fruits and vegetables. Also, studies using 24-hour dietary recall methods have also consistently reported an association with

increasing age and increasing intake (Casagrande, et al., 2007; Guenther, et al., 2006; Krebs-Smith, et al., 1995).

Education, which is frequently used as a marker for socioeconomic status, has been reported to be associated with fruit and vegetable intake in a number of national studies (Kimmons, et al., 2009; Casagrande, et al., 2007; Krebs-Smith, et al., 1995). However, in the current study, as was the case with age, education was only associated with ‘5 or more’ when ‘5 or more’ was calculated using responses to the single question but not when it was calculated using responses to the multi-item FFQ. When demographic findings in the current study by ethnicity are compared with ‘5 or more’ findings by ethnicity, some interesting patterns are apparent. While ‘5 or more’ percentages are highest for Caucasians and Hawai‘ians, and lowest for Japanese and Filipinos, the oldest groups by ethnicity and the most educated groups by ethnicity are Caucasians and Japanese while the youngest and least educated groups are Hawai‘ians and Filipinos. As discussed earlier, when the single question methods was used, ‘5 or more’ percentages for Filipinos were exceedingly and questionably low, which could also bias age and education results as Filipino participants were younger and less educated compared with Caucasians. Again, the single question method does not appear valid for this population.

Vulnerable Populations Conceptual Model

What is interesting then if one accepts that results from the multi-item FFQ are valid is that in Hawai‘i, unlike the mainland, education, and therefore also likely SES, do not explain ethnic differences in fruit and vegetable intake (although they could explain

differences within ethnic groups). This appears to conflict with the “Vulnerable Populations Conceptual Model” which views ethnic minority populations as automatically being ‘vulnerable populations’. Hawai‘i, of course, is quite different from the mainland US and does not have a history of a large majority Caucasian population. In fact, Caucasians have never been the majority population in Hawai‘i. This does not mean the model does not apply to Hawai‘i, just that what constitutes ‘vulnerable populations’ in Hawai‘i, at least with respect to ethnicity, is different from the mainland US. Also, it may be that cultural differences in eating habits between ethnic groups in Hawai‘i have a much stronger effect than SES differences, but not that SES differences do not play a role. Again, it might be necessary to evaluate SES differences within ethnic groups rather than between them in the Hawai‘ian population to accurately assess the role they might play in fruit and vegetable intake.

Limitations of the Current Study

There were a number of limitations with the current study. First and foremost is that it did not have 24-hour dietary recall data, the gold standard, to compare results using the two assessment instruments that were used against. While current results alone and when compared with other studies suggest that the one item instrument is less useful in evaluating fruit and vegetable intake because it appears to sorely underestimate intake among Filipinos, that cannot be said with absolute certainty. It also cannot be said with certainty that the multi-item FFQ is a much better choice for evaluating Hawai‘i’s adult population, although it does appear to be the better tool. It would be helpful to do a small study with a purposive sample of adults from the different major ethnic groups in Hawai‘i where our two instruments, and perhaps other screeners, were compared with 24-hour

dietary recall data to validate what screener is most appropriate for use in this population. Another limitation of the current study is that the sample contained a much higher percentage of females and a much higher percentage of persons with four year college degrees or higher than is found in the general population of adults in Hawai‘i. While the parent study was a stratified, cross-sectional sample, the current study consisted of those who participated in the cross-sectional studied who agreed to and who were reachable at 2-year follow-up, factors which would probably lead to more females and more highly educated participants.

Conclusions

In conclusion, results from the current study indicate that how fruit and vegetable intake can interact with ethnicity indicating that before researchers utilize a fruit and vegetable screener in an ethnically diverse population they should first evaluate if the screener is consistent across the ethnic groups that will be studied. Specifically in the current study it appears that in the adult population of Hawai‘i a single item instrument for determining average daily fruit and vegetable intake is not consistent across the diverse ethnic groups found in Hawai‘i and thus should not be used. The current study also indicates that among adults in Hawai‘i, there are significant differences in fruit and vegetable intake by ethnicity, with persons of Japanese ethnicity having lower intakes compared with other ethnic groups.

The current study has important implications for nursing science and is unique in the nursing literature. First, results indicate that it is essential in future research that involves assessing food intake in a large, ethnically diverse population, that if screeners

are used for assessment, that they first be validated across the ethnic groups that will be surveyed. While this issue could be avoided by using 24-hour dietary recall, 24-hour dietary recall is often too resource intensive to be an option and screeners are the only practical tools to assess food intake. In the current study, very different conclusions could have been drawn if the single question screener had been the only tool employed to assess fruit and vegetable intake in the study population. Second, results indicate that differences in ethnicity, at least in the area of fruit and vegetable intake, are not simply an issue of generally lower socioeconomic status compared with Caucasians. In the current study, Japanese participants generally had the lowest intake of fruits and vegetables but were very similar to Caucasians in educational attainment, a strong marker of socioeconomic status. Hawaiians, who had much lower educational attainment than Japanese, had much higher intake of fruits and vegetables. At least when it comes to eating patterns, it appears that cultural factors play as important a role in influencing patterns as do socioeconomic factors. Nursing researchers and educators need to recognize this is also an issue so as to identify cultural factors that need to be targeted for interventions to increase fruit and vegetable intake. Finally, the current results do indicate that ethnicity is associated with fruit and vegetable intake, and nursing researchers and educators will need to elucidate how and why this is so in order to develop effective intervention strategies to increase intake, including strategies that may have to be variable depending on the ethnicity of the target.

APPENDIX**TABLES**

Table 1

Different methods for determining fruit and vegetable intake

1. **Multi-item screener method** – Participants asked about intake, both frequency and amount consumed, of 10 items including: 100% fruit juice, fruit, lettuce salad, French fries/fried potatoes, other white potatoes, beans, tomato sauce, vegetable soups, mixtures that included vegetables, and other vegetables. For each item, numerous examples of each item were provided. Average daily servings for each item were calculated then the sum of all 10 represented daily servings of fruits and vegetables for that participant.
2. **Multi-item screener method excluding French fries/fried potatoes** – Same as for #2 except the number of servings of French fries/ fried potatoes was not included.
3. **Multi-item screener method excluding all potatoes** – Same as for #2 except the number of servings of all potatoes (fried and non-fried) were not included.
4. **Multi-item screener method requiring at least 2 servings from fruit/fruit juice and at least 3 servings from vegetables** – Same as #2 with the further requirement of at least 2 daily servings of fruit/fruit juice and at least 3 daily servings of vegetables.
5. **Single question method** – Participants were simply asked how many servings of fruits and vegetables they usually eat each day and were told that one serving equals a half cup of cooked vegetables, a cup of salad, a piece of fruit, or three-fourths of a cup of 100% fruit juice .

Table 2

Study Participants

Telephone numbers attempted in initial HHI Baseline Cross-Sectional Survey	62237
Non-residential or disconnected numbers, or no answer after repeated attempts	<u>-43168</u>
Persons contacted and asked to participate in cross-sectional study	19069
Persons who refused to participate	-12605
Person non-English speaker or underage	<u>-1758</u>
Participants who completed cross-sectional survey	4706
Participants who did not agree to participate in the longitudinal survey	<u>-1173</u>
Participants who agreed at baseline to participate in the longitudinal study	3533
Participants unable to be contacted or who would not participate at 2-year follow-up	<u>-2183</u>
Participants who participated in the baseline study and the 2 year follow-up survey	1350

Table 3

Demographics of the sample overall and by race/ethnicity

	<u>Overall</u> (N = 1350)	<u>Caucasian</u>	<u>Hawai'ian</u>	<u>Japanese</u>	<u>Filipino</u>	<u>Other</u>
Percent	100	36.2	16.7	23.3	7.7	16.1
¹ <u>Gender‡</u>						
Female %	63.7	59.5	71.1‡	67.6†	63.5	59.9
($\chi^2(4) = 12.5$, $p < .001$)			<i>ExpB(CI)</i> 1.7 (1.2-2.4)	<i>ExpB(CI)</i> 1.4(1.1-1.9)		
² <u>Age‡</u>						
<i>M (SD)</i>	50.8 (15.4)	53.0 (14.0)	46.9‡ (15.8)	54.0 (15.1)	44.4‡ (16.3)	48.4‡ (16.1)
$F(4, 1343) =$ 16.0, $p < .001$			<i>MD (CI)</i> 6.2 (2.8-9.5)		<i>MD (CI)</i> 8.6 (4.2-13.1)	<i>MD (CI)</i> 4.6 (1.2-8.0)
² <u>Educ‡ years</u>						
<i>M (SD)</i>	15.2 (3.2)	16.0 (3.2)	13.9‡ (2.8)	15.1‡ (3.1)	14.1‡ (2.8)	15.2† (3.2)
$F(4, 1343) =$ 21.2, $p < .001$			<i>MD (CI)</i> 2.1 (1.4-2.8)	<i>MD (CI)</i> .88 (.27-1.5)	<i>MD (CI)</i> 1.9 (.94-2.8)	<i>MD (CI)</i> .79 (.10-1.5)

Note. *CI* = confidence interval; *M* = mean; *SD* = standard deviation; *MD* = mean difference.

¹ Chi-square analysis to test for overall difference in gender percentages by ethnic group then logistic regression analysis with Caucasian as the referent groups to test for specific differences

² ANOVA analysis to test for overall difference in means by ethnic group then post hoc analyses with Tukey's HSD to specifically compare each ethnic group against Caucasian ethnic group

† $p < 0.05$, ‡ $p < 0.01$

Table 4

Percentage meeting '5 or more' by the different methods for determining '5 or more' and chi-square analyses for each method compared with the "All items FFQ" method

<u>Method</u>	<u>All items FFQ</u>	<u>No fried potatoes</u>	<u>No potatoes any type</u>	<u>2 fruit + 3 veges</u>	<u>Single Question</u>
Percentage	60.8	56.7‡	46.4‡	30.8‡	20.9‡
Chi-Square and p value		$(\chi^2(1)= 1129.9, p < .001)$	$(\chi^2(1)= 746.0, p < .001)$	$(\chi^2(1)= 302.4, p < .001)$	$(\chi^2(1)= 85.71, p < .001)$

‡ $p < 0.01$

Table 5

Percentage meeting '5 or more' criteria for the different methods by race/ethnicity

<u>Ethnicity</u>	<u>Caucasian</u>	<u>Hawai'ian</u>	<u>Japanese</u>	<u>Filipino</u>	<u>Other</u>
<u>Method</u>					
All 10 items FFQ	67.5	64.0	49.5	57.7	60.4
No fried potatoes	64.6	60.0	45.4	45.2	57.1
No potatoes any type	51.5	50.7	35.9	36.5	50.2
2 fruit + 3 veges	37.6	34.7	24.0	19.0	31.8
Single Question	29.0	17.8	15.9	7.7	19.4

Table 6

Factors associated with reporting "five or more" (logistic regression model) using "all items FFQ" method

Variable	B	S.E.	Wald	Sig	OR (95% C.I.)
Japanese ethnicity (vs Caucasian)	-.797	.150	28.055	.000	.451 (.34-.61) *
Filipino ethnicity (vs Caucasian)	-.417	.226	3.400	.065	.659 (.42-1.03)
Hawaiian ethnicity (vs Caucasian)	-.181	.176	1.053	.305	.835 (.59-1.18)
Other (vs Caucasian)	-.333	.172	3.770	.052	.717 (.51-1.00)
Male gender (vs Female)	-.223	.118	3.583	.058	.800 (.64-1.01)
Age (years)	.004	.004	1.022	.312	1.04 (.99-1.01)
Education (years)	-.011	.018	.347	.556	.989 (.95-1.03)

* $p < 0.01$ (0.05/5 to correct for 5 models)

Table 7

Factors associated with reporting “five or more” (logistic regression model) using “no fried potatoes” method

Variable	B	S.E.	Wald	Sig	OR (95% C.I.)
Japanese ethnicity (vs Caucasian)	-.840	.150	31.427	.000	.432 (.32-.58) *
Filipino ethnicity (vs Caucasian)	-.752	.224	11.229	.001	.471 (.30-.73) *
Hawaiian ethnicity (vs Caucasian)	-.190	.173	1.209	.272	.827(.59-1.16)
Other (vs Caucasian)	-.318	.170	3.515	.061	.728(.52-1.02)
Male gender (vs Female)	-.318	.117	7.390	.007	.727 (.58-.92) *
Age (years)	.007	.004	3.650	.056	1.01 (1.00-1.02)
Education (years)	.000	.018	.001	.978	1.00 (.97-1.04)

* $p < 0.01$ (0.05/5 to correct for 5 models)

Table 8

Factors associated with reporting "five or more" (logistic regression model) using "no potatoes" method

Variable	B	S.E.	Wald	Sig	OR (95% C.I.)
Japanese ethnicity (vs Caucasian)	-.698	.151	21.430	.000	.497 (.37-.67) *
Filipino ethnicity (vs Caucasian)	-.603	.229	6.964	.008	.547 (.35-.86) *
Hawaiian ethnicity (vs Caucasian)	-.064	.168	.144	.704	.938 (.67-1.31)
Other (vs Caucasian)	-.074	.167	.195	.659	.929 (.67-1.29)
Male gender (vs Female)	-.385	.117	10.781	.001	.681 (.54-.86) *
Age (years)	.006	.004	2.313	.128	1.006 (.998-1.01)
Education (years)	-.009	.018	.244	.622	.991 (.960-1.03)

* $p < 0.01$ (0.05/5 to correct for 5 models)

Table 9

Factors associated with reporting "five or more" (logistic regression model) using "2 plus 3" method

Variable	B	S.E.	Wald	Sig	OR (95% C.I.)
Japanese ethnicity (vs Caucasian)	-.934	.172	29.306	.000	.393 (.28-.55) *
Filipino ethnicity (vs Caucasian)	-.648	.253	6.569	.010	.523 (.32-.86) *
Hawaiian ethnicity (vs Caucasian)	-.133	.176	.573	.449	.876(.62-1.24)
Other (vs Caucasian)	-.276	.176	2.440	.118	.759(.54-1.07)
Male gender (vs Female)	-.185	.127	2.139	.144	.831 (.65-1.07)
Age (years)	-.003	.004	.503	.478	.997 (.99-1.01)
Education (years)	.016	.019	.712	.399	1.02 (.98-1.06)

* $p < 0.01$ (0.05/5 to correct for 5 models)

Table 10

Factors associated with reporting "five or more" (logistic regression model) using "single question" method

Variable	B	S.E.	Wald	Sig	OR (95% C.I.)
Japanese ethnicity (vs Caucasian)	-.831	.189	19.370	.000	.435 (.30-.63) *
Filipino ethnicity (vs Caucasian)	-1.39	.388	12.779	.000	.250 (.12-.53) *
Hawaiian ethnicity (vs Caucasian)	-.490	.211	5.385	.020	.613(.41-.93)
Other (vs Caucasian)	-.468	.207	5.139	.023	.626(.42-.94)
Male gender (vs Female)	-.690	.156	19.707	.000	.501 (.37-.68) *
Age (years)	.021	.005	19.859	.000	1.02 (1.01-1.03) *
Education (years)	.063	.022	8.057	.005	1.07 (1.02-1.11) *

* $p < 0.01$ (0.05/5 to correct for 5 models)

Table 11

Mean daily servings by race/ethnicity

<u>Food</u>	<u>Overall</u>	<u>Caucasian</u>	<u>Hawai'ian</u>	<u>Japanese</u>	<u>Filipino</u>	<u>Other</u>
¹ All F&V‡ F(4, 1344) = 5.72, <i>p</i> < .001	6.54	6.79	6.97	5.50‡ MD(CI) 1.31 (.39- 2.24)	7.07	6.80
¹ All veges‡ F(4, 1344) = 7.81, <i>p</i> < .001	3.52	3.81	3.86	2.79‡ MD (CI) 1.03 (.46- 1.59)	3.84	3.46
¹ All fruit F(4, 1344) = 2.23, <i>p</i> = .063 (No groups significantly different from Caucasian)	3.02	2.99	3.11	2.71	3.24	3.34

Note. CI = confidence interval; MD = mean difference.

¹ANCOVA analysis to test for overall difference in means by ethnic group then post hoc analyses with Tukey's HSD to specifically compare each ethnic group against Caucasian ethnic group

† *p* < 0.05, ‡ *p* < 0.01

Table 12

Mean daily servings by race/ethnicity for specific types vegetables

<u>Food</u>	<u>Overall</u>	<u>Caucasian</u>	<u>Hawai'ian</u>	<u>Japanese</u>	<u>Filipino</u>	<u>Other</u>
<u>¹Salad</u>	1.13	1.20	1.35	1.01	0.85	1.06
<u>¹Potatoes (non-fried)‡</u> <i>F(4, 1344) = 9.50, p < .001</i>	0.30	0.36	0.30	0.15‡	0.39	0.32
				<i>MD (CI)</i> .21 (.11- .31)		
<u>¹Potatoes (fried) †</u> <i>F(4, 1344) = 3.04, p = .016</i>	0.28	0.23	0.37	0.24	0.50‡	0.28
					<i>MD (CI)</i> -.21 (-.40- -.01)	
<u>¹Beans</u>	0.29	0.34	0.27	0.17	0.37	0.30
<u>¹Tomato Sauce</u>	0.22	0.22	0.24	0.19	0.28	0.21
<u>¹Soups‡</u> <i>F(4, 1344) = 14.58, p < .001</i>	0.22	0.21	0.21	0.15	0.46‡	0.24
					<i>MD (CI)</i> -.27 (-.39- -.15)	
<u>¹Mixed/Other‡</u> <i>F(4, 1344) = 3.31, p = .010</i>	1.09	1.26	1.10	0.87‡	0.98	1.06
				<i>MD (CI)</i> .40 (.09- .72)		

Note. CI = confidence interval; MD = mean difference.

¹ANCOVA analysis to test for overall difference in means by ethnic group then post hoc analyses with Bonferroni correction for multiple comparisons to specifically compare each ethnic group against Caucasian ethnic group.

† $p < 0.05$, ‡ $p < 0.01$

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