ABSTRACT

Title of Thesis: DIETARY QUALITY AND TYPE 2 DIABETES MELLITUS IN US ASIAN INDIAN POPULATIONS

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Asian Indians (AIs) have Type 2 Diabetes (T2DM) at extraordinarily high rates, and it is associated with higher central adiposity, lower lean muscle mass to fat ratios and insulin resistance. Associations between diabetes status and dietary quality, physical activity, acculturation and demographic characteristics were investigated in a convenience sample of older Gujaratis residing in Maryland. Diagnostic cut-offs, acculturation, physical activity and dietary assessment tools used were validated for South Asian populations. Results showed that pre-diabetics and diabetics had lower diet quality than non-diabetics, and anthropometric measurements except BMI varied significantly by diabetes status. Vegetarians consumed less protein and fat than non-vegetarians. Most participants self-identified as bicultural, but Asian (traditional) values were associated with lower dietary quality. Females were universally responsible for cooking, suggesting control over dietary consumption that could impact diabetes status. Evidence-based education with a focus on diet quality could improve management of T2DM in this high-risk population.

DIETARY QUALITY AND TYPE 2 DIABETES MELLITUS IN US ASIAN INDIAN POPULATIONS

by

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Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

Abbreviation or Acronym	Description
ACE/AACE	The American College of Endocrinology/American Association of Clinical Endocrinologists
ADA	American Diabetes Association
AHA	American Heart Association
AI	Asian Indian
AMDR	Acceptable Macronutrient Distribution Ranges
BF	Body Fat
BF:BMI Ratio	Body Fat to Body Mass Index Ratio
BFBMIR	Body Mass Index Ratio
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CBG	Capillary Blood Glucose
CHD	Coronary Heart Disease
cm	Centimeter
CVD	Cardio Vascular Disease
DEXA	Dual Energy X-ray Absorptiometry
DF	Degrees of Freedom
DIT	Diet Induced Thermogenesis
DRI	Dietary Reference Intakes
EGIR	European Group for the Study of Insulin Resistance
FBG	Fasting Blood Glucose
FFA	Free Fatty Acids
FFQ	Food Frequency Questionnaire
FNDDS	Food and Nutrition Database for Dietary Studies
FPED	Food Patterns Equivalents Database
FPID	Food Patterns Equivalents Ingredients Database
GEE	Generalized Estimating Equation
GLP	Glucagon Like Protein
HbA1c	Hemoglobin A1c
HDL	High Density Lipoprotein
HEI	Healthy Eating Index
HP	Hip Circumference
HUF	High Unsaturated Fat
ICMR	Expert Committees of Indian Council of Medical Research

Abbreviation or Acronym	**Description**
IDF	International Federation of Diabetes
IGT	Impaired Glucose Tolerance
INS	Insulin Receptor Substrate
IPAQ	International Physical Activity Questionnaire
IR	Insulin Resistance
IRB	Internal Review Board
Kg	Kilogram
LDL	Low Density Lipoprotein
m	meter
MetS	Metabolic Syndrome
MUFA	Monounsaturated Fatty Acids
NAD	Nicotinamide Adenine Dinucleotide
NADP	Nicotinamide Adenine Dinucleotide Phosphate
NCD	Non-Communicable Disease
NCEP ATP III	National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of high blood cholesterol in Adults (Adult Treatment Panel III)
NEFA	Non-Esterified Free Fatty Acids
NNMB	National Nutrition Monitoring Bureau
no-T2DM	No-diabetes
OGTT	Oral Glucose Tolerance Test
PA	Physical Activity
POC	Point of Care
pre-T2DM	Pre-diabetes
PUFA	Polyunsaturated Fatty Acids
RDA	Recommended Daily Allowance
SAFFQ	South Asian Food Frequency Questionnaire
SFA	Saturated Fatty Acids
SHARE	Study of Health Assessment and Risk in Ethnic
SL-ASIA	Suinn-Lew Asian Self-Identity Acculturation Instrument
Stddev	Standard Deviation
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
TAG	Triacylglycerides
TBF	Total Body Fat
TFA	Trans Fatty Acids
TG	Triglycerides
UMCP	University of Maryland at College Park

Abbreviation or Acronym	Description
VF	Visceral Fat
VLCARB	Very Low Carbohydrate
VLF	Very Low Fat
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist to Hip Ratio
wk	Week

Chapter 1: Introduction

Type 2 diabetes mellitus (T2DM) is a chronic condition that affects either the production or the utilization of insulin, a hormone which is needed for cells to import their main source of energy, glucose. The cellular energy provided by glucose is used by the cells to perform their vital functions. In those with T2DM, insulin is either not used effectively by cells, or sufficient amounts of insulin are not produced to import glucose into cells from the blood. In either case, glucose remains in the blood instead of being utilized by the cell for energy. Functionally, insulin, which is produced in the beta cells of the islets of Langerhans in the pancreas, is required to bind to its receptor on cell membranes to allow for glucose to enter the cell. Insulin resistance (IR) results when this "lock and key" mechanism does not work as intended. In IR, glucose remains in the blood and the cell is deprived of the energy needed to function. If the beta cells in the islets of Langerhans of the pancreas, do not produce enough insulin, then glucose will remain in the blood and not be allowed entry into the cell. Prolonged elevated blood glucose results in comorbidities associated with poorly controlled T2DM.

The body's primary source of glucose is food. There are three macronutrients, or energy producing molecules, that food provides for the body to break down to glucose; 1) Carbohydrates, 2) Fats, and 3) Proteins. Each energy producing macronutrient has its own metabolic function and is broken down into component parts to source the body with the nutrients needed to survive and thrive. Glucose is a common component of all three macronutrients and the molecule of interest for T2DM.

Although there is currently no cure for T2DM, it may be prevented or managed by healthy diet, exercise, and practicing healthy living, such as sufficient sleep, stress management, moderation of alcohol, and smoking cessation. Medications may be needed if lifestyle choices or other factors are not effectively managing blood glucose levels. There are various reasons why this may occur. First, there is no absolute definition for eating "well" therefore what exactly to eat, how much, and in what proportion can become confusing and sometimes frustrating. Secondly, influences of both nature (e.g., race, genetics, etc.) and nurture (e.g., ethnicity/culture, education, income, etc.) can play a significant role in how good blood glucose is managed. For example, individuals and groups may consume different proportions of macronutrients based on culture or socioeconomics[1] and have different pathophysiology of disease based on that consumption due to their race or genetic makeup[2]. Therefore, the amount, type and proportion of macronutrients consumed are important. Also, choices regarding exercise and lifestyle can vary greatly based on cultural values, behavior and identity, so understanding what influences dietary and lifestyle behaviors is important. Thus, dietary quality, quantity and macronutrient distribution, as well as factors that impact dietary intake, such as exercise, cultural beliefs and lifestyle play a role in blood glucose control. For Asian Indians, the incidence and prevalence of T2DM is increasing dramatically.

Asian Indians in India as well as those who have emigrated to the United States and other western nations are seeing an increase in incidence and prevalence of T2DM.[3] The prevalence of T2DM in India in 2015, was estimated to be 9.3%, and in 2040 it is estimated to be 10.1%. [4] A higher prevalence is seen in urban compared to rural India, however, in some parts of India, as with other low and middle income countries, the T2DM prevalence gap between urban and rural is closing.[1, 3] Asian Indians living in Great Britain or other western nations have about 4 times higher prevalence of diabetes than those living in India.[5] Additionally, estimates of undiagnosed T2DM in AI populations in India is estimated at greater than 50%.[6] Estimates of undiagnosed diabetes in emigrants to other countries varies, but is still high. In the Great Britain, it is estimated that up to 40% of the Asian Indian population remains undiagnosed for T2DM.[3]

There are complex and poorly understood reasons for the increasing incidence and prevalence of T2DM in AIs, including pathophysiological and sociocultural characteristics specific to this population. Asian Indians have unique physical attributes and cultural attitudes that increase their risk for T2DM compared to other ethnic groups. [7] For example, two commonly cited factors for IR, a precursor to the development of T2DM, are obesity, as measured by body mass index (BMI), and adverse fat distribution, neither of which seem to be associated with high basal insulin levels in this population. [8] Asian Indians have younger onset for T2DM and lower body mass index (BMI)[1] values as compared with other populations.[3, 9-12] The age of onset for T2DM in AIs is estimated to occur 10 years earlier than in Europeans, and AIs require lower BMI cut-offs for effective identification of T2DM risk.[6] Additionally, AIs may be predisposed to IR and T2DM because AI children are born smaller, have more fat, and less lean muscle.[7] Reduced lean muscle mass at birth is significant because lean muscle mass

[1] Body Mass Index (BMI) is calculated by taking weight in kilograms divided by the square of height in meters $(kg/(m)^2)$.

contains more mitochondria[2] than fat tissue and so is more metabolically efficient. However, because the secretion of insulin is triggered by adipose tissue upon consumption of food, individuals with higher adipose to lean muscle mass ratios may have increased blood insulin levels, which can trigger a negative feedback response resulting in insulin receptor dysfunction leading to IR and T2DM.

Physical characteristics can differ for AIs in urban and rural environments in India as well as in AIs that migrate to other countries. In a study by Misra and Vikram (2004) urban Asian Indians in India with T2DM were shown to have smaller waist circumferences, lower BMIs, and higher percent body fat compared to their rural counterparts, as well as Whites, Blacks and Chinese study groups. [10] Sociocultural characteristics, however, seem to exacerbate the risk, primarily because of dietary and other life style choices. The Asian Indian diet is also high in carbohydrates, and with urbanization and migration, there has been a growing tendency towards processed, refined and higher fat convenience foods, coupled with decreases in physical activity seen both in Asian Indians living in India and abroad. [1, 13]

The purpose of this study is two-fold: 1) to describe the dietary intake of Asian Indian adults with and without T2DM, and 2) to determine whether there is an association between diabetes status, diet and anthropometric measures indicative of T2DM. Dietary intake was examined as dietary quality, as measured by the Healthy Eating Index (HEI), and dietary quantity as measured by macronutrients (protein, fat and carbohydrates) as a

[2] Mitochondria, the power generator, is a cellular organelle that converts oxygen and nutrients resulting from the processing of glucose once entered into the cell, into adenosine triphosphate (ATP). ATP is the chemical energy that powers the cell's metabolic activities.

proportion of total kilocalories; both were assessed relative to diabetes status, anthropometric measurements, vegetarianism and acculturation.

Chapter 2: Literature Review

Prevalence of T2DM In Asian Indian Populations

The International Diabetes Federation (IDF) reported in 2015 that approximately 415 million people (8.8%) world-wide were living with diabetes, and is projected to grow to 642 million by 2040. In IDF's South East Asia region[3] alone it is estimated that more than 78 million people are living with diabetes and that number is expected to almost double to more than 140 million by 2040. Although the United States has a higher national prevalence rate (12.8%; 10.8% age adjusted), China and India have the greatest number of people living with diabetes in the world (almost 110 million and 69 million, respectively). The third largest population of people living with diabetes is in the US at 29 million. The age adjusted prevalence of T2DM in India in 2011 was estimated at 9.2%.[13] In 2015, it was estimated to be 9.3%, and in 2040 it is estimated to be 10.1%. [4] A higher prevalence is seen in urban compared to rural India, however, in some parts of India, as with other low and middle income countries, the T2DM prevalence gap between urban and rural is closing.[1, 3]

Asian Indians experience similarly higher prevalence rates for T2DM after migrating to western countries.[3, 14] For example, one study comparing Indians living in the state of Gujarat, India and in Indians living in Great Britain, showed that both Gujarati females and males living in Great Britain had higher prevalence rates

[3] The International Diabetes Federation member states in the South-East Asia region include: India, Bangladesh, Nepal, Sri Lanka, Maldives, and Mauritius.

than Gujarati females and males living in India (16.6% and 19.6% respectively in Great Britain, and 11.0% and 18.2% respectively in India).[13] In fact, Asian Indians living in Great Britain or other western nations have about 4 times higher prevalence of diabetes than those living in India.[5] Asian Indians comprise approximately 4 percent of the population in Great Britain, yet represent 20 percent of the people living with diabetes, and up to 40 percent of the Asian Indian population in Great Britain is thought to be undiagnosed.[3] Therefore, the actual prevalence is thought to be underestimated.

In the US, prevalence of diabetes among Asian Indians is estimated at 18% [15, 16], which exceeds that seen in other Asian groups (e.g., Chinese, Vietnamese, Korean, and Japanese) [3] as well as other ethnic groups; (Hispanics (8.4 %), Blacks (12.8 %), and Whites (6.6 %)).[17] Asian Indians have significantly higher rates of T2DM relative to Caucasians, however, rates of obesity in the AI population as measured by BMIs are significantly lower than in Caucasians. [14] In the US, racial and ethnic disparities in the prevalence of T2DM are partially attributed to socioeconomic factors related to access to health insurance and health care. [5, 17] AIs as a group in the US have high levels of education and income as well as high rates of health insurance[18-20], therefore disparities in T2DM prevalence for AIs are likely attributable to personal choices.

Globally, there has been a 3-5 fold increase in the prevalence of diabetes in Asian populations over the past 30 years; it is occurring at younger ages (45-64 years) and in people with less obesity and lower BMIs than experienced elsewhere in the world.[8, 12] Similarly, the prevalence of Metabolic Syndrome (MetS)[4] is higher in Asian and Asian Indian populations. Developing countries in South Asia, including India, have about one fourth to one third of their urban populations diagnosed with MetS.[21] In the US, the age-adjusted prevalence of MetS in Asian Indians is up to 38 percent.[15] MetS often occurs concomitantly with T2DM, and although not everyone with MetS will develop T2DM, there is evidence that particular elements of MetS may be more predictive than others for T2DM [15]. Frist, we will review the definitions of MetS and T2DM and then review key characteristics of each and how they are relevant to Asian Indians.

Type 2 Diabetes Mellitus Defined

The definition of T2DM is generally consistent across global entities. WHO, the American Diabetes Association (ADA) and the International Diabetes Federation (IDF) all share the same definition of T2DM. Generally, diagnosis is made with a Fasting Plasma Glucose (FPG) of ≥126 mg/dL (or 7mmol/L), an oral glucose tolerance test (OGTT) result of ≥200mg/dL (or 11.1mmol/L) 2 hours after a 75g glucose drink, or HbA1c of ≥6.5%.[22-24] The American Diabetes Association also defines pre-diabetes as a FPG from 100-125mg/dL, a blood glucose level of 140-199mg/dL after a glucose challenge, and HbA1c from 5.7-6.4%.[24]

[4] Metabolic Syndrome is defined as a cluster of conditions including increased blood pressure, blood glucose, and body fat around the waist, as well as abnormal cholesterol or triglyceride levels that occur together, increasing risk of heart disease, stroke and type 2 diabetes mellitus.

Metabolic Syndrome and Its Relationship to T2DM

Metabolic syndrome is defined as the co-occurrence of five main conditions; T2DM or pre-T2DM, hypertension, abdominal (or central) obesity, lipid disorders, and hyperinsulinemia or insulin resistance (IR).[25] There are, however, differences in the definition of MetS, and these differences have been shown to result in different rates of identification.[15] Figure 1 below describes the various definitions used by The World Health Organization (WHO), The European Group for the Study of Insulin Resistance (EGIR), The US National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of high blood cholesterol in Adults (Adult Treatment Panel III) (NCEP ATP III), The American College of Endocrinology/American Association of Clinical Endocrinologists (ACE/AACE), and The International Diabetes Federation (IDF).[25-27]

There are notable differences between these definitions. For example, WHO and EGIR both consider insulin resistance as criteria for MetS, whereas NCEP ATP III, AACE, and IDF do not. WHO, NCEP ATP III, and IDF place T2DM as a criterion for MetS, whereas EGIR and AACE suggest T2DM is a result of unmanaged MetS. Also, AACE does not require waist circumference, whereas all of the other organizations do; IDF considers population specific waist circumference cut-offs.[26] However, cut offs for population specific waist circumferences are still being defined.[28] Finally, AACE alone includes family history of T2DM, polycystic ovary syndrome, sedentary lifestyle, advancing age, and ethnic groups susceptible of T2DM.[26]

Clinical Measure	WHO (1998)	EGIR	ATP III (2001)	AACE (2003)	IDF (2005)
Insulin resistance	IGT, IFG, T2DM, or lowered insulin sensitivity* **plus any 2 of the following**	Plasma insulin >75th percentile **plus any 2 of the following**	None, **but any 3 of the following 5 features**	IGT or IFG **plus any of the following based on clinical judgment**	None
Body weight	Men: waist-to-hip ratio >0.90; women: waist-to-hip ratio >0.85 and/or BMI >30 kg/m^2	WC ≥94 cm in men or ≥80 cm in women	WC ≥102 cm in men or ≥88 cm in women†	BMI ≥25 kg/m^2	Increased WC (population specific) **plus any 2 of the following**
Lipid	TG ≥150 mg/dL and/or HDL-C <35 mg/dL in men or <39 mg/dL in women	TG ≥150 mg/dL and/or HDL-C <39 mg/dL in men or women	TG ≥150 mg/dL HDL-C <40 mg/dL in men or <50 mg/dL in women	TG ≥150 mg/dL and HDL-C <40 mg/dL in men or <50 mg/dL in women	TG ≥150 mg/dL or on TG Rx HDL-C <40 mg/dL in men or <50 mg/dL in women or on HDL-C Rx
Blood pressure	≥140/90 mm Hg	≥140/90 mm Hg or on hypertension Rx	≥130/85 mm Hg	≥130/85 mm Hg	≥130 mm Hg systolic or ≥85 mm Hg diastolic or on hypertension Rx
Glucose	IGT, IFG, or T2DM	IGT or IFG (but not diabetes)	>110 mg/dL (includes diabetes)‡	IGT or IFG (but not diabetes)	≥100 mg/dL (includes diabetes)
Other	Microalbuminuria			Other features of insulin resistance§	

T2DM indicates type 2 diabetes mellitus; WC, waist circumference; BMI, body mass index; and TG, triglycerides. All other abbreviations as in text.

*Insulin sensitivity measured under hyperinsulinemic euglycemic conditions, glucose uptake below lowest quartile for background population under investigation.

†Some male patients can develop multiple metabolic risk factors when the waist circumference is only marginally increased (eg, 94 to 102 cm [37 to 39 in]). Such patients may have a strong genetic contribution to insulin resistance. They should benefit from changes in lifestyle habits, similar to men with categorical increases in waist circumference.

‡The 2001 definition identified fasting plasma glucose of ≥110 mg/dL (6.1 mmol/L) as elevated. This was modified in 2004 to be ≥100 mg/dL (5.6 mmol/L), in accordance with the American Diabetes Association's updated definition of IFG.[46,47,77]

§Includes family history of type 2 diabetes mellitus, polycystic ovary syndrome, sedentary lifestyle, advancing age, and ethnic groups susceptible to type 2 diabetes mellitus.

Figure 1. Previous Criteria Proposed for Clinical Diagnosis of Metabolic Syndrome[26]

Although the definitions differ, central obesity, or excessive fat around the abdominal area, is generally agreed to be a driving force for MetS.[25-27] Evidence has been presented for the strong correlation of IR to central obesity, suggesting that central obesity could be a surrogate for IR.[25] The WHO definition recognizes IR as the underlying cause of T2DM and a risk factor for Cardio Vascular Disease (CVD). IR and central obesity are present in almost all patients with MetS, however, which of these is the primary factor is still unclear.[25]

Obesity and Its Relationship to T2DM

The Centers for Disease Control and Prevention (CDC) has shown the prevalence of T2DM increases with the increasing prevalence of obesity, as defined by BMI.[28] By some calculations, the risk of T2DM increases by 4.5 percent for every kilogram of weight gain. [5] However, while obesity may increase risk for T2DM, it alone does not lead to its cause. Data from the CDC assert that of the approximately 70 percent of the US population that is either overweight (BMI ≥27kg/m2) or obese (BMI ≥30kg/m2), about 38 percent are obese[29], and only about 12 percent of overweight or obese individuals have T2DM. Within diabetics, however, 67 percent are overweight and 46 percent are obese.[28]

Although BMI is the common measurement used to define obesity, this measure is imperfect because it tends to ignore the distinction between fat and fat free mass, or lean muscle.[30] About 68 percent of body fat is subcutaneous, or directly under the skin, 20 percent is abdominal, and 12 percent is intramuscular, or inside skeletal muscle [31]. It is primarily abdominal fat, or adiposity, that contributes to T2DM, independent of BMI.[3, 30, 31] Abdominal adiposity reduces the amount of glucose insulin can clear from the blood regardless of total body fat. Thus, even without high amounts of total fat, it is possible that adiposity concentrated in the abdominal area can induce insulin resistance. Abate, et. al., also assert that Asians and Hispanics are two ethnic groups that have noted mutations in genes that regulate and signal secretin of insulin, putting them at higher risk to develop abdominal adiposity, and therefore experience insulin resistance at higher rates than other ethnicities such as African and Caucasian Americans, despite comparable levels of total fat. Therefore, ethnic differences in fat distribution may explain higher prevalence rates of insulin resistance and T2DM in Asian Indian populations. [5]

In Asian Indians generalized obesity, as measured by BMI, is less prevalent than in Caucasian populations in Europe and the US, however, Asian Indians have higher levels of central obesity. An alternate measure of obesity to BMI that is commonly used is waist circumference. In general practice, the conventional cut-offs for waist circumference that are used are based on studies of Caucasian populations.[9, 10, 31, 32] Numerous studies have established that Asian Indians have higher morbidity and excess risk for T2DM and CVD at BMI and waist circumference considered to be "normal" in Caucasians and Europeans, suggesting that these cut-offs may need to be lowered to adequately identify Asian Indians at risk for these disorders.[9, 11, 32]

To better identify insulin resistance and T2DM in the Asian Indian population, a measure of waist circumference (WC), has been compared to another measure of central adiposity, waist to hip ratio (WHR). WHR is thought to be a better indicator of central obesity in Asian Indians than WC alone. Asian Indians carry less of their fat in their lower trunk and limbs. Therefore, the ratio of waist circumference to the hip circumference may be high, even though the absolute value of the waist circumference may not be high. Therefore, WHR for AIs is higher than other ethnic groups that carry more of their fat lower in their bodies. As a screening tool, the WHR has outperformed WC in detecting cardiovascular risk factors, T2DM being one of those risk factors. WHR detected significantly more cases than WC alone, at WC values considered normal by WHO. WHR was a better measure to detect T2DM especially for Asian Indian females, further suggesting that the cut-offs for WC may need to be reduced for the Asian Indian population.[11] It is possible that Asian Indians may have overall lower energy requirements because of high amounts of adiposity, which is less metabolically active than lean tissue, suggesting that Asian

Indians are more susceptible to adverse effects of excess energy intake, even at lower BMIs.[7]

Another new and novel measure of obesity was proposed by Dudeja, et., al., involving the relationship of body fat (BF) to BMI. The basis for this was the observation that different ethnic groups have widely different percentage body fat for similar BMI. The authors introduced the BF:BMI ratio, a novel measure that considers both body fat and BMI when assessing obesity across different ethnic populations. Interpretation of this measure considers a high BF:BMI ratio metabolically detrimental. The aim was to establish appropriate BMI cut-offs for overweight and obese, considering total body fat, in Asian Indians. Ethnic differences were identified in Caucasian, Black, Polynesian, and other Asian (e.g., Chinese, Malay, Singapore) groups. In all cases, Asian Indians had higher body fat per given BMI.[30] Other studies have confirmed that for the same BMI, Asian Indians have a higher percentage of body fat; significantly higher than in Caucasians, but also higher than Malays who were higher in turn than the Chinese.[12, 33] For Asian Indian females, the prevalence of overweight estimated by body fat was twice that estimated by BMI; this degree of misclassification of BMI was not seen in Asian Indian males. Other studies have confirmed these findings in Asian Indian females, the implications of which raise further questions about the use of BMI alone as an appropriate tool for assessing obesity in Asian Indian populations, particularly for females.[34]

Insulin Function and Pathophysiology

The intake of a high fat diet, which may be related to obesity, is associated with hyperinsulinemia; when there is excess insulin in the blood relative to the level of glucose. Hyperinsulinemia is also associated with a lower insulin sensitivity index[5], which is an indication of the efficiency of insulin to clear glucose from the blood.[21] High insulin sensitivity would require less insulin to clear glucose from the blood than lower insulin sensitivity; it is the inverse of insulin resistance, which is the body's reduced ability to use insulin to clear glucose from the blood. Data from 'developed nations' show that total fat intake is higher in patients with T2DM than in control subjects with normal glycemic control. High fat intake has also been shown to be predictive of impaired glucose tolerance (IGT)[6] and the progression of IGT to T2DM.[21] Thus, high fat intake can trigger a cascade of metabolic disturbances starting with obesity, followed by IGT, which is indicative of impaired glucose uptake, and IR, which is indicative of impaired insulin function, and eventually leading to T2DM.[21] One important indicator of progression down this path may be reduced functioning of the pancreatic beta cells, the cells in the pancreas that produce insulin. Even at IGT, beta cell function is very low, so that by the time the T2DM diagnosis is made, progression to T2DM may not be preventable.[5]

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[5] Insulin Sensitivity Index is calculated by taking the inverse of the sum of the logarithms of fasting insulin and glucose levels: [*1 / (log(fasting insulin µU/mL) + log(fasting glucose mg/dL))]*

[6] Impaired Glucose Tolerance (IGT) refers to blood glucose levels that are higher than what would be considered normal after consuming a meal, but not high enough to be considered T2DM; it is usually diagnosed with an oral glucose tolerance test (OGTT) in which blood glucose is measured two hours after consuming a sugary drink (<140 mg/dl = Normal, 140 mg/dl-199 mg/dl = Prediabetes, and ≥200 mg/dl = Diabetes).

IR occurs when insulin does not bind to its receptor because of a disruption in the signal between it and its receptor, preventing insulin from performing its physiological functions, namely, reducing sensitivity to insulin for glucose uptake in skeletal muscle and adipose tissue. Reduced sensitivity to insulin for glucose uptake subsequently reduces sensitivity to insulin to inhibit glucose production in skeletal muscle and liver, and increases hydrolysis, or break down, of triglycerides (TGs)[7] in adipose tissue, increasing plasma free fatty acid (FFA) concentrations. The effect of IR is to increase glucose production and decrease glucose storage (in the form of glycogen and TGs).[25, 27] The resultant hyperglycemia creates an insulin-glucose imbalance, which stimulates the pancreatic beta-cells to secrete large amounts of insulin in a compensatory fashion, particularly after meals.[27] This compensatory behavior of the beta-cells continues until the amount of insulin secreted is no longer sufficient to clear the blood of glucose. Gradually, beta-cell function is reduced and eventually halted.[3, 27] In obese patients, both IR and beta-cell dysfunction are impacted, however, in non-obese patients there is variability in insulin sensitivity; only about 50 percent of this variability is attributed to obesity. Therefore, it is possible for some individuals to have IR without obesity.[5]

A recent study by Misra et.al., investigated the relationship between location of adipose tissue, or body fat patterning, and fat accumulated in their liver (hepatic fat) and pancreas (pancreatic volume), in non-obese Asian Indians (BMI <25 kg/m^2). It was found that non-obese Asian Indians with T2DM have excess abdominal adiposity,

[7] Triglycerides (TG) are a type of fat molecules with three fatty acid tails connected by a molecule of glycerol. Hydrolysis of TGs results in the breaking off the fatty acid tails from the glycerol, resulting in free fatty acids.

increased pancreatic volume, and hepatic fat, which results in an increase in both the number and size of fat cells in the abdominal area in Asian Indians and correlates with an increased release of free fatty acids, also known as, non-esterified free fatty acids (NEFAs)[8] as compared to that seen in Caucasian populations. Therefore, increased NEFA load in the pancreas (termed lipotoxicity) leads to impaired beta-cell response and hyperglycemia, which if maintained over prolonged periods of time results in fatty deposits in the pancreas and liver. As mentioned above, fatty liver is central to the development of insulin resistance and metabolic syndrome. AIs have been shown to have higher accumulation of hepatic fat and insulin resistance than seen in BMI matched Caucasians. Also, pancreatic fat accumulation may be at the cause of beta-cell dysfunction in Asian Indians. [2] These findings suggest that there may be a genetic link specific to AIs that may predispose them to T2DM.

Effects of Environment on Genetic Factors Linked to T2DM in AIs

Genetics can be impacted by environmental factors such as dietary and other life style choices. A four-stage explanatory model has been proposed to understand the development of metabolic disorders, including T2DM, in South Asian populations throughout an individual's life cycle. The first stage involves the tracking of a high fat and low lean muscle mass baby throughout his/her life. The second stage involves deposition of excess energy in upper body and ectopic fat reserves instead of lower body or subcutaneous fat reserves. The third stage involves the appearance of high levels of

[8] Non-esterified free fatty acids are fatty acid chains not connected to an alcohol, usually, a glycerol head group.

plasma insulin, TGs, glucose and the vicious cycle of the fatty liver. Finally, the fourth stage involves beta-cell failure and development of T2DM due to fewer beta-cells at birth, apoptosis of beta-cells due to fat in the pancreas, and increased demand for insulin secretion because of insulin resistance.[7]

The progression of these stages is exacerbated by dramatic changes in environment and diet caused by migration to either urban settings or different cultures. The progressive increase in the prevalence of T2DM due to urbanization or westernization is seen in all ethnic groups, however, the degree to which changes in prevalence occur, when facing similar environmental challenges, varies across ethnic groups suggesting an ethnic susceptibility to T2DM.[5] As previously mentioned, AIs have greater insulin resistance than those from European descent, and without excessive obesity, as defined by BMI. Additionally, the tendency towards accumulation of abdominal fat has been proposed as explaining insulin resistance in AIs and being genetically determined.[5] Although extremely rare, over 30 mutations to the insulin receptor gene (INSR) have been shown to cause insulin receptor dysfunction, which then can lead to insulin resistance by disrupting signaling of downstream proteins initiated by binding to the insulin receptor. Other mutations may be play a role as well, for example, mutations in the DN1 kinase gene can cause alternate splicing of the INSR gene, and mutations in the high mobility group A1 (HMGA1) gene can suppress expression of INSR which can both lead to insulin resistance. Dysfunction in the insulin receptor can occur by the suppression of the insulin receptor substrate (IRS), which permits insulin binding and triggers downstream pathways to import glucose into the cell. Therefore, as adipose tissue accumulates, the storage and release of FFA increases, and more insulin is released. Excessive amounts of insulin trigger inflammatory adipokines such as TNF-α, IL-6, and IL-1β. These inflammatory adipokines suppress and degrade IRS, which impairs the insulin receptor, which then leads to insulin resistance.[25, 35]

Specifically, AIs may have genetic mechanisms related to the interaction between FFA and the insulin signaling process that make them particularly sensitive to even low levels of fat accumulation.[14] A predisposition to disruptions in signaling due to increased fat, has identified AIs as susceptible to abdominal obesity, T2DM, and CVD. Genetic and epi-genetic (in utero impact) as well as gene-environmental interactions and lifestyle factors have been proposed to explain the high incidence to these diseases in AIs.[13] It is further thought that the presence of lower lean muscle mass in Asian adults as compared to Caucasians, implicate genetic factors for these observed differences.[12] Genetic predispositions of AIs to obesity, as defined by BMI, can be triggered by environmental factors,[5] just as it is possible that genetic factors may modify the influence of nutrient intakes on T2DM and CVD.[36]

The Asian Indian Diet and Its Relationship to T2DM

Although genetic predisposition is one determinant of these higher rates of T2DM, diet also has a significant influence. In India, the urban and middle class diet has shifted towards consumption of more processed, ready to eat, and fried foods, refined grains and sweets; these shifts in diet are termed the nutrition transition. The nutrition transition has resulted in a diet high in saturated and trans-fats, and low in fresh fruits and vegetables and insoluble fiber,[1, 3, 10, 13] and coupled with low levels of physical activity has put Asian Indians at greater risk for T2DM as well as other diet related non-communicable diseases.[1] In the US, differences in the prevalence of T2DM between ethnic groups may be exacerbated by diet (i.e., diet composition as well as total kilocalories) and physical activity.[5]

Traditionally, Asian Indians consume the bulk of their kilocalories from carbohydrates in the form of cereals, or grains (wheat in north India and rice in south India); carbohydrate intake levels are higher in Asian Indians than other ethnic groups. And although wheat has higher dietary fiber than rice (12.5% and 4.1%, respectively), and high fiber diets have been shown to improve glucose tolerance by increasing "transit time" and lowering post prandial blood glucose levels, cooking of these cereals decreases their total dietary fiber and insoluble fiber contents.[1, 13, 37, 38] Although, in the past few decades there has been a shift away from cereal consumption in both urban and rural environments in India, rural intake of carbohydrate rich cereals remains higher than in urban areas.[1] Lower levels of consumption of carbohydrate rich cereals in urban areas may be an indication of higher consumption of more energy-dense convenience foods as evidenced by increasing prevalence of MetS in India, particularly in urban areas. For example, increased risk of MetS with increased consumption of refined grains has been shown in a recent study on urban south Indian adults.[1] Assessments of fresh fruit and vegetable intake among Asian Indians showed lower levels of consumption for both per person per day compared to 47 non-South Asian countries. [1] In a study by Misra, et., al., dietary data from the National Nutrition Monitoring Bureau (NNMB) were used to determine whether participant diets reflected nutrient intakes as recommended by the Expert Committees of Indian Council of Medical Research (ICMR), a body that determines the recommended daily allowances (RDA) for

Indians. From this study, it was found that leafy green vegetable consumption is below the Indian RDA in both rural and urban areas of India, and the majority of fruit consumption in India comprises 30 percent of total dietary fiber as soluble dietary fiber.[1] Protein intake in both urban and rural areas in India is approximately 57 grams per person per day (about 11 percent of total daily energy) as reported in 2004-2005. Interestingly, the consumption of pulses and legumes remained lower than the Indian RDA in rural areas, while in urban areas it increased from 57.5 percent of Indian RDA to 107.5 percent of Indian RDA between 1975 and 1996.[1, 13] There is, however, a distinction made between vegetarian sources of protein and those from animal sources. Animal sources are associated with a higher cardiovascular mortality and diabetes than vegetable protein.[13, 39] Although total fat consumption for Asian Indians is within recommended limits (15.6 percent in rural areas and 21.1 percent in urban areas), there has been an increase in the proportion of SFAs and TFAs, coupled with decreased levels of physical activity due to rapid urbanization. Concomitantly, low MUFA and n-3 PUFA, high salt consumption, high glucose intake (in the form of sweetened beverages), and low dietary fiber intakes all contribute to the growing prevalence of obesity and related chronic non-communicable diseases (NCDs)[9], one of which is T2DM.[1, 13]

Prevention of obesity and its related disorders can also be facilitated by limiting fat intake to 30-35 percent of total energy, with special attention to limiting saturated fatty acids (SFA), in particular, trans fatty acids (TFAs).[13] Consuming

[9] Non-communicable diseases (NDCs) are chronic in that they slowly progress over a long period. There are 4 main types of NDCs: 1) cardiovascular **diseases** (like heart attacks and stroke), 2) cancer, 3) chronic respiratory **diseases** (such as chronic obstructed pulmonary **disease** and asthma), and 4) type 2 diabetes.

high levels of SFAs[10] and TFAs[11] can change the composition and function of the cellular membrane, decreasing its fluidity, as well as impact insulin receptor binding. [13] In fact, habitual intake of fat is positively associated with IR, independent of obesity, in non-diabetic individuals, the effects of which are enhanced by obesity and low levels of physical activity.[5, 14] Replacement of SFAs or TFAs with monounsaturated fatty acids (MUFAs), fatty acid chains with one carbon-carbon double bond, and polyunsaturated fatty acids (PUFAs), fatty acid chains with multiple carbon-carbon double bonds, may prevent metabolic dysfunction and improve insulin sensitivity. [13, 14, 38] Thus, choices regarding dietary intake and physical activity, as discussed below, can play a significant role in metabolic function and the progression of insulin resistance to T2DM in the Asian Indian population. Because food is an expression of culture, cultural identity is an important factor in dietary choices. Therefore, levels of acculturation can provide insight into dietary choices.

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[10] Saturated Fatty Acids (SFAs) are non-polar lipid chains composed of carbon-carbon single bonds with a hydroxyl group at one end. SFA chains are oriented in a straight line with no bends in the chain. When multiple SFA chains lie side by side, no space is created between them. When this occurs in the cellular membrane, fluidity is decreased because molecules such as glucose have reduced space to pass through via facilitated diffusion or active transport. In contrast, unsaturated fatty acids (USFAs) contain carbon-carbon double bonds which are connected at an angle. When USFAs are laid next to each other the carbon-carbon double bonds create kinks, or spaces, between them. Because they are not tightly bound to one another, molecules such as glucose can pass through them more easily, also via facilitated diffusion or active transport. Note: Glucose is a polar molecule and so needs to bind to a non-polar energy producing molecule to pass through the non-polar inner core of the phospholipid bilayer that comprises the cellular membrane.

[11] Trans Fatty Acids (TFAs) are USFAs that have been converted into SFAs. TFAs are formed by the hydrogenation of USFAs. This means that hydrogen atoms are added to USFAs, removing the carbon-carbon double bonds and creating carbon-carbon single bonds. This is most commonly done when vegetable oils, which are normally USFAs in a liquid form at room temperature, are hydrogenated converting them to SFAs in a solid form at room temperature (e.g., Crisco).

Acculturation and Implications for Diet Choices in AIs with T2DM

Asian Indians not only differ in their experience of diabetes related outcomes when compared to other races and ethnicities, but even within their own population based on where they live. For example, Asian Indians who immigrate to various countries show increases in diabetes within relatively short periods of time compared to their counterparts in India.[3] Dietary acculturation has been defined as "the process that occurs when members of a minority group adopt the food choices and eating patterns of the host country." The concept of acculturation includes shifts in identity, attitudes and values, but these shifts are not linear; moving away from a traditional diet to one of the host country, but instead involve blending of cultures to facilitate assimilation.[13]

Differences between Asian Indians residing in rural and urban settings within India have also been documented. These differences suggest that environmental and behavioral changes may play a role in disease rates; possibly more than genetic differences.[3] Insulin resistance, for example, is associated with obesity, sedentary lifestyle, diets rich in animal products, and aging across all ethnic groups. However, for Asian Indians specifically, environmental determinants of insulin resistance such as nutrition, lack of exercise and obesity may be attributable to the westernization process seen in both urban and migrating Asian Indians.[14] Asian Indians residing in India have lower average BMI, higher insulin sensitivity, and higher fasting insulin concentrations than their siblings living in the UK, which suggests that dietary and lifestyle differences may play a role in these observed differences.[10]

The nutrition transition is a process driven by industrialization and globalization of the food market. It usually starts in high income countries, and eventually makes its way to lower income countries starting with their urban areas and then moving to rural areas. There are several ways that the nutrition transition may affect dietary acculturation after migration. For example, if energy-rich highly processed foods reach a level of status in the home country, unaffordable to most, then the availability of those foods in the host country at cheaper prices may accelerate dietary acculturation. However, if those same energy-rich highly processed foods were already available and consumed in the home country, then their availability in the host country will not have as much of an impact on dietary acculturation. Thus, the nutrition transition, which is a global phenomenon, and dietary acculturation, which occurs with migration, need to be taken into account for Asian Indians, as they consume more total energy and energy dense-foods after migration than they did prior to migration.[13]

Asian Indians, like most populations, find cultural identity through communal eating of culturally accepted foods, and as such, refusal of foods and eating different foods separately from others can result in marginalization and loss of identity. Food itself carries more than nutritional value; it is bound to social relations, power, inclusion and exclusion from group membership. For Asian Indians living abroad, maintaining their cultural identity becomes that much more important, and so although health is a consideration, rather than changing to a recommended diet, Asian Indian diabetics often attempt to manage their disease by decreasing the quantity of what they eat.[40] Thus, a paradoxical relationship with food is created. Eating a recommended diet to manage T2DM compromises their identities as family and community members, however, eating culturally appropriate foods is detrimental to their health but maintains their identities.[40] Connection to cultural identity can have the effect of perceived satiation from traditional foods and lack thereof from foods of the host country, suggesting that changing eating behavior in order to improve health of Asian Indians living abroad requires creativity and cultural sensitivity. Along with dietary choices, engaging in physical activity to stay healthy is influenced by cultural identity.

Physical Activity and Its Relationship to T2DM in AIs

Poor levels of physical activity have been attributed to greater risk for adipose tissue dysfunction, IR, obesity, MetS, T2DM and coronary heart disease (CHD).[1, 5, 10, 28] Physical activity in South Asian and Asian Indian populations (i.e., Indian, Pakistani, and Bangladeshi) varies across groups, but still remains lower than White Europeans.[41] Both urbanization and migration have contributed to the lower levels of physical activity in Asian Indians. Asian Indians in urban India have lower levels of physical activity than those in rural India, and Asian Indian migrants have lower levels of physical activity than Caucasian Americans or Europeans.[1, 13] Further, although urbanization, migration and their related affluence limit physical activity, sedentary lifestyles have been reported in rural areas as well. Asian Indians who are sedentary have higher average BMIs, serum triacylglycerol levels, blood pressure, and are at risk of developing hyperglycemia.[10] Additionally, physical inactivity is correlated with low high density lipoprotein (HDL), or “good”, cholesterol levels.[41] Thus, low levels of physical activity could be an important risk factor for insulin resistance and CHD mortality. In particular, among Asian Indians, females, the elderly, those in higher socioeconomic groups, and those under stress engage in lower levels of physical activity and thus have a higher prevalence of IR. [10, 41] Considering both dietary choices and levels of physical activity in the Asian Indian population, there are some general dietary recommendations for good glucose control.

Dietary Recommendations for AIs with T2DM

Dietary recommendations for Asian Indians with T2DM are currently consistent with those for other groups globally, but may not address the issues discussed above that are specific to this population. Generally, dietary recommendation for Asian Indians include consuming a balanced and healthy diet low in fat, sugar, and salt, [40] and replacing fat-rich foods and other dietary sources of fat with high fiber, low glycemic carbohydrates and whole grains as well as fruits and vegetables. [3, 40] When weight management is required, the recommendation is to reduce overall energy content, and modify the composition of dietary intake (e.g., increasing consumption of fresh fruits and vegetables as well as low fat foods), rather than reducing total kilocalories is important and will achieve feelings of satiety.[3, 40] Since, IR and T2DM are present in Asian Indian populations usually without concomitant obesity (as defined by BMI), simply reducing total kilocalories may not advised in this population. However, reducing the ratio of LDL to HDL and TG, by replacing foods rich in SFAs and TFAs with foods rich in MUFAs and n-3 PUFAs, is suggested to reduce the risk of T2DM and CVD. .[13] Also, a focus on whole grains rather than processed grains and on consuming sufficient amounts of protein should also be considered appropriate for this population.

The Need for Protein and its Relationship to Metabolism

As mentioned above, AIs consume approximately 11% of total kilocalories from protein.[1] The question of what is the appropriate level of protein consumption has been asked, but there is little agreement regarding levels for optimal metabolic function.

Proteins contribute to metabolic function, and are the essential building blocks of our cells and bodies. They are composed of combinations of twenty amino acids; nine are essential, meaning our bodies cannot make them and therefore they must be obtained from diet. Not only are amino acids used to build proteins, but they can also be converted to other amino acids or other needed nitrogen containing compounds such as the vitamin niacin, a water-soluble B vitamin which can be converted to nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP) in the blood, brain, kidney and liver to generate energy for the cell. If amino acids are not used to build proteins or other nitrogen containing compounds, they can be "wasted," that is, burned as fuel or converted to glucose or fat. Amino acids are "wasted" when 1) other sources of energy are not available, 2) dietary protein requirements are exceeded, 3) when there is an excess of any single amino acid, or 4) when the diet supplies low quality proteins with too few essential amino acids.[42] The synthesis and catabolism of proteins is occurring continuously in our cells, but how much and what types of proteins are required in our diet to ensure that the needed component amino acid building blocks are available when they are needed?

The Dietary Reference Intakes (DRI) provides guidelines for daily intake of nutrients. The DRI for protein in healthy adults is about 0.8 grams per kilogram of body weight; about 46 and 56 grams/day for females and males, respectively.[42] Deficiency or excess in daily dietary protein intake can result in deleterious effects. In many cultures, it is widely believed that dietary protein consumption is required for good health, and within western more developed nations the source of that dietary protein is usually animal based. Animal based proteins do more closely resemble human proteins and therefore are absorbed more readily than plant based proteins; which are encased in a carbohydrate cell wall requiring specific enzymes to breakdown that humans do not produce.[43] But how much protein and what type is optimal for good health is still under debate. Several studies have tried to determine optimal protein intake (quantity and source) for body-weight regulation and optimal health. Common measurements include feelings of satiety, thermogenesis, energy efficiency, body composition of fat free mass, and nitrogen balance.

Westerterp-Plantenga, et. al. (2006), conducted a meta-analysis of various studies that explored protein requirements for body-weight management by looking at multiple variables measuring how protein is metabolized by the body. The satiating effect of protein was studied because protein is the most satiating of the energy macronutrients and fat the least. Two groups, one consuming high proportion of protein and one normal (protein/carbohydrate/fat: 30/60/10 versus 10/30/60 percent of energy, respectively) were assessed over 24 hours. Satiety and fullness persisted in the high protein group, whereas, the low protein group felt hungry with strong desires to eat. Furthermore, satiety was positively related to 24-hour diet induced thermogenesis (DIT), indicating that increased energy expenditures at rest lead to increased oxygen consumption which elevates body temperature and causes feelings of oxygen deprivation, which are translated into feelings of satiety. Using a similar methodology, a group of lean females were given a high protein diet of protein 30% of energy and normal protein diet of protein 10% of energy. Results were similar; the high protein group experienced greater 24-hour satiety than the normal protein group without any differences in energy intake. Additional measures of ghrelin, a hormone that induces appetite, and glucagon like peptide – 1 (GLP-1), which is a hormone that suppresses glucagon and stimulates insulin production, were taken showing no difference in ghrelin between groups, however, GLP-1 concentrations after dinner were significantly higher in the high protein diet group. Therefore, the difference between the two groups of lean females was in the 24 hour DIT component of energy expenditure relative to the absolute amount of protein consumed.[44]

Westerterp-Plantenga, et al. (2006), also reviewed the thermogenic effects of proteins, stating a similar finding as with satiety. The thermogenic effect for protein is higher than for both fat and carbohydrates, and is illustrative of the amount of ATP required to metabolize and store protein in the form of glucose. High thermogenic effects may be mediated by the high ATP cost of post-prandial protein synthesis. In elderly females, an increase in the amount of protein in the diet from 10 to 20% resulted in a 63-95% increase in protein oxidation; 63% increase being for soy protein, whereas the 95% increase being for animal proteins. Thus, more energy was required and thus a higher thermogenic effect was seen in the metabolism of the animal protein versus the soy. The digestion rate is an important factor for determining post-prandial protein metabolism, the faster the digestion rate the greater the increase in post-prandial protein synthesis. The slower digestion rate of animal proteins would translate into lower rates of protein synthesis.

Additionally, high levels of protein stimulate gluconeogenesis pathways to produce glucose when in a fasting state, and glycogen synthesis when in a fed state, which is consistent with the satiety findings cited above; increased production of glucose likely contributes to the feeling of fullness. Weight loss in high protein group did not differ significantly from the normal protein group; however, a greater reduction in intra-abdominal adipose tissue was seen in the high protein group improving overall metabolic profile. Contrary to this finding, the lower protein group lost 3 kilograms of lean muscle mass compared to 1.4 kilograms lost by the higher protein group. Finally, the authors state that optimal metabolic efficiency of weight gain (of lean muscle mass) is when protein intake is 10-15% of energy; the greatest inefficiency was noted as being when protein intake is less than 5% or greater than 20% of energy.[44]

In another study the absorption of protein from plant-based and animal-based sources was evaluated by looking at digestion/absorption rates (i.e., gastrointestinal kinetics) of various dietary proteins. Twelve subjects were assigned to the mixed cow's milk or animal protein group and 8 were assigned to the soy isolate or plant protein group. Each group was subjected to dietary standardization for 7 days at a normal protein level (1 g/kg), then at the end of this adaptation period, brought in for a metabolic test, which consisted of an overnight fast followed by ingestion of a test meal that was adjusted for body weight and contained the same amount of nitrogen (~68 mg/kg, or 0.41 g/kg of protein), carbohydrates (1.51 g/kg, or 99 and 90 g in milk and soy, respectively), and fat (0.38 g/kg, or 24 and 22 g in the milk and soy, respectively). Both types of proteins were radioactively labeled for nitrogen (^{15}N). Post prandial metabolic tests consisted of hourly blood draws and urine samples every two hours for an 8-hour period. Following this first dietary standardization period and metabolic test, both groups were then subjected to another 7 day period of dietary standardization at a higher protein level (2 g/kg), and then repeated the metabolic testing.[45]

The meal N content (Nm) in the blood and urine samples was determined by measuring the ^{15}N enrichment in plasma-free amino acids, protein and urea, as well as urinary urea and ammonia by isotope mass spectrometry. The model that was utilized for this study was designed to describe the post prandial utilization of Nm in the body; its ingestion, transfer through the gastrointestinal tract, absorption, elimination in the urine, and distribution in different regional metabolic pools (i.e., peripheral organs). The results were measured by group (NP-milk, NP-soy, HP-milk, HP-soy), and the effects that were noted were whether measured variables differed after dietary standardization at normal protein levels versus high protein levels.[45]

The results were as follows: 1) intestinal absorption was higher after HP dietary standardization period (85%) than after the NP (75%), and gastric emptying and intestinal transit and absorption were faster after ingestion of soy protein than with milk protein (half-time of gastric emptying and intestinal absorption accelerated by about 20 and 40 minutes, respectively). Thus, incorporation of ^{15}N into free amino acids in peripheral organs was faster after HP than NP (peak at about 20 minutes earlier regardless of test meal), and for soy than milk (peak at about 30 minutes earlier regardless of adaptation diet); peak absorption of HP-soy was higher (25%) than HP-milk (20%) – indicating that influx into peripheral organs after intestinal absorption was more significantly affected by meal protein source than diet protein level. 2) Three of the four measures of Nm flux (intestinal absorption, peripheral anabolic use, and peripheral catabolic use for urea production), showed higher percentages of ingested nitrogen in the soy groups versus the milk group (regardless of protein level). The fourth measure of flux (peripheral delivery of Nm) was lower for HP versus NP adaptation (1.5 and 7.5 hours post meal, respectively), and this effect was more significant for soy than for milk protein ingestion – indicating that soy protein is more efficiently delivered to peripheral tissues than milk protein (see Figure 1). 3) Post prandial orientation of Nm through urea metabolism in the deamination subsystem showed greater urea losses, urea production, urea recycling and urea recycling efficiency for soy than with milk in both the HP and NP groups. The authors concluded that absorption kinetics are in fact a key factor in the regulation of post prandial protein metabolism related to both amount of protein and type of protein. Soy protein was absorbed more rapidly and stimulated catabolic use of Nm resulting in extraction of Nm from peripheral organs and tissues, but anabolic use was only transiently increased indicating less availability of Nm in peripheral organs and tissues. Reduced Nm availability in peripheral organs and tissues was amplified after the HP adaptation versus the NP because of both the increase in intestinal absorption and peripheral organ/tissue catabolism of Nm from soy versus milk proteins. These findings suggest that habitual protein intake amplifies the differences in protein sources regarding their anabolic utilization and peripheral delivery. Thus, a high protein diet will condition the body to metabolize protein differently than a normal protein diet.[45]

From these studies, it can be inferred that there is an optimal range for protein intake as evidenced in metabolic efficiency (between 5 and 20% of total energy), and that plant based proteins require less energy to metabolize than animal proteins. Satiety is better achieved with high protein diets versus lower, and absorption is greater for plant based proteins than with animal based proteins. Also, absorption of plant proteins is faster and the metabolic turnover is greater than that of animal proteins, however, availability for protein synthesis in peripheral tissues is less for plant protein than for animal protein when equal amounts of plant and animal protein are consumed, suggesting that perhaps a greater quantity of plant proteins would be required to achieve the same levels of anabolic availability.

Protein alone cannot maintain good metabolic function. Other macronutrients, carbohydrates and fats, also play a role in a healthy metabolism. As mentioned above, AIs diabetics, as with most diabetics are recommended to consume a balanced healthy diet, low in fat, sugar and salt, and replacing fats with whole grains, fruits and vegetables.[3, 40] There is little discussion of what comprises a balanced healthy diet, and therefore dietary recommendations may be difficult to follow. One way to describe a balanced diet is in terms of balanced macronutrients.

Macronutrient Composition and its role in T2DM

The American Diabetes Association as well as the American Heart Association recommended energy-reduced and balanced diets without giving specific guidance on macronutrient composition.[46] The United States Department of Agriculture's general dietary guidelines for adults provide recommendations for Acceptable Macronutrient Distribution Ranges (AMDR) of 45-65% of total energy from carbohydrates, 20-35% from fat, and 10-35% from protein.[47] Is there an macronutrient composition that is optimal for managing diabetes as well as cardiovascular risk?

Several studies have looked at varying macronutrient compositions to determine impact on bio markers associated with good metabolic and cardiovascular health (e.g., blood glucose, fasting insulin, triacylglycerides (TAG), high density lipoprotein (HDL), low density lipoprotein (LDL), blood pressure, lean muscle mass loss, and weight loss). Schwingshackl, et. al. (2014), conducted a meta-analysis on fourteen studies with 1753 subjects to look at the long-term effects of high-fat versus low-fat diet consumption on cardiometabolic risk factors in subjects with abnormal glucose metabolism. Low fat was defined as ≤30% of total kilocalories from fat, 15% of total kilocalories from protein, and 55% of total kilocalories from carbohydrates. High fat was defined in two ways: 1) >30% of total kilocalories from fat, with the further requirement that the proportion of total kilocalories from saturated fat be >10%; 2) >30% of total kilocalories from fat, with the further requirement that the proportion of total kilocalories from monounsaturated fats (MUFA) be 12%, and <50 g carbohydrates/daily.[46]

The high-fat diet protocol resulted in significantly lower levels of TAG levels as compared to the low-fat diet, however, upon closer examination this effect was specifically within the high-fat group with high MUFA levels. Blood pressure values were significantly lower for the high-fat diet than the low-fat diet, however, again further analysis showed this was specifically in the high-fat group with high MUFA levels. Glycemic control as measured by fasting insulin levels did not differ between the high-fat and low-fat diet groups, however, further analysis showed that fasting insulin levels were significantly higher for the usual high-fat diet group than for the low-fat diet group. Changes in HDL levels were correlated with total fat as well as unsaturated fat intake; suggesting that either mono or poly unsaturated fat intake with concomitant reductions in carbohydrates resulted in higher HDL levels.

A study by Noakes, et., al. (2006), compared isocaloric very low carbohydrate/high saturated fat, and high carbohydrate/low saturated fat diets regarding their impact on body composition and cardiovascular risk. The very low-fat (VLF) diet was composed of macronutrient proportions of total kilocalories from carbohydrates, fats, and protein representing 70:10:20; the high unsaturated fat (HUF) diet was composed of 50:30:20; and the very low carbohydrate (VLCARB) diet was composed of 4:61:35. Dual energy X-ray absorptiometry (DEXA) measuring human body composition showed that although the proportion of fat loss was comparable across all three groups, both the VLCARB and VLF diets resulted in significantly more lean mass loss as a proportion of total weight loss than the HUF. Glucose tolerance improved for the HUF and VLF diets, but not for the VLCARB diet. Also, although weight loss was observed across all three diets, it was greatest for the VLCARB diet; however, the VLCARB diet significantly lowered fasting insulin levels (33%) as compared to the HUF diet (19%) or the VLF diet

(15%). Finally, LDL levels increased significantly for the VLCARB diet as compared to the HUF and VLF diets.[48]

In a study by Pesta, et., al. (2014), a high-protein diet was compared to an adequate protein diet. High-protein was defined as having a macronutrient proportion of total kilocalories from protein, carbohydrates and fat of 30:40:30, and the adequate protein diet was defined as having a macronutrient proportion of 10:60:30. Although the high-protein diet results in increased satiety and weight control, it also results in an increased acid load to the kidneys, and if the source is from animal protein, fat can also be increased. The authors advise careful choice of source of protein for a high protein diet, and emphasize the consumption of high quality plant proteins to avoid the high levels of saturated fats and cholesterol that can accompany animal proteins, and can increase risk for heart disease, hyperlipidemia, and hypercholesterolemia if consumed in high quantities. Proteins from vegetables (soy protein, beans, tofu, seitan or nuts) or fish could be a valuable alternative to animal protein. Regardless of source, all protein consumed in excess of what is needed, based on energy requirements, will eventually be converted to glucose (via gluconeogenesis) or ketone bodies, and will be stored as glycogen or fat, which is metabolically unfavorable.[47]

From the discussion above we can infer that different macronutrient compositions can result in different outcomes as measured by bio markers such as blood glucose, fasting insulin, HDL and LDL, lean mass, blood pressure, and acid load. Based on the data above, for good glycemic control, an optimal macronutrient proportion of total kilocalories from carbohydrates, fat and protein may be 50:30:20. Lower proportions of carbohydrates and higher proportions of fat result in increased fasting insulin levels as well as higher LDL levels, both of which are not conducive to good glycemic control. Lower levels of protein do not preserve lean mass, and higher levels of protein result in high acid loads, ketone bodies and more stored glycogen and fat, which is not metabolically efficient.

Chapter 3: Methods

Study Parameters

Study Design

This study had a cross-sectional descriptive design that examined the relationship between dietary intake, both in terms of diet quality (HEI Score and nutrient content of food groups) and diet quantity (macronutrient distribution relative to average daily energy requirement) and diabetes status, anthropometric measurements indicative of MetS and T2DM, acculturation, and physical activity. The study obtained a convenience sample of 60 Asian Indian (AI) adults from an AI organization in the Baltimore/Washington Metropolitan Area, and was conducted over a three-month period, from July through September 2016. The primary outcome variable was diabetes status as determined by HbA1c level. Explanatory variables included anthropometric measurements (i.e., waist circumference, waist to hip ratio, percent body fat, body mass index, body fat to body mass index ratio, and visceral fat), physical activity level (i.e., low, moderate, and high), three acculturation measures (i.e., values, behavior and self-identity), and demographic variables (i.e., age, gender, years in the US, education level, income, marital status, family structure, primary language spoken in home, vegetarian, alcohol use, and history of smoking). See Appendix A for a list of data variables collected as well as those that were calculated for use in the analysis.

Inclusion and Exclusion Criteria

AI adults ≥18 years of age who are literate in English were targeted for this study.

Individuals who met the following exclusion criteria were not included in the study: 1) a diagnosis of T2DM and taking insulin or other diabetes medications that could impact body composition; 2) a diagnosis of Type 1 diabetes mellitus (T1DM); 3) pregnant or lactating; 4) a previous or current mental health or psychological diagnosis; 5) undergoing cancer treatment; 6) a current smoker; 7) not literate in English; 8) <18 years of age; and 9) a resident of US for <5 years.

IRB approval was obtained at the University of Maryland, College Park, MD. See Appendix B to see a copy of the IRB approval letter and other IRB related materials.

Study Group Assignments

The study aimed to recruit a total of 80 study participants stratified by gender and diabetes status. The final target sample size was 60 participants (30 male and 30 female) assigned to three groups as shown in Figure 2. Group assignment was decided based Hemoglobin A1c level per WHO, IDF, and ADA definitions of T2DM (HbA1c ≥6.5%), Pre-T2DM (HbA1c ≥5.7% and <6.5%), and No-T2DM (HbA1c <5.7%). Each study group was to have a sample size of 20 (10 males and 10 females).

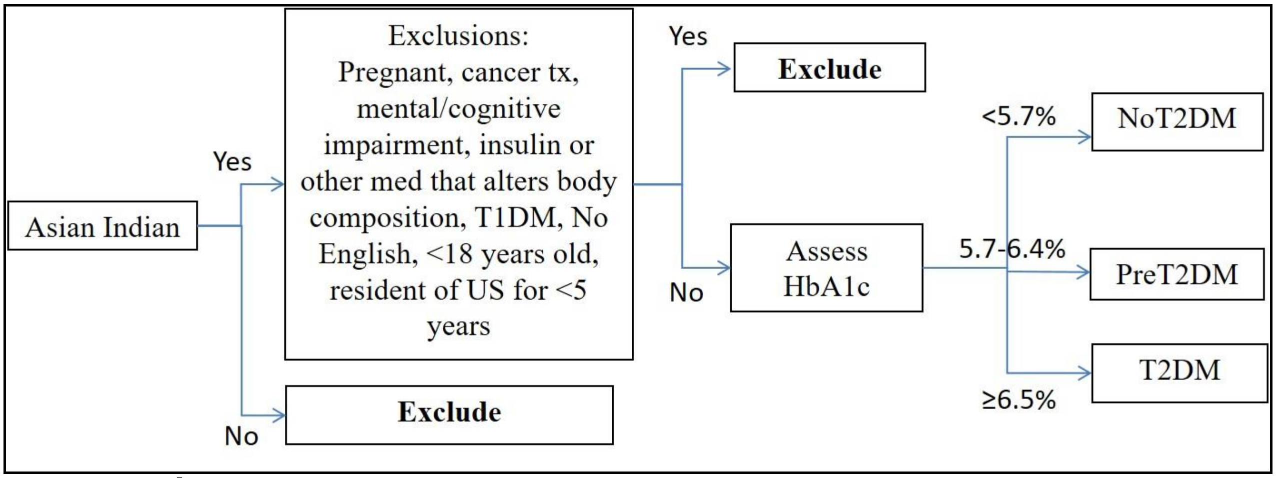


Figure 2. Study Participant Assignment

Sample Size Determination

An *a priori* estimation of sample size needed for this study was conducted using independent means for non-diabetics, and Pre- and diabetics, from a large-scale study (n = 2188) on HbA1c cut points in Asian Indian populations.[49] The sample size calculation of n=15 per group or a total of 45 participants was based on achieving a power of 0.80. Two methods were used to calculate the sample size needed to achieve a power of 0.80. First, a hand calculation was performed and then an online sample size calculator (https://www.stat.ubc.ca/~rollin/stats/ssize/n2.html) was used to verify the hand calculations. See Appendix C for the methodology used to calculate needed sample size. The final power achieved by the study was approximately 0.76, with an average of 13 participants per group.

Study Protocols

Study Participant Recruitment Methods

Participants were recruited from the Sri Mangal Mandir, a Hindu Temple in Silver Spring, Maryland, which is attended predominantly, but not exclusively, by Asian Indians from the state of Gujarat in India. Announcements were made about the study at various temple activities and programs and study materials were distributed to provide information about the study, its procedures, intent, and benefits (see Appendix D for copies of recruitment materials used, including a recruitment flyer and script, a tri-fold study brochure, and a handout with relevant anthropometric reference values for Asian Indians). Interested participants were asked to provide telephone numbers and email addresses so that they could be contacted to go through an eligibility screening for participation. Those that provided contact information were contacted to establish eligibility until the list was exhausted or a desired number of participants was reached. Couples were permitted to participate together if no exclusion criteria applied to either one. Once interest in participation was established, and it was determined that no exclusions applied, participants were scheduled to provide signed consent, and complete the study protocol including an initial participant interview, collection of blood results (FBG and HbA1c), anthropometric measurements (waist circumference, hip circumference, height, weight, percent body fat, and visceral fat), and three assessments (an acculturation survey, a physical activity survey and a food frequency questionnaire).

Survey Instruments

Four types of assessments were administered to all participants:

1) A participant interview including items such as name, contact information, date of birth, gender, place of birth (self and parents), languages spoken, years/generation in US, education, marital status, income, family structure, vegetarian or non-vegetarian dietary preference, alcohol use, smoking history, primary person responsible for cooking and grocery shopping, access to transportation, current health issues and any current treatments. The participant interview was custom developed and has not been validated with Asian Indian populations, however, it was pilot tested with a convenience sample of Asian Indians at the Mangal Mandir temple;

2) Dietary assessment was performed with the South Asian Food Frequency Questionnaire (SAFFQ), which includes 163 food items, 61 of which are unique to the South Asian

diet. The tool captures regular eating habits over a time period of 12 months, including frequency and serving size [39, 50] within 11 different food categories; beverages, dairy products, vegetables, peas, and beans, cooked dried beans and lentils, meats, breads, cereals and grains, snacks, mixed dishes, pizza and pasta, desserts and sweets, and miscellaneous. The SAFFQ instrument also includes 12 items vegetarian/non-vegetarian preference, dietary fats, frequency of fruit consumption as well as eating out, and a 13th item which covers a full list of vitamins and minerals taken; these additional items were not analyzed. The SAFFQ was adapted from the Study of Health Assessment and Risk in Ethnic (SHARE) and was developed and validated in South Asians [50] and Asian Indians[39]. The nutrient analysis for the SAFFQ data was provided by the Public Health Research Institute, located in Canada. See Appendix A for a list of nutrient data variables obtained from the nutrient analysis.

3) Acculturation was measured using the Suinn-Lew Asian Self-Identity Acculturation instrument (SL-ASIA), which is the most widely used acculturation tool within Asian populations. The author of the tool has added five new items SL-ASIA, to make the instrument at 26 item tool. The original 21 item SL-ASIA instrument has been validated in Asian populations [51-61] and in Asian Indians specifically.[17] The additional 5 items have not been validated, but were added to capture the non-linear multidimensional nature of acculturation. The 21 items on the original instrument are non-orthogonally scored and unidimensional. They include 5 dimensions (language (4 questions), identity (4 questions), friendship choice (4 questions), behaviors (5 questions), generation/geographic history (3 questions), and attitudes (1 question). The 5 additional questions all are orthogonal in format. Items 22 and 23 are scored together and provide a "value" score, high on 22 and low on 23 indicates Asian identified, high on 23 and low on 22 indicates Western identified, high on both 22 and 23 indicates bicultural, and low on both 22 and 23 indicates alienation from both cultures. Items 24 and 25 are scored together and provide a "behavioral competencies" score. High on 24 and low on 25 indicates Asian identified, high on 25 and low on 24 indicates Western identified, high on both 24 and 25 indicates bicultural, and low on both 24 and 25 indicates alienation from both cultures. Item 26 has 5 choices and is scored separately to provide a "self-identity" score. There are two methods to score this item: 1) each item could stand on its own to indicate Asian identified (1), Western identified (2), Bicultural but Asian most deeply (3), Bicultural but Western most deeply (4), or Bicultural and Bicultural most deeply (5); or 2) choice 1 or 3 indicate Asian identified, choice 2 or 4 indicate Western identified, and choice 5 indicates Bicultural. Items 22-25 are interpreted on a 5 point scale with a score

of 1 indicating no acculturation to the host culture, and a score of 5 indicating full acculturation or assimilation to the host culture.[17] Item 26 as described is scored a little differently.

This study only used the five additional items added because many of the items on the 21 items instrument were already addressed in the participant interview, and only the final 5 additional items were designed particularly to address the non-linear multidimensional nature of acculturation, and the interest in acculturation in this study was primarily to assess the association between acculturation and dietary choices which are based in cultural identity. These 5 items were condensed down to 3 acculturation measures (assignment of cultural values, assignment of cultural behavior, and assignment of cultural self-identity) with 3 levels of cultural assignment (Asian, Western, and Bi-cultural). Since the abridged version of this tool has not been tested separately from the full instrument, the authors of the instrument have requested that results of its use be shared with them.

4) Physical activity was measured using the International Physical Activity Questionnaire (IPAQ), which has been validated for use in Asian Indian populations.[62] The IPAQ was developed in 1998 in Geneva, Switzerland and has since been tested in multiple race/ethnicities and languages. The IPAQ is comprised of a set of 4 questionnaires, and is available in a long (27 question) and short (4 question) format. The long version includes 5 activity domains asked independently, and the short version only includes 4 generic items. Both versions were designed for use by either telephone or self-administered methods. This study used the short version of the IPAQ because the short and long versions both reliably measure levels of physical activity but the short version is

much more direct and easy to understand. Originally it was thought that participants could self-administer the instrument, and if that were done, an instrument that could be navigated by a wide range of ages was desired. The IPAQ is designed as a tool to obtain internationally comparable data on health–related physical activity. More information about this tool can be found at http://www.ipaq.ki.se/ipaq.htm. The results from this instrument were not only compared to dietary intake, but were also used to determine kilocalories burned from physical activity, which were added to the kilocalories calculated for basal metabolic rate for each participant to obtain a total daily caloric need. Refer to Appendix D for an enumeration of each tool and its validation in Asian Indian populations, Appendix E for the study packet, including the consent form and all study instruments, and Appendix G for the methodology used to determine level of physical activity and determine kilocalories burned.

Data Collection Procedures

Once eligibility for study participation was established, each participant was scheduled to complete all study assessments. The leadership of the Mangal Mandir designated a private room in which assessments could be performed. Assessments were either completed at the Mangal Mandir or within participants' homes. The study consent was read while each participant read along (see Appendix E). Once it was confirmed that study participation was consented, then participants were asked to sign the consent form. Each signed consent form was collected, scanned and then returned to each participant via email. All responses obtained were done so voluntarily; if there was a question that was uncomfortable to answer, the participant was permitted to refrain from answering.

Study instruments were administered in the following order following signed consent: 1) The participant interview (duration approximately 15 minutes), 2) The 5-item SL-ASIA acculturation tool (duration approximately 10 minutes), 3) The 4-item IPAQ physical activity tool (duration approximately 10 minutes), and 4) The SAFFQ (duration approximately 2-3 hours). Anthropometric measurements were then taken, which included collection of height (in meters), weight (in pounds, later converted to kilograms), percent body fat, visceral fat, waist circumference (WC), and hip circumference (HC). Variables derived from these measures included body mass index (BMI), and waist to hip ratio (WHR). Anthropometric measurements were completed in approximately 20 to 25 minutes. Each of these measures is described in more detail below.

Height was measured with the SECA 213 portable stadiometer in centimeters, with each participant standing without shoes with heals pressed up against the back panel, body straight with the head touching the stadiometer. The arm of the stadiometer was then lowered to press the top of the head to reach the scalp. Two successive measurement were taken for each participant in approximately 5 minutes; these were averaged for analysis.

Weight, percent body fat and visceral fat was measured with a battery powered Tanita BC-558 Ironman Segmental Body Composition Monitor, which was calibrated by the researcher prior to use. Participants stood on the scale without their shoes or socks while holding firmly onto two small metal rods. Bioelectric impedance sends a small electrical impulse through the body to measure not only weight, but bone mass, lean muscle mass, total body fat, visceral fat, water, basal metabolic rate and metabolic age.

Two readings were taken for each participant in approximately 10 minutes, which were again averaged for analysis. BMI will be calculated using the accepted equation of weight(kg) divided by the square of the height(m)^2.

Waist circumference measurements were done in 5-10 minutes, and were measured using a cloth tape measure at the site of maximum circumference midway between the lower ribs and the anterior superior iliac spine.[39] Cut-offs for waist circumference in Asian Indians have been accepted as 90 cm for males and 80 cm for females. These cut-offs are supported by WHO and NCEP and reflect a decrease from >102 cm in males and >88 cm in females. The reduction in waist circumference has resulted in an increase in prevalence from 12.2% to 17.9%; the highest prevalence found in Asian Indians (28.8%).[5, 9, 10, 32, 34] The hip circumference will be measured at the maximum circumference of the buttocks, the subject standing with feet placed together. The mean of two readings of each circumference will be taken for the calculation of the waist to hip ratio.[30] Waist to hip ratio has been thought to be a better indicator of central obesity in Asian Indians than waist circumference alone. The WHR is also suggested to be a better measure, especially in the Asian Indian population because a significant amount of cardiovascular morbidity was undetected at WC values consider normal by WHO, which was especially true for AI females, suggesting that the cut-offs for WC be reduced for this population.[11]

Following the anthropometric measurements, diabetes status was assessed with the collection of an HbA1c obtained from the participant's most recent lab report as ordered by their doctor (where HbA1c was not available, participants had their HbA1c assessed with the A1cNow Point of Care (POC) Monitor). Where lab results were available the collection of this value was <1 minute, however, when the POC HbA1c monitor was used, the procedure required approximately 15 minutes to complete. POC HbA1c was used as a supplementary measure to ensure that all participants have these readings to assign study groups appropriately. Requesting recent (within the past three months) physician ordered blood results was considered a reasonable alternative for ordering blood tests for each participant as part of the study. For missing HbA1c lab results, the POC HbA1c was used because it is more convenient and has been shown to be accurate and reliable.[63, 64] In a large meta-analysis of 61 studies reporting on the reliability and validity of POC A1C Monitors, the A1CNow was not significantly different in performance between a clinical and laboratory operator.[65] Capillary Blood Glucose (CBG) was considered for cases where FBG was not available from a physician ordered lab report, but abandoned because it was not be possible to obtain 8 hour fasting measures based on availability of participants to complete the study protocol; self-administered glucose test could not be confirmed as reliable because methodologies varied even when participants measured their blood glucose daily, and so was not used. Fasting blood glucose values were collected from all participants that could provide them, but ultimately were not used to assess diabetes status. The Oral Glucose Tolerance Test (OGTT) was also considered but thought to be too burdensome for participants and was therefore not included. The definition of T2DM is generally consistent across global entities. The World Health Organization, the American Diabetes Association and the International Diabetes Federation all share the same definition of T2DM. Generally, diagnosis is made with an FPG of $\geq$126 mg/dL, an HbA1c of $\geq$6.5%, or an oral glucose tolerance test (OGTT) result of ≥200mg/dL 2 hours after a 75g glucose drink.[23, 24, 39, 66]

A data form was created to capture all anthropometric and blood results for each participant (Appendix D). Completion of all assessments required an appointment time of 2-3 hours per participant. Table 1 below lists all assessment methods to be used with their respective reference values for this study; sources are also provided.

Table 1.
Anthropometric Measurement Reference Values for Asian Indians

Measures	**Reference Values**	**Citation**
Body Mass Index (BMI)		
Overweight	≥21.5Kg/m^2 (males); ≥19.0Kg/m^2 (females)	[28], [30], [7]
Obese	≥25.0Kg/m^2 (males); ≥23.0Kg/m^2 (females)	
Percent Body Fat (%BF)	≥25.5% (males); ≥35% (females)	[34], [11], [30]
Visceral Fat (VF) Score	1-12 (healthy); 13-59 (excessive)	[67]
Waist Circumference (WC)	≥35.4in (males); ≥31.5in (females)	[5]
Waist to Hip Ratio (WHR)	≥0.95 (males); ≥0.80 (females)	[11], [27]
Body Fat to Body Mass Index (BF:BMI) Ratio	≥1.00 (males); ≥1.5 (females)	[30]

Data Analysis

All data preparation was done using Excel from the Microsoft Office Suite and statistical analysis using was done using SAS 9.4.

Data Preparation

All data were collected using paper forms, which were labeled with a participant ID only. All identifying information was kept separately in a secure location to protect the personal information of participants. The participant interview data was the only instrument that contained identifying information. The data were transcribed from the interview form into Excel by participant ID. All text responses were converted to numeric categories for analysis. Age was calculated as the difference between the interview date and date of birth. Categories for income, education, alcohol use, primarily responsible for grocery shopping and cooking and access to transportation/ability to drive were condensed into fewer categories for ease of analysis (see Appendix A for all collected and derived variables). Current and previous disease and medication history was transcribed into Excel; however, this data was not analyzed.

Physical activity responses were transcribed into Excel, and converted to a composite score for low, moderate or high physical activity per the instructions of the author. Responses from each question on the instrument were also translated to MET minutes and then to kilocalories burned, also per the instructions provided by the author (Appendix G).

Acculturation responses were transcribed into Excel, and converted to three composite scores (values, behavior and self-identity) with three levels each (Asian, Western, and Bicultural) per the instructions of the author (Appendix H).

Anthropometric measurements were transcribed into Excel and converted to appropriate units of measure for each variable. For example, weight was collected in pounds and was converted to kilograms. The following derived variables were then calculated, BMI, BF:BMI, BMI normal, overweight and obese categories were created, and basal metabolic rate (BMR) was calculated for each participant (see Appendix I for methodologies used). The initial selection of BMR equations was based on methods used in various studies. There was consideration given to equations applied to Asian Indians in India, however, their use over other methods was not validated in the literature.[68-70] There are four equations commonly cited in the literature. They are the Owen, Mifflin-St. Jeor, Harris Benedict, and the WHO/FAO/UNU; there is varying agreement as to which method is the most reliable.[71-74] Therefore, 5 different methods were calculated and tested in this study: The Owen Equation, Mifflin St. Jeor, Harris Benedict, WHO/FAO/UNU, and the BMR provided by the Tanita Scale (BC-558 Ironman Segmental Body Composition Monitor) used to capture bioelectrical impedance measures. Each has its predictive variability, and none can be validated as the most accurate predictor in Asian Indian populations. Thus, all were considered in the analysis. The different methods used are provided Table 2 below. The BMR calculations were added to kilocalories burned through physical activity to determine total daily energy requirement.

The data from the SAFFQ was transcribed into an online system hosted by the Public Health Research Institute in Canada, the organization that granted permission for use of the instrument in this study and that provided the nutritional analysis. PHRI required about 4 weeks to provide the nutrient analysis; they provided both the raw data and the nutritional content of all foods and micronutrients as well as their respective serving sizes in SAS tables. See Appendix A for a listing of data fields provided. The primary variables used from the nutrient analysis include, total kilocalories, total daily intake of macronutrients in grams (protein, animal protein, vegetable protein, fish protein,

Table 2.
Basal Metabolic Rate Equations Used

BMR Method Name	BMR Equation	Notes
Owen		Slightly underestimates, but sometimes overestimates
Males	879 + (10.2 x weight in kg)	
Females	795 + (7.18 x weight in kg)	
Mifflin - St Jeor		Slightly underestimates, or overestimates
Males	9.99 x weight (kg) + 6.25 x height (cm) – 4.92 x age (y) + 5	
Females	9.99 x weight (kg) + 6.25 x height (cm) – 4.92 x age (y) - 161	
Harris-Benedict Formula		Most commonly used, but can underestimate or overestimates significantly
Males	66.47 + (13.75 X weight in kg) + (5.0 X height in cm) - (6.75 X age in years)	
Females	655.09 + (9.56 X weight in kg) + (1.84 X height in cm) - (4.67 X age in years)	
The WHO/FAO/UNU Equation		Typically, over estimates
Males	RMR for age18-30 years = (15.4 x weight in kg) – (27 x height in meters) + 717	
	RMR for age 31-60 years = (11.3 x weight in kg) + (16 x height in meters) + 901	
	RMR for age >60 years = (8.8 x weight in kg) + (1128 x height in meters) – 1071	
Females	RMR for age18-30 years = (13.3 x weight in kg) + (334 x height in meters) + 35	
	RMR for age 31-60 years = (8.7 x weight in kg) – (25 x height in meters) + 865	
	RMR for age >60 years = (9.2 x weight in kg) + (637 x height in meters) – 302	

carbohydrates, fiber, soluble fiber, insoluble fiber, sugar, carbohydrates absent of fiber, fat, saturated fat, monounsaturated fat, polyunsaturated fat, trans fat, and cholesterol), alcohol, and caffeine. Derived variables from this data included percent protein, percent carbohydrates, percent fat, proportion of animal protein, vegetable protein and fish protein of total protein, proportion of fiber, soluble fiber, insoluble fiber, sugar and carbohydrates absent fiber of total carbohydrates, and proportion of saturated, monounsaturated, polyunsaturated, trans fat, and cholesterol of total fat. To establish a reference value for macronutrient distribution, total caloric energy requirement as determined from BMR + kilocalories burned through physical activity, was multiplied by a standard recommended proportion of total kilocalories for each macronutrient (50 percent of total kilocalories from carbohydrates, 30 percent of total kilocalories from fat, and 20 percent of total kilocalories from protein) to get the daily required grams of each macronutrient. A ratio to actual to needed kilocalories from each macronutrient was then calculated by dividing daily intake of macronutrients (protein, carbohydrate and fat) by the daily required grams of each macronutrient. These ratios of actual to needed protein, carbohydrates and fats were then tested against diabetes status and other variables to identify associations.

The diet quality measure used in this study, the Health Eating Index 2015 Score, was calculated using the following USDA data tables: 1) the Food and Nutrition Database for Dietary Studies (FNDDS), 2) the Food Patterns Equivalents Database (FPED), and 3) the Food Patterns Equivalents Ingredient Database (FPID). It was necessary to use these tables to calculate the HEI 2015 Score which is based on USDA's nutrition datasets. Deriving the HEI 2015 Scores involved the following steps: 1) Mapping of all foods in the SAFFQ to the FNDDS. Where foods were not able to be mapped, such as prepared Asian Indian foods, the foods were deconstructed down to the ingredients and portions of each ingredient were normalized between the amount needed to make the FNDDS serving size and the amount needed to make the SAFFQ serving size. To do this, all components of the deconstructed foods were mapped to both FPED and FPID to get the nutrient data for each component. With nutrients for each deconstructed ingredient identified in the correct serving size, all deconstructed components were aggregated back to the SAFFQ food level so that the serving size consumed by participants could be applied. Once the serving size that participants consumed was applied across the 37 food groups produced by the FPED/FPID tables then a composite equivalence for each food group was calculated for each participant. The HEI 2015 algorithms also required additional data points not provided in the 37 FPED/FPID food groups; total daily kilocalories consumed, Sodium, monounsaturated fatty acids, and polyunsaturated fatty acids; this additional nutrient data was obtained from the FNDDS dataset. These 41 data points were then used to construct the 13 HEI categories as described by the SAS Code provided by the National Institutes of Health (NIH) Researcher site for HEI calculation (https://epi.grants.cancer.gov/hei/sas-code.html). Appendix J provides a more detailed description of the process, assumptions and data manipulations needed to calculate the HEI 2015 Score for diet quality. HEI 2015 scores derived from an FFQ are not recommended to describe mean diet quality among a population, or estimate distributions of diet quality among a population. The FFQ derived HEI score can be used to examine associations between diet quality and a dependent variable, examine associations between an independent variable and diet quality, and assess the effects of interventions on diet quality.

Initial Testing for Normality and Covariance

To establish the basis for data analysis and confirm use of appropriate statistical tests, each variable included in the analysis was assessed for its distribution and found to be normally distributed (Shapiro-Wilk statistic close to 1 with a $p>0.05$ confirms normality; skewness and kurtosis were also examined). Covariance was tested for participants who took part in the study as married couples, because married couples may have similar feelings about cultural values and identity, exhibit similar culturally identified behaviors, consume similar diets, and engage in similar patterns of physical activity. To do this, correlational analysis was performed on a subset of data representing just those who participated as married couples. Correlations were conducted between responses from each spouse on the three acculturation measures (values, behavior and self-identity), physical activity, and key diet variables (percent protein, percent carbohydrates, percent fat, and ratios for actual to needed kilocalories from protein, carbohydrates and fat). Student t-tests were also performed on each variable listed above by gender to assess whether participant couple males differed from participant couple females. Finally, a GENMOD procedure using the generalized estimating equation (GEE) model with nested and repeated measures was used to test for covariance between spouses in the same family.

Assumptions

There are two primary assumptions made about the dietary data collected in this study: 1) participants were truthful about the foods they consumed, both in terms of type and quantity. As with any dietary recall, but especially with an FFQ, recalling dietary intake over 12 months is difficult to do. The rationale for using an FFQ adapted for Asian Indians was to ensure that the food items on the FFQ reflected what is normally consumed, otherwise it may be difficult to recall all the foods consumed; and 2) the nutrient analysis performed by PHRI was accurate. It is not possible to validate that data.

There were also three primary assumptions made about the derivation of the HEI 2015 scores: 1) the entire recipe was not needed to adequately determine diet quality from the deconstructed foods, so only major ingredients were included; 2) added salt and oil/fat for each deconstructed food was within reasonable amounts, and 3) although adjustments were made for uncooked meat, to account for loss or gain in weight once cooked, allowance for added water was not made since it did not add any nutritional value, however, any impact added water would have made on the weight of the food was ignored.

Statistical Analysis

Descriptive statistics such as mean, standard deviations and correlational analyses were used to describe the data and establish covariance for any variables. Univariate analyses of variance, including T-Tests, ANOVAs, and linear and logistic regression models were used to determine whether diet, anthropometric measurements, physical activity and acculturation were associated across diabetes status groups. Multiple linear logistic regressions were used to determine the relationship between diabetes status and all predictive variables such as anthropometric measurements, age, gender, diet, acculturation and physical activity.

Research Questions

1. Do AI pre-diabetics and diabetics consume lower proportions of actual to needed macronutrients (protein, carbohydrate and fat) and have lower diet quality (HEI scores) than AI non-diabetics?
2. Do AIs with larger anthropometric measurements (e.g., waist circumference (WC), waist to hip ratios (WHR), visceral fat (VF), total body fat (TBF), and body fat to body mass index ratio (BF:BMI)) consume lower proportions of actual to needed macronutrients (protein, carbohydrate and fat) and have lower diet quality (HEI Score) than AIs with smaller anthropometric measurements?
3. Do AI vegetarians consume lower proportions of actual to needed macronutrients (protein, carbohydrate and fat), and have lower diet quality (HEI Score), than AI non-vegetarians?
4. Do AIs who value, behave and self-identify as Asians or Bi-cultural consume lower proportions of actual to needed macronutrients (protein, carbohydrate and fat) and have lower diet quality (HEI Score) than AIs who value, behave and self-identify as Western?

Chapter 4: Results

Study Sample

A convenience sample of 60 Asian Indian adults was drawn from Mangal Mandir, a Hindu Temple frequented by many Asian Indians residing in Maryland. A total of 59 individuals signed up to participate in the study. Of those who expressed an interest, 10 did not respond to follow-up calls, and 10 did not meet study criteria and were subsequently excluded, leaving 39 participants who completed all parts of the study and whose data were included in the analyses reported. The final sample size of 39 achieved a power of 0.76 (refer to Appendix C for sample size and power calculations).

Study participants were about equally divided by gender (49% male and 51% female) with an average age of 65.2 years (67.4 years for males and 63.0 years for females). Participants were predominantly Gujarati[12] immigrants (95%) who had lived an average of 37 years in the United States (39 years for males and 35 years for females). Ninety-seven percent of all participants were born in India or Africa, and 3% were born in the United States.

In the final dataset, 72% of participants participated as married couples, so the data were examined to determine any effect this may have had on variable confounding. A correlational analysis was performed between males and females of participant couples (Table 3). Participant couples had similar feelings about cultural identity and behavior, and consumed similar diets, however, participants were not significantly correlated on

[12] Gujarat is a state in the Indian subcontinent where the primary language is Gujarati.

physical activity, cultural values and diabetes status. Therefore, comparisons by diabetes status or gender would still reveal real differences between Asian Indian male and female non-diabetics, pre-diabetics and diabetics.

Table 3.
Correction Coefficients and P-Values for Select Variables by Gender for Participant Couples

Variable	**N‡**	**Pearson Correlation Coefficient (r)**	**p-value**
Diabetes Status (No, Pre, & Diabetes)	14	0.4778	0.08
Physical Activity Level	14	0.4206	0.13
Acculturation	14		
Values	14	0.4170	0.14
Behavior	14	0.9597	<<0.01*
Self-Identity	14	0.9597	<<0.01*
Select Diet Variables			
Percent Protein	14	0.6315	0.02*
Percent Carbohydrates	14	0.6214	0.02*
Percent Fat	14	0.6855	<0.01*
Protein Ratio - Actual to Needed	14	0.5975	0.02*
Carbohydrate Ratio - Actual to Needed	14	0.5911	0.03*
Fat Ratio - Actual to Needed	14	-0.2147	0.46

‡N represents the number of couples whose data were correlated by gender; data were from 28 participants.
*Indicates a significant p-value (p<0.05); < indicate p<.005; << indicates p<.0005.

An additional GENMOD procedure using the generalized estimating equation (GEE) model with nested and repeated measures was used to test for covariance between spouses in the same family and ensured no covariance on diabetes status (p<0.0001).

Descriptive Statistics

Eighty two percent of participants claimed Gujarati as their primary language (90% for males and 75% for females). Both males and females considered English as their secondary language (47% for males and 51% for females) more often than Hindi (42% for males and 33% for females) or Gujarati (5% for males, and 13% for females). The predominant language spoken in participant households was Gujarati (67% overall, 63% for males and 70% for females). About 16% of males and 15% of females predominantly spoke English at home, and 16% of males and 5% of females spoke a mix of English and Gujarati while at home.

Most participant households reported a nuclear family structure (82% overall, 84% of males and 80% of females), and about 95% of participants were married. Almost two thirds (61.5%) of participants had earned a Bachelor's degree or less and 38.5% had earned post graduate or professional degrees. Males were twice as likely to have a post graduate or professional degree than females (53% vs. 25%). Only 2 (10%) of females had less than a Bachelor's degree. Participants were almost equally split in terms of household income, with 56.4% earning less than or equal to $100,000 annually and 43.6% earning more than $100,000 annually.

Dietary Intake

Almost three quarters of participants were vegetarian (58% of males and 90% of females, $p<.0310$). About 90% of participants, both male and female, consumed alcohol occasionally (1-2 times/month) or never, and most participants did not have a history of smoking (92% overall, 100% for females, and 84% for males). About 53% of males and 70% of females reported primarily being responsible for grocery shopping in their households, whereas most females were predominantly responsible for cooking (0% of males, and 90% of females, $p<.0001$). About 87% of all participants had access to transportation and drove a car, versus 13% who did not (95% and 5% respectively for males, and 80% and 20% respectively for females). Table 4 presents relevant demographic variables by gender.

Diabetes Status

Diabetes status was assessed by Hemoglobin A1c readings obtained via physician ordered lab results as well as an HbA1c point of care (POC) monitor for those that did not have HbA1c readings from their physicians. Cut-offs used for no-diabetes, pre-diabetes and diabetes are those widely accepted by the American Diabetes Association (ADA), the World Health Organization (WHO), and the International Diabetes Federation (IDF); >5.7% = No Diabetes, >=5.7% but <6.5% = Pre-Diabetes, and >=6.5% = Diabetes. Hemoglobin A1c level was chosen as the exclusive diagnostic variable because it was the most reliable measure of diabetes status. The collection of fasting blood glucose after 8 hours of fasting was found not to be feasible and could not always be obtained from participant physician ordered lab results (about 13% of participants were missing this data point). Therefore, fasting blood glucose was dropped as a diagnostic variable. Participants also provided self-report of their diabetes status as well as one fasting blood glucose reading. Table 4 compares participant self-report to HbA1c groupings for both diabetes and pre-diabetes. Thirty six percent of participants self-reported having diabetes (23% males and 13% females), and 21% self-reported having elevated blood sugar or pre-diabetes (8% males and 13% females). In contrast, using the cut-offs for HbA1c levels indicated that 57% of females correctly self-reported diabetes, whereas only 14% of males did (p=0.0275*). Further, of the 21% of participants who self-reported having pre-diabetes, HbA1c cut-offs indicated that 63% of females correctly

Table 4.
Determination of Diabetes Status for Establishing Study Groups

Variable	Male (n=19)	Female (n=20)	p-value
1. Self-reported diabetes (Yes/No)			
No-diabetes	25.60%	38.50%	0.19
Diabetes	23.10%	12.80%	
1.a. HbA1c determined diabetes status for those that self-reported having diabetes			
No-diabetes	7.10%	0.00%	
Pre-diabetes	0.00%	21.40%	**0.03***
Diabetes	14.30%	57.10%	
2. Self-Reported high blood glucose or pre-diabetes (Yes/No)			
No-pre-diabetes	41.00%	38.50%	0.69
Pre-diabetes	7.70%	12.80%	
2.a. HbA1c determined diabetes status for those who self-reported not having high blood glucose or pre-diabetes			
No-diabetes	12.90%	9.68%	
Pre-diabetes	9.68%	29.03%	0.05
Diabetes	29.03%	9.68%	
3. Diabetes status based HbA1c			
No-diabetes	10.30%	7.70%	
Pre-diabetes	12.80%	35.90%	**0.02***
Diabetes	25.60%	7.70%	

1. Responses to interview question asking if had ever been told had diabetes.
1.a. Actual diabetes status as determined by HbA1c for those that self-reported diabetes.
2. Responses to interview question asking if had ever been told had pre-diabetes.
2.a. Actual diabetes status as determined by HbA1c for those that self-reported not having pre-diabetes. Too few self-reported having pre-diabetes; significance testing not possible, so not shown.
3. Diabetes status as determined by HbA1c for all participants.
*Indicates a significant p-value ($p<0.05$).

Table 5.
Demographic Characteristics by Gender

Variable	Male (n=19)	Female (n=20)	p-value
Gender	48.7%	51.3%	
Age	67.4 (± 12.5)	63.0 (± 11.6)	**0.03***
Years in the United States	39.2 (± 13.4)	34.7 (± 11.6)	0.27
Primary Language Spoken in Home			
English or Gujarati and English	15.40%	10.30%	
Gujarati Only or Other	33.30%	41.00%	0.48
Education			
≤Bachelor's Degree	23.10%	38.50%	0.11
≥Master's Degree	25.60%	12.80%	
Family Structure			
Nuclear	41.00%	41.00%	1.00
Extended	7.70%	10.30%	
Marital Status			
Single/Widowed	2.60%	2.60%	
Married	46.20%	48.70%	1.0
Participant Couple			
Yes	35.90%	35.90%	
No	12.80%	15.40%	1.00
Income			
<$100K	30.80%	25.60%	
≥$100K	18.00%	25.60%	0.52
Consumed Vegetarian Diet			
Yes	28.20%	46.20%	
No	20.50%	5.10%	**0.03***
History of Smoking			
Yes	7.70%	0.00%	
No	41.00%	51.20%	0.11
Alcohol Use			
Never or Occasional (1-2/mo.)	46.20%	48.70%	
Regular (1-3/wk.) or Frequent (>3/wk.)	2.60%	2.60%	0.16
Grocery Shops			
Yes	23.10%	35.90%	
No	25.60%	15.40%	0.20
Cooks			
Yes	0.00%	41.00%	
No	48.70%	10.30%	**<<.01***
Drives			
Yes	46.20%	41.00%	
No	2.60%	10.30%	0.34

*Indicates a significant p-value (p<0.05); < indicate p<.005; << indicates p<.0005.

self-reported their pre-diabetes, whereas only 25% of males did. Of the 44% of participants who self-reported neither diabetes nor pre-diabetes (18% males and 33% females), 65% were undiagnosed for either diabetes or pre-diabetes (24% males and 41% females). Of the 21% of participants who self-reported having pre-diabetes (13% females and 8% males), 13% were undiagnosed for diabetes (13% males and 0% females). This represented an overall undiagnosed rate of 39% for this study population (39% undiagnosed for pre-diabetes and 12% undiagnosed for diabetes); 26% of males and 50% of females were undiagnosed.

Figure 3 gives a break out of diabetes status groups; 18% of participants were non-diabetic (10% male and 8% female), 49% of participants were pre-diabetic (13% male and 36% females), and 33% were diabetic (26% male and 8% female); the difference by gender across these three diabetes status groups is significant (F=0.0017, p=0.0197). Figure 4 shows the breakout of diabetes status group by gender.

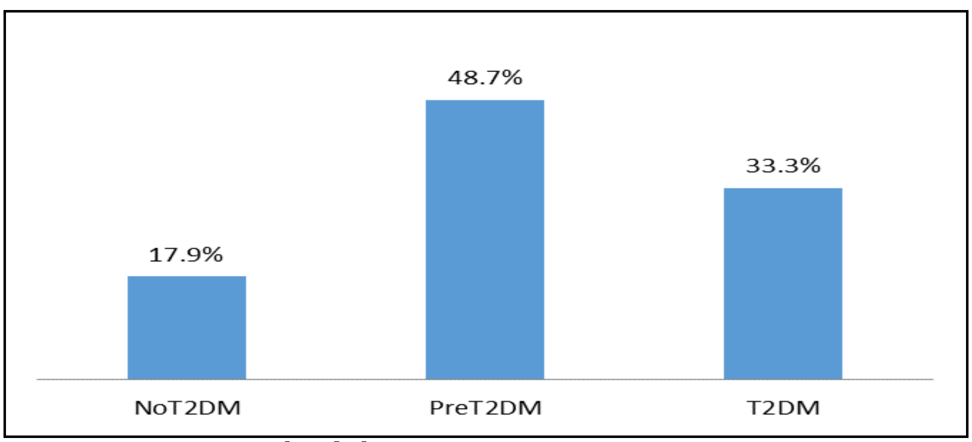


Figure 3. Participants by diabetes status

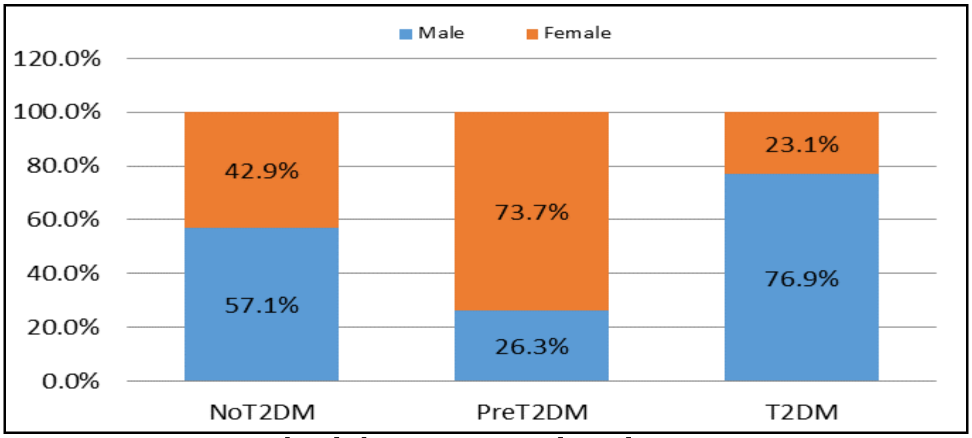


Figure 4. Participants by diabetes status and gender

Physical Activity

Participants were mostly engaged in either moderate (54%) or high (21%) levels of physical activity. Females reported being more physically active than males (80% of females reported moderate or high levels of physical activity versus 68% of males).

Table 6.
Participant Physical Activity Levels by Gender

Physical Activity Level	Male (n=19)	Female (n=20)	p-value
Low	15.40%	10.30%	0.11
Moderate	17.80%	35.90%	
High	15.40%	5.10%	

*Indicates a significant p-value ($p<0.05$).

Overall, females engage more in moderate levels of physical activity (36%), whereas males engage similarly in low, moderate and high levels of physical activity (15%, 18%, and 15%, respectively). There were no significant differences in physical activity levels by gender (Table 6), by diabetes status, or for females and males by diabetes status (Table 7). Most notably, however, for females only, pre-diabetics were more likely to engage in moderate or high levels of physical activity (60%), whereas for males only, diabetics were more likely to engage in moderate or high levels of physical activity (47%). Figure 3 shows physical activity by diabetes status, and Figure 4 breaks out physical activity by both diabetes status and gender. Pre-diabetic males more often engaged in high levels of physical activity (40%) than pre-diabetic females (14%). Diabetic males more often engaged in high levels of physical activity (30%) than diabetic females (0%). pre-diabetic and diabetic females were more likely to engage in moderate levels of physical activity (76%) than pre-diabetic and diabetic males (40%). About 26% of participants reported low levels of physical activity (32% of males and 20% of females). Most of the non-diabetic participants reported low levels of physical activity (50% for males and 67% for females).

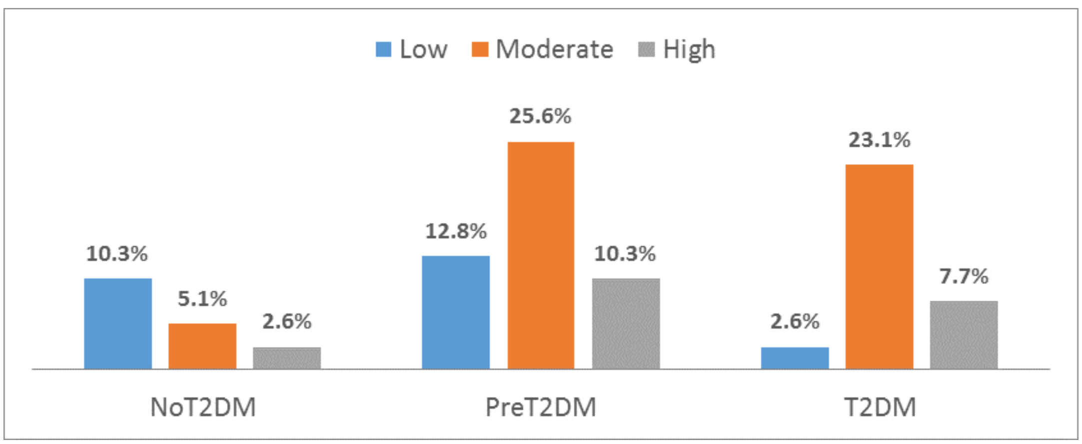


Figure 5. Physical activity by diabetes status

Table 7.
Physical Activity by Diabetes Status (All, Females and Males)

	All (n=39)			
Physical Activity Level	**No-Diabetes**	**Pre-Diabetes**	**Diabetes**	**p-value**
All Participants	**(n=7)**	**(n=19)**	**(n=13)**	
Low	10.26%	12.82%	2.56%	0.22
Moderate	5.13%	25.64%	23.08%	
High	2.56%	10.26%	7.69%	
Female Participants	**(n=3)**	**(n=14)**	**(n=3)**	
Low	10.00%	10.00%	0.00%	0. 24
Moderate	5.00%	50.00%	15.00%	
High	0.00%	10.00%	0.00%	
Male Participants	**(n=4)**	**(n=5)**	**(n=10)**	
Low	10.53%	15.79%	5.26%	0.12
Moderate	5.26%	0.00%	31.58%	
High	5.26%	10.53%	15.79%	

*Indicates a significant p-value (p<0.05).

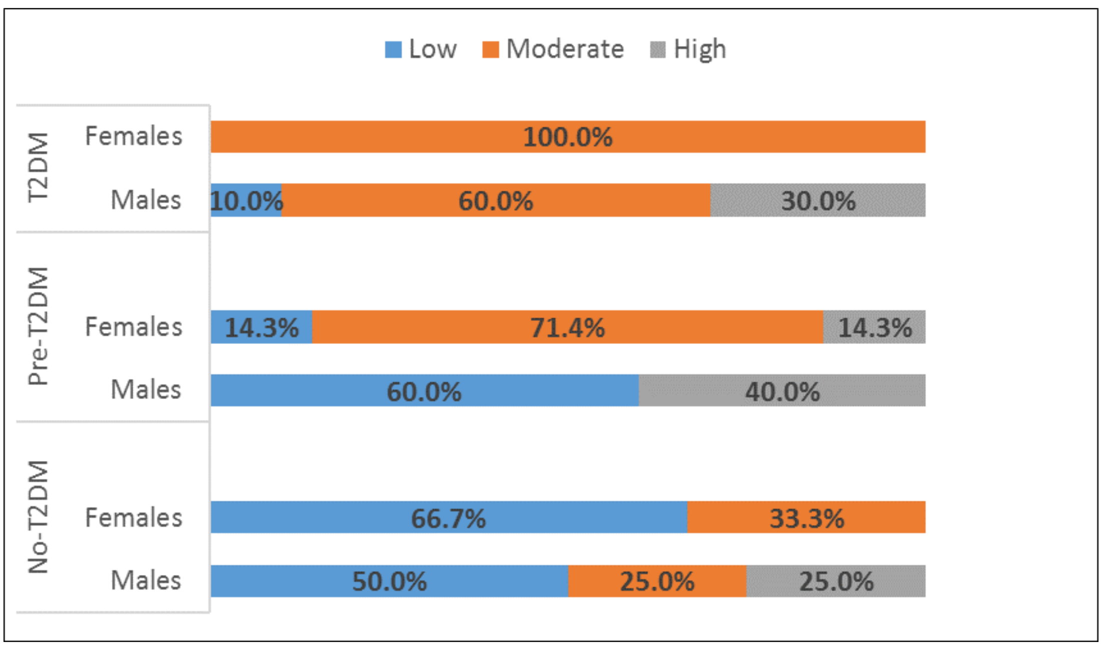
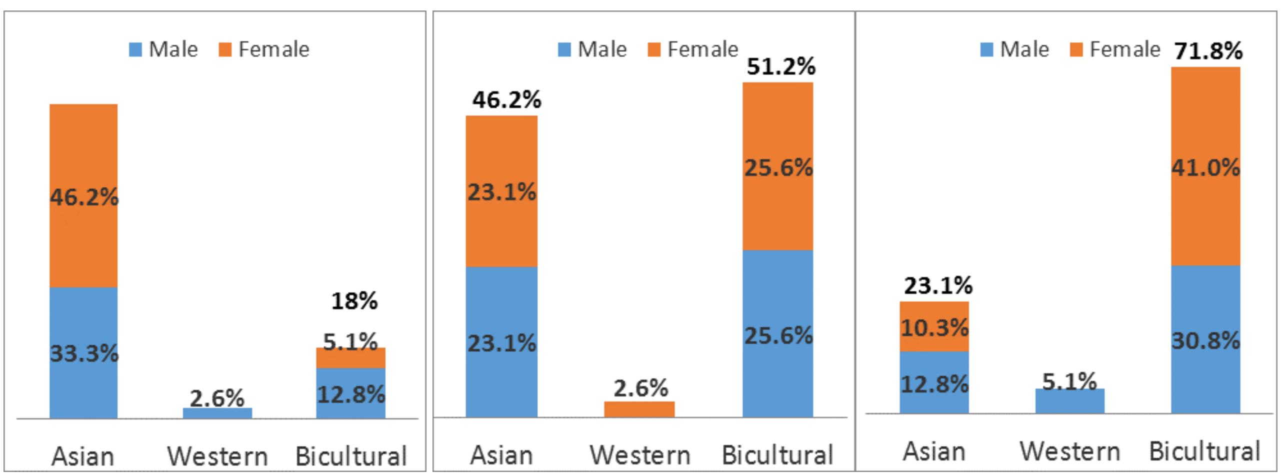


Figure 6. Physical activity by diabetes status and gender

Acculturation

Figure 7 shows participants by three acculturation measures, values, behavior and self-identity, as well as gender. Seventy-nine percent of participants identified their values as being Asian Indian (46% female and 33% male), versus 18% as bicultural (5% female and 13% male) and only 3% western (3% males and 0% females). Participant behavior was identified as 46% Asian Indian (23% female and 23% male) and 51% bicultural (25.5% female and 25.5% male), and 3% western (0% males and 3% females). Seventy-two percent of participants self-identified as bicultural (41% female and 31% male), versus 23% Asian Indian (10% female and 13% male) and only 5% western (5% males and 0% females). More females self-identified as bicultural (80%) than males (63%). Very few participants self-identified as western



Values Behavior Self-Identity

(0% for females and 11% for males). Acculturation did not vary significantly for

values, behavior or self-identity by gender.

Figure 7 Acculturation by Gender (values, behavior, and self-identity)

Figures 8-10 looks at the three acculturation measures, values, behavior and self-identity by diabetes status and gender. Of the non-diabetic males and females, their values were predominantly identified as Asian Indian (75% of males and 100% of females), however, for non-diabetic males, their behavior and self-identity was identified as being bicultural (75% and 75% respectively), which was the opposite for non-diabetic females (0% and 33% respectively). Of the pre-diabetic males and females, their values were predominantly identified as Asian Indian (80% of males and 86% of females), and their behavior was identified as almost equally split between Asian Indian (60% for males and 50% for females and bicultural (40% for males and 50% for females), however, whereas pre-diabetic males were almost equally split on self-identity across Asian Indian (40%) and bicultural (60%), pre-diabetic females predominantly self-identified as bicultural (86%) versus 14% Asian Indian.

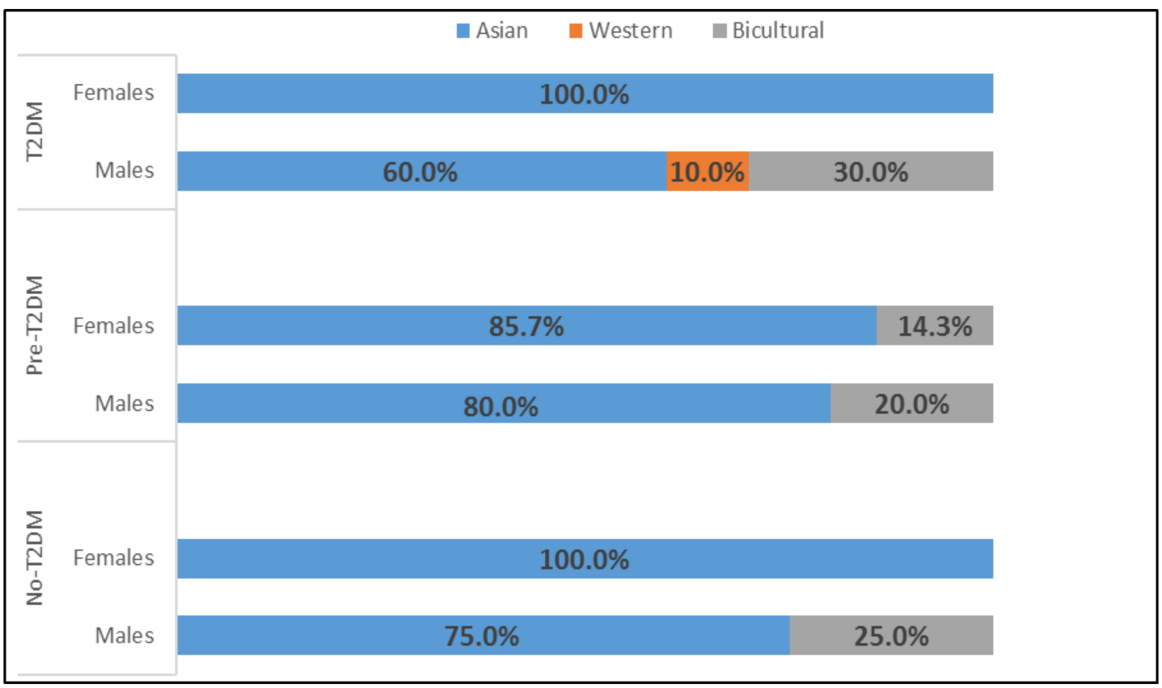


Figure 8. Values by diabetes status and gender

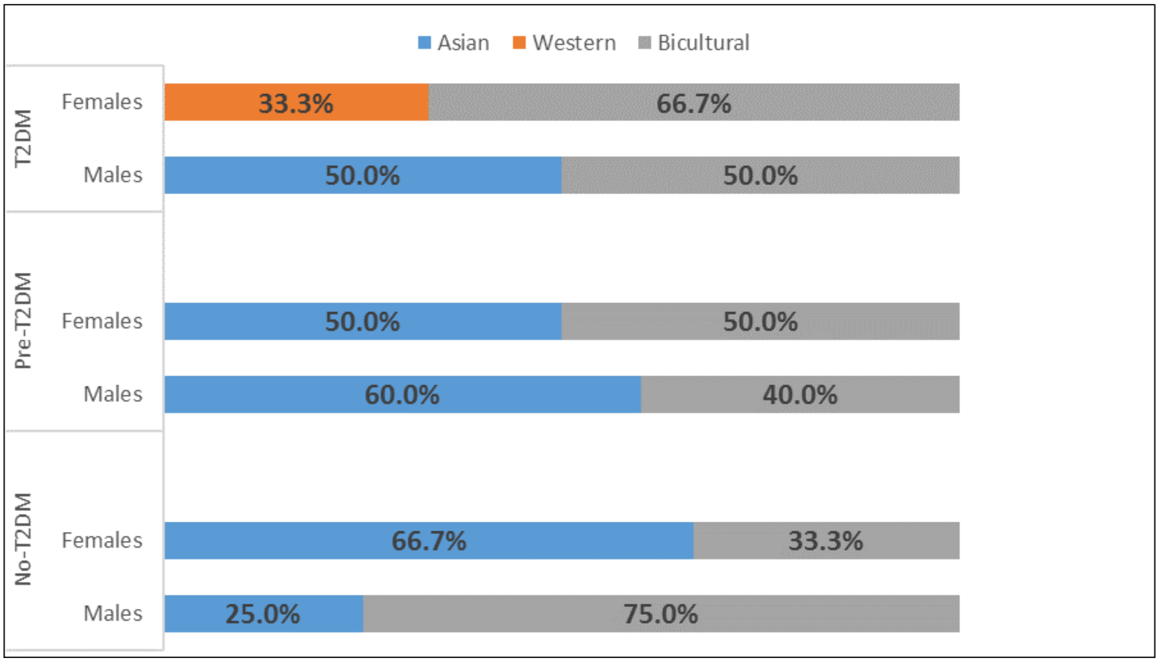


Figure 10. Behavior by diabetes status and gender

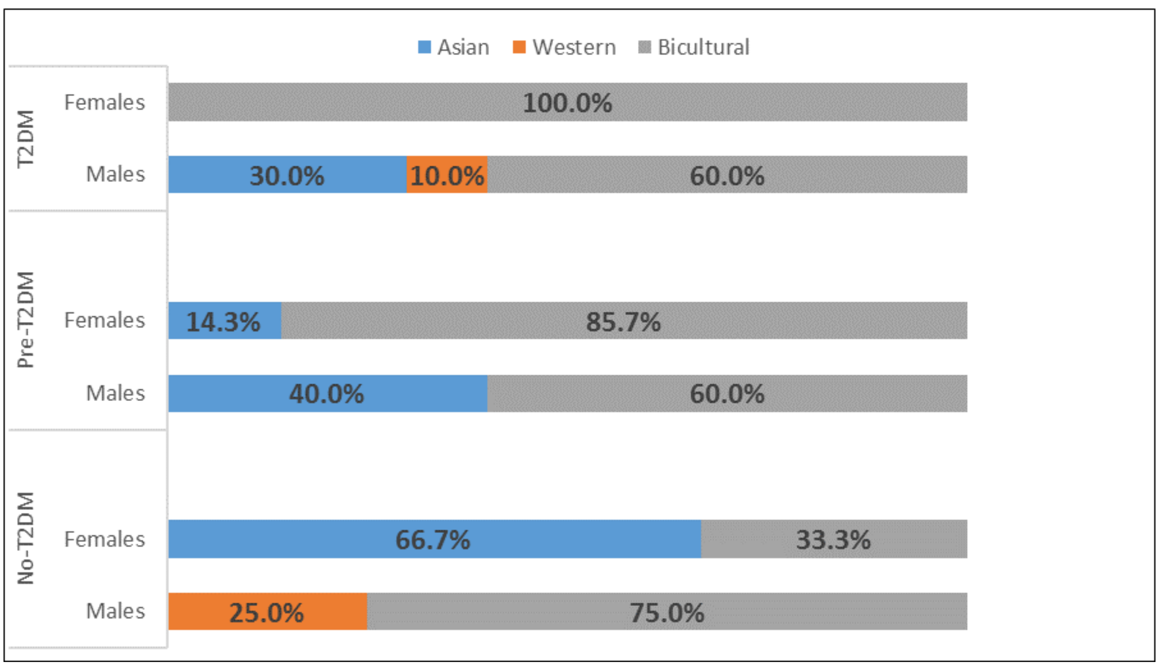


Figure 9. Self-identity by diabetes status and gender

Of the diabetic males and females, their values were predominantly identified as Asian Indian (60% of males and 100% of females), however, whereas diabetic males identified their behavior as equally split between Asian Indian (50%) and bicultural (50%), diabetic females identified their behavior as mostly bicultural (67%) and western (33%). Both male and female diabetics self-identified as more bicultural (60% of males, and 100% of females) than Asian Indian (30% for males and 0% for females). For females and males only, no significant differences were noted by diabetes status, however, female pre-diabetic were more likely to identify their values as Asian (60%) and their self-identity as bicultural (60%); their behavior was reported as being split between Asian (35%) and bicultural (35%). Male diabetics reported their values as being mostly Asian (32%) and their self-identity as bicultural (32%); their behavior was split between Asian (26%) and bicultural (26%).

Anthropometric Measurements

Anthropometric measurements were measured against cited reference values for Asian Indian adults (Table 1). Body mass index (BMI) across all groups of males was within the obese range (27.9 for noT2DM, 25.2 for pre-T2DM, 26.5 for T2DM), and within the overweight range for females with noT2DM (21.5) and T2DM (22.9), but in the obese range for females with pre-T2DM (26.0). Waist circumference for all groups of males (36.8 for noT2DM, 36.7 for pre-T2DM, and 37.8 for T2DM) was greater than the reference value for healthy metabolic function for Asian Indian males (35.4). Waist circumference for females was within the reference value for healthy metabolic function (31.5) for noT2DM (30.8) and greater than the reference value for pre-T2DM (34.6in) and T2DM (35.6). Waist to hip ratio for males was within the reference value for healthy metabolic function (.95) for males with noT2DM (.94) and greater than the reference value for pre-T2DM (.95) and T2DM (.97), and greater than the reference value for healthy metabolic function (.80) for all groups of females (.85 for noT2DM, .87 for pre-T2DM, and .94 for T2DM). Percent body fat for all groups of males exceeded the Asian Indian reference value (25.5%) for healthy metabolic function (29.8 for noT2DM, 27.3 for pre-T2DM, 28.1 for T2DM), and was within the Asian Indian reference value for healthy metabolic function (35%) for females with no-T2DM (28.5) and exceeded for pre-T2DM (38.3) and T2DM (38.1). Although visceral fat reference values were not given for Asian Indians specifically, for all groups of males, visceral fat was in the excessive range (15.8 for no-T2DM, 14.2 for pre-T2DM, and 20.6 for T2DM), and in the healthy range for all groups of females (5.3 for no-T2DM, 9.0 for pre-T2DM, and 8.2 for T2DM). Table 8 gives participant anthropometric measurements by gender. All anthropometric measurements differ significantly by gender except for BMI as both a continuous variable as well as categorical. Table 9 provides the breakout by diabetes status and gender.

For females and males separately, non-diabetic and pre-diabetic females had significantly different percent body fat (mean=28.45 (±4.6), and 38.3(±4.4), respectively, $F=6.18$, $p=0.0096$), and non-diabetic and diabetic females had significantly different BF:BMI ratios (mean=1.32 (±0.12), and 1.72 (±0.4), respectively, $F=3.82$, $p=0.0428$). Males did not vary significantly on any anthropometric measures by diabetes status.

Table 8.
Anthropometric Measures by Gender

Variable	Male (n=19)	Female (n=20)	p-value
Waist Circumference (mean)	37.30 (≥35.4)	34.10 (≥31.5)	**<<.01***
Waist to Hip Ratio (mean)	0.96(≥0.95)	0.88 (≥0.80)	**<<.01***
Body Fat (BF) (mean)	28.20 (≥25.5)†	36.70 (≥35.0)†	**<<.01***
Body Mass Index (BMI) (mean)	26.40 (≥25.0)	24.90 (≥23.0)	0.20
Normal (percent)	2.60%	2.60%	0.65
Overweight (percent)	23.10%	15.40%	
Obese (percent)	23.10%	33.30%	
BF to BMI Ratio (mean)	1.07 (≥1.0)	1.49 (≥1.5)	**<<.01***
Visceral Fat (mean)	17.87 (>12)†	8.36 (>12)†	**<<.01***

*Indicates a significant p-value (p<0.05); < indicate p<.005; << indicates p<.0005.
† Methods for measuring visceral fat and body fat cannot be validated.
Reference values are provided for unhealthy cut-offs in parentheses after means.

Participant Diets

All participants completed a 163 item Food Frequency Questionnaire (FFQ) that gave a one year retrospective to their dietary intake. Two approaches to dietary quality assessment are presented: 1) dietary quality as measured by Healthy Eating Index (HEI) 2015 scores, and 2) dietary quantity as measured by the proportion of total kilocalories consumed daily in the form of the three energy producing macronutrients, protein, carbohydrates and fats. Two other components of data gathered were used in the analyses of dietary intake: 1) anthropometric measurements taken were used to calculate each participants basal metabolic rate (BMR), and 2) the physical activity (PA) assessment tool administered to participants was used to calculate kilocalories burned during physical activity (sitting, walking, doing household chores, or exercising) to estimate total daily kilocalorie energy requirement (i.e., BMR + Kilocalories burned through PA = total daily energy requirement).

Table 9.
Anthropometric Measures by Diabetes Status (All)

Variable	N	No-Diabetes	N	Pre-Diabetes	N	Diabetes (n=13)	p-value
WC							
All	7	34.22 (±3.8)	19	35.13 (±3.0)	13	37.29 (±3.2)	**<<0.01***
Females	3	30.79 (±0.94)	14	34.56 (±3.1)	3	35.58 (±2.8)	**0.04***
Males	4	36.78 (±2.7)	5	36.73 (±2.3)	10	37.80 (±3.3)	**<<0.01***
WHR							
All	7	**0.90 (±0.06)†**	19	**0.89 (±0.06)†***	13	**0.96 (±0.06)***	**<<0.01***
Females	3	0.85 (±0.06)	14	0.87 (±0.04)	3	0.94 (±0.06)	<<**0.01***
Males	4	0.94 (±0.02)	5	0.95 (±0.06)	10	0.97 (±0.07)	**<<0.01***
BF							
All	7	**29.20 (±4.2)**†	19	**35.41 (±6.8)**†*	13	**30.41 (±6.7)***	**<<0.01***
Females	3	28.45 (±0.5)	14	38.30 (±4.4)	3	38.08 (±4.7)	**<0.01***
Males	4	29.76 (±4.4)	5	27.30 (±5.8)	10	28.11 (±5.4)	**<<0.01***
BMI							
All	7	25.18 (±5.1)	19	25.80 (±3.0)	13	25.63 (±4.2)	0.63
Females	3	21.52 (±2.1)	14	26.04 (±3.2)	3	22.90 (±5.8)	0.93
Males	4	27.93 (±5.1)	5	25.15 (±2.5)	10	26.45 (±3.5)	0.22
BF:BMI							
All	7	**1.18 (±0.2)†**	19	**1.37 (±0.22)†***	13	**1.21 (±0.35)***	**<<0.01***
Females	3	1.32 (±0.1)	14	1.48 (±0.1)	3	1.72 (±0.4)	**<0.01***
Males	4	1.08 (±0.1)	5	1.08 (±0.2)	10	1.06 (±0.1)	**<<0.01***
VF							
All	7	11.29 (±5.9)	19	10.39 (±3.8)	13	17.70 (±15.8)	**<<0.01***
Females	3	5.33 (±1.2)	14	9.04 (±2.5)	3	8.2 (±4.0)	0.06
Males	4	15.75 (±2.5)	5	14.20 (±4.6)	10	20.55 (±17.0)	**<<0.01***

† and * Indicate a significant p-value ($p<0.05$); < indicate $p<.005$; << indicates $p<.0005$.
Three p-values are given for each measure (testing difference in overall model, diabetes status, and gender).

Participants consumed an average of 1463.7 kilocalories per day (1600.9 for males and 1333.3 for females). Figure 11 shows the macronutrient intake per day (in grams) for all participants as well as for males and females separately. Daily consumption of protein averaged 51.4 grams across all participants (46.8 grams for females and 56.4 grams for males), carbohydrates averaged 201.3 grams across all participants (181.3 grams for females and 222.4 grams for males), and fats averaged 49.5 grams across all participants (46.4 grams for females and 52.9 grams for males).

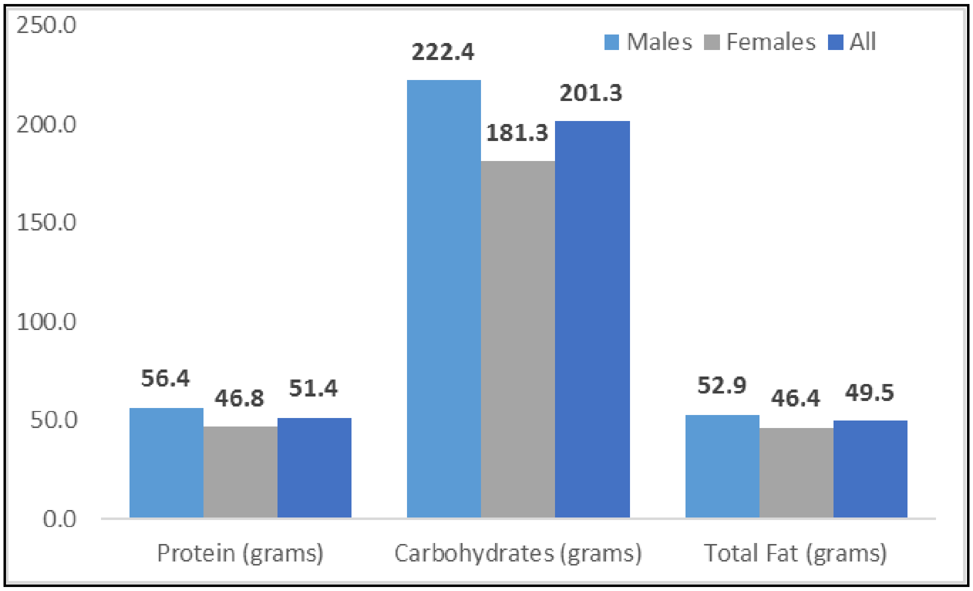


Figure 11. Daily macronutrient consumption

Table 10 provides diet variables by gender. Although males and females consume significantly different amounts of total kilocalories per day, they do not differ significantly when each macronutrient is examined as the percent of total kilocalories, or when macronutrient components were examined as proportion of their respective macronutrient. Protein, as a percent of total kilocalories, was about 14% for both males and females, carbohydrates, as a percent of total kilocalories, was 56% for males and 55% for females, and fat, as a percent of total kilocalories, was 29% for males and 31% for females.

Table 10.
Dietary Components by Gender

Variable	Male (n=19)	Female (n=20)	p-value
Total kilocalories	1600.90 (±310.2)	1333.30 (±257.1)	**0.01***
Protein as percent of total kilocalories	14.03 (±2.4)	14.14 (±2.1)	0.89
Proportion Animal Protein	0.43 (±0.13)	0.40 (±0.14)	0.54
Proportion Vegetable Protein	0.57 (±0.14)	0.59 (±0.15)	0.74
Proportion Fish Protein	0.00 (±0.01)	0.01 (±0.05)	0.30
Carbohydrates as percent of total kilocalories	56.01 (±5.3)	54.54 (±5.0)	0.38
Proportion Total Fiber	0.08 (±0.01)	0.09 (±0.02)	0.55
Proportion Soluble Fiber	0.04 (±0.01)	0.04 (±0.01)	0.40
Proportion Insoluble Fiber	0.04 (±0.01)	0.04 (±0.01)	0.74
Proportion of Carbohydrates w/o Fiber	0.86 (±0.06)	0.88 (±0.04)	0.22
Proportion of Sugar	0.06 (±0.02)	0.05 (±0.02)	0.18
Fat as percent of total kilocalories	29.26 (±4.3)	31.01 (±4.5)	0.22
Proportion Saturated Fat	0.28 (±0.05)	0.27 (±0.06)	0.61
Proportion Monounsaturated Fat	0.40 (±0.03)	0.41 (±0.03)	0.27
Proportion Polyunsaturated Fat	0.21 (±0.03)	0.22 (±0.03)	0.20
Proportion Trans Fat	0.002 (±0.01)	0.003 (±0.01)	0.62
Proportion Cholesterol	2.03 (±1.1)	1.54 (±1.4)	0.22
Alcohol as percent of total Kilocalories	0.69 (±1.24)	0.31 (±0.63)	0.25

*Indicates a significant p-value ($p<0.05$).

Although the percentages of total kilocalories from protein, carbohydrates and fats for both males and females fell within acceptable macronutrient distribution ranges for daily consumption by adults in the US as recommended by the Food and Nutrition Board, Institute of Medicine, National Academies[75], protein as percent of total kilocalories was at the lower recommended ranges for daily consumption. Table 11 provides a comparison of the IOM's Acceptable Macronutrient Distribution Ranges (AMDR) with participant daily intakes.

Participants had lower than recommended daily ranges for total fiber consumption (16.10g for females and 19.00g for males, IOM recommendations ranged 21-25% for females and 30-38% for males) and dramatically less than the maximum allowances for sugar (<1% for both males and females; IOM maximum allowance is 25%). No recommendations were given by the IOM for monounsaturated fatty acids and the nutrient data for this study did not break out polyunsaturated fatty acids into n-6 (linoleic acid) and n-3 (α-linolenic acid), so those comparisons were not possible. Saturated fat and trans fatty acids were consumed in small quantities by participants (<1% and <<1% respectively), and cholesterol was consumed in relatively small quantities as well (5.35% of total kilocalories for females, and 6.63% for males).

Looking at these dietary components by diabetes status reveals that there was a significant difference between the proportion of trans fat consumed of total fat across groups. Non-diabetics consumed the largest proportion (1%), pre-diabetics consumed a smaller proportion (0.2%) and diabetics consumed the smallest proportion of all (0.08%), p=0.036*. There was a difference in the consumption of cholesterol as a proportion of total fat, but it was not significant (p=0.2225). Non-diabetics again consumed the largest proportions (2.67) followed by diabetic (1.85), and then pre-diabetic (1.41), p=0.0636. These differences were not seen when looking at males alone, but were when looking at females alone, albeit not significantly. non-diabetic females consumed 1% of total fat from trans-fat, whereas pre-diabetic consumed 0.1%, and diabetic consumed 0.03%, p=0.0522. For proportion of cholesterol, non-diabetic females consumed the most (3.03), followed by pre-diabetic females (1.40), and then diabetic females (0.74), p=0.0867.

Table 11.
Dietary Components as Compared to IOM's Acceptable Macronutrient Distribution Ranges (AMDR)

Variable	IOM Males	IOM Females	Female (n=20)	Male (n=19)
Protein as Percent of Total Kilocalories	10-35%	10-35%	14.14%	14.04%
Carbohydrates as Percent of Total Kilocalories	45-65%	45-65%	54.54%	56.01%
Fat as Percent of Total Kilocalories	20-35%	20-35%	31.01%	29.26%
Total Fiber	30-38g	21-25g	16.10g	19.00g
Sugar	25%	25%	0.76%	0.87%
Monounsaturated Fat	NA	NA	1.43%	1.32%
Polyunsaturated Fat	NA	NA	0.77%	0.69%
n-6 (linoleic acid)	5-10%	5-10%	NA	NA
n-3 (α-linolenic acid)	0.6-1.2%	0.6-1.2%	NA	NA
Saturated Fat	Minimal	Minimal	12.68g (0.94%)	14.76g (0.91%)
Trans Fat	Minimal	Minimal	0.20g (0.01%)	0.19g (0.01%)
Cholesterol	Minimal	Minimal	68.90g (5.35%)	106.43g (6.63%)

BMR By Diabetes Status

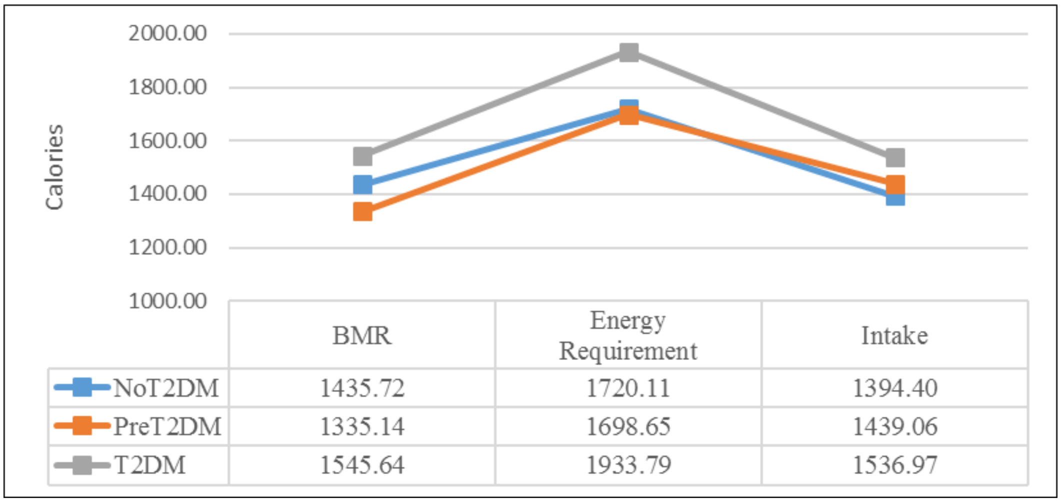
BMR calculations were done using 5 different methods, all varied slightly but they each generally followed the same trend by diabetes status. Correlational analysis confirmed that all 5 methods were significantly correlated with one another ($p<0.0001$). Therefore, only the Owen method was selected for the remainder of the analyses. Table 12 provides the mean BMR by gender and diabetes status.

Table 12.
Basal Metabolic Rate (BMR) Calculated Using Five Different Methods by Gender and Diabetes Status

BMR Method	**No-Diabetes**	**Pre-Diabetes**	**Diabetes**
All	**(n=7)**	**(n=19)**	**(n=13)**
Owen	1435.73 (±.280.7)	1335.14 (±.176.8)	1545.64 (±.208.2)
Harris-Benedict	1359.18 (±.300.2)	1291.30 (±.140.0)	1411.39 (±.186.9)
Mifflin St. Jeor	1286.67 (±.307.4)	1192.23 (±.193.9)	1381.08 (±.203.2)
WHO	1253.27 (±.177.0)	1276.27 (±.106.9)	1362.19 (±.116.2)
Tanita Scale	1347.50 (±.303.0)	1252.87 (±.183.2)	1455.81 (±.234.7)
Females	**(n=3)**	**(n=14)**	**(n=3)**
Owen	1161.72 (±.53.5)	1238.49 (±.52.3)	1209.09 (±.72.5)
Harris-Benedict	1188.51 (±.157.0)	1238.88 (±.96.7)	1198.90 (±.107.4)
Mifflin St. Jeor	1049.64 (±.193.2)	1103.50 (±.126.8)	1086.58 (±.129.0)
WHO	1147.99 (±.110.2)	1248.83 (±.99.2)	1247.90 (±.136.7)
Tanita Scale	1101.83 (±.111.8)	1164.61 (±.94.3)	1094.50 (±.119.0)
Males	**(n=4)**	**(n=5)**	**(n=10)**
Owen	1641.23 (±.155.7)	1605.76 (±.86.8)	1646.60 (±.86.9)
Harris-Benedict	1487.18 (±.335.9)	1438.10 (±.145.7)	1475.14 (±.156.3)
Mifflin St. Jeor	1464.45 (±.256.6)	1440.68 (±.110.2)	1469.43 (±.117.5)
WHO	1332.23 (±.187.5)	1353.08 (±.96.8)	1396.47 (±.90.4)
Tanita Scale	1531.75 (±.263.9)	1500.00 (±.136.1)	1564.20 (±.117.1)

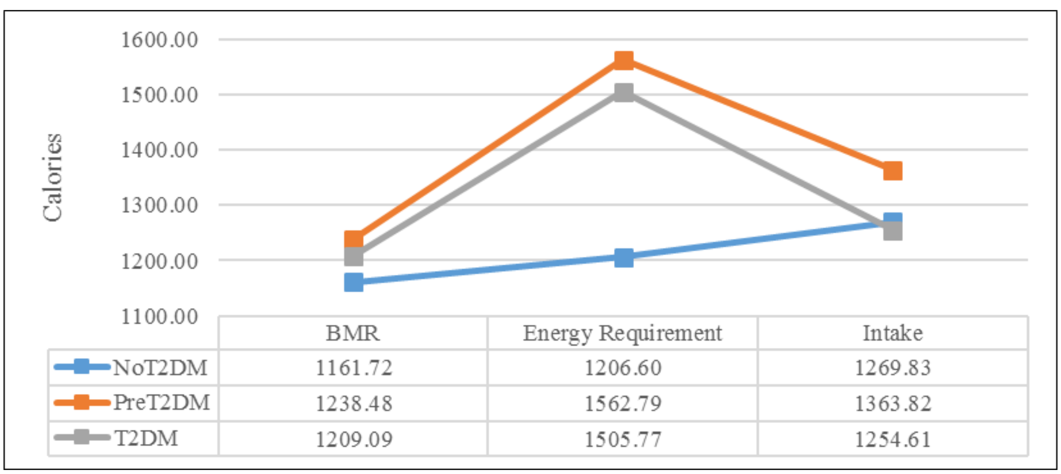
BMR establishes the minimum caloric intake needed to meet energy requirement assuming no physical activity. Based on each participant's reported physical activity level, total caloric intake needed to meet energy requirements was calculated (BMR + kilocalories burned through physical activity). Figures 12-14 show the average BMR, average caloric intake needed to meet energy requirements and average caloric intake by diabetes status and gender. Correlational analysis shows that BMR is significantly correlated with total caloric intake for all participants (0.4251, p=0.0070), but not for males only (0.0334, p=0.8920), or females only (0.1088, p=0.6478). However, BMR was significantly correlated with total caloric intake needed to meet energy requirements for all participants, males only and females only (0.7799, p<0.0001; 0.6738, p=0.0016;

0.6865, p=0.0008, respectively). Total caloric intake to meet energy needs significantly exceeds total kilocalories consumed for all participants as well as for males only and females only (0.3015, p=0.0625; 0.0444, p=0.8569; 0.2550, p=0.2779, respectively), except for female non-diabetics, whose caloric intake exceeds total kilocalories needed for energy needs.



	BMR	Energy Requirement	Intake
NoT2DM	1435.72	1720.11	1394.40
PreT2DM	1335.14	1698.65	1439.06
T2DM	1545.64	1933.79	1536.97

Figure 12. BMR, energy requirement, and caloric intake for all participants by diabetes status



	BMR	Energy Requirement	Intake
NoT2DM	1161.72	1206.60	1269.83
PreT2DM	1238.48	1562.79	1363.82
T2DM	1209.09	1505.77	1254.61

Figure 13. BMR, energy requirement, and caloric intake for female participants by diabetes status

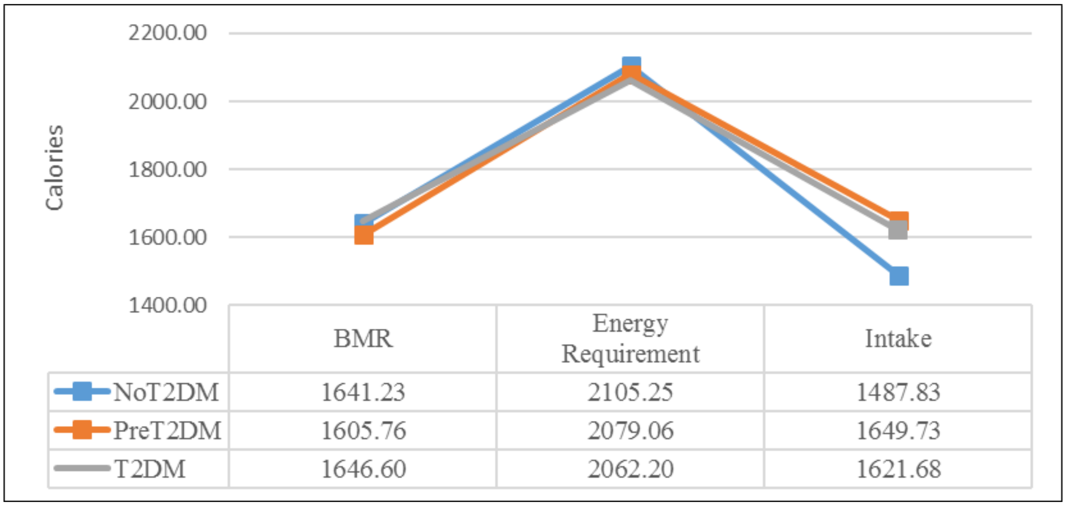


Figure 14. BMR, energy requirement, and caloric intake for male participants by diabetes status

Kilocalories required to meet energy needs exceeded caloric intake for all groups, except non-diabetic females; caloric intakes for diabetic females was slightly higher than what is needed to meet energy needs.

Statistical Analysis to Address Research Questions

Research Question Number 1 (Macronutrients)

The association between macronutrient distribution and diabetes status was examined by looking at the ratio of actual to needed total kilocalories, protein, carbohydrates and fats based on energy needs by gender and diabetes status (Figures 15-18).

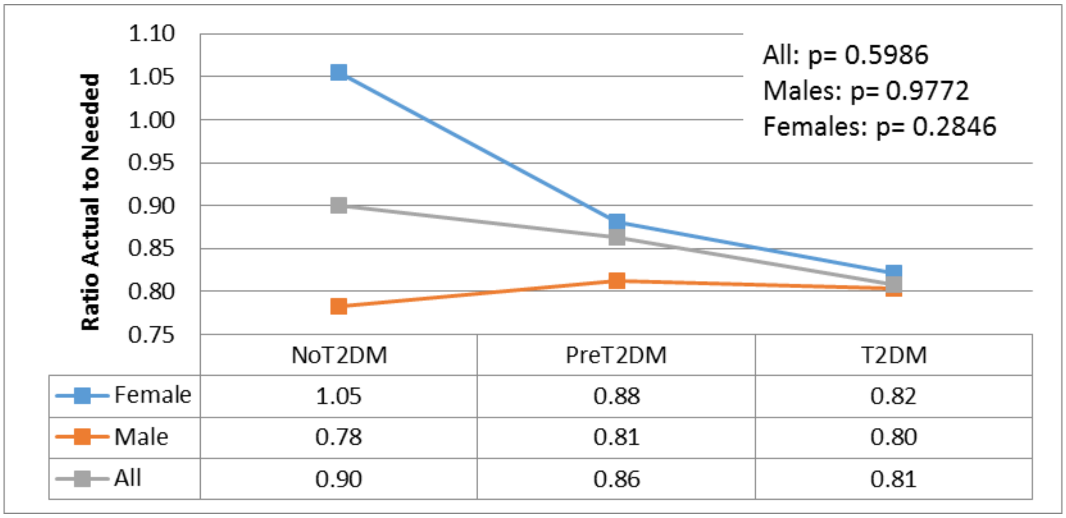


Figure 15. Actual to needed total kilocalories by diabetes status and gender

There were no significant differences noted by diabetes status for total actual to needed kilocalories (Figure 15). However, non-diabetic females did exceed their total needed caloric intake (105%), whereas pre-diabetic and diabetic females consume 81% and 80%, respectively, of their needed kilocalories. Actual to needed ratios of total kilocalories were lower for non-diabetic men (78%) than pre-diabetic (81%) and diabetic men (80%).

Figure 16 shows non-diabetics consuming higher ratios of actual to needed protein than pre-diabetics and diabetics (64%, 59% and 60%, respectively); this difference was not statistically significant (p=0.8450). Non-diabetic females consumed much higher ratios of actual to needed protein than pre-diabetic and diabetic females (83%, 61%, and 57%, respectively); this difference was not statistically significant (p=0.0699). Male diabetics consumed the highest ratios of actual to needed protein (61%), followed by pre-diabetics (55%) and then non-diabetics (50%); this difference was not statistically significant (p=0.6786).

Correlational analysis also showed a significant relationship between diabetes status and actual to needed kilocalories from protein for females (- 0.45122, p=0.0458).

This relationship was not seen in males; however, correlational analysis did show a significant

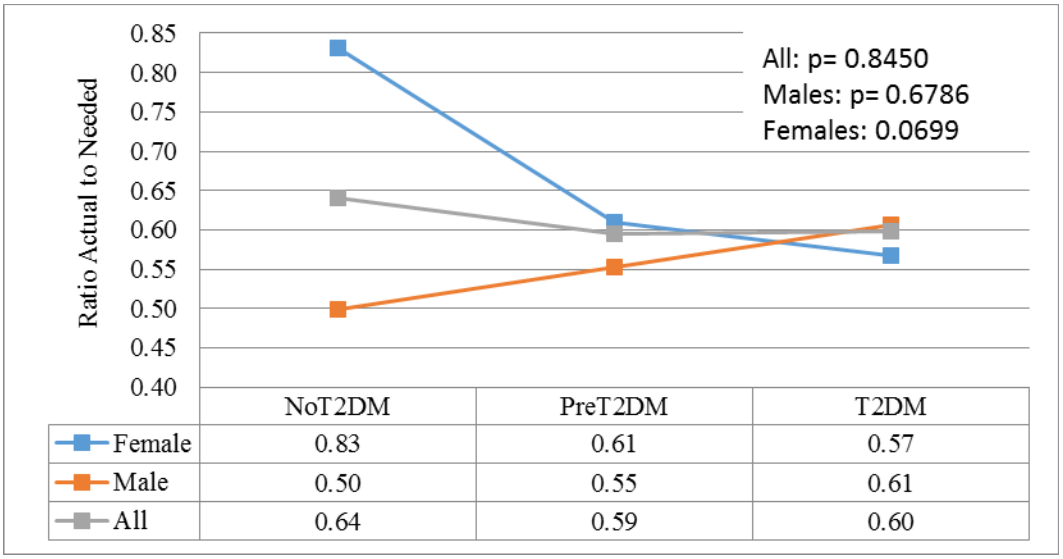


Figure 16. Actual to needed kilocalories from protein by diabetes status and gender

relationship for males only between A1c level and actual to needed kilocalories from protein (0.51431, p=0.0243); this relationship is in the reverse direction than seen in females. Additionally, when looking at the correlation between A1c levels and actual to needed kilocalories from protein across all participants, a weak significant positive relationship was found (0.2930, p=0.0703; for the WHO BMR method).

Figure 17 shows a similar pattern for actual to needed kilocalories from carbohydrates as shown for actual to needed consumption of protein. Non-diabetic females were consuming higher ratios of carbohydrates than pre-diabetics (111% and 96%, respectively; diabetic females consumed the lowest ratios of carbohydrates (90%). The pattern for men is slightly different. Pre-diabetic males consumed the highest ratio of actual to needed carbohydrates (94%), followed by non-diabetic (88%) and finally diabetic males (87%).

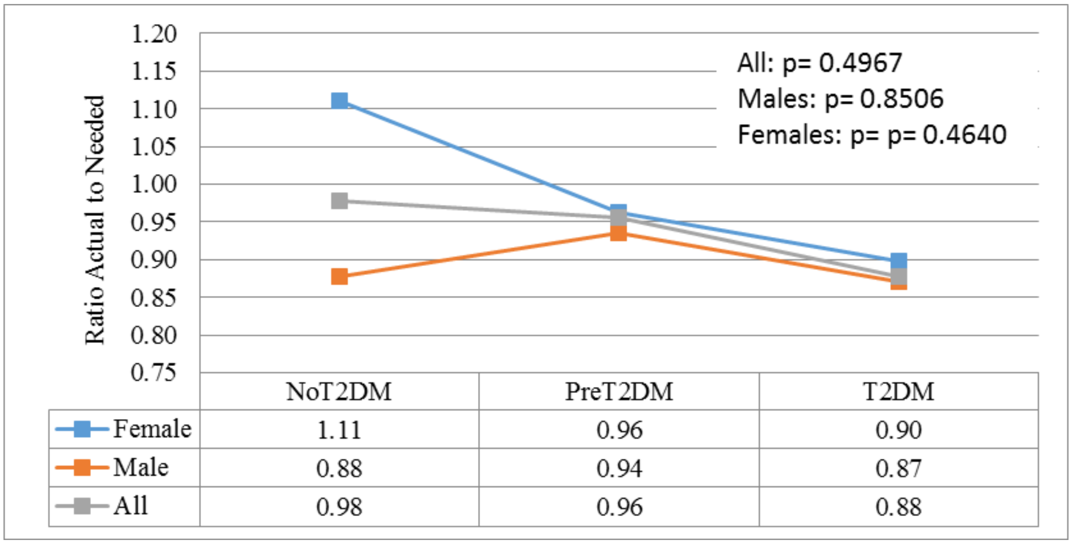
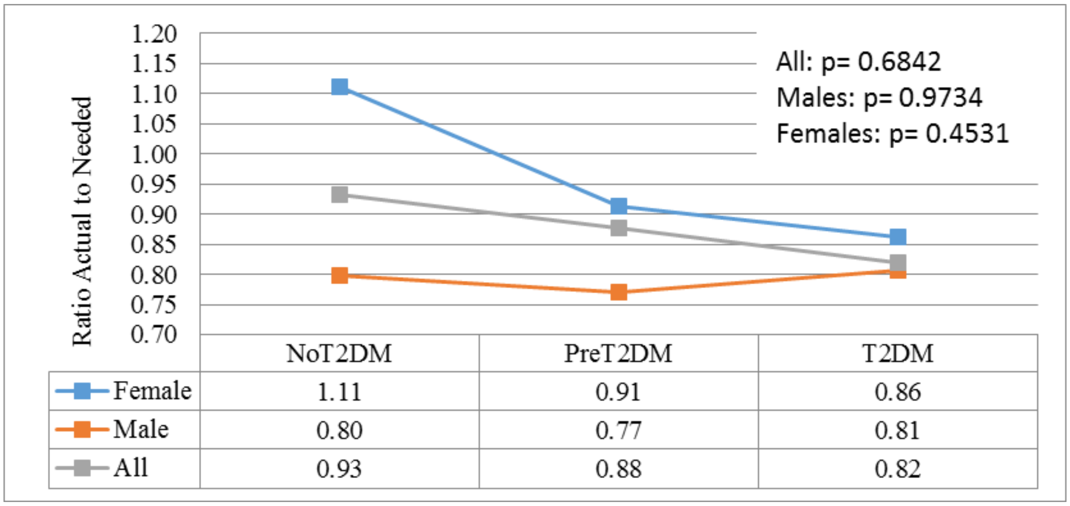


Figure 17. Actual to needed kilocalories from carbohydrates by diabetes status and gender

Figure 18 shows actual to needed consumption of fat was highest for non-diabetic females, exceeding the daily caloric needed for fat (111%). Pre-diabetics consumed the second highest percent (91%), followed by diabetics (86%). For males, however, diabetics consumed the highest percent of actual to needed fat (81%), followed by non-diabetics (80%) and then pre-diabetics (77%).

Additional findings from the correlational analysis showed a significant relationship between diabetes status and proportion of trans fats (-0.34034, p=0.034) and a weak correlation between diabetes status and proportion of insoluble fiber (0.30208, p=0.0616) for all participants, and a significant correlation between diabetes status and proportion of insoluble fiber (0.45653, p=0.043) for females only. However, when correlations between A1c, macronutrients and other dietary components were examined, percent protein (0.33328, p=0.0381), proportion of soluble fiber (0.31638, 0.0497), and total kilocalories consumed were significantly correlated with A1c levels for all participants. Males did not show any specific significant correlations between diabetes



	NoT2DM	PreT2DM	T2DM
Female	1.11	0.91	0.86
Male	0.80	0.77	0.81
All	0.93	0.88	0.82

Figure 18. Actual to needed kilocalories from fat by diabetes status and gender

status and any macronutrient, however, when looking at the correlations between A1c, macronutrients and other dietary components, percent protein (0.50846, p=0.0262), and proportion of insoluble fiber (0.50401, p=0.0278), were significantly correlated, while proportion of soluble fiber was weakly correlated with diabetes status for males (0.45357, p=0.0511).

A multiple linear regression model was performed to test how well macronutrient independent variables, that were correlated with diabetes status, could predict diabetes status. With diabetes status as the dependent variable the initial model included actual to needed kilocalories from protein, actual to needed kilocalories from carbohydrates, actual to needed kilocalories from fat, proportion of trans fat, proportion of cholesterol, proportion of soluble and insoluble fiber, percent protein, proportion of vegetable protein and proportion of carbohydrates absent any fiber as independent variables. This model was weakly significant (F=2.05, p=0.0653). The two variables that did not significantly contribute to the model were proportion of vegetable protein and proportion of carbohydrates absent any fiber, and so these two variables were removed from the model. The resulting significant regression equation was found for the remaining variables ($F(7,1,1,1,1,1,1,1,1)=2.58$, $p=0.0282$), with an R2 of 0.5126. Participants' predicted diabetes status is equal to 14.41 + 15.50 (Actual to Needed Kilocalories from Protein) – 6.54 (Actual to Needed Kilocalories from Carbohydrates) – 3.37 (Actual to Needed Kilocalories from Fat) -61.91 (Proportion of Trans Fat) – 0.19 (Proportion of Cholesterol) – 57.59 (Proportion of Soluble Fiber) + 75.27 (Proportion of Insoluble Fiber) – 0.64 (Percent Protein). All independent variables were significant predictors of diabetes status, except proportion of trans fat and proportion of soluble fiber. However, when these variables were removed from the model, the model was no longer significant, so these variables were retained in the overall model. Table 13 provides the test statics for this multiple regression model.

Table 14 shows the results when the same independent variables were tested to predict A1c level, the overall model was also significant ($F(7,1,1,1,1,1,1,1,1)=4.39$, $p=0.0013$). The model's performance was improved by removing proportion of cholesterol from the model. The resulting significant regression equation was found for the remaining variables ($F(7,1,1,1,1,1,1,1)=2.66$, $p=0.0012$), with an R2 of 0.4165.

Table 13.
Parameter Estimates for Predicting Diabetes Status

Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Standardized Estimate**
Intercept	1	8.24	2.74	3.01	**0.01***	0.00
Ratio of Actual to Needed Kilocalories from Protein	1	9.68	3.75	2.58	**0.02***	2.51
Ratio of Actual to Needed Kilocalories from Carbohydrates	1	-4.60	1.68	-2.73	**0.01***	-1.35
Ratio of Actual to Needed Kilocalories from Fat	1	-2.18	1.02	-2.14	**0.04***	-0.86
Proportion of Trans Fat (of Total Fat)	1	-39.61	19.41	-2.04	0.05	-0.32
Proportion of Cholesterol (of Total Fat)	1	-0.19	0.10	-1.91	0.07	-0.33
Proportion of Soluble Fiber (of Total Carbohydrates)	1	-61.04	29.21	-2.09	**0.04***	-0.75
Proportion of Insoluble Fiber (of Total Carbohydrates)	1	60.82	22.42	2.71	**0.01***	0.91
Percent Protein (of Total Kilocalories)	1	-0.45	0.18	-2.5	**0.02***	-1.43

*Indicates a significant p-value ($p<0.05$).

Table 14.
Parameter Estimates for Predicting A1c Level

Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Standardized Estimate**
Intercept	1	14.41	3.39	4.25	**<<0.01***	0
Ratio of Actual to Needed Kilocalories from Protein	1	15.50	4.73	3.28	**<0.01***	2.74
Ratio of Actual to Needed Kilocalories from Carbohydrates	1	-6.54	2.10	-3.12	**<0.01***	-1.31
Ratio of Actual to Needed Kilocalories from Fat	1	-3.37	1.31	-2.57	**0.01***	-0.90
Proportion of Trans Fat (of Total Fat)	1	-61.91	25.17	-2.46	**0.02***	-0.34
Proportion of Soluble Fiber (of Total Carbohydrates)	1	-57.59	34.42	-1.67	0.10	-0.49
Proportion of Insoluble Fiber (of Total Carbohydrates)	1	75.27	27.56	2.73	**0.01***	0.77
Percent Protein (of Total Kilocalories)	1	-0.64	0.23	-2.75	**0.01***	-1.37

*Indicates a significant p-value (p<0.05); < indicate p<.005; << indicates p<.0005.

Participants' predicted diabetes status was equal to 14.40 + 15.50 (Actual to Needed Kilocalories from Protein) – 6.55 (Actual to Needed Kilocalories from Carbohydrates) – 3.37 (Actual to Needed Kilocalories from Fat) -61.91 (Proportion of Trans Fat) – 57.59 (Proportion of Soluble Fiber) + 75.27 (Proportion of Insoluble Fiber) – 0.64 (Percent

Protein). All independent variables were significant predictors of diabetes status, except proportion of soluble fiber (p=0.1044).

Research Question Number 1 (Healthy Eating Index)

Participants did not differ significantly on HEI Scores by gender or diabetes status (Table 15). Both males and females had HEI scores just above 60 on a 100-point scale (62.00 for males and 61.85 for females).

Table 15.
HEI 2015 Scores by Gender and Diabetes Status

Variable	Male (n=19)	Female (n=20)	p<.05
Gender	62.00 (±7.0)	61.85 (±5.3)	0.9398
Diabetes Status			
No Diabetes	58.00 (±10.1)	62.33 (±5.8)	
Pre-Diabetes	61.60 (±5.5)	62.36 (±5.3)	
Diabetes	63.80 (±6.2)	59.00 (±6.1)	0.8021

*Indicates a significant p-value (p<0.05).

A simple linear regression model predicting diabetes status with HEI 2015 scores was not significant (F(1,1)=0.85, p=0.3636). Similarly, regressing HEI 2015 scores on A1c was also not significant (F(1,1)=0.16, p=0.6956).

Research Question Number 2 (Macronutrients)

Ratio of actual to needed kilocalories from protein, carbohydrates and fat were examined by anthropometric measurements (refer to Table 1); waist circumference (WC; cut-offs were ≥35.4in (males); ≥31.5in (females)), waist to hip ratio (WHR; cut-offs were ≥0.95 (males); ≥0.80 (females)), percent body fat (BF; cut-offs were ≥25.5% (men);

≥35% (women)), body mass index (BMI; cut-offs were <21.5Kg/m^2 (males) and <19Kg/m2 (females) = normal; ≥21.5 but <25.0Kg/m^2 (males) and ≥19.0 but <23.0Kg/m^2 (females) = overweight; ≥25.0Kg/m^2 (males) and ≥23.0Kg/m^2 (females) = obese)), body fat to body mass index ratio (BFBMIR; cut-offs were ≥1.00 (males) and ≥1.5 (females)), and Visceral Fat (VF; cut-offs were ≤12 (healthy) and ≥13 (excessive)). For all anthropometric measurements, the ratio of actual to needed kilocalories from protein was lower for anthropometric measurements above the respective cut-off, except for BMI (Figure 19). Across all participants, these differences in the ratio of actual to needed kilocalories from protein were significant for WHR (p=0.0493), BF (p=0.0450), and VF (p=0.0066). For males, these differences were significant for VF (p=0.0130), and slightly significant for WHR (p=0.0539). Females only showed a slightly significant difference for BF (p=0.0678).

For all anthropometric measurements, the ratio of actual to needed kilocalories from carbohydrates was lower for anthropometric measurements above the respective cut-off, except for BMI (Figure 20). These differences in the ratio of actual to needed kilocalories from carbohydrates were significant for WHR for all participants (p=0.0493) as well as males only (p=0.0219). Females did not show any significant differences in actual to needed kilocalories from carbohydrates on any of the anthropometric measurements.

For all anthropometric measurements, the ratio of actual to needed kilocalories from fat was lower for anthropometric measurements above the respective cut-off, except for BMI, and WC for all participants and males only (Figure 21). These differences in the ratio of actual to needed kilocalories from fat were significant for WHR for females

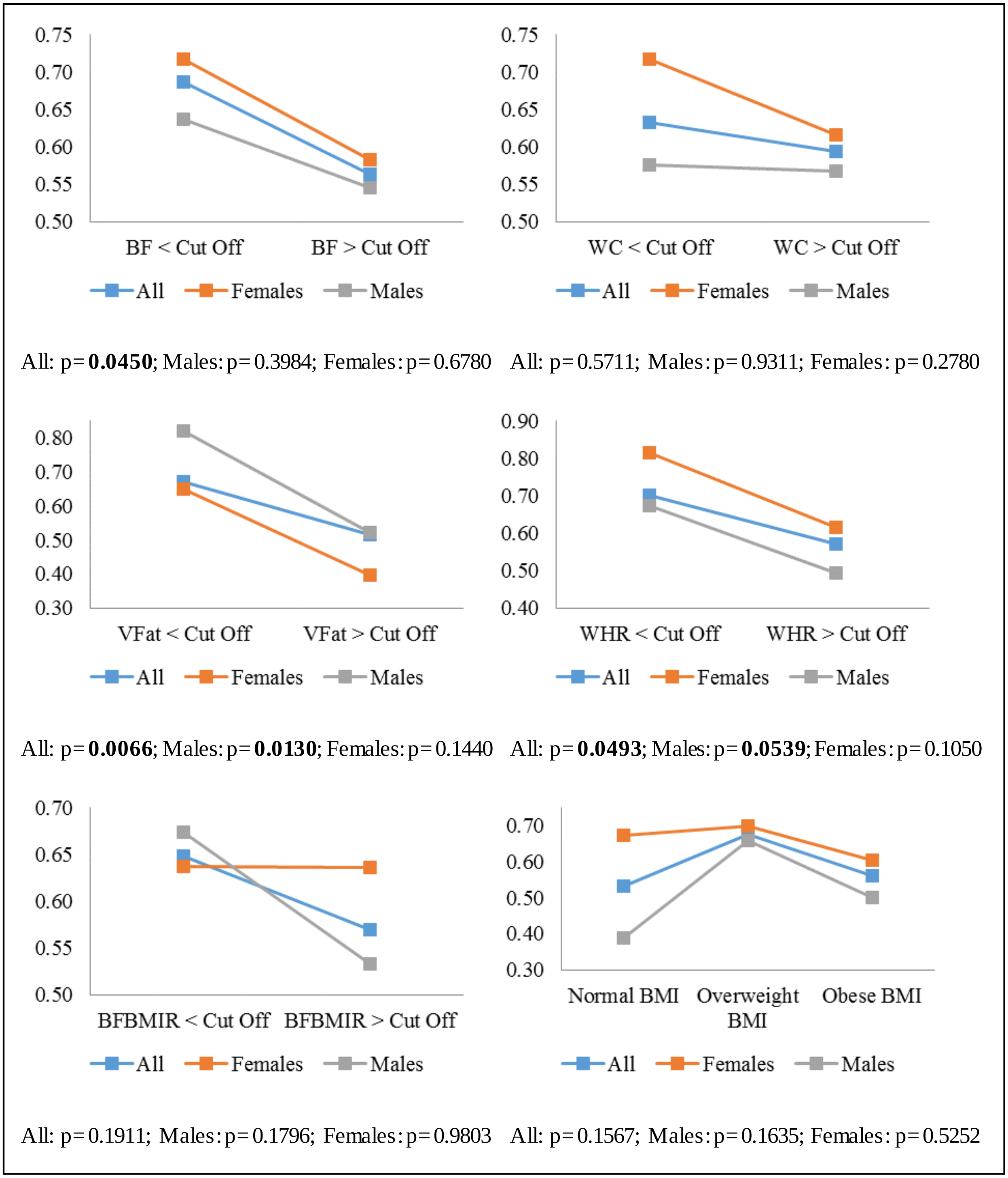


Figure 19. Ratio of actual to needed calories from protein by anthropometric measurements

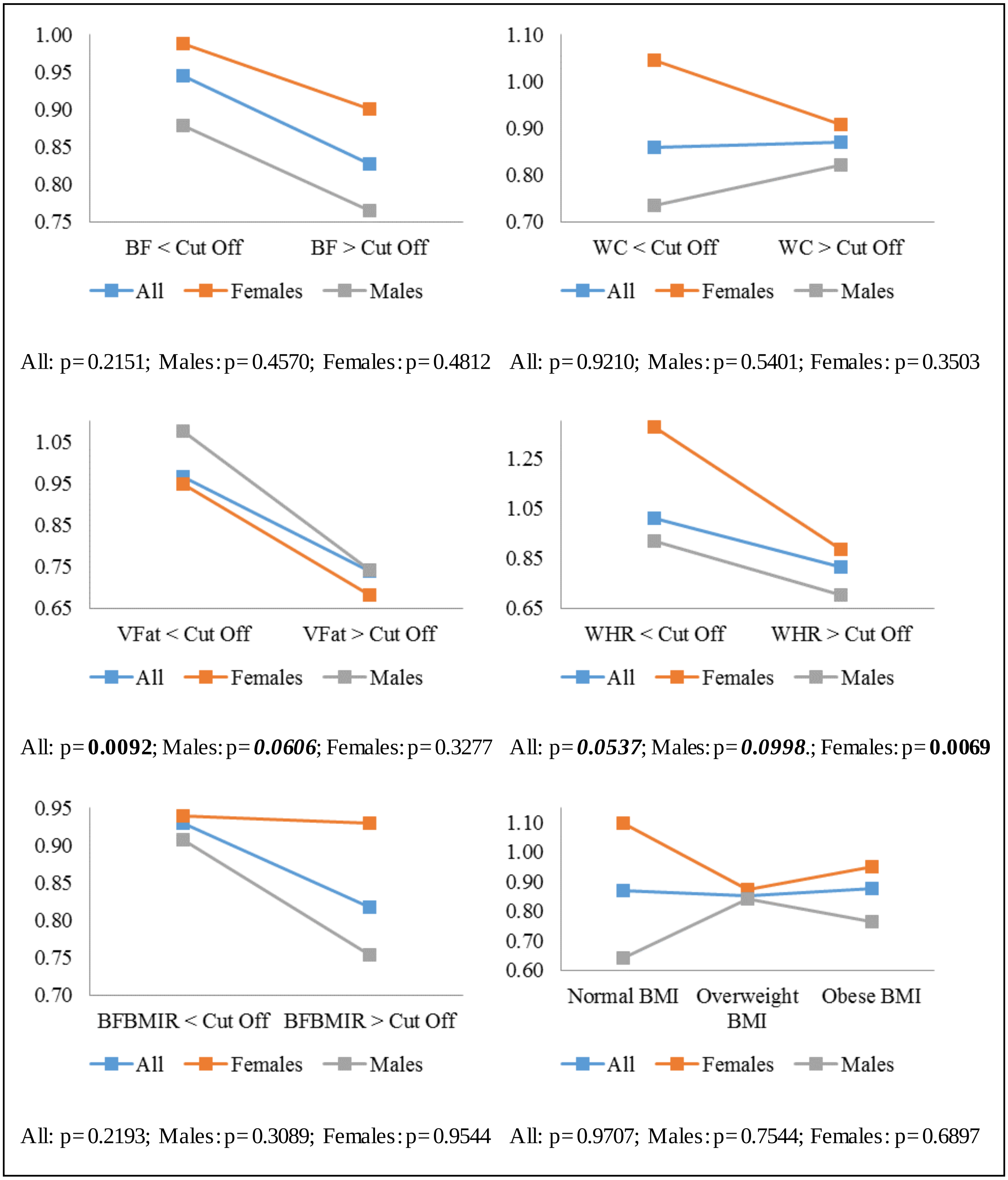


Figure 20. Ratio of actual to needed calories from carbohydrates by anthropometric measurements

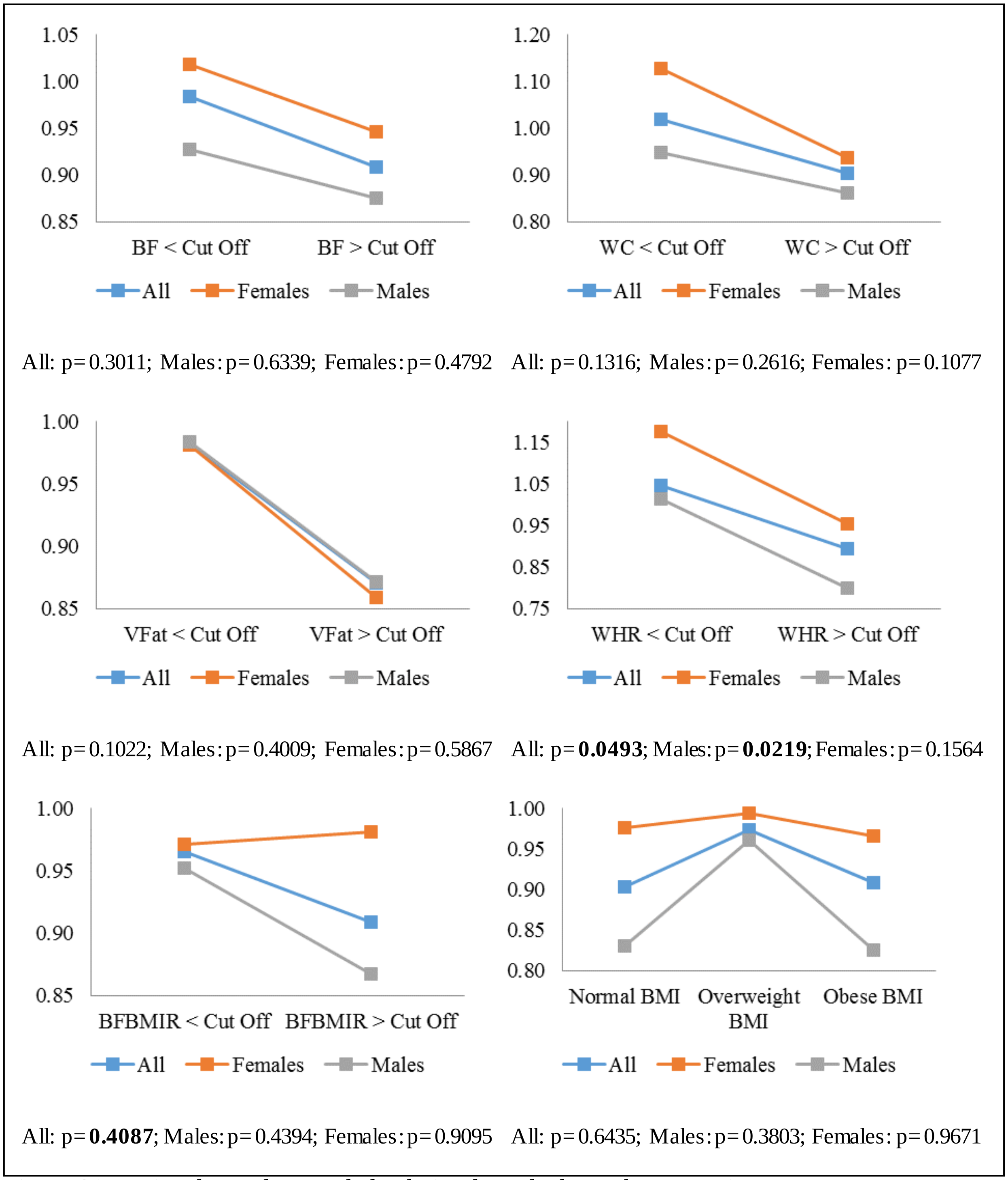


Figure 21. Ratio of actual to needed calories from fat by anthropometric measurements

(p=0.0069), and slightly significant for all participants (p= 0.0537) as well as males only (p=0.0998). Differences in the ratio of actual to needed kilocalories from fat were also seen for all participants for VF (p=0092), and for males only (p=0606).

Correlational analysis and univariate statistics (T-tests and Anovas) provided insight into which independent diet variables may be able to predict six anthropometric measures, waist circumference (WC), waist to hip ratio (WHR), Visceral Fat (VF), percent body fat (BF), body mass index (BMI), and body fat to body mass index ratio (BF_BMI_Ratio). A multivariate multiple regression model was used to predict five of the six anthropometric dependent variables; BMI was dropped from the model because of its inconsistent relationships with several different variables. The mtest function in SAS was used to regress each independent variable on each dependent variable as well as the group of dependent variables.

Table 16.

Multivariate Multiple Regression Results for Predicting Anthropometric Measurements with Macronutrients

					Independent Variable Ratio Actual to Needed Kilocalories from Protein	
Dependent Variable	**DF**	**F-Statistic**	**p-value**	**Adj R2**	**T-Statistic**	**p-value**
WHR	1,1	7.45	**0.01***	0.15	-2.73	**0.01***
VF	1,1	6.44	**0.02***	0.13	-2.54	**0.02***
WC	1,1	10.15	**<0.01***	0.19	-3.19	**0.01***
Overall Adj R2				0.46		
Pillai's Trace Statistic	3,36	3.77	**0.02***			

*Indicates a significant p-value (p<0.05); < indicate p<.005.

Highly significant ($p<0.05$) independent variables for WHR, WC and VF, BF and BF:BMI Ratio included ratio of actual to needed kilocalories from protein, carbohydrates and fat, percent protein, proportion of vegetable protein, percent carbohydrates, proportion of soluble fiber, proportion of insoluble fiber, proportion of carbohydrates absent fiber, percent fat, proportion of cholesterol, and proportion of trans fat. All variables were loaded into the model in both a positive and negative stepwise fashion. The final model retained only three of dependent variables, waist circumference (WC), waist to hip ratio (WHR), and visceral fat (VF), and only one of the independent variables, ratio of actual to needed kilocalories from protein. The resulting regression model had an overall r-squared of 0.4645 and a Pillai's Test statistic of $F(3,36)=3.16$, $p=0.0192$. Table 16 provides the test statistics for each dependent variable and the independent variable.

Research Question Number 2 (Healthy Eating Index)

Participants did not differ significantly on HEI Scores by gender or anthropometric measurements, except for WC (Table 17). Anthropometric measures were tested against HEI 2015 scores both as continuous and categorical variables (See Table 1 for reference cut-off values for each anthropometric measure). HEI 2015 scores were significantly different by WC for all participants ($p=0.0398$) as well as by WHR for females only ($p=0.0350$). Additionally, various combinations of independent anthropometric variables were regressed on HEI 2015 scores, with no significant findings.

Table 17.
Differences by Gender Between HEI 2015 Score and Anthropometric Measurements

Variable	**Male (n=19); p-value**	**Female (n=20); p-value**	**All (n=39); p-value**
Waist Circumference	0.2644	0.1033	0.2671
Categorical (Below Cut-Off or Above Cut-Off	0.0522	0.5008	**0.0398***
Waist to Hip Ratio	0.4326	**0.0350***	0.4132
Categorical (Below Cut-Off or Above Cut-Off	0.5272	0.8605	0.6715
Body Fat (BF)	0.3301	Insufficient DF	0.9674
Categorical (Below Cut-Off or Above Cut-Off	0.6659	0.1422	0.5457
Body Mass Index (BMI)	Insufficient DF	0.9585	0.9194
Categorical (Normal, Overweight, and Obese)	0.3479	0.2319	0.1105
BF to BMI Ratio	0.3088	0.4145	0.3088
Categorical (Below Cut-Off or Above Cut-Off	0.8294	0.9209	0.8068
Visceral Fat	0.5906	0.7343	0.8476
Categorical (Below Cut-Off or Above Cut-Off	0.1046	0.2681	0.4867

*Indicates a significant p-value (p<0.05).

Research Question Number 3 (Macronutrients)

Vegetarians comprised 74% of the study population (46% female and 28% male). Figure 22 show breakdown of the ratio of actual to needed kilocalories from protein by vegetarian and non-vegetarian participants. Vegetarians overall did not consume significantly lower ratios of actual to needed kilocalories from protein than non-vegetarians (t=0.57, p=0.5711), nor did females only (t=0.08, p=0.9374), or males only (t=1.10, p=o.2850).

Figure 23 shows that vegetarians overall as well as female vegetarians consumed higher ratios of actual to needed kilocalories from carbohydrates, however these differences were not statistically significant (t= -0.78, p=0.4382; t= -1.27, p=0.2207, respectively). Male vegetarians consumed a slightly lower ratio of actual to needed

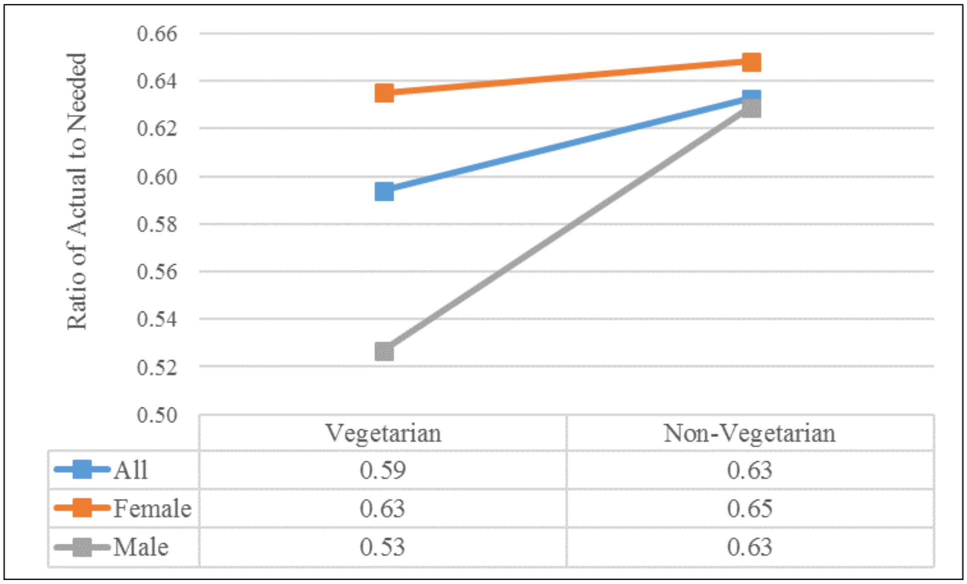


Figure 22. Ratio of actual to needed protein by gender and vegetarianism

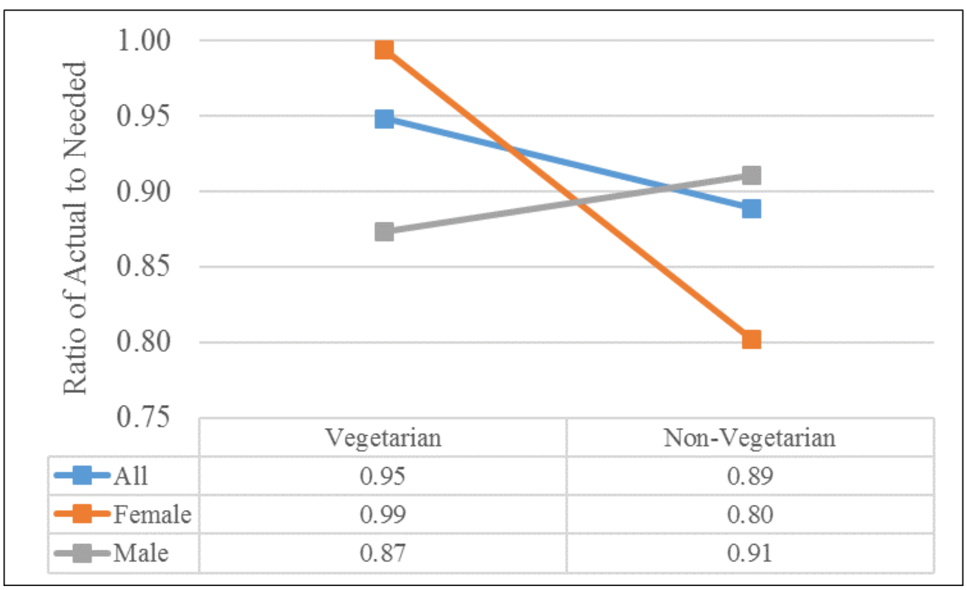
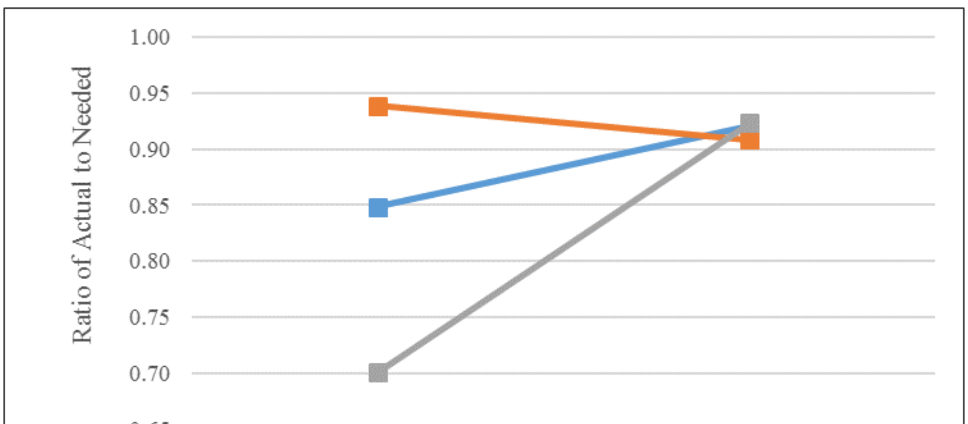


Figure 23. Ratio of actual to needed carbohydrates by gender and vegetarianism

kilocalories from carbohydrates than male non-vegetarians, but this difference was also not statistically significant (t=0.37, p=0.7145).

For the ratio of actual to needed kilocalories from fat, female vegetarians consumed a slightly higher ratio than female non-vegetarians, but this difference was not statistically significant (t= -0.17, p= 0.8670). For all participants as well as for males only, vegetarians consumed lower ratios of actual to needed kilocalories from fat than non-vegetarians, but these differences were also not statistically significant, although the difference between male vegetarians and non-vegetarians was almost significant (t=0.69, p= 0.4968, and t= 1.78, p= 0.0927, respectively). Figure 24 shows the breakdown by gender and vegetarianism for ratio of actual to needed kilocalories from fat.



	Vegetarian	Non-Vegetarian
All	0.85	0.92
Female	0.94	0.91
Male	0.70	0.92

Figure 24. Ratio of actual to needed fat by gender and vegetarianism

Looking at other dietary components, overall vegetarians were consuming significantly more carbohydrates (p= 0.0427) and significantly less proportion of cholesterol (p= 00102) than non-vegetarians (Table 18). Among females, non-vegetarians were consuming significantly more percent protein of total kilocalories than vegetarians (p= 0.0008; Table 19). Among males, non-vegetarians were consuming significantly more percent fat of total kilocalories than non-vegetarians (p= 0.0401; Table 20).

Logistic regression was used to identify which independent macronutrient variables could predict vegetarianism in this population. Independent macronutrient variables for the logistic regression model were identified through correlational analysis as well as the univariate testing of means in Tables 18-20. Those included, percent carbohydrates of total kilocalories, percent fat of total kilocalories, percent protein of total kilocalories, proportion cholesterol, and proportion of fish protein from total protein. These variables were tested in the model, but only proportion cholesterol was significant. Therefore, gender was added to the model, which enhanced the predictive ability of the model.

Percent carbohydrates, protein and fat, as well as proportion of fish protein were added back into the model in a step-wise fashion. The final model retained proportional cholesterol, gender and percent fat (chi-square = 27.7 (3), p<0.001). Table 21 shows the output from the regression model. Both proportion cholesterol (p=0.0378) and percent fat (p=0.0416) were predictive of vegetarianism.

Table 18.
Macronutrient Intake by Vegetarianism

Variable	All Participants (n=39) Vegetarian (n=29)	Non-Vegetarian (n=10)	p-value
Total Kilocalories	1424.11 (±265.3)	1578.43 (±413.4)	0.18
Percent Protein of Total Kilocalories	13.78 (±2.3)	15.00 (±.2.0)	0.14
Proportion Animal Protein	0.40 (±0.1)	0.43 (±0.1)	0.61
Proportion Vegetable Protein	0.59 (±0.1)	0.54 (±.0.1)	0.25
Proportion Fish Protein	0.00 (±0.0)	0.03 (±0.1)	0.13
Percent Carbohydrates of Total Kilocalories	56.22 (±4.7)	52.4 (±.5.5)	**0.04***
Proportion Total Fiber	0.09 (±0.02)	0.08 (±0.01)	0.36
Proportion Soluble Fiber	0.04 (±0.01)	0.04 (±0.01)	0.84
Proportion Insoluble Fiber	0.04 (±0.01)	0.43 (±413.4)	0.62
Proportion of Carbohydrates w/o Fiber	0.88 (±0.1)	0.85 (±0.1)	0.27
Proportion of Sugar	0.06 (±0.02)	0.06 (±0.02)	0.34
Percent Fat of Total Kilocalories	29.51 (±4.4)	32.0 (±4.1)	0.12
Proportion Saturated Fat	0.27 (±0.1)	1578.43 (±0.1)	0.71
Proportion Monounsaturated Fat	0.41 (±0.03)	0.40 (±0.03)	0.53
Proportion Polyunsaturated Fat	0.22 (±0.03)	0.21 (±0.04)	0.62
Proportion Trans Fat	0.004 (±0.01)	0.003 (±0.0)	0.66
Proportion Cholesterol	1.36 (±0.7)	3.00 (±1.6)	**0.01***
Percent Alcohol	0.48 (±1.1)	0.54 (±0.7)	0.88

*Indicates a significant p-value (p<0.05).

Table 19.
Macronutrient Intake for Females by Vegetarianism

Variable	**Female (n=20)** Vegetarian (n=18)	Non-Vegetarian (n=2)	**p-value**
Total Kilocalories	1359.19 (±257.4)	1100.74 (±95.6)	0.18
Percent Protein of Total Kilocalories	13.94 (±2.1)	15.96 (±0.05)	**<<0.01***
Proportion Animal Protein	0.40 (±0.1)	0.43 (±0.2)	0.73
Proportion Vegetable Protein	0.60 (±0.1)	0.43 (±0.1)	0.11
Proportion Fish Protein	0.00 (±0.0)	0.14 (±0.1)	0.26
Percent Carbohydrates of Total Kilocalories	55.15 (±4.6)	49.02 (±7.1)	0.10
Proportion Total Fiber	0.09 (±0.2)	0.08 (±0.01)	0.33
Proportion Soluble Fiber	0.04 (±0.01)	0.03 (±0.01)	0.17
Proportion Insoluble Fiber	0.04 (±0.01)	0.03 (±0.004)	0.21
Proportion of Carbohydrates w/o Fiber	0.88 (±0.04)	0.91 (±0.04)	0.42
Proportion of Sugar	0.05 (±0.02)	0.06 (±0.03)	0.55
Percent Fat of Total Kilocalories	30.70 (±4.4)	33.81 (±5.4)	0.37
Proportion Saturated Fat	0.27 (±0.06)	0.30 (±0.1)	0.80
Proportion Monounsaturated Fat	0.42 (±0.03)	0.39 (±0.02)	0.26
Proportion Polyunsaturated Fat	0.22 (±0.03)	0.21 (±0.1)	0.88
Proportion Trans Fat	0.004 (±0.006)	0.005 (±0.002)	0.87
Proportion Cholesterol	1.19 (±0.7)	4.78 (±2.2)	0.26
Percent Alcohol	0.21 (±0.4)	1.23 (±1.7)	0.56

*Indicates a significant p-value (p<0.05); < indicate p<.005; << indicates p<.0005.

Table 20.
Macronutrient Intake for Males by Vegetarianism

Variable	Male (n=19) Vegetarian (n=11)	Non-Vegetarian (n=8)	p-value
Total Kilocalories	1530.36 (±253.7)	1697.86 (±370.0)	0.26
Percent Protein of Total Kilocalories	13.51 (±2.5)	14.76 (±2.2)	0.28
Proportion Animal Protein	0.42 (±0.1)	0.43 (±0.1)	0.88
Proportion Vegetable Protein	0.58 (±0.1)	0.56 (±0.1)	0.80
Proportion Fish Protein	0.00 (±0.0)	0.007 (±0.006)	**0.02***
Percent Carbohydrates of Total Kilocalories	58.0 (±4.6)	53.30 (±5.2)	0.05
Proportion Total Fiber	0.09 (±0.01)	0.08 (±0.01)	0.86
Proportion Soluble Fiber	0.04 (±0.006)	0.04 (±0.1)	0.51
Proportion Insoluble Fiber	0.04 (±0.01)	0.05 (±0.02)	0.36
Proportion of Carbohydrates w/o Fiber	0.87 (±0.06)	0.84 (±0.06)	0.28
Proportion of Sugar	0.06 (±0.02)	0.06 (±0.01)	0.80
Percent Fat of Total Kilocalories	27.58 (±3.7)	31.58 (±4.1)	**0.04***
Proportion Saturated Fat	0.28 (±0.05)	0.28 (±0.06)	0.80
Proportion Monounsaturated Fat	0.40 (±0.03)	0.41 (±0.03)	0.65
Proportion Polyunsaturated Fat	0.21 (±0.03)	0.21 (±0.04)	0.82
Proportion Trans Fat	0.004 (±0.007)	0.003 (±0.005)	0.61
Proportion Cholesterol	1.66 (±0.8)	2.55 (±1.2)	0.07
Percent Alcohol	0.92 (±1.6)	0.36 (±0.3)	0.28

*Indicates a significant p-value (p<0.05).

Table 21.
Logistic Regression to Predict Vegetarianism with Macronutrients

Variable	Odds Ratio	95% Confidence Interval	p-value	Chi-square (DF)
Proportion Cholesterol	0.10	0.01, 0.88	**0.04***	4.31 (1)
Percent Fat (of total kilocalories)	0.54	0.29, 0.98	**0.04***	4.15 (1)
Gender	0.003	<0.001,1.93	0.08	3.10 (1)

*Indicates a significant p-value (p<0.05).

Research Question Number 3 (Healthy Eating Index)

HEI 2015 was not significantly correlated with vegetarianism across all participants (0.0218, p=0.8950) as well as within females (-0.3650, p=0.1136) or males (0.2206, p=0.3642). Student's t-tests also did not show any significant differences in HEI 2015 score based on vegetarianism (all participants, t=-0.10, p=0.9191; females, t=1.66, p=0.1136; males, t=-0.93, p=0.3642).

Research Question Number 4 (Macronutrients)

Three levels of acculturation were measured in this study; the culture from which values were aligned, the culture from which behavior is aligned and the culture from which identity is derived. These three levels were further described by the specific culture of affiliation; Asian, western or bicultural. The ratio of actual to needed kilocalories from protein, carbohydrates and fats were examined by acculturation. Figure 25 provides ratios of actual to needed protein consumed by participants by gender and acculturation. Participants who identified with Asian values consumed significantly lower ratios of actual to needed protein than those identified as bicultural or western (p=0.0395). Similarly, participants who identified themselves as being Asian consumed a lower ratio of actual to needed kilocalories from protein than did those who identified as western or bicultural, however, this difference was not statistically significant (p=0.6641). Participants that aligned their behavior with western culture consumed a higher ratio of actual to needed kilocalories from protein than did those that reported their behavior as being bicultural or as Asian. This difference was not statistically significant (p=0.7155).

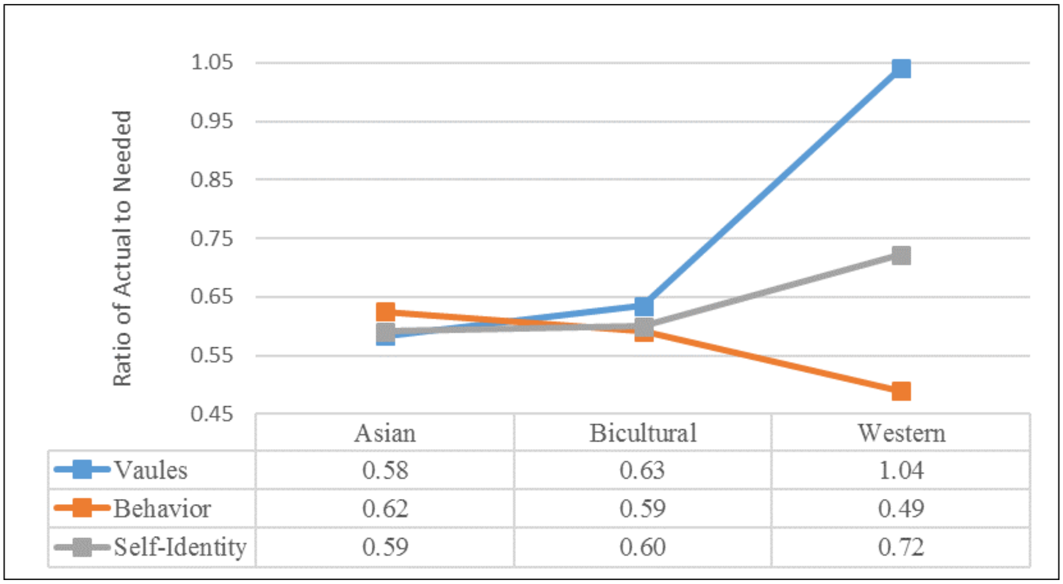


Figure 25. Ratio of Actual to Needed Kilocalories from Protein by Acculturation Level

Figure 26 illustrates that ratios of actual to needed kilocalories from carbohydrates followed a similar pattern across acculturation levels. Participants whose values aligned with Asian culture consumed a lower ratio of actual to needed kilocalories from carbohydrates than did those with bicultural or western values, however, this difference was not statistically significant (p=0.4476). The same pattern is shown for participants who identify as being Asian. Asians consumed a lower ratio of actual to needed kilocalories from carbohydrates than did participants who identified as being bicultural or western; this difference was not statistically significant (p=0.4997). Participants who reported their behavior as aligned with Asian or western culture consumed the same ratio of actual to needed kilocalories from carbohydrates, whereas, those whose behavior was more bicultural consumed a lower ratio, albeit not significantly lower (p=0.9180).

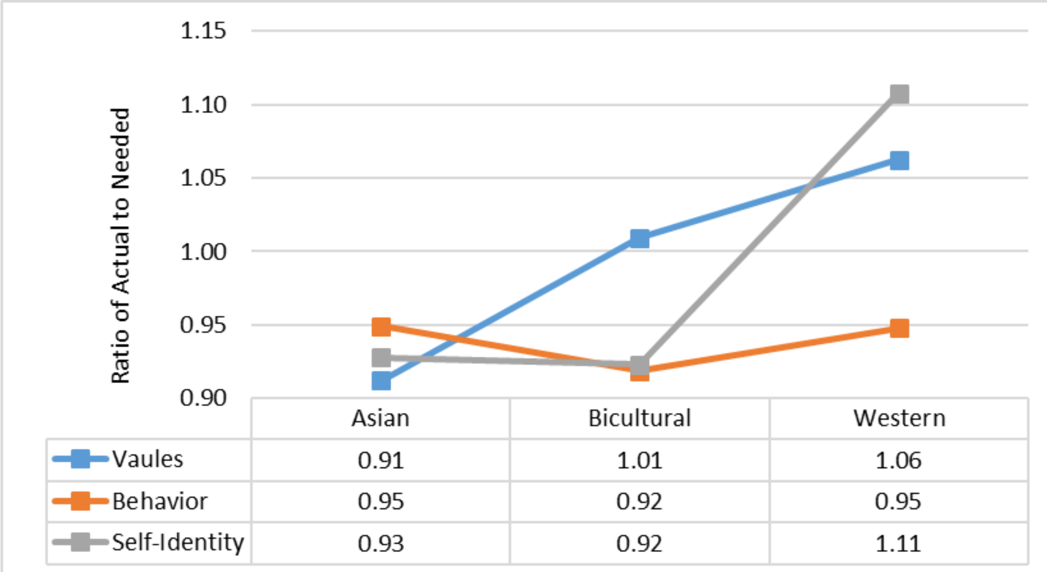


Figure 26. Ratio of Actual to Needed Kilocalories from Carbohydrates by Acculturation Level

Participants who identified as having western values, behaviors and identities consistently consumed a higher ratio of actual to needed kilocalories from fat than did those who were more bicultural or Asian on all three acculturation measures. Statistical significance was not established for this difference (values, p=2518; behavior, p=0.8352; self-identity, p=0.1493). Figure 27 illustrates this relationship.

Tables 22-24 look further at the relationship between diet and acculturation. Overall, participants differed by acculturation in their consumption of fiber, cholesterol, protein, and total kilocalories. Those with western values consumed significantly higher proportions of soluble and insoluble fiber than those with Asian or bicultural values (Table 22, p=0.0017, and p=0.0001, respectively). Participants with western identified behaviors also consumed significantly higher proportions of total fiber than did participants with Asian or bicultural behavior (Table 23, p=0.0305). Those with bicultural and western values consumed significantly higher proportions of cholesterol than did those with Asian values (Table 24, p=0.0162).

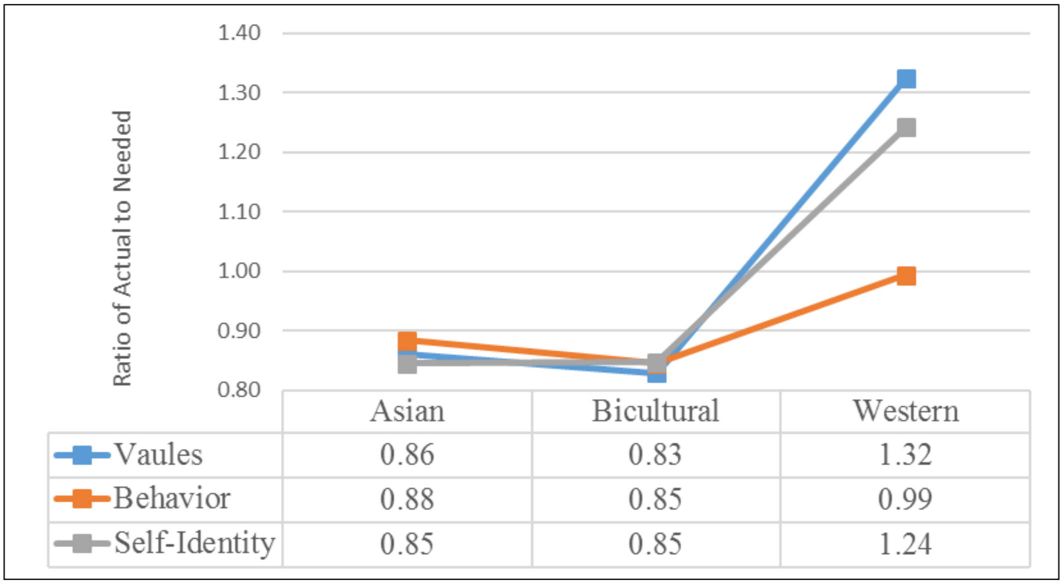


Figure 27. Ratio of Actual to Needed Kilocalories from Fat by Acculturation Level

Looking at behavior, those who identified as having bicultural or western behavior consumed significantly higher proportions of animal (p=0.0306) and vegetable (0.0221) protein (Table 23). Finally, Table 24 shows that participants consumed significantly more total kilocalories by acculturation level. Those who identified themselves as western consumed more total kilocalories than those who identified as bicultural, who in-tern consumed more total kilocalories than those who identified as Asian (p=0.0113).

Regression analysis shows that the main predictor for values and behavior is proportion of cholesterol (F(1,1)=8.82, p=0.0052) with an adjusted R2 of 0.1707. Adding proportion of insoluble fiber and ratio of actual to needed kilocalories from protein increase the R2 to 0.2213 and 0.2009, respectively, however, the adjusted R2 remained 0.1545 with insoluble fiber and 0.1565 with ratio of actual to needed

Table 22.
Macronutrient Intake by Acculturation – Values

	All Participants (n=39)			
Variable	**Asian (n=31)**	**Bicultural (n=7)**	**Western (n=1)**	**p-value**
Total Kilocalories	1426.34 (±319.0)	1539.59 (±161.5)	2090.01 (±...)	0.08
Percent Protein of Total Kilocalories	13.89 (±2.3)	14.39 (±1.7)	18.27 (±...)	0.14
Proportion Animal Protein	0.40 (±0.1)	0.47 (±0.1)	0.38 (±...)	0.47
Proportion Vegetable Protein	0.59 (±0.15)	0.53 (±0.1)	0.61 (±...)	0.57
Proportion Fish Protein	0.01 (±0.04)	0.002 (±0.003)	0.01 (±...)	0.86
Percent Carbohydrates of Total Kilocalories	55.08 (±5.3)	57.28 (±2.8)	46.60 (±...)	0.14
Proportion Total Fiber	0.09 (±0.01)	0.09 (±0.01)	0.09 (±...)	0.93
Proportion Soluble Fiber	**0.04 (±0.01)***	**0.03 (±0.006)***	**0.07 (±...)***	**<0.01***
Proportion Insoluble Fiber	**0.04 (±0.01)***	**0.04 (±0.007)***	**0.08 (±...)***	**<<0.01***
Proportion of Carbohydrates w/o Fiber	0.87 (±0.05)	0.86 (±0.05)	0.88 (±...)	0.73
Proportion of Sugar	0.06 (±0.02)	0.07 (±0.01)	0.06 (±...)	0.49
Percent Fat of Total Kilocalories	30.50 (±4.7)	27.99 (±2.2)	34.85 (±...)	0.23
Proportion Saturated Fat	0.27 (±0.06)	0.28 (±0.04)	0.25 (±...)	0.81
Proportion Monounsaturated Fat	0.41 (±0.03)	0.39 (±0.03)	0.44 (±...)	0.23
Proportion Polyunsaturated Fat	0.22 (±0.04)	0.20 (±0.01)	0.23 (±...)	0.44
Proportion Trans Fat	0.004 (±0.006)	0.004 (±0.005)	0.001 (±...)	0.87
Proportion Cholesterol	**1.50 (±1.1)***	**2.85 (±1.1)***	3.04 (±...)	**0.02***
Percent Alcohol	0.54 (±1.1)	0.34 (±0.3)	0.28 (±...)	0.88

*Indicates a significant p-value (p<0.05); < indicate p<.005; << indicates p<.0005.

Table 23.
Macronutrient Intake by Acculturation – Behavior

Variable	All Participants (n=39) Asian (n=18)	Bicultural (n=20)	Western (n=1)	p-value
Total Kilocalories	1446.88 (±264.5)	1477.63 (±361.7)	1487.21 (±...)	0.95
Percent Protein of Total Kilocalories	14.29 (±2.1)	14.06 (±2.3)	11.24 (±...)	0.42
Proportion Animal Protein	0.41 (±0.15)	**0.43 (±0.1)***	**0.07 (±...)***	**0.03***
Proportion Vegetable Protein	0.59 (±0.15)	**0.55 (±0.1)***	**0.93 (±...)***	**0.02***
Proportion Fish Protein	0.0001 (±0.0004)	0.02 (±0.05)	0.00 (±...)	0.34
Percent Carbohydrates of Total Kilocalories	55.38 (±5.2)	55.19 (±5.4)	54.44 (±...)	0.98
Proportion Total Fiber	0.09 (±0.01)	**0.08 (±0.01)***	**0.12 (±...)***	**0.03***
Proportion Soluble Fiber	0.04 (±0.004)	0.04 (±0.01)	0.06 (±...)	0.09
Proportion Insoluble Fiber	0.04 (±0.006)	0.04 (±0.01)	0.06 (±...)	0.20
Proportion of Carbohydrates w/o Fiber	0.88 (±0.06)	0.86 (±0.05)	0.87 (±...)	0.51
Proportion of Sugar	0.06 (±0.02)	0.06 (±0.02)	0.06 (±...)	0.90
Percent Fat of Total Kilocalories	30.16 (±4.0)	29.95 (±4.9)	34.25 (±...)	0.65
Proportion Saturated Fat	0.27 (±0.05)	0.29 (±0.06)	0.17 (±...)	0.12
Proportion Monounsaturated Fat	0.41 (±0.03)	0.40 (±0.03)	0.47 (±...)	0.08
Proportion Polyunsaturated Fat	0.22 (±0.03)	0.21 (±0.03)	0.27 (±...)	0.19
Proportion Trans Fat	0.004 (±0.007)	0.004 (±0.004)	0.01 (±...)	0.40
Proportion Cholesterol	1.40 (±0.8)	2.18 (±1.5)	0.78 (±...)	0.11
Percent Alcohol	0.17 (±0.3)	0.81 (±1.3)	0.07 (±...)	0.12

*Indicates a significant p-value ($p<0.05$).

kilocalories from protein. Also, neither proportion of insoluble fiber nor ratio of actual to needed kilocalories from protein contributed significantly to the model (t=0.96,

Table 24.
Macronutrient Intake by Acculturation - Self-Identity

Variable	All Participants (n=39)			
	Asian (n=9)	Bicultural (n=28)	Western (n=2)	p-value
Total Kilocalories	**1397.44 (±183.3)***	**1441.00 (±308.7)***	**2079.37 (±178.1)***	**0.01***
Percent Protein of Total Kilocalories	13.84 (±2.3)	14.20 (±2.3)	13.76 (±2.8)	0.90
Proportion Animal Protein	0.36 (±0.2)	0.43 (±0.1)	0.43 (±0.2)	0.41
Proportion Vegetable Protein	0.62 (±0.2)	0.57 (±0.1)	0.56 (±0.3)	0.62
Proportion Fish Protein	0.02 (±0.07)	0.004 (±0.01)	0.01 (±0.01)	0.38
Percent Carbohydrates of Total Kilocalories	56.14 (±6.3)	55.3 (±4.8)	51.09 (±3.6)	0.46
Proportion Total Fiber	0.09 (±0.01)	0.09 (±0.02)	0.08 (±0.01)	0.93
Proportion Soluble Fiber	0.04 (±0.005)	0.04 (±0.01)	0.03 (±0.02)	0.77
Proportion Insoluble Fiber	0.04 (±0.007)	0.04 (±0.01)	0.04 (±0.02)	0.81
Proportion of Carbohydrates w/o Fiber	0.87 (±0.08)	0.88 (±0.04)	0.80 (±0.05)	0.12
Proportion of Sugar	0.06 (±0.02)	0.06 (±0.02)	0.06 (±0.03)	0.51
Percent Fat of Total Kilocalories	29.80 (±4.9)	29.95 (±4.3)	34.71 (±0.6)	0.33
Proportion Saturated Fat	0.26 (±0.06)	0.28 (±0.05)	0.32 (±0.1)	0.42
Proportion Monounsaturated Fat	0.41 (±0.03)	0.41 (±0.03)	0.39 (±0.05)	0.68
Proportion Polyunsaturated Fat	0.23 (±0.04)	0.21 (±0.03)	0.20 (±0.08)	0.24
Proportion Trans Fat	0.007 (±0.01)	0.003 (±0.004)	0.002 (±0.002)	0.23
Proportion Cholesterol	1.82 (±1.8)	1.79 (±1.06)	1.59 (±1.2)	0.97
Percent Alcohol	0.22 (±0.4)	0.59 (±1.1)	0.45 (±0.2)	0.64

*Indicates a significant p-value ($p<0.05$).

p=0.3453; and t=0.62, p=0.5420, respectively). No dietary variable was identified to predict self-identity.

Research Question Number 4 (Healthy Eating Index)

The relationship between acculturation and diet quality as measured by the HEI 2015 score was tested with correlations and ANOVAs. HEI 2015 was not significantly correlated with values (0.2114, p=0.1965), behavior (0.1742, p=0.2890), or self-identity (-0.0230, p=0.8894) across all participants as well as within females (values 0.0743, p=0.7556; behavior 0.1608, p=0.4983; self-identity -0.1357, p=0.5685) or males (values 0.2925, p=0.2243; behavior 0.1869, p=0.4435; self-identity 0.0625, p=0.7994). Although not significant, self-identity was negatively correlated with HEI 2015 score for all participants, and values was negatively correlated with HEI 2015 score for females. ANOVA also did not show any significant differences in HEI 2015 score based on acculturation for all participants (values F=3.19, p=0.0529; behavior F=1.25, p=0.2991; self-identity F=0.89, p=0.4214), females (values F=0.10, p=0.7556; behavior F=1.13, p=0.3458; self-identity F=0.34, p=0.5685) or males (values F=2.83, p=0.0889; behavior =0.62, p=0.4435; self-identity =0.68, p=0.5212). Regression analysis was also attempted, but no significant findings resulted.

Summary of Results

Demographic Characteristics of Study Population

Participants were mostly retired Gujarati immigrants who had been in the US for an average of 37 years. Participants were 49 percent male and 51 percent female, primarily spoke Gujarati in the home, lived in nuclear families, and were married.

Seventy-two percent of participants participated as married couples. About 38 percent of participants had earned a master's degree or higher, with only 10 percent of females having less than a bachelor's degree. Almost 44 percent of participants reported a household income of greater than one hundred thousand dollars per year. Only 8 percent of participants, all males, had a history of smoking and more than 95 percent either never or only occasionally drink alcohol; 74 percent were vegetarian. Although most males and females had access to transportation and drove, and the responsibility for grocery shopping was shared between the genders, females were primarily responsible for all the household cooking.

Diabetes Status

Participants were 18% non-diabetic (10% male and 8% female), 49% pre-diabetic (13% male and 36% females), and 33% diabetic (26% male and 8% female). Of the 14 couples that participated in the study together, 20 percent had females without diabetes or pre-diabetes but males with diabetes, 50 percent had females with pre-diabetes and males with diabetes, 15 percent had both females and males with pre-diabetes, and 15 percent had females with either pre-diabetes or diabetes and males with no diabetes.

Physical Activity

About 54 percent of participants (18% male and 36% female) engaged in moderate levels of physical activity and 21 percent (16% male and 5% female) engaged in high levels of physical activity. Of the 49 percent of participants that had pre-diabetes, 26 percent engaged in moderate levels of physical activity and 10 percent engaged in high levels of physical activity. Of the 33 percent of participants with diabetes, 23 percent engaged in moderate levels of physical activity and 8 percent engaged in high levels of physical activity. Of the diabetics, 100 percent of females and 90 percent of males were physically active. Of the pre-diabetics, 86 percent of females and 40 percent of males were physically active. Of the non-diabetics, 33 percent of females and 50 percent of males were physically active.

Acculturation

Seventy-nine percent of participants identified having Asian values, but only 46 percent identified having Asian behaviors, and only 23 percent identified as being culturally Asian. Fifty-two percent identified having bicultural behaviors, and 72 percent identified being culturally a blend of both Asian and western cultures, or bicultural. Only 10 percent of the participants identified either their values (2.5% male diabetics), behaviors (2.5% female diabetics) or identity (5% male diabetics and non-diabetics) as western.

Anthropometric Measurements

All male participants met the BMI cut-offs for obesity across diabetes status (27.9% for noT2DM, 25.2% for pre-T2DM, 26.5% for T2DM). Females without diabetes (22%) and with diabetes (23%) met the BMI cut-offs for being overweight. Twenty-six of females were pre-diabetic and obese. All male participants had waist circumference measurements greater than the cut-off for healthy metabolic function (35.4in), while only female pre-diabetics and non-diabetics had waist circumference measurements greater than the cut-off for healthy metabolic function (31.5in). All females had waist to hip ratios greater than the cut-off for healthy metabolic function (0.80), while only males with pre-diabetes and diabetes had waist to hip ratios greater than the cut-off for healthy metabolic function (0.95). All males had body fat percentages greater than the cut-off for healthy metabolic function (25.5%), whereas only females with pre-diabetes and diabetes exceeded body fat percentages for healthy metabolic function (35%). All males had visceral fat measurements outside of the healthy range, while all females had visceral fat measurements within the healthy range.

Participant Diets

Participants consumed an average of 1463.7 kilocalories per day (1600.9 for males and 1333.3 for females). This is below the average daily calorie requirement of 1780.9 kilocalories (2075.7 for males and 1500.8 for females) based each participant's basal metabolic rate and physical activity level. Macronutrient intake was comparable to the Institute of Medicine's daily recommended intake for carbohydrates and fats, and protein; participants consumed on average 55% of their kilocalories from carbohydrates, 30% from fat, and 14% from protein.

Most participants obtained dietary protein from vegetarian sources, however, about 26 percent of participants were non-vegetarians; meat consumption even in non-vegetarians was relatively low. Participants on average consumed more than half of the daily recommended intake for dietary fiber (about 55% for males and 70% for females), and miniscule amounts of added sugars (<1% of total kilocalories). Saturated fat, trans fat and cholesterol consumption were non-negligible, however, reference amounts for these macro-nutrients were not provided.

An additional measure to assess dietary quality, the Healthy Eating Index (HEI 2015 version) was calculated for all participants. Overall, participants scored about 62.0 on a 100-point scale (62.0 for males and 61.9 for females). Male non-diabetics and female diabetics had the lowest HEI scores (58.0 and 59.0, respectively), whereas male diabetics, female pre-diabetics and female non-diabetics had the highest HEI scores (63.8, 62.4 and 62.3, respectively). Male pre-diabetics had HEI scores slightly lower than the overall male average (61.6).

Research Question #1

Recommended optimal levels of macronutrients for this study were defined a priori as a proportion of total kilocalories; 50% of total kilocalories from carbohydrates, 30% of total kilocalories from fat, and 20% of total kilocalories from protein. Across all participants, the ratio of actual to needed kilocalories from carbohydrates was about 93 percent (98% for females and 89% for males). This varied by diabetes status. Female non-diabetics consumed the highest ratio of actual to needed kilocalories form carbohydrates at 111%, whereas male non-diabetics only consumed about 88%. Female pre-diabetics consumed 96% of the carbohydrates they require and male pre-diabetics consumed 94%. Female diabetics consumed 90% of needed carbohydrates while male diabetics consumed 87%. The ratio of actual to needed kilocalories from fat was about 87 percent (94% for females and 79% for males). This also varied by diabetes status. Female non-diabetics again consumed the highest ratio of actual to needed kilocalories from fat at 111%, whereas male non-diabetics only consumed about 80%. Female pre-diabetics consumed 91% of the fat they require and male pre-diabetics only consumed 77%. Female diabetics consumed 86% of needed fat while male diabetics only consumed 81%. The ratio of actual to needed kilocalories from protein was dramatically lower across all participants and diabetes groups; 60% for all participants, 64% for females, and 57% for males. Female non-diabetics retained the highest ratio of actual to needed kilocalories from protein at 83%, while male non-diabetics only consumed 50%. Female pre-diabetics consumed 61% of needed kilocalories from protein, while male pre-diabetics only consumed 55%. Finally, female diabetics consumed 57% of needed kilocalories from protein while male diabetics consumed 61%.

The association between diabetes status and macronutrient sufficiency was explored. Regression analysis showed that all three macronutrient ratios for actual to needed kilocalories (from protein, carbohydrates and fat) could predict diabetes status, when regressed both as a categorical variable as well as continuous A1c level. An additional predictor for diabetes status is fiber; insoluble and soluble.

There was no association established between HEI 2015 scores and diabetes status.

Research Question #2

The association between anthropometric measurements and diet was established in this study. For all anthropometric measurements, except BMI, the ratio of actual to needed kilocalories from protein was lower for anthropometric measurements above the respective cut-off. Across all participants, these differences in the ratio of actual to needed kilocalories from protein were significant for WHR, BF, and VF. Within all males only differences in VF were significant, and WHR was slightly significant. Within all females only differences in BF were significant.

For all anthropometric measurements, except BMI, the ratio of actual to needed kilocalories from carbohydrates was lower for anthropometric measurements above the respective cut-off. These differences in the ratio of actual to needed kilocalories from carbohydrates were significant for WHR for all participants as well as males only. Females did not show any significant differences in actual to needed kilocalories from carbohydrates on any of the anthropometric measurements.

For all anthropometric measurements, except BMI and WC, the ratio of actual to needed kilocalories from fat was lower for anthropometric measurements above the respective cut-off, for all participants as well as within males only. The differences in the ratio of actual to needed kilocalories from fat were significant by WHR for females, and slightly significant for all participants and males only. Differences in the ratio of actual to needed kilocalories from fat were also seen by VF measurements for all participants, and for males only.

Regression analysis confirmed the ability to use the ratio of actual to needed kilocalories from protein to predict WHR, WC and VF.

HEI 2015 scores were significantly different by BF to BMI Ratio for all participants as well as for men only. However, regression analysis did not yield any anthropometric variables able to predict HEI 2015 scores.

Research Question #3

The relationship between vegetarianism and macronutrient sufficiency was examined. Vegetarians overall did not consume significantly lower ratios of actual to needed kilocalories from protein than non-vegetarians; this was true for all participants as well as for males and females only. Across all vegetarians, as well as female vegetarians only, higher ratios of actual to needed kilocalories from carbohydrates were consumed, however these differences were not statistically significant. Male vegetarians consumed a slightly lower ratio of actual to needed kilocalories from carbohydrates than male non-vegetarians, but this difference was also not statistically significant. For all participants as well as for males only, vegetarians consumed lower ratios of actual to needed kilocalories from fat than non-vegetarians, but these differences were not statistically significant, although the difference between male vegetarians and non-vegetarians was almost significant. Female vegetarians consumed a slightly higher ratio of actual to needed kilocalories from fat than female non-vegetarians, but this difference was not statistically significant.

With respect to other dietary components, vegetarians overall consumed significantly more carbohydrates and less cholesterol than non-vegetarians. Among females, non-vegetarians consumed a significantly higher percentage of protein than vegetarians. Among males, non-vegetarians consumed a significantly higher percentage of fat than non-vegetarians.

Regression analysis showed that vegetarianism could be predicted by proportion of cholesterol, percent fat of total kilocalories and gender.

No association was found between HEI 2015 scores (an index of diet quality) and vegetarianism.

Research Question #4

The association between acculturation and diet was examined. Participants who identified with Asian (traditional) values consumed significantly lower ratios of actual to needed protein than those who self-identified as bicultural or western. Similarly, participants who identified themselves as being culturally Asian (traditional) consumed a lower ratio of actual to needed kilocalories from protein than did those who identified as western or bicultural, however, this difference was not statistically significant. Participants that aligned their behavior with western culture consumed a higher ratio of actual to needed kilocalories from protein than did those that reported their behavior as being bicultural or Asian; although not at statistically significant levels.

Participants whose values aligned with Asian culture or who identified as being culturally Asian consumed a lower ratio of actual to needed kilocalories from carbohydrates than did those with bicultural or western values, however, these differences were not statistically significant. Participants who reported their behavior as aligned with Asian or western culture consumed the same ratio of actual to needed kilocalories from carbohydrates, whereas, those whose behavior was more bicultural consumed a lower ratio, but not significantly lower.

Participants who identified as having western values, behaviors and identities consistently consumed a higher ratio of actual to needed kilocalories from fat than did those who were more bicultural or Asian on all three acculturation measures.

Looking at other dietary components by acculturation, those with western values consumed significantly higher proportions of soluble and insoluble fiber than those with Asian or bicultural values. Participants with western identified behaviors also consumed significantly higher proportions of total fiber than did participants with Asian or bicultural behavior. Those with bicultural and western values consumed significantly higher proportions of cholesterol than did those with Asian values. Those whose behavior was bicultural or western consumed significantly higher proportions of animal and vegetable protein. Finally, culturally western identified participants consumed significantly more total kilocalories than bicultural participants, who consumed more than culturally Asian identified participants.

Regression analysis indicated that of the diet variables that were significantly different by level of acculturation, the best predictor for cultural values and behavior is proportion of cholesterol. There was no adequate dietary predictor of self-identity.

There was no association established between HEI 2015 scores and acculturation.

Chapter 5: Discussion and Conclusions

Discussion

The prevalence of T2DM in Gujarat, a state in the western part of India, is not well documented, however, estimates are in the range of 7% to 14%[76], which is the second highest prevalence of T2DM in India.[77] In our population of Gujarati AIs residing in Maryland, the prevalence of T2DM was 33%, the prevalence of pre-diabetes was 49%, and the percentage undiagnosed was 39%

Asian Indians have several well documented characteristics that put them at high risk for T2DM, namely, high ratios of body fat to lean muscle, high levels of central adiposity, and genetic predispositions to insulin resistance and reduced pancreatic function. Additionally, migration of AIs from rural to urban areas and from India to other countries has shifted not only attitudes (values) but behaviors and self-identities. Acculturation of AIs to urban areas and other countries has resulted in changes in family structure; nuclear families allowing for greater freedom in dietary choices. Consumption of processed foods higher in refined carbohydrates, saturated and trans-fats. Lower levels of physical activity resulting from modern conveniences such as cars and appliances, as well as higher levels of education and income have facilitated sedentary lifestyles. Without significant evidence-based lifestyle changes, the burden of type 2 diabetes, cardiovascular disease and other co-morbidities associated with T2DM will continue to explode and AIs will continue to experience epidemic levels of T2DM resulting in morbidity and mortality at younger ages and across generations. Therefore, understanding the impacts of acculturation on dietary intake and physical activity and associations between diabetes status and anthropometric measurements related to adiposity and diabetes may provide evidenced based strategies to reduce risk of T2DM in this population. Participants in this study resided in nuclear families had greater control over their dietary choices. They also drove and had access to transportation, which suggest that participants enjoyed more freedom and were not subjected to cultural pressures as often encountered in extended families. As would be the norm in traditional Indian families, females in this population were responsible for cooking and had control over dietary consumption for themselves as well as their families. Additionally, of those that participated as married couples, 70% of the females did not have diabetes or had pre-diabetes while their spouses had diabetes. Along with females being responsible for the household cooking, this suggests a level of control over dietary options that may have an impact on their spouses' diabetes status.

Contrary to the normal pattern of low physical activity among Asian Indians, levels of physical activity by diabetes status in this study population suggest participants may be recognizing the need for physical activity as a strategy to manage diabetes. Recognition of the benefits of physical activity are evidenced by pre-diabetic and diabetic males' and females' higher engagement in moderate or high levels of physical activity as compared to male and female non-diabetics.

A predominance of vegetarianism is seen in AI populations, and in Gujaratis in particular. A review of the literature suggests that Gujarati Hindus and Jains have the highest rates of vegetarianism in the world, as a matter of choice. About three quarters of all participants in this study were vegetarian, and of those that were non-vegetarian, 80 percent were male. it is widely believed that Asian Indian vegetarians living in the US eat diets low in protein. This was generally not of concern in our population. Regardless of vegetarianism, the study participants' consumption of macronutrients (i.e., carbohydrates, fat, and protein) was in recommended ranges, however, protein consumption in this population was found to be on the lower end of recommendations in India as well as in the US. Vegetarians in this study achieved comparable nutritional sufficiency as judged by percent kilocalorie intakes from protein as compared to non-vegetarians, but the expected attributes of vegetarian diets, higher consumption of carbohydrates, and those of non-vegetarian diets, higher consumption of fat, were maintained in the study population.

Examination of the association between acculturation and diet suggest that the AI immigrants in this study who self-identified as having predominantly traditional Asian values and identities have adapted to their host country (United States) and leading them to adopt some healthier dietary choices such as consuming more dietary fiber, but also some less healthy choices consistent with Asian culture, such as consuming high amounts of carbohydrates and fats. Lower protein consumption for those with self-reported traditional Asian values and identities is hypothesized to be predominantly due to their adherence to the more traditional Indian vegetarian diet.

The emphasis on macronutrient intake AIs centers around carbohydrate and fat intake because these two macronutrients contribute to central adiposity and cardiovascular health risks, however as mentioned, protein levels are not considered to be problematic in this population. Additionally, when considering dietary recommendations for diabetics, regardless of cultural background, often the recommendation is to first reduce total kilocalorie intake, without regard to macronutrient composition, to promote weight loss, because obesity and its anthropometric consequences are implicated as risk factors for pre-diabetes and diabetes. Consumption of healthy fats and lean proteins are recommended to support cardiovascular health as well as maintenance of lean muscle mass. Finally, whole grains and whole fruits and vegetables are recommended to generally promote increased fiber intake, which supports increased transit time and absorption of nutrients in the small intestines. This study aimed to show that rather than the absolute level of individual macronutrients, it is the relative proportion that is associated with diabetes status.

This study established an association between diet and diabetes status, and diet and anthropometric measurements. Specifically, participants with pre-diabetes and diabetes consumed lower ratios of actual to needed protein, carbohydrates and fats relative their energy requirements than participants without diabetes. In addition, participants with pre-diabetes and diabetes were eating smaller proportions of insoluble and higher proportions of soluble fiber. These differences suggest that adherence, or lack thereof, to a metabolically supportive macronutrient distribution 50% of total kilocalories from carbohydrates, 30% of total kilocalories from fat, and 20% of total kilocalories from protein may be able to predict diabetes status. Consumption of insoluble fiber was also associated with lower A1c levels.

There is a well-established association between anthropometric measurements and diabetes status; anthropometric measurements are used to identify risk for MetS and T2DM. Due to physiologic differences in Asian Indians, lower cut-offs for BMI, WC, WHR, and BF are recommended to more accurately identify risk for MetS and T2DM in this population. Among these, BMI has not been a reliable measure with Asian Indians because of the higher ratios of fat to lean muscle mass than found in Caucasian populations. This study found that although differences by gender and diabetes status were not significant for BMI and a consistent pattern of increasing BMI by diabetes status was not shown, all participants, male and female, had BMIs above the specific cut-offs for overweight and most were above the specific cut-offs for obese. All other anthropometric measurements, WC, WHR, BF, BF:BMI, and VF were all significantly different by gender and diabetes status in this study. However, it is noteworthy that participants were above specific cut-offs for all measures except non-diabetic females for WC and BF, non-diabetic males for WHR, and all females on VF. Additionally, as stated earlier, this study showed moderate to high levels of physical activity among pre-diabetics and diabetics, and overall caloric restriction as well as lower ratios of actual to needed macronutrients than non-diabetics, both of which are intended to reduce anthropometric measurements. However, despite this anthropometric measures remained above specific cut-offs for most participants regardless of diabetes status.

Limitations

There were several notable limitations in the current study.

1. Generalization of findings to all AIs in general, or Gujaratis in particular, was not possible because this study used a convenience sample, and most participants were from a specific cohort of AIs; first generation older Gujarati adults with high levels of education, income and acculturation.

2. The cross-sectional design of the current study only allowed for examination of associations between diet and diabetes status, anthropometric measurements, vegetarianism and acculturation; and do not imply causality.
3. All data captured in the current study were self-reported except for A1c levels. The Food Frequency Questionnaire (FFQ) utilized data requiring a one year retrospective review and may be subject to recall error. Also, the suggestive nature of the FFQ may have excluded foods consumed but not included on the FFQ. It is not known to what extent, the age of the study participants contributed to error in recall.
4. For study participants with no physician's diagnosis of diabetes or with pre-diabetes, physician ordered labs for fasting blood glucose and hemoglobin A1c are not warranted and therefore were not available. Thus, point of care glucose and A1c monitors were utilized to confirm diabetes status. Although use of point of care monitors which utilize capillary blood sample have been shown to be reasonably comparable to venous blood draws, it is possible that a mix of venous blood draws and point of care monitor results may have had a minor impact on comparability of the results.
5. Although data on current diagnoses and medications were collected, they were not analyzed to examine any associations between medications and anthropometric measurements.

Strengths

There were a several strengths of this study.

1. This is the first study to examine and identify a relationship between diabetes status and macronutrient composition; suggesting a greater adherence to an optimal

macronutrient composition (50:30:20; for percent of total kilocalories from carbohydrates, fat and protein) in non-diabetics than in pre-diabetics or diabetics.

2. This is the first study to examine the association between anthropometric measurements indicative of metabolic dysfunction and macronutrient composition; suggesting that those with anthropometric measurements (in particular, WHR) above stated cut-offs consumed lower ratios of actual to needed kilocalories from protein, carbohydrates and fats relative to energy requirements than those with anthropometric measurements below stated cut-offs.
3. This is the first study to examine differences in macronutrient composition between AI vegetarians and non-vegetarians; suggesting that AI vegetarians do not consume significantly different macronutrient compositions than AI non-vegetarians.
4. This is the first study to examine diet quality in AIs using the Healthy Eating Index (version for 2015) calculated from a food frequency questionnaire validated in AI populations.
5. This study shows an association between high levels of behavioral acculturation in older Gujarati adults and higher levels of physical activity based on diabetes status.
6. Study instruments (i.e., food frequency questionnaire, physical activity questionnaire, the full acculturation tool), and anthropometric cut-offs specific to AIs, were previously tested and validated in Asian Indian populations.
7. The researcher's cultural competence and familiarity with Gujarati diets facilitated the acquisition of more complete food frequency data.

Recommendations for Future Research

The prevalence of Type 2 Diabetes and its associated co-morbidities within AI populations, especially Gujaratis, in the US and elsewhere is at extremely high levels and is continuing to rise. As such, further research in this population is needed to more thoroughly study the relationship between diet quality, diabetes status, anthropometric measurements, acculturation and physical activity to develop evidence-based strategies helpful in the prevention and management of diabetes in this high-risk population. Specifically, further examination is recommended for:

- the relationships between physical activity, and acculturation, dietary quality and acculturation to more reliably understand how behavior change attributed to acculturation is impacting diabetes related outcomes;
- the association between diabetes status and anthropometric measurements to provide insight into more nuanced differences in physical attributes of pre-diabetics and diabetics and how they differ by gender, and other demographic characteristics, such as education and income; and
- the relationship between diabetes status and demographic characteristics to inform the environmental circumstances, such as family structure, that can pose challenges to behavior change that may be prohibiting AIs from effectively using diet and physical activity to prevent or manage their pre-diabetes or diabetes.

Additionally, HEI scores calculated from 24-hour recalls could be used validate the FFQ calculated HEI scores in this study. Finally, the association between macronutrient distribution and diabetes status should be further explored in Asian Indians and other racial and ethnic groups.

Conclusions

The current study is the first to investigate a relationship between the consumption of macronutrients in general and in specific relative proportion (50:30:20) and diabetes status, as well as between macronutrient distribution and anthropometric measurements, in an Asian Indian population. These relationships can be further explored to develop a recommended diet for Asian Indians that is both specific yet flexible to accommodate the variety of ethnically specific food preferences that exist within this community while preserving the aspect of taste that maintains the link to the home culture.

This study also shows that Asian Indian pre-diabetics and diabetics recognize the benefit of physical activity and caloric restriction, as they relate to their diabetes status and as recommended for diabetes management by health care providers; and establishes a pattern of decreased overall caloric intake, and decreased intake for each macronutrient (protein, carbohydrate and fat), below required levels based on energy requirements for pre-diabetics and diabetics in the United States. Additionally, it is not known if the combination of increased physical activity and decreased caloric intake discovered in this population can be viewed as contributing to health or negatively impacting diabetes status.

Asian Indians are at high risk for IR leading to IGT and T2DM and their sequelae. Future research is needed to establish the association between diet quality and diabetes status; however, it is not known those at risk for T2DM may benefit from adhering to a macronutrient distribution of approximately 50% of total kilocalories from carbohydrates, 30% from fat and 20% from protein or from a higher intake of dietary protein

Finally, the implications of near universal female responsibility for cooking, in households where a spouse or other family members are diagnosed with either pre-diabetes or diabetes, are intriguing. Targeted education to AI females about preparing meals that adhere to optimal dietary choices, may have a potential benefit to the entire family including those with diabetes and prediabetes.

Appendices

Appendices contain information that is supplemental to the full study.

Appendix A. Data Dictionary (collected and calculated)

Appendix B. IRB Approval

Appendix C. Sample Size Calculations

Appendix D. Study Recruitment Materials (flyer, brochure, reference values

Appendix E. Reliability and Validity of Study Instruments

Appendix F. Study Instruments and Data Collection Form

Appendix G. Calculation of Physical Activity Score and Conversion to Kilocalories Burned

Appendix H. Calculation of Acculturation Scores

Appendix I. Calculation of Healthy Eating Index (HEI) 2015 Score

Appendix A: Data Dictionary

Data Dictionary of Raw and Derived Variables			
Variable	**Raw**	**Derived**	**Description**
ID	X		Participant ID number (1-39)
FamID		X	Participant Couple ID number (1-25)
GroupID		X	0=NoT2DM, 1=Pre-T2DM, 2=T2DM
Gender	X		F=1, M=2
YearsUS	X		Years lived in US - continuous
HighestEd	X		1=High School, 2=Associates, 3=Bachelors, 4=Masters, 5=Doctorate, 6=Professional
Ed		X	1≤Bachelors, 2>Bachelors
PLangHome_English	X		
FamStructure	X		1=Nuclear, 2=Extended
MaritalStatusO	X		1=Single/Unattached, 2=Married, 3=Widow
MaritalStatus		X	0=Single/Unattached or Widow, 1=Married
ParticipantCouple	X		0=No, 1=Yes
HouseholdIncome	X		1<$50K, 2=$50-100K, 3=$100-150K, 4=$150-200K, 5>$200K
Income		X	1≥$100K, 2>$100K
Vegetarian	X		0=No, 1=Yes
TypeVeg	X		1=Lacto-vegetarian, 2=Lacto-Ovo-vegetarian, 3=Pesco-Vegetarian
HxSmoking	X		0=No, 1=Yes
CurSmoker	X		0=No, 1=Yes
Alcohol	X		0=Never, 1=Occasional (1-2/mo), 2=Regular (1-3/wk), 3=Frequent (>3/wk)
AlcoholUse		X	0=Never or Occasional (1-2/mo), 1=Regular (1-3/wk) or Frequent (>3/wk)
PrimGrocShop	X		1=Self, 2=Spouse, 3=Self/Spouse, 4=Parents/In-laws, 5=Children, 6=Self/Daughter In-law, 7=Spouse/Daughter-in-law, 8= Self/Other (hired)
SelfShop		X	0=No (Spouse, Parents/In-laws, Children, Spouse/Daughter-in-law), 1=Yes (Self, Self/Spouse,

			Self/Daughter-in-law, Self/Other (hired))
PrimCook	X		1=Self, 2=Spouse, 3=Self/Spouse, 4=Parents/In-laws, 5=Children, 6=Self/Daughter In-law, 7=Spouse/Daughter-in-law, 8= Self/Other (hired)
SelfCook		X	0=No (Spouse, Parents/In-laws, Children, Spouse/Daughter-in-law), 1=Yes (Self, Self/Spouse, Self/Daughter-in-law, Self/Other (hired))
Transport_Access	X		1= Car/Licensed to Drive, 2=Car/Driven, 3=Licensed to Drive/Driven, 4=Other-Licensed but do not drive
SelfDrive		X	0= No (Car/Driven, Licensed to Drive/Driven, Other-Licensed but do not drive), 1=Yes (Car/Licensed to Drive)
T2DM	X		0=No, 1=Yes
HighBS_PreT2DM	X		0=No, 1=Yes
PhyAct_Score_Corrected		X	0=Low, 1=Moderate, 2=High
Total_METmin_week		X	Physical Activity in MET minutes per week (See Appendix G for calculation method)
KcalBurned_PhyAct		X	Kilocalories burned through physical activity (See Appendix G for calculation method)
Values		X	1=Asian, 2=Western, 3=Bicultural
Behavior		X	1=Asian, 2=Western, 3=Bicultural
Self-Identity	X		1=Asian, 2=Western, 3=Bicultural/Asian Identified, 4=Bicultural/Western Identified, 5= Bicultural/Bicultural Identified
Self_Identity_condensed		X	1=Asian, 2=Western, 3=Bicultural
FBG	X		Fasting Blood Glucose
A1c	X		Hemoglobin A1c
Age	X		Age
AveH		X	Height (averaged over two readings)
AveW		X	Weight (averaged over two readings)
AveBF		X	Percent Body Fat (averaged over

			two readings)
BF		X	1<cut-off, 2≥cut-off
AveBMR	X		Basal Metabolic Rate (averaged over two readings)
AveVFat	X		Visceral Fat (averaged over two readings)
VFatScore		X	1<cut-off, 2≥cut-off
AveWC	X		Waist Circumference (averaged over two readings)
WC		X	1<cut-off, 2≥cut-off
AveHC	X		Hip Circumference (averaged over two readings)
WHRatio		X	Waist to Hip Ratio (calculated: waist circumference/hip circumference; averaged over two readings)
WHR		X	1<cut-off, 2≥cut-off
BMI		X	Body Mass Index (calculated: weight (kg)/height(m)^2)
BF_BMI_Ratio		X	Body Fat to Body Mass Index Ratio (calculated: Percent Body Fat/Body Mass Index)
BFBMIR		X	1<cut-off, 2≥cut-off
OW_OB		X	0=Normal, 1=Overweight, 2=Obese
BMRMif		X	Basal Metabolic Rate (Mifflin St. Jeor Method)
BMRHarBen		X	Basal Metabolic Rate (Harris Benedict Method)
BMROwen		X	Basal Metabolic Rate (Owen Method)
BMRWHO		X	Basal Metabolic Rate (WHO/FAO/UNU Method)
CALORIES	X		Daily Total Kilocalories (provided from nutrient analysis)
PROTEIN	X		Daily Grams of Protein (provided from nutrient analysis)
ANIMPRO	X		Daily Grams of Animal Protein (provided from nutrient analysis)
VEGPRO	X		Daily Grams of Vegetable Protein (provided from nutrient analysis)
FISHPRO	X		Daily Grams of Fish Protein (provided from nutrient analysis)
CARB	X		Daily Grams of Carbohydrates (provided from nutrient analysis)

TFIBER	X		Daily Grams of Total Fiber (provided from nutrient analysis)
SFIBER	X		Daily Grams of Soluble Fiber (provided from nutrient analysis)
IFIBER	X		Daily Grams of Insoluble Fiber (provided from nutrient analysis)
SUGAR	X		Daily Grams of Sugar (provided from nutrient analysis)
TFAT	X		Daily Grams of Total Fat (provided from nutrient analysis)
SFAT	X		Daily Grams of Saturated Fat (provided from nutrient analysis)
MFAT	X		Daily Grams of Monounsaturated Fat (provided from nutrient analysis)
PFAT	X		Daily Grams of Polyunsaturated Fat (provided from nutrient analysis)
TRANS	X		Daily Grams of Trans Fat (provided from nutrient analysis)
CHOL	X		Daily Grams of Cholesterol (provided from nutrient analysis)
ETOH	X		Daily Grams of Alcohol (provided from nutrient analysis)
ABSCARB	X		Daily Grams of Carbohydrates Absent Fiber (provided from nutrient analysis)
Tcalories_w_ETOH	X		Daily Total Kilocalories with Alcohol (provided from nutrient analysis)
PercentProtein		X	Percent Protein (Daily Grams of Protein/Total Kilocalories with Alcohol)
PercentCarb		X	Percent Carbohydrates (Daily Grams of Carbohydrates/Total Kilocalories with Alcohol)
PercentFat		X	Percent Fat (Daily Grams of Total Fat/Total Kilocalories with Alcohol)
PercentETOH		X	Percent Alcohol (Daily Grams of Alcohol/Total Kilocalories with Alcohol)
PropSFAT		X	Proportion Saturated Fat (Daily Grams of Saturated Fat/Grams Total Fat)
PropMFAT		X	Proportion Monounsaturated Fat (Daily Grams of Monounsaturated

			Fat/Grams Total Fat)
PropPFAT		X	Proportion Polyunsaturated Fat (Daily Grams of Polyunsaturated Fat/Grams Total Fat)
PropTRANS		X	Proportion Trans Fat (Daily Grams of Trans Fat/Grams Total Fat)
PropChol		X	Proportion Cholesterol (Daily Grams of Cholesterol/Grams Total Fat)
PropAnimalProtein		X	Proportion Animal Protein (Daily Grams of Animal Protein/Grams of Protein)
PropVegProtein		X	Proportion Vegetable Protein (Daily Grams of Vegetable Protein/Grams of Protein)
PropFishProtein		X	Proportion Fish Protein (Daily Grams of Fish Protein/Grams of Protein)
PropTFIBER		X	Proportion Total Fiber (Daily Grams of Total Fiber/Grams of Carbohydrates)
PropSFIBER		X	Proportion Soluble Fiber (Daily Grams of Soluble Fiber/Grams of Carbohydrates)
PropIFIBER		X	Proportion Insoluble Fiber (Daily Grams of Insoluble Fiber/Grams of Carbohydrates)
PropSUGAR		X	Proportion Sugar (Daily Grams of Sugar/Grams of Carbohydrates)
PropABSCarb		X	Proportion Carbohydrates Absent Fiber (Daily Grams of Carbohydrates Absent Fiber/Grams of Carbohydrates)
CaloriesNeeded_O		X	Daily Total Kilocalories Needed_O (BMROwen + Kilocalories Burned through Physical Activity)
GramsProteinNeeded_O		X	Daily Grams of Protein Needed_O (calculated: (CaloriesNeeded_O X 0.20)/4)
GramsCarbNeeded_O		X	Daily Grams of Carbohydrates Needed_O (calculated: (CaloriesNeeded_O X 0.50)/4)
GramsFatNeeded_O		X	Daily Grams of Fat Needed_O (calculated: (CaloriesNeeded_O X 0.30)/9)

ProteinRatio_ActualtoNeeded_O		X	Ratio of Actual to Needed Protein_O (calculated: Daily Grams of Protein/Daily Grams of Protein Needed_O)
CarbRatio_ActualtoNeeded_O		X	Ratio of Actual to Needed Carbohydrates_O (calculated: Daily Grams of Carbohydrates/Daily Grams of Carbohydrates Needed_O)
FatRatio_ActualtoNeeded_O		X	Ratio of Actual to Needed Fat_O (calculated: Daily Grams of Fat/Daily Grams of Fat Needed_O)
CaloriesNeeded_H		X	Daily Total Kilocalories Needed_H (BMRHarben + Kilocalories Burned through Physical Activity)
GramsProteinNeeded_H		X	Daily Grams of Protein Needed_H (calculated: (CaloriesNeeded_H X 0.20)/4)
GramsCarbNeeded_H		X	Daily Grams of Carbohydrates Needed_H (calculated: (CaloriesNeeded_H X 0.50)/4)
GramsFatNeeded_H		X	Daily Grams of Fat Needed_H (calculated: (CaloriesNeeded_H X 0.30)/9)
ProteinRatio_ActualtoNeeded_H		X	Ratio of Actual to Needed Protein_H (calculated: Daily Grams of Protein/Daily Grams of Protein Needed_H)
CarbRatio_ActualtoNeeded_H		X	Ratio of Actual to Needed Carbohydrates_H (calculated: Daily Grams of Carbohydrates/Daily Grams of Carbohydrates Needed_H)
FatRatio_ActualtoNeeded_H		X	Ratio of Actual to Needed Fat_H (calculated: Daily Grams of Fat/Daily Grams of Fat Needed_H)
CaloriesNeeded_M		X	Daily Total Kilocalories Needed_M (BMRMif + Kilocalories Burned through Physical Activity)
GramsProteinNeeded_M		X	Daily Grams of Protein Needed_M (calculated: (CaloriesNeeded_M X 0.20)/4)
GramsCarbNeeded_M		X	Daily Grams of Carbohydrates Needed_M (calculated: (CaloriesNeeded_M X 0.50)/4)
GramsFatNeeded_M		X	Daily Grams of Fat Needed_M

			(calculated: (CaloriesNeeded_M X 0.30)/9)
ProteinRatio_ActualtoNeeded_M		X	Ratio of Actual to Needed Protein_M (calculated: Daily Grams of Protein/Daily Grams of Protein Needed_M)
CarbRatio_ActualtoNeeded_M		X	Ratio of Actual to Needed Carbohydrates_M (calculated: Daily Grams of Carbohydrates/Daily Grams of Carbohydrates Needed_M)
FatRatio_ActualtoNeeded_M		X	Ratio of Actual to Needed Fat_M (calculated: Daily Grams of Fat/Daily Grams of Fat Needed_M)
CaloriesNeeded_W		X	Daily Total Kilocalories Needed_W (BMRWHO + Kilocalories Burned through Physical Activity)
GramsProteinNeeded_W		X	Daily Grams of Protein Needed_W (calculated: (CaloriesNeeded_W X 0.20)/4)
GramsCarbNeeded_W		X	Daily Grams of Carbohydrates Needed_W (calculated: (CaloriesNeeded_W X 0.50)/4)
GramsFatNeeded_W		X	Daily Grams of Fat Needed_W (calculated: (CaloriesNeeded_W X 0.30)/9)
ProteinRatio_ActualtoNeeded_W		X	Ratio of Actual to Needed Protein_W (calculated: Daily Grams of Protein/Daily Grams of Protein Needed_W)
CarbRatio_ActualtoNeeded_W		X	Ratio of Actual to Needed Carbohydrates_W (calculated: Daily Grams of Carbohydrates/Daily Grams of Carbohydrates Needed_W)
FatRatio_ActualtoNeeded_W		X	Ratio of Actual to Needed Fat_W (calculated: Daily Grams of Fat/Daily Grams of Fat Needed_W)
CaloriesNeeded_S		X	Daily Total Kilocalories Needed_S (AveBMR + Kilocalories Burned through Physical Activity)
GramsProteinNeeded_S		X	Daily Grams of Protein Needed_S (calculated: (CaloriesNeeded_S X 0.20)/4)
GramsCarbNeeded_S		X	Daily Grams of Carbohydrates

			Needed_S (calculated: (CaloriesNeeded_S X 0.50)/4)
GramsFatNeeded_S		X	Daily Grams of Fat Needed_S (calculated: (CaloriesNeeded_S X 0.30)/9)
ProteinRatio_ActualtoNeeded_S		X	Ratio of Actual to Needed Protein_S (calculated: Daily Grams of Protein/Daily Grams of Protein Needed_S)
CarbRatio_ActualtoNeeded_S		X	Ratio of Actual to Needed Carbohydrates_S (calculated: Daily Grams of Carbohydrates/Daily Grams of Carbohydrates Needed_S)
FatRatio_ActualtoNeeded_S		X	Ratio of Actual to Needed Fat_S (calculated: Daily Grams of Fat/Daily Grams of Fat Needed_S)
AveW_kg		X	Average Weight in Kilograms (calculated: Average Weight X 0.454)
Req_Daily_Protein_g		X	Required Daily Protein (calculated: Average Weight in Kilograms X 0.8grams
TCRatio_ActualtoNeeded_O		X	Daily Total Kilocalories Needed_O (CaloriesNeeded_O + Kilocalories Burned through Physical Activity)
TCRatio_ActualtoNeeded_H		X	Daily Total Kilocalories Needed_H (CaloriesNeeded_H + Kilocalories Burned through Physical Activity)
TCRatio_ActualtoNeeded_M		X	Daily Total Kilocalories Needed_M (CaloriesNeeded_M + Kilocalories Burned through Physical Activity)
TCRatio_ActualtoNeeded_W		X	Daily Total Kilocalories Needed_W (CaloriesNeeded_W + Kilocalories Burned through Physical Activity)
TCRatio_ActualtoNeeded_S		X	Daily Total Kilocalories Needed_S (CaloriesNeeded_S + Kilocalories Burned through Physical Activity)
HIE2015_SCORE_1		X	Healthy Eating Index 2015 Score (See Appendix I for calculation method)

Appendix B: IRB Approval

INSTITUTIONAL REVIEW BOARD

DATE: July 14, 2016

TO: Amisha Pandya, MA

FROM: University of Maryland College Park (UMCP) IRB

1204 Marie Mount Hall College Park, MD 20742-5125 TEL 301.405.4212

FAX 301.314.1475

irb@umd.edu www.umresearch.umd.edu/IRB

PROJECT TITLE: [771334-2] Dietary Quality and Type 2 Diabetes Mellitus in US Asian Indian Populations

REFERENCE #:

SUBMISSION TYPE: Amendment/Modification

ACTION: APPROVED APPROVAL DATE: July 14, 2016

EXPIRATION DATE: June 2, 2017

REVIEW TYPE: Expedited Review

REVIEW CATEGORY: Expedited review category # 2(a), 4, & 7

Thank you for your submission of Amendment/Modification materials for this project. The University of Maryland College Park (UMCP) IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

Prior to submission to the IRB Office, this project received scientific review from the departmental IRB Liaison.

This submission has received Expedited Review based on the applicable federal regulations.

This project has been determined to be a Minimal Risk project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of June 2, 2017.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Unless a consent waiver or alteration has been approved, Federal regulations require that each participant receives a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others (UPIRSOs) and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. Please use the appropriate reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

Please note that all research records must be retained for a minimum of seven years after the completion of the project.

If you have any questions, please contact the IRB Office at 301-405-4212 or irb@umd.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Maryland College Park (UMCP) IRB's records.

Appendix C: Sample Size Calculation

Population estimates for T2DM prevalence were not specific enough for the population targeted for this study. Therefore, the method of Inference for means, which involves comparing two independent means from a large-scale study to base sample size calculations was employed. The Study used was one titled A1c Cut Points to Define Various Glucose Intolerance Groups in Asian Indians. The sample size from the study was n=2188. [49] Table X below shows the means from the study that were considered for the sample size calculation.

Table
Means from Mohan (2010) Study Considered in the Calculation of Sample Size

Variable	**No T2DM means (n=1710)**	**No T2DM Stddev**	**Pre-T2DM means (n=258)**	**Pre-T2DM Stddev**	**T2DM means (n=220)**	**T2DM Stddev**
HbA1c (%)	5.5	0.4	5.9	0.6	8.3	2

Sample Size was calculated with pooled means for pre-diabetics and diabetics using the following equation: $\bar{y} = ((n_1\bar{y}_1) + (n_2\bar{y}_2))/(n1+n2)$, and the standard deviations for pre-diabetics and diabetics, and non-diabetics and pre-diabetics and diabetics, were pooled using the following equation:

$$s = (n_1-1)s^2_1 + (n_2-1)s^2_2 + n_1(\bar{y}_1-\bar{y})^2 + n_2(\bar{y}_2-\bar{y})^2 / (n_1+n_2-2).$$

Table X below provides the pooled means and standard deviations calculated for sample size based on the Mohan (2010) study.

Table

Calculated Pooled Means and Standard Deviations for Sample Size Calculation

Variable	**No T2DM Mean**	**No T2DM Stddev**	**Pre- and T2DM Pooled Mean**	**Pre- and T2DM Pooled Stddev**	**No, Pre- and T2DM Pooled**
HbA1c (%)	5.5	0.4	7	1.43	0.75

The equation for sample size that was applied was obtained from www.ncbi.nlm.nih.gov/pmc/articles/PMC2876926/:

$$n = \frac{2(Z\alpha + Z1 - \beta)^{2\sigma 2,}}{\Delta^2}$$

Where,

n = sample size needed,

$Z\alpha$ = 1.96 (for 95% 2-sided effect),

$Z1\text{-}\beta$ = .8416 (for 0.80 power)

Δ = difference in two different groups (effect size)

In this case, from Mohan (2010), Δ = prevalence of NoT2DM – prevalence of pre- and T2DM, or $\Delta = (1710/2188) - (458/2188) = 0.573$. The term $2\sigma2$ is meant to represent the standard deviation squared. In this case the pooled standard deviation for all three groups was used, so $2\sigma2 = 0.75$.

Solving for $n = \frac{2(1.96+0.8416)2 \ \text{x}\ (.75)2}{0.573} = 15$ (this would be per group)

So, the total needed sample size would be 15 x 3 = 45.

This value was checked with an on-line sample size calculator (https://www.stat.ubc.ca/~rollin/stats/ssize/n2.html) to obtain the same result.

Appendix D: Study Recruitment Materials

Recruitment Flyer

University of Maryland

Department of Nutrition and Food Science

Research Volunteers Needed!

For a Study, on

Dietary Quality and Type 2 Diabetes Mellitus in US Asian Indian Populations

We need

- **Male and Female 18 years or older**
- **Asian Indians Literate in English**
- **Take 2 diagnostic tests involving a finger prick, have anthropometric measurements taken, complete a participant interview and 3 surveys**
- **90-120 Minutes**

What do you get?

Nutrition and Health Information on Type 2 Diabetes specifically in Asian Indians

If interested in participating, please contact Amisha at:
apdiabetesstudy@verizon.net or 240-676-6594

Appendix D: Study Recruitment Materials

Recruitment Script

University of Maryland

Department of Nutrition and Food Science

RECRUITMENT Script for Interview/Data Collection

Hello! My name is _______________. I am a Graduate Nutrition Science student working under the supervision of Dr. Mira Mehta at the University of Maryland. We are conducting a research study to **understand the association between diet quality and Type 2 Diabetes Mellitus in Asian Indians.**

I am recruiting individuals who are 18 years are older to participate in a survey. If you agree to participate, I will ask you to complete a participant interview, take 2 diagnostics tests to determine your blood glucose levels involving a finger prick, take measurements of your waist circumference, hip circumference, height, weight and body fat, and complete 1 longer and 2 very short surveys. The questions I will ask you will be about: 1) the foods you have eaten over the past year, 2) how much you identify with American culture versus Indian culture, 3) your level of physical activity, and 4) what is your background, current health issues and your current home environment related to your dietary choices.

Would it be okay with you if I used the information we talk about in my study? This is completely voluntary and you may say no if you do not want this information used in the study. If you agree and we start talking and you decide you no longer want to do this, we can stop at any time. I will not identify you or use any information that would make it possible for anyone to identify you in any presentation or written reports about this study. There is no expected risk to you for helping me with this study. The information you provide will be kept locked up and will only be shared with those working in this research.

For participating in this study, if you are interested, I can provide you information on how the Asian Indian diet may impact blood glucose levels, and tips on healthy eating and better nutrition practices for good glucose control.

Do you have any questions? Would you like to participate in my study?

Appendix D: Study Recruitment Materials

Study Information Brochure (page 1 of 2)

What we know…..

- We know that Diabetes is a growing epidemic worldwide, but especially in Asian Indian populations.
- We know that eating a healthy diet and exercising can improve blood sugar levels.
- We know that different cultures favor different foods and that most of us adapt to new cultures, but still favor our home cultures.
- We know that what tastes best to us is not always the best for us.

What we don't know…..

- We don't know what particular foods, improve blood sugar levels in Asian Indians.
- We don't know if particular proportions of protein, carbohydrates and fats are best for reducing blood sugar levels in Asian Indians.
- We don't know if the quality of the proteins, carbohydrates and fats makes a difference in reducing blood sugar

How you will benefit…..

- You will learn if your waist and hip circumferences are associated with diabetes and diabetes risk for Asian Indians.
- You will learn if the foods you are eating are associated with diabetes and diabetes risk for Asian Indians.
- You will learn what role your level of adaptation to the US has played on your food choices.

UMD

AMISHA PANDYA, MHS
MASTERS CANDIDATE
NUTRITION SCIENCE
UNIVERSITY OF MARYLAND
DEPARTMENT OF NUTRITION
AND FOOD SCIENCE

Phone: 240-676-6594
E-mail: apdiabetesstudy@verizon.net

UNIVERSITY OF MARYLAND

Department of Nutrition and Food Science, College Park, Maryland

Diet Quality and Type 2 Diabetes Mellitus in US Asian Indian Populations

AMISHA PANDYA, MHS

Phone:

240-676-6594

Email:

apdiabetesstudy@verizon.net

Appendix D: Study Recruitment Materials

Study Information Brochure (page 2 of 2)

Description of the Research Study

STUDY PURPOSE

1. To describe the dietary intake of Asian Indian adults living in the US according to their Type 2 Diabetes status.
2. To determine whether there is an association between Diabetes status, body measurements indicating Type 2 Diabetes, and dietary preferences.

STUDY OBJECTIVES

1. Compare the diets of Asian Indians by diabetes status (capillary blood glucose and anthropometric measures (i.e., waist circumference, waist to hip ratio and BMI):
   - macronutrient composition from food frequency questionnaire,
   - quality, measured by the Healthy Eating Index, and
   - differences in diet by level of acculturation, physical activity, and socioeconomic measures (i.e., age, gender, education and income).

STUDY TIMELINES

Start in summer 2016 and last 1-3 months

Total Participation Time = 90-120 minutes:

- Consent to Participate = 10 minutes
- Initial Interview = 20 minutes
- Study Measurements = 60-90 minutes

WHO CAN PARTICIPATE:

1. Asian Indian Adult men and women (aged 18 years or older), with and without a diagnosis of type 2 diabetes mellitus (T2DM), who have lived in the US for more than 5 years, who are literate in English and are not currently:
   a. Taking insulin or other diabetes medication that can impact body composition,
   b. Type 1 Diabetic,
   c. Pregnant or lactating,
   d. Undergoing treatment for mental or psychological disorders,
   e. Undergoing cancer treatment (e.g., chemotherapy or other cancer treatments that can have an impact on normal dietary intake)

STUDY PROCEDURES

The study will include study participants assigned to 2 study groups:

1) Diabetes (previously told had elevated blood sugar and/or diagnosis confirmed with Capillary Blood Glucose (CBG) and Point Of Care Hemoglobin A1c (HbA1C)).

2) No Diabetes (not previously told had elevated blood sugar and with CBG and POC HbA1c in non-diabetic range).

If interested, you will be scheduled to provide signed consent, and complete an orientation and initial participant interview. If you meet the requirements for the study, then you will complete a fasting CBG, and body measurements (waist circumference, hip circumference, height and weight) and assessments.

STUDY MEASURES

1. Participant interview to capture contact and demographic information, current health issues/ treatments, length of residence in the US, and diet preferences (vegetarian/non-vegetarian).
2. Study of Health Assessment and Risk in Ethnic (SHARE) groups South Asian Food Frequency Questionnaire (FFQ) – a 163 item, 12 month recall, including frequency and serving size.
3. Acculturation measured with the Suinn-Lew Asian Self-Identity Acculturation instrument (SL-ASIA) – a 5 point scale measuring how much a person has adopted new culture (1=No acculturation; 5=Full acculturation).
4. Physical activity measured by the International Physical Activity Questionnaire (IPAQ) – a 4 question Physical Activity Assessment Tool.
5. Finger Prick for glucometer and POC HbA1c reading to assess fasting and 3 month average blood glucose levels.
6. Body measurements including waist circumference, hip circumference, height and weight – measurements taken with a tape measure, a height scale and a weight scale.

STUDY IMPLICATIONS

1. The results of this preliminary pilot study will be used to inform future studies to arrive at dietary recommendations for Asian Indian with Diabetes.
2. Future studies may also attempt to make a more direct connection between food eaten and blood sugar levels in Asian Indians with and without Type 2 Diabetes.

Appendix D: Study Recruitment Materials

Reference Values Handout

Measures	**Reference Values for General Population**	**Reference Values for Asian Indians**
Body Mass Index (BMI)		
Overweight	25-29.9Kg/m^2	≥21.5Kg/m^2 (males); ≥19.0Kg/m^2 (females)
Obese	≥30.0Kg/m^2	≥25.0Kg/m^2 (males); ≥23.0Kg/m^2 (females)
Percent Body Fat	≥26% (males); ≥32% (females)	≥25% (males); ≥30% (females)
Waist Circumference	≥102cm or 40 inches (males); ≥88cm or 35 inches (females)	≥85cm or 34.0 inches (males); ≥80cm or 31.5 inches (females)
Waist:Hip Ratio	≥0.95 (males); ≥0.85 (females)	≥0.90 (males); ≥0.80 (females)

Appendix E: Reliability and Validity of Study Instruments

Type, Description, Validity and Reliability of Measurement Tools

Measure	**Tool/Measurement**	**Validity/Reliability**
Demographics	Participant Interview	Not validated; was piloted with a convenience sample of Asian Indians prior to its use in the study.
Dietary Intake	Study of Health Assessment and Risk in Ethnic (SHARE) groups South Asian Food Frequency Questionnaire (FFQ)	Use of FFQs for dietary assessments require customization, but are considered valid and reliable.[78] Developed from foods reported in the diet records and recalls of 29 South Asians, 25 Chinese, and 20 Europeans participating in a pilot study from 1995-1996 in Hamilton, Ontario, Canada. The FFQ and a seven-day diet record were then administered to 342 South Asians, 317 Chinese, and 346 Europeans participating in SHARE in three Canadian centers from 1996-1998. Validation included a subset of these participants completing a second seven-day diet record and second FFQ 8 to 10 months later. The SHARE FFQ underestimated macronutrients and overestimated micronutrients. Consumption of most macronutrients was lower among South Asians. Energy-adjusted de-attenuated correlation coefficients between the records and second FFQ ranged from 0.32 to 0.73 (South Asians), 0.17 to 0.84 (Chinese), and 0.30 to 0.83 (Europeans).[50] Validated in Asian Indian populations.[39]

Appendix E: Reliability and Validity of Study Instruments (continued)

Type, Description, Validity and Reliability of Measurement Tools

Measure	Tool/Measurement	Validity/Reliability
Acculturation	Suinn-Lew Asian Self-Identity Acculturation instrument (SL-ASIA) - Five New Orthogonal Items have been added to the SL-ASIA that can be used in conjunction with or in place of the original 21 items. Also, the author states that all five or just #26 alone can be used to assess acculturation.	Multiple Studies show: Factor Analysis resulting in 5 factors (Language, Identity, Friendship Choice, Behaviors, Generation/Geographic History, Attitudes; and Cronbach's alpha ranging from .72-.91.[51-61] NOTE: New items have not been tested for reliability or validity. The author requests that results from the use of these items be shared with him.
Physical Activity	International Physical Activity Questionnaire (IPAQ) - short version includes 4-7 items.	Tested in 12 countries (14 sites) during 2000. The final results suggest measures have acceptable measurement properties, and are suitable for national population-based prevalence studies of participation in physical activity.[79] Validated in Asian Indian populations.[62]
Anthropometric measures	Waist circumference, Hip circumference, Height and Weight, percent body fat and visceral fat	Standard methodology; weight, percent body fat and visceral fat were taken with the Tanita BC-558 Ironman Segmental Body Composition Monitor. This scale was chosen because it is also used in the Expanded Food and Nutrition Education Program (EFNEP) at the University of Maryland. Height was measured with the SECA 213 precision for health stadiometer in centimeters. Waist and Hip circumference were measured with a cloth measure tape.

Appendix F: Study Instruments and Data Collection Form

Consent Form

Project Title	**Dietary Quality and Type 2 Diabetes Mellitus in US Asian Indian Populations**
Purpose of the Study	This research is being conducted by Amisha Pandya at the University of Maryland, College Park. You are being invited to participate in this study because you are an Asian Indian, 18 years of age or older, have resided in the US for more than 5 years, are literate in English, and have either been diagnosed with Type 2 Diabetes Mellitus (T2DM), are interested in assessing your risk for T2DM, or wish to learn more about T2DM in Asian Indians. The purpose of this study is to analyze dietary quality and quantity, and assess its association with T2DM status, acculturation, and physical activity.
Procedures	The procedures involve scheduling a time for you to provide signed consent, and complete an orientation. The study orientation will include an overview of the study, its purpose, and explanation of all measurements to be taken and their purpose, diabetes in Asian Indian populations and any relevant findings from the study. Once the orientation is complete, you will be asked to complete a demographic participant interview including items such as: - name and contact information, - date of birth, - gender, - place of birth (self and parents), - languages spoken, - years/generation in US, - education, - marital status, - income, - family structure, - primary person responsible for cooking and grocery shopping, - access to transportation, - current health issues, including

	- previous diagnosis of T2DM or elevated blood sugar, - T1DM, - heart disease/hypertension/CVD, cancer, - mental health diagnoses, - pregnancy, or - other – and specify the other, - whether you are receiving any treatment for any health issues, - if so when were you diagnosed (how long have you had the particular condition), - the value of test results that are applicable to your condition, and - what treatment/medications you are taking, - length of residence in the US, - whether both parents are Asian Indian, - whether you are vegetarian or non-vegetarian, - if vegetarian what type of vegetarian: o no animal products (vegan), o dairy but no meat/fish or poultry, o fish and/or poultry but no red meat, o other. Should any of the study exclusions apply to you at the conclusion of the participant interview, you will be informed that you will not be able to continue your participation in the study because of the applied exclusions. You will still be provided any information about diabetes in Asian Indian populations and any relevant findings from the study. If no exclusions apply, you will have your finger pricked for a fasting Capillary Blood Glucose (CBG), and Point Of Care (POC) Hemoglobin A1c (HbA1c) measurement. Then, various body measurements such as waist circumference, hip circumference will be taken with a standard measuring tape, and height and weight will be taken with the use of a stadiometer and a scale. Body fat assessment will be done with a body composition scale and may also involve the use of calipers to pinch fat at the back of arms, and waist. All blood tests and body measurements will be taken by study staff that have been trained in proper measurement technique as well as blood safety and instrument use. Following this, you will be guided through three assessments – 1) A 163 item Food Frequency Questionnaire, which will ask you to recall the types and amounts of foods you have eaten, including how often you ate them, over the past year;

	2) A 5 question Acculturation Assessment, which will assess how much you identify with Asian Indian culture and American culture; and 3) A 4 question Physical Activity Assessment, which will assess how physically active you are. The entire study will take about 90-120 minutes in total. All of your answers are voluntary and you will not be compensated for your participation.
Potential Risks and Discomforts	Please note that no results from this study or any of its tests will be considered as providing an official diagnosis for T2DM. Although the tests may indicate a potential diagnosis for T2DM, you must consult a medical doctor for an official diagnosis. The potential risks and discomforts of your participation may include: 1. Your test results may indicate T2DM. If you would prefer not to learn the results of these tests, your results will be kept for analysis only. If you would prefer to learn the results these tests, you will be provided your results and encouraged to follow-up with a physician. 2. Your study information could become known to others outside of the study researchers. We will take every precaution to prevent this from occurring such as using a non-descript ID instead of names on any of the data collection forms (there will be a key to which only the researchers have access), and keeping all forms and assessments stored in a locked file box immediately after their completion. At the end of each day of data collection, all locked file boxes will be transported to a locked office with a locked file cabinet. 3. A small prick of a finger to obtain a droplet of blood for the capillary blood glucose and point of care Hemoglobin A1c tests (HbA1c). The capillary glucose test will be repeated three times to ensure an accurate reading and the HbA1c will only be done once. Your finger will only be pricked once. If we are unable to obtain a sufficient blood sample after two finger pricks, we will stop with the tests. Also, if you need antibacterial ointment and band aides, they will be made available to you. Should you require medical attention as a result of pricking your finger, you will be asked if you would prefer to be taken to the closest urgent care facility, or be taken to the nearest hospital emergency room (via car or ambulance). You will be sent in a taxi cab at no cost to you, or if you would prefer, study staff will be available to drive you as needed if no other form of transportation is available or desired. 4. Body measurements will be taken and recorded; each will be done

	three times. These will involve some physical contact with the researcher, as a tape measure will be used to measure the waist and hip circumferences, and a stadiometer will be used to measure height. Also, calipers may be used to measure skin folds for body fat measurements, which may pinch at the tricep and waist. Weight and percent body fat will be measured using a digital scale and those readings recorded as well. Should you be uncomfortable with a researcher taking these measurements, you will be shown how to take each measurement by yourself. 5. Through this study you will be asked to share personal, dietary, physical activity and acculturation information. All responses you provide are voluntarily. Any information you are uncomfortable with providing can be skipped. If there are too many skipped responses, your information may not be included in the analysis. If at any point wish to withdraw from the study, you are free to do so; your data will be destroyed, and not included in the final analysis for the study.
Potential Benefits	Although there are no direct benefits to participants, this research has the potential to identify associations between diet and a highly prevalent chronic disease in Asian Indian populations. This could be a tremendous benefit if a chronic condition that was previously unknown becomes known in time to address it. Much of the benefit of this study will be longer term, resulting from the analysis of the data, and will be less tangible to participants at the time of the study. These include information on potential associations between specific foods and the macronutrient distribution of the diet, and T2DM status. Additionally, another longer team benefit will be the eventual development of dietary recommendations for Asian Indians with T2DM. These longer term products can be shared with participants once available. All participants will have the option to receive updates and publication citations from published papers from this research, as well as additional products developed, such as dietary recommendations for Asian Indian diabetics, fact sheets, or additional information about current and future research. We hope that, in the future, other people might benefit from this study through improved understanding of dietary recommendations to control and prevent type 2 diabetes.

Confidentiality	Any potential loss of confidentiality will be minimized by storing the completed survey forms in a locked portable file drawer during data collection and then transferring to a locked file cabinet in a locked office. Blood samples will not be retained, just results noted; an enclosed collections container to dispose of used lancet cartridges and glucose strips will be on site during data collection and disposed of properly at the end of each data collection session. Electronic data, including raw data with all analytic files will be kept on an encrypted, password-protected flash drive and kept in a locked drawer in a locked office when not in use by the primary researcher. All data will be de-identified with ID keys kept in a separate encrypted flash drive than where the data will be stored. If we write a report or article about this research project, your identity will be protected to the maximum extent possible. In the case of low numbers of participants, data that could be used to identify individuals will be masked in publications. All paper documents will be destroyed within 2 years of the study's completion to ensure time for planned publications. Electronic data will be retained for up to 10 years, to allow for subsequent analyses and publications. All data will be deleted or destroyed after 10 years from the time of data collection. Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law.
Right to Withdraw and Questions	Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify. If you decide not to participate or withdraw from this study, data gathered for you and any other information that you have provided

	will not be analyzed, and any such data already analyzed will be deleted. If you decide to stop taking part in the study, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact the investigator: Amisha Pandya (240) 676-6594 *apdiabetesstudy@verizon.net* This study is in no way affiliated with the temple and your decision to participate or not participate will have no effect on your current or future membership/services within the temple.
Participant Rights	If you have questions about your rights as a research participant or wish to report a research-related injury, please contact: **University of Maryland College Park** **Institutional Review Board Office** **1204 Marie Mount Hall** **College Park, Maryland, 20742** **E-mail: irb@umd.edu** **Telephone: 301-405-0678** This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.
Statement of Consent	Your signature indicates that you are at least 18 years of age; you have read this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree to participate in this research study. You will receive a copy of this signed consent form.

<table>
<tr><td></td><td colspan="2">If you agree to participate, please sign your name below.</td></tr>
<tr><td rowspan="3">Signature and Date</td><td>NAME OF PARTICIPANT

[Please Print]</td><td></td></tr>
<tr><td>SIGNATURE OF PARTICIPANT</td><td></td></tr>
<tr><td>DATE</td><td></td></tr>
</table>

Appendix F: Study Instruments and Data Collection Form

Participant Interview

Dietary Intake By Type Two Diabetes Mellitus Status in Asian Indians

Participant Interview

Name: ________________________________ Date of Interview:_______________
Contact Phone: _________________________ Email: _______________________
Street Address: ____
City: __________________________ State: ________ Zip Code: _______________
Date of Birth:___________________ Gender: M F

Birth Country ____________________________ Region/State: _________________
Birth Country (Mother): _____________________ Region/State: __________________
Birth Country (Father): ______________________ Region/State: __________________

Primary Language: _______________ Fluency: Read B I A; Write B I A; Speak B I A
Secondary Language: _____________ Fluency: Read B I A; Write B I A; Speak B I A
Other Languages: ________________ Fluency: Read B I A; Write B I A; Speak B I A
Primary Language Spoken in Home: ____

Years in US: ________ Generation in US: First Second Third Fourth
Other_______

Highest Level of Education Achieved:
High School Bachelors Masters Doctorate Professional (MD, DO, DS, JD, _____)

Marital Status: Married Coupled Single/Unattached

Household Income: <$50K $50K-100K $100K-150K $150K-200K >$200K
Family Structure: Nuclear Extended

Vegetarian: Y N Type of Vegetarian: No animal products (vegan)
Dairy but no meat/fish or poultry
Fish and/or poultry but no red meat
Other (specify: ______________________)

History of Smoking: Y N Current Smoker: Y N

Alcohol Use: Never Occasional (1-2/mo) Regular (1-3/wk) Frequent (>3/wk)

Responsible for household grocery shopping: Self Spouse Parents/In-Laws Child(ren)

Other________________________

Primary cook in household: Self Spouse Parents/In-Laws Child(ren)

Other____

Access to Transportation: Car/Licensed to Drive Car/Driven Public Transportation None

Other_______________________________

<u>Current Health Issues:</u>

Previous diagnosis of T2DM	Y	N
Elevated blood sugar/Prediabetes	Y	N
T1DM	Y	N
Heart disease/hypertension/CVD	Y	N
Cancer	Y	N
Mental health diagnoses (specify:_______________________)	Y	N
Pregnancy	Y	N
Other (specify: ______________________________________)	Y	N

Current Treatments for Health Issues:

Diagnosis	When Diagnosed	Test Result (if applicable)	Treatment/Medications	When Treatment Started

Appendix F: Study Instruments and Data Collection Form

Acculturation Tool – SL-ASIA

Name of Measure: The Suinn-Lew Asian Self Identity Acculturation (Suinn, Ahuna, & Khoo, 1992)

Purpose of Measure: To level of acculturation of Asian populations

Author(s) of Abstract:

Richard M. Suinn, Ph.D., ABPP
Emeritus Professor
Dept. of Psychology, Colorado State University

Five New Orthogonal Items that can be used in conjunction with or in place of the original 21 items. Also, the author states that all five or just #26 alone can be used to assess acculturation. NOTE: these new items have not been tested for reliability or validity. The author requests that results from the use of these items be shared with him.

22. Rate yourself on how much you believe in Asian Indian values (e.g., about marriage, families, education, work):

1	2	3	4	5
(do not believe in Asian values)				(Strongly believe in Asian values)

23. Rate yourself on how much you believe in American (Western) values:

1	2	3	4	5
(do not believe in Asian values)				(Strongly believe in Asian values)

24. Rate yourself on how well you fit when with other Asian Indians of the same ethnicity:

1	2	3	4	5
(do not fit)				(fit very well)

25. Rate yourself on how well you fit when with other Americans who are non-Asian (Westerners):

1	2	3	4	5
(do not fit)				(fit very well)

26. There are many different ways in which people think of themselves. Which ONE of the following most closely describes how you view yourself?

1. I consider myself basically an Asian Indian person. Even though I live and work in America, I still view myself basically as an Asian Indian person.
2. I consider myself basically as an American. Even though I have an Asian Indian background and characteristics, I still view myself basically as an American.
3. I consider myself as an Asian Indian-American, although deep down I always know I am an Asian Indian.
4. I consider myself as an Asian Indian-American, although deep down, I view myself as an American first.
5. I consider myself as an Asian Indian-American. I have both Asian and American characteristics, and I view myself as a blend of both.

Appendix F: Study Instruments and Data Collection Form

Physical Activity Tool – IPAQ – Short

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (August 2002)

SHORT LAST 7 DAYS TELEPHONE FORMAT

For use with Young and Middle-aged Adults (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ

The development of an international measure for physical activity started in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ

Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation

Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Data Entry and Coding

Attached to the response categories for each question are suggested variable names and valid ranges to assist in data management and interviewer training. We recommend that the actual response provided by each respondent is recorded. For example, "120 minutes" is recorded in the minutes response space. "Two hours" should be recorded as "2" in the hour's column. A response of "one and a half hours" should be recorded as either "1" in hour column and "30" in minutes' column.

Further Developments of IPAQ
International collaboration on IPAQ is on-going and an *International Physical Activity Prevalence Study* is in progress. For further information see the IPAQ website.

More Information
More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). Assessment of Physical Activity: An International Perspective. Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

Short Last 7 Days Telephone IPAQ

READ: I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

READ: Now, think about all the *vigorous* activities which take *hard physical effort* that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities?

_____ Days per week [VDAY; Range 0-7, 8,9]

8. Don't Know/Not Sure

9. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time.]

[**Interviewer note**: If respondent answers zero, refuses or does not know, skip to Question 3]

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

__ __ Hours per day [VDHRS; Range: 0-16]
__ __ __ Minutes per day [VDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Think only about those physical activities you do for at least 10 minutes at a time.]

[**Interviewer probe**: An average time for one of the days on which you do vigorous activity is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "How much time in total would you spend **over the last 7 days** doing vigorous physical activities?"

__ __ Hours per week [VWHRS; Range: 0-112]

__ __ __ __Minutes per week [VWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about activities which take *moderate physical effort* that you did in the last 7 days. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking. Again, think about only those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities?

____ Days per week [MDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time]

[**Interviewer Note**: *If respondent answers zero,* refuses or does not know, skip to Question 5]

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

__ __ Hours per day [MDHRS; Range: 0-16]

__ __ __ Minutes per day [MDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time.]

[**Interviewer probe**: An average time for one of the days on which you do moderate activity is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: "What is the total amount of time you spent over the **last 7 days** doing moderate physical activities?"

__ __ __ Hours per week [MWHRS; Range: 0-112]

__ __ __ __Minutes per week [MWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

____ Days per week [WDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[**<u>Interviewer clarification</u>**: Think only about the walking that you do for at least 10 minutes at a time.]

[**<u>Interviewer Note</u>**: <u>*If respondent answers zero,*</u> refuses or does not know, skip to Question 7]

6. How much time did you usually spend **walking** on one of those days?

__ __ Hours per day [WDHRS; Range: 0-16]

__ __ __ Minutes per day [WDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer probe**: An average time for one of the days on which you walk is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent walking over **the last 7 days**?"

__ __ __ Hours per week [WWHRS; Range: 0-112]

__ __ __ __Minutes per week [WWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about the time you spent sitting on week days during the last 7 days. Include time spent at work, at home, while doing course work, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

7. During the last 7 days, how much time did you usually spend ***sitting*** on a **week day**?

__ __ Hours per weekday [SDHRS; 0-16]

__ __ __ Minutes per weekday [SDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**<u>Interviewer clarification</u>**: Include time spent lying down (awake) as well as sitting]

[**<u>Interviewer probe</u>**: An average time per day spent sitting is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent *sitting* last **Wednesday**?"

__ __ Hours on Wednesday [SWHRS; Range 0-16]

__ __ __ Minutes on Wednesday [SWMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

Appendix F: Study Instruments and Data Collection Form

Food Frequency Questionnaire – SAFFQ

NutriMAPS FFQ-SA Instructions

HOW TO FILL OUT THIS QUESTIONNAIRE

We would like to know about your usual eating habits DURING THE LAST ONE YEAR.
Please complete this questionnaire without the help of your family or friends.
It will take you 30 minutes to 1 hour to finish.

1. For each food item listed in the booklet, choose **one** column (Per Day, Per Week, Per Month or Per Year/Never) that best describes HOW OFTEN you ate or drank that item. For example, if you ate EGGS 2 times per week during the last year, you would write | 0 | 2 | in the PER WEEK column.

   If you don't recognize the name, you probably don't eat it. If you never ate an item in the past year, fill in the last column (PER YEAR or NEVER) with 0 (= never eaten). DO NOT LEAVE BLANK.

2. We then want to know what size your USUAL SERVING is. We have given an example of an average serving size: is it less than that, the same, or more than that? Less than average = 3/4 or less than the average size. More than average = 1 1/4 times or more than the average size. Mark your serving size by putting an **X** in **one** of the boxes DO NOT LEAVE BLANK..

   Some questions ask you to refer to the picture page to help you to choose your usual serving size. Please use this page when filling out this questionnaire.

   If you never ate an item, it is not necessary to choose a serving size for that item.

3. Please try to average your seasonal use of foods over the entire year.

Please use a black pen to fill out this questionnaire.

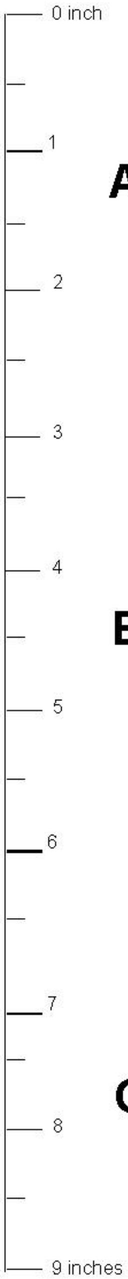
EXAMPLE

	How often? *Write in ONE column only*				Average Serving	Your Serving Size		
	Per Day	Per Week	Per Month	Per Year or Never		Less Than Average (small)	Average (medium)	More Than Average (large)
26. EGG, boiled, poached		0 2			1 egg	S	X	L
48. FRENCH FRIES and FRIED POTATOES			0 3		1 cup or small McDonald's	S	X	L
87. HOT DOGS, SAUSAGES (example pork, link sausages)				0 0	1hot dog or 2 links	S	M	L
112. BRAN or OAT MUFFINS		0 1			1 small or 1/2 large	S	M	X

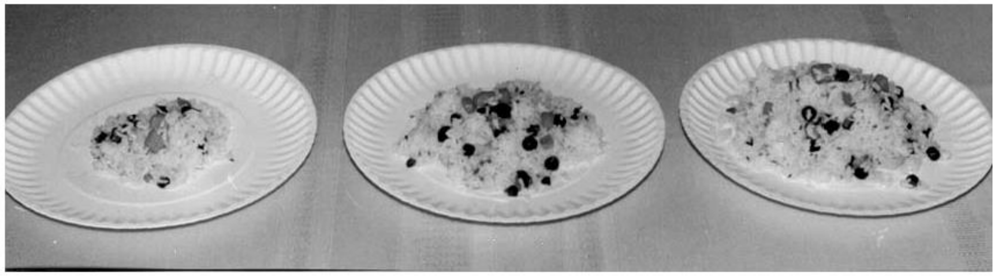
QUESTIONS?
PLEASE CALL THE OFFICE AT 1-800-263-9428

Adapted from the Study of Health Assessment and Risk in Ethnic groups (SHARE)™

Some foods in the questionnaire ask you to refer to either photo A, B or C to help you estimate your usual serving size. Please note that the dinner plate is 9 inches wide. The ruler on the left will help you to estimate this size.



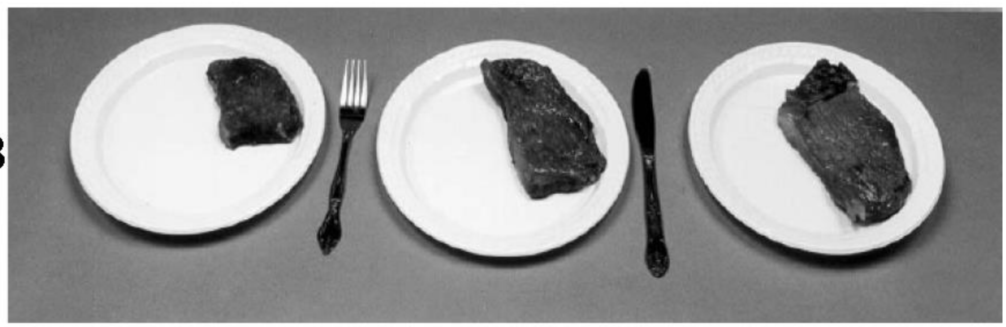
A



SMALL MEDIUM LARGE

Size of Dinner Plate Shown is 9 inches

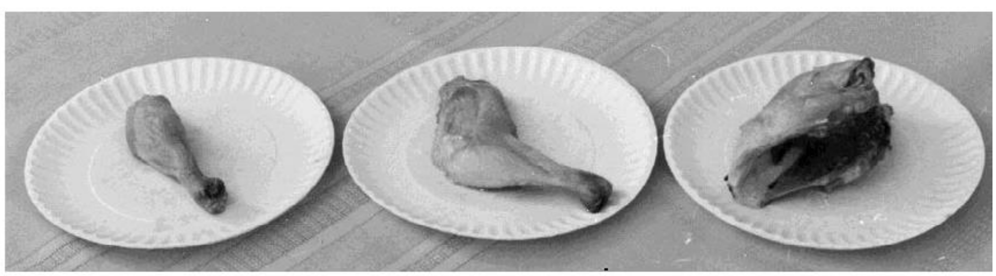
B



SMALL MEDIUM LARGE

Size of Dinner Plate Shown is 9 inches

C



SMALL MEDIUM LARGE

Size of Dinner Plate Shown is 9 inches

NutriMAPS **FFQ-SA** **SA-FFQ 3**

DRFAT

ID#

Client # Participant #

Date year month day

BEVERAGES	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
1. WHOLE MILK (HOMO) (as beverage or in cereal, but not in coffee or tea)					1 cup or 250 ml	S	M	L
2. 2% MILK (includes Lactaid) (as beverage or in cereal, but not in coffee or tea)					1 cup or 250 ml	S	M	L
3. 1% MILK (as beverage or in cereal, but not in coffee or tea)					1 cup or 250 ml	S	M	L
4. SKIM MILK (as beverage or in cereal, but not in coffee or tea)					1 cup or 250 ml	S	M	L
5. COFFEE, regular (brewed or instant)					1 cup or 250 ml	S	M	L
6. COFFEE, decaffeinated					1 cup or 250 ml	S	M	L
7. TEA, regular (Red Rose, Salada)					1 cup or 250 ml	S	M	L
8. MILK in Tea and Coffee Please mark type:								
Homo milk					2 tbsp or 30 ml	S	M	L
2%/1%					2 tbsp or 30 ml	S	M	L
Skim					2 tbsp or 30 ml	S	M	L
9. CREAM in Tea and Coffee Please mark type:								
Coffee cream					1 tbsp or 15 ml	S	M	L
Half & Half					1 tbsp or 15 ml	S	M	L
Non dairy creamer					1 tbsp or 15 ml	S	M	L

July 31, 2002

Please continue on next page

NutriMAPS FFQ-SA SA-FFQ 4

DRFAT

ID#

Client #	Participant #

BEVERAGES cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
10. SUGAR or HONEY in Tea and Coffee					1 tsp or 1 pak	S	M	L
11. COLAS, non dietetic (Coca Cola, Pepsi)					1 can or 355 ml	S	M	L
12. OTHER SOFT DRINKS, non dietetic (7-Up)					1 can or 355 ml	S	M	L
13. DIET COLAS					1 can or 355 ml	S	M	L
14. ORANGE, GRAPEFRUIT JUICE					3/4 cup or 175 ml	S	M	L
15. APPLE, PINEAPPLE, OTHER JUICES					3/4 cup or 175 ml	S	M	L
16. FRUIT DRINK (iced tea, lemonade)					1 cup or 250 ml	S	M	L
17. VEGETABLE JUICE					3/4 cup or 175 ml	S	M	L
18. YOGURT DRINK (also Lassi with sugar)					1 cup or 250 ml	S	M	L
19. BEER, ALE					1 bottle or 355 ml	S	M	L
20. WHITE WINE					5 oz or 150 ml	S	M	L
21. RED WINE, SHERRY, PORT					5 oz or 150 ml	S	M	L
22. SPIRITS, Liquor only					1.5 oz or 45 ml	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

	How often? *Write in ONE column only*				Average Serving	Your Serving Size		
DAIRY PRODUCTS	Per Day	Per Week	Per Month	Per Year or Never		Less Than Average (small)	Average (medium)	More Than Average (large)
23. EGG (ANDA), boiled, poached					1 egg	S	M	L
24. EGG, fried, scrambled, curry					1 egg	S	M	L
25. CHEESE, regular fat, CREAM CHEESE					1 slice or 2 tbsp	S	M	L
26. CHEESE, part-skim					1 slice or 30 gm	S	M	L
27. YOGURT, CURD, plain, regular fat					3/4 cup or 175 ml	S	M	L
28. YOGURT, Buttermilk, plain, low fat					3/4 cup or 175 ml	S	M	L
29. RAITA, with vegetables (cucumber, tomato, onion)					1/2 cup or 125 ml	S	M	L
30. YOGURT, fruit flavored					3/4 cup or 175 ml	S	M	L
31. PANIR, RICOTTA CHEESE in curry, Malai kofta, Matar pani					photo B, medium (1/2 cup)	S	M	L
VEGETABLES, PEAS AND BEANS								
32. POTATOES, boiled, mashed or baked					1 medium or 1/2 cup	S	M	L
33. POTATO SABJI, stir fried, dry or sukhi (made with no liquid, tari or sauce)					photo A, small (1/2 cup)	S	M	L
34. POTATO SABJI, curry (made with liquid, tari)					photo B, medium (1/2 cup)	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # | Participant #

VEGETABLES, PEAS AND BEANS cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size Less Than Average (small)	Average (medium)	More Than Average (large)
35. CAULIFLOWER or CABBAGE SABJI, stir fried					photo A, small (1/2 cup)	S	M	L
36. GREEN PEPPER SABJI, stir fried					photo A, small (1/2 cup)	S	M	L
37. FRENCH BEANS, STRING BEANS, stir fried					photo A, small (1/2 cup)	S	M	L
38. BROCCOLI SABJI, stir fried					photo A, small (1/2 cup)	S	M	L
39. PEAS or MATAR CURRY (includes corn)					photo B, medium (1/2 cup)	S	M	L
40. OKRA or BHINDI, stir fried					photo A, small (1/2 cup)	S	M	L
41. DARK LEAFY VEGETABLES (example spinach, palak ka saag, sarson ka saag)					1/2 cup or 125 ml	S	M	L
42. TOMATO, fresh					1 medium	S	M	L
43. ONIONS, raw, cooked, (alone or in mixed dishes such as curries)					1/2 cup or 125 ml	S	M	L
44. YELLOW SQUASH, PUMPKIN					1/2 cup or 125 ml	S	M	L
45. WHITE SQUASH, GHIA, ZUCCHINI, EGGPLANT					1/2 cup or 125 ml	S	M	L
46. VEGETABLE KOFTA CURRY					photo B, medium (1/2 cup)	S	M	L
47. LETTUCE					1 cup or 250 ml	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

VEGETABLES, PEAS AND BEANS cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
48. CUCUMBER					1/2 cup or 125 ml	S	M	L
49. CARROTS, raw or boiled					1/2 cup or 125 ml	S	M	L
50. CARROTS SABJI, stir fried					photo A, small (1/2 cup)	S	M	L
51. MIXED VEGETABLE SALADS (kachumbar, onion, tomato, pepper)					1/2 cup or 125 ml	S	M	L
52. SWEET POTATO, LEEKS, RADISH, OTHER ROOTS					1/2 cup or 125 ml	S	M	L
53. OTHER VEGETABLES, CURRY (example mushrooms, celery)					photo B, medium (1/2 cup)	S	M	L
54. OTHER VEGETABLES, STIR FRIED (example mushrooms, celery)					photo A, small (1/2 cup)	S	M	L
COOKED DRIED BEANS AND LENTILS								
55. LENTIL/DAL CURRY (moong, masoor, urad, chana dal, split peas, besan curry)					photo B, medium (1/2 cup)	S	M	L
56. SAMBHAR, RASAM					photo B, medium (1/2 cup)	S	M	L
57. CHICK PEAS CURRY (chane, white gram)					photo B, medium (1/2 cup)	S	M	L
58. OTHER DRIED BEANS CURRY (kidney beans/Rajmah, black-eyed beans)					photo B, medium (1/2 cup)	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

COOKED DRIED BEANS AND LENTILS cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
59. DHOKLA, IDLI (includes KHICHRI, no ghee)					2, 2" pieces	S	M	L
60. DOSA					1 medium	S	M	L
61. BUTTER/PURE GHEE on lentils, baghar					1 tsp or 1 pat	S	M	L
62. MARGARINE on lentils, baghar					1 tsp or 1 pat	S	M	L
MEATS/GOSHT								
63. BEEF CURRY, kofta, no vegetables					photo B, medium (1/2 cup)	S	M	L
64. GROUND BEEF (mince, hamburger, keema kabob, dry kofta)					6" kabob or 2 kofta or 3" patty	S	M	L
65. OTHER BEEF (roast, steak)					photo C, medium	S	M	L
66. PORK CURRY, kofta, no vegetables					photo B, medium (1/2 cup)	S	M	L
67. OTHER PORK (pork chop, mince,keema, kabob, dry kofta)					6" kabob or 2 kofta or 3" patty	S	M	L
68. GOAT , LAMB CURRY, no vegetables					photo B, medium (1/2 cup)	S	M	L
69. OTHER GOAT, LAMB (mince, roast, steak, chop, keema, kabob, dry kofta, raan)					6" kabob or 2 kofta or 3" patty	S	M	L
70. HOT DOGS, SAUSAGES (example pork, link sausages)					1 hot dog or 2 links	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

MEATS/GOSHT cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
71. LUNCH MEAT (ham, salami, bologna, bacon)					1 slice (about 30 g)	S	M	L
72. LIVER, fried or tala kaleja					photo C, medium	S	M	L
73. FRIED CHICKEN, (includes chicken nuggets), CHICKEN WINGS					photo C, medium or 4 wings	S	M	L
74. CHICKEN CURRY (includes turkey, duck)					photo B, medium (1/2 cup)	S	M	L
75. ROAST, TANDOORI CHICKEN, tikka, in rice					photo C, medium	S	M	L
76. FRESH FISH, MACHLI, steamed, baked					photo C, medium	S	M	L
77. FISH CURRY, fish ball, kofta curry					photo B, medium (1/2 cup)	S	M	L
78. CANNED FISH, salmon, sardines					1/2 can or 50 gm	S	M	L
79. DEEP FRIED FISH, breaded, battered, fish stick, tali machli					photo C, medium or 5 fish sticks	S	M	L
80. SEAFOOD, SHRIMP CURRY					photo B, medium (1/2 cup)	S	M	L
BREADS, CEREALS AND GRAINS								
81. WHITE BREAD					1 slice	S	M	L
82. WHOLE WHEAT BREAD, 100% (includes dark rye)					1 slice	S	M	L
83. WHOLE WHEAT BREAD, 60% (includes light rye)					1 slice	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

BREADS, CEREALS AND GRAINS cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
84. BREAD ROLLS (white flour), kaisers, bagels, hamburger/ hot dog buns					1 medium	S	M	L
85. BREAD ROLLS (whole wheat), kaisers, bagels					1 medium	S	M	L
86. ROTI, CHAPATI					1, 6" diameter	S	M	L
87. NAAN, PITA BREAD					1, 6" diameter	S	M	L
88. PARATHA, made with:								
oil					1, 6" diameter	S	M	L
pure ghee					1, 6" diameter	S	M	L
vegetable ghee					1, 6" diameter	S	M	L
89. PURI / MATHRI, fried in oil					1, 4" diameter	S	M	L
90. BRAN/GRANOLA CEREALS Specify usual brand: ____________					3/4 cup or 175 ml	S	M	L
91. WHOLE WHEAT CEREALS (such as Shreddies) Specify usual brand: ____________					1 cup or 250 ml	S	M	L
92. SUGAR COATED CEREALS (Frosted Flakes, Fruit Loops) Specify usual brand: ____________					1cup or 250 ml	S	M	L
93. NO SUGAR CEREALS (Corn Flakes, Rice Krispies) Specify usual brand: ____________					1cup or 250ml	S	M	L

Please continue on next page

DRFAT

ID#

Client # | Participant #

BREADS, CEREALS AND GRAINS cont.	Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Less Than Average (small)	Average (medium)	More Than Average (large)
94. COOKED CEREALS (porridge, oatmeal, dalia, bulgar) Specify usual brand: ______					1 cup or 250ml	S	M	L
95. SUGAR on cereal (white, brown)					1 tsp	S	M	L
96. CRACKERS (soda or snack type)					2 crackers	S	M	L
97. MUFFINS (bran, oat, fruit, fruit breads)					1 small or 1/2 large	S	M	L
98. RICE, boiled					photo A, small (1/2 cup)	S	M	L
99. FRIED RICE, plain or pulao					photo A, small (1/2 cup)	S	M	L
100. BUTTER on breads, roti or boiled rice					1 tsp or 1 pat	S	M	L
101. MARGARINE on breads, roti or boiled rice					1 tsp or 1 pat	S	M	L
SNACKS								
102. FRENCH FRIED POTATOES					1 cup or small McDonald's	S	M	L
103. SAMOSA, vegetable					1 medium	S	M	L
104. SAMOSA, meat					1 medium	S	M	L
105. VEGETABLE PAKORAS					photo A, small (1/2 cup)	S	M	L
106. PAPAD					1 small	S	M	L

How often? *Write in ONE column only*

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

SNACKS cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
107. DAL KI PAKORI / VADA includes yogurt topping					1/2 cup or 125 ml	S	M	L
108. DAHI PAPRI includes yogurt topping					1/2 cup or 125 ml	S	M	L
109. BHAJIA, SEV, GATHIA					1/4 cup or 60 ml	S	M	L
110. CRISP SNACKS (popcorn, potato chips, nachos)					1/2 cup or 125 ml	S	M	L
111. TIKIA ,potato patties, vegetable cutlets					1, 3" diameter	S	M	L
112. NUTS					2 tbsp or 30 ml	S	M	L
MIXED DISHES, PIZZA AND PASTA								
113. SOUP, creamed					photo B, medium (1/2 cup)	S	M	L
114. SOUP, not creamed					photo B, medium (1/2 cup)	S	M	L
115. PIZZA, no meat					1 medium slice	S	M	L
116. PIZZA, with meat					1 medium slice	S	M	L
117. MACARONI, SPAGHETTI, boiled					photo A, medium (1 cup)	S	M	L
118. PASTA WITH TOMATO SAUCE, no meat					photo A, medium (1 cup)	S	M	L
119. PASTA WITH CREAM SAUCE, no meat					photo A, medium (1 cup)	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

MIXED DISHES, PIZZA AND PASTA cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
120. PASTA WITH CHEESE/MEAT					photo A, medium (1 cup)	S	M	L
FRUITS								
121. APPLE, PEAR					1 medium	S	M	L
122. CITRUS FRUITS (oranges, clementines, grapefruit)					1 orange or 2 clementines or 1/2 grapefruit	S	M	L
123. BANANA					1 medium	S	M	L
124. GRAPES					1/2 cup or 125 ml	S	M	L
125. BERRIES (strawberries, raspberries)					1/2 cup or 125 ml	S	M	L
126. PEACH, PLUM, NECTARINE					1 medium peach or 1 large plum	S	M	L
127. CANTELOUPE					1 slice or 1/2 cup	S	M	L
128. WATERMELON, HONEYDEW					1 wedge or 1 cup or 250 ml	S	M	L
129. MANGO, PAPAYA					1/2 mango or 1/2 cup	S	M	L
130. ALL OTHER FRUIT (such as pineapple, kiwi)					1 slice or 1/2 cup	S	M	L
131. CANNED FRUIT					1/2 cup or 125 ml	S	M	L
132. DRIED FRUIT (such as raisins, dates)					1 tbsp raisins or 2 dates	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

DESSERTS AND SWEETS	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
133. CAKES					1 slice or 2" x 4" x 1"	S	M	L
134. DOUGHNUTS, SWEET ROLLS					1 doughnut or 1 sweet roll	S	M	L
135. ICE CREAM					1/2 cup or 125 ml	S	M	L
136. PIES AND TARTS, danish					1 slice or 1/6 pie	S	M	L
137. COOKIE					1 cookie	S	M	L
138. CHOCOLATE (includes chocolate candy, bar)					1 small-size bar (45 gm) or 5 chocolates	S	M	L
139. CANDY, no chocolate					2 candies	S	M	L
140. BARFI / LADOO, milk based, gajjar halwa					1 piece, 1"	S	M	L
141. BARFI / LADOO, (lentil, chick pea flour, besan-based, fried jalebi, bundi)					1 piece, 1"	S	M	L
142. CHUMCHUM / RASGULLA - type desserts					1 piece	S	M	L
143. GULAB JAMUN - type desserts, fried					1 piece	S	M	L
144. SUJI KA HALWA / LENTIL HALWA					1/2 cup or 125 ml	S	M	L
145. RASMALAI - type desserts					1 piece	S	M	L
146. RICE KHEER (suji kheer, seviaan)					1/2 cup or 125 ml	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

MISCELLANEOUS	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
147. TOFU					1/2 cup or 125 ml	S	M	L
148. PEANUT BUTTER					1 tbsp or 15 ml	S	M	L
149. JAM, SYRUP, HONEY (not used in beverages)					1 tsp	S	M	L
150. KETCHUP					1 tbsp or 15ml	S	M	L
151. SALAD DRESSING, creamy type, regular					1 tbsp or 15 ml	S	M	L
152. SALAD DRESSING, oil/vinegar, regular					1 tbsp or 15 ml	S	M	L
153. MAYONNAISE on sandwiches					1 tbsp or 15 ml	S	M	L
154. CORIANDER, MINT, PARSLEY (includes chutneys)					4-5 stalks or 1 tbs ground	S	M	L
155. COCONUT, fresh, in cooking, desserts, chutneys					1 tbsp or 1" piece	S	M	L
156. SOUTH ASIAN PICKLES, oil based (mango, lime, chili)					1 tsp	S	M	L
157. PICKLES in brine (such as dills, relish, Kanji)					1/2 dill or 1 tbsp	S	M	L
158. SOY SAUCE, in cooking, added to food					1 tsp	S	M	L
159. GINGER					1/2 tsp	S	M	L
160. FRESH GARLIC (includes use in cooking)					1/2 tsp	S	M	L

July 31, 2002

Please continue on next page

DRFAT

ID#

Client #	Participant #

MISCELLANEOUS cont.	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
161. CHILIES, green, red					1 small	S	M	L
162. ADDED SALT AT TABLE on raw or cooked dishes					2 sprinkles	S	M	L
163. SUGAR SUBSTITUTES (such as Equal, Nutrasweet)					1 pak or 1 tablet	S	M	L

FOR THE FOLLOWING QUESTIONS, PLEASE MARK **X** IN THE BOX THAT BEST DESCRIBES YOUR ANSWER

1. Are you a (*Please mark one box only)*:

- ☐ Non-vegetarian (eats **ALL** meat, chicken and fish)
- ☐ Vegan (eats **NO** meat, **NO** chicken, **NO** fish, **NO** milk/dairy foods, **NO** eggs)
- ☐ Lacto-vegetarian (eats milk/dairy foods, but **NO** meat, **NO** chicken, **NO** fish, **NO** eggs)
- ☐ Lacto-ovo vegetarian (eats milk/dairy foods and eggs, but **NO** meat, **NO** chicken, **NO** fish)
- ☐ Semi-vegetarian (eats meat occasionally)
- ☐ Vegetarian who eats chicken and fish, but **NO** meat

2. How much of the visible fat on the meats do you eat? (*Please mark one box only)*:

- ☐ most of it
- ☐ some of it
- ☐ as little as possible
- ☐ do not eat meat

Please continue on next page

DRFAT

ID#

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Client # *Participant #*

3. How often do you eat the skin on chicken? (*Please mark one box only)*:

☐ always

☐ often

☐ sometimes

☐ never

☐ do not eat chicken

4. What kind of fat do you usually use for cooking curries, sabji? (*Please mark one box only)*:

☐ vegetable oil ☐ pure ghee or butter ☐ do not cook

☐ vegetable shortening or vegetable ghee ☐ other, please specify: ___________________

5. What kind of fat do you usually use for frying? (*Please mark one box only)*:

☐ vegetable oil ☐ pure ghee or butter ☐ do not fry

☐ vegetable shortening or vegetable ghee ☐ other, please specify: ___________________

6. What kind of fat do you usually use for baking? (*Please mark one box only)*:

☐ butter ☐ vegetable shortening or vegetable ghee

☐ margarine ☐ pure ghee ☐ do not bake

☐ vegetable oil ☐ other, please specify:___________________

7. What type of oil do you usually use? (*Mark all that apply)*:

☐ corn oil ☐ sunflower oil ☐ vegetable oil

☐ canola oil ☐ soybean oil ☐ mustard oil

☐ peanut oil ☐ olive oil ☐ sesame oil or Til

☐ coconut oil ☐ other, please specify: ___________________

Please continue on next page

DRFAT

ID#

Client # Participant #

8. How often do you eat fried foods? *(Please mark one box only)*:

At home	Away from home
☐ daily	☐ daily
☐ 4-6 times per week	☐ 4-6 times per week
☐ 1-3 times per week	☐ 1-3 times per week
☐ less than 1 per week	☐ less than 1 per week

9. How often do you eat fresh fruits and vegetables? (*Please mark one box only*):

☐ more than 6 servings per day
☐ 5-6 servings per day
☐ 2-4 servings per day
☐ less than 1 serving per day

10. How often do you eat “take out” or meals away from home? (*Please mark one box only*):

☐ daily
☐ 4-6 times per week
☐ 1-3 times per week
☐ less than 1 per week

11. How often do you use coconut oil in cooking or coconut milk (liquid removed from shredded coconut which has been soaked in water)?

☐ often ☐ sometimes ☐ never

12. What type of the following items do you use? (*Please mark one box per line)*:

butter	☐ regular	☐ light	☐ both	☐ none
margarine	☐ regular	☐ light	☐ both	☐ none
mayonnaise	☐ regular	☐ light	☐ both	☐ none
cream cheese	☐ regular	☐ light	☐ both	☐ none
salad dressing	☐ regular	☐ calorie-wise	☐ both	☐ none
sour cream	☐ regular	☐ light	☐ both	☐ none

Please continue on next page

DRFAT

ID#

Client # Participant #

13. **VITAMINS**

During the last year, did you take any of the following multivitamins or multivitamins with minerals?

If no, put an **X** in the box NONE and continue to the next item.

If yes, please write the brand name, if known, the number of **pills** taken **per week** *(mark X)* and the number of **years** and **months** that you took them in the past.

VITAMINS/SUPPLEMENTS	None	More than 7 per week	7 per week	3-5 per week	1-2 per week	How long taken in years and months?	
Multiple vitamins, no minerals Brand: ________	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
Multiple plus iron Brand: ________	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
Multiple plus minerals Brand: ________	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
B complex: Brand: ________	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
Brewer's yeast	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
Cod liver or halibut oil	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo

Do not include your intake of multivitamins for the following. For each item, please mark **(X)** the number of **pills** taken **per week,** the number of **years** or **months** that you took them in the past and the **strength** you currently take (for example, 500 mg of Vitamin C),

Vitamin C only	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo

- ☐ 250 mg or less
- ☐ 500
- ☐ 1,000
- ☐ 1,500 or more

July 31, 2002

Please continue on next page

DRFAT

ID#

Client # Participant #

VITAMINS/SUPPLEMENTS cont.	None	More than 7 per week	7 per week	3-5 per week	1-2 per week	How long taken in years and months?	
Vitamin E only	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
☐ 200 IU or less							
☐ 400							
☐ 800							
☐ 1,000 or more							
Vitamin A only	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
☐ 5,000 IU or less							
☐ 10,000							
☐ 15,000							
☐ 25,000 or more							
Beta carotene only	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
☐ 5,000 IU or less							
☐ 10,000							
☐ 15,000							
☐ 25,000 or more							
Other vitamins:							
Folic Acid	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
Pyridoxin	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
B12	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo
Other: ________________	☐	☐	☐	☐	☐	☐☐ yrs	☐☐ mo

Please continue on next page

DRFAT

ID#

Client # Participant #

VITAMINS/SUPPLEMENTS cont.	None	More than 7 per week	7 per week	3-5 per week	1-2 per week	How long taken in years and months?
Iron only	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
☐ 50 mg or less						
☐ 100						
☐ 200						
☐ 300 or more						
Calcium only	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
☐ 500 mg or less						
☐ 1,000						
☐ 1,500						
☐ 2,000 or more						
Magnesium only	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
☐ 100 mg or less						
☐ 200						
☐ 300 or more						
Selenium only	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
☐ 50 ug or less						
☐ 100						
☐ 150						
☐ 200 or more						

July 31, 2002

Please continue on next page

DRFAT

ID#

☐☐☐ Client # ☐☐☐☐☐☐☐ Participant #

VITAMINS/SUPPLEMENTS cont.	None	More than 7 per week	7 per week	3-5 per week	1-2 per week	How long taken in years and months?
Zinc only	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo

☐ 20 mg or less

☐ 50

☐ 75

☐ 100 or more

14. Other health or nutritional products (example, ginseng) *Please specify:*

	None	More than 7 per week	7 per week	3-5 per week	1-2 per week	How long taken in years and months?
Garlic pills	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
Metamucil, psyllium, Isabgol	☐	☐	☐	☐	☐	☐☐ yrs ☐☐ mo

NAME OF ITEM	More than 7 per week	7 per week	3-5 per week	1-2 per week	How long taken in years and months?
______________________	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
______________________	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
______________________	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
______________________	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
______________________	☐	☐	☐	☐	☐☐ yrs ☐☐ mo
______________________	☐	☐	☐	☐	☐☐ yrs ☐☐ mo

Please continue on next page

NutriMAPS **FFQ-SA** **SA-FFQ 23**

DRFAT

ID#

Client # Participant #

Other FOODS or BEVERAGES consumed frequently	How often? *Write in ONE column only* Per Day	Per Week	Per Month	Per Year or Never	Average Serving	Your Serving Size: Less Than Average (small)	Average (medium)	More Than Average (large)
1.________						S	M	L
2.________						S	M	L
3.________						S	M	L
4.________						S	M	L
5.________						S	M	L
6.________						S	M	L
7.________						S	M	L
8.________						S	M	L
9.________						S	M	L
10.________						S	M	L

THANK YOU FOR YOUR HELP AND PARTICIPATION IN THE STUDY

July 31, 2002

Appendix F: Study Instruments and Data Collection Form

Anthropometric Measurements Data Collection Form

Participant ID: ___________________________

Date of Assessment: ______________________

Body Measurements:

Measurement	**Value 1**	**Value 2**	**Value 3**
Height			
Weight			
%Body Fat			
%Total Body Water			
Muscle Mass			
BMR			
Metabolic Age			
Bone Mass			
Visceral Fat			
Waist Circumference			
Hip Circumference			
Blood Sugar Measure	Value 1	Value 2	Date
Fasting Blood Glucose			
A1c			

Appendix G – Calculation of Physical Activity Score and Conversion to Kilocalories Burned

Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) - Short Form, Version 2.0. April 2004

Introduction

This document provides a revision to the outline for scoring the short form of the International Physical Activity Questionnaire (IPAQ). This is available on the website www.ipaq.ki.se.

There are many different ways to analyse physical activity data, but to-date there is no consensus on a correct method for defining or describing levels of activity based on self-report surveys. The use of different scoring protocols makes it very difficult to compare within and between countries, even when the same instrument has been used.

IPAQ is an instrument designed primarily for population surveillance of adults. It has been developed and tested for use in adults (age range of 15-69 years) and until further development and testing is undertaken the use of IPAQ with older and younger age groups is not recommended. IPAQ is being used also as an evaluation tool in some intervention studies, but the range of domains and types of activities included in IPAQ should be carefully noted before using it in this context.

This document describes the *April 2004 revision* to the IPAQ short scoring protocol[13]. These revisions have been suggested by the IPAQ scientific group, to examine variation among countries in more detail[14]. Given the broad range of domains of physical activity asked in IPAQ, new cut-points need to be trialed and developed to express physical activity in the population. These cut-points are preliminary, in the sense that they are not yet supported by epidemiological studies, which have typically used Leisure time physical activity (LTPA) to examine benefits or risks of being active. Hence, 30 minutes of moderate intensity PA on most days of the week was evidence-based, using the estimates of risk (reduction) from these LTPA measures in numerous epidemiological studies.

A new set of suggested cut-points is based on work in the area of total physical activity, specifically total walking, where recommendations of at least 10,000 steps, and possibly 12,500 steps per day are considered high active (Tudor Locke reference). This equates to at least 2 hours of all forms of walking per day, which includes all settings and domains of activity, and could be a population goal for total HEPA (health-enhancing physical activity). With this background, new cut-points are proposed for expressing physical activity levels in populations using generic physical activity measures such as IPAQ[15].

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[13] The first version of an IPAQ scoring protocol was in August 2003; this is a revised version, April 2004. This revised version does not change the continuous forms of reporting data, but does suggest a new category for describing the most active groups in populations. The changes from the August 2003 scoring protocol are indicated in this document.

[14] Previous scoring algorithms returned high prevalence rates with limited variation among countries; hence a higher cut point is sought, as the IPAQ instrument measures total PA, including LTPA as well as incidental, occupational and transport related PA all in one question. This results in much higher prevalence estimates than measures of LTPA alone.

[15] This results in changes to the categories used for levels of activity, and to the truncation rules [as greater than two hours per day may be required as usable data for walking and other physical activity behaviors].

Characteristics of the IPAQ short-form instrument:

1) IPAQ assesses physical activity undertaken across a comprehensive set of domains including leisure time, domestic and gardening (yard) activities, work-related and transport-related activity;
2) The IPAQ short form asks about three specific types of activity undertaken in the three domains introduced above and sitting. The specific types of activity that are assessed are walking, moderate-intensity activities and vigorous intensity activities; frequency (measured in days per week) and duration (time per day) are collected separately for each specific type of activity.
3) The items were structured to provide separate scores on walking; moderate-intensity; and vigorous-intensity activity as well as a combined total score to describe overall level of activity. Computation of the total score requires summation of the duration (in minutes) and frequency (days) of walking, moderate-intensity and vigorous-intensity activity;
4) Another measure of volume of activity can be computed by weighting each type of activity by its energy requirements defined in METS (METs are multiples of the resting metabolic rate) to yield a score in MET minutes. A MET-minute is computed by multiplying the MET score by the minutes performed. MET-minute scores are equivalent to kilocalories for a 60-kilogram person. Kilocalories may be computed from MET-minutes using the following equation: MET-min x (weight in kilograms/60 kilograms). The selected MET values were derived from work undertaken during the IPAQ Reliability Study undertaken in 2000-2001. Using the Ainsworth et al. Compendium (Med Sci Sports Med 2000) an average MET score was derived for each type of activity. For example; all types of walking were included and an average MET value for walking was created. The same procedure was undertaken for moderate-intensity activities and vigorous-intensity activities. These following values continue to be used for the analysis of IPAQ data: Walking = 3.3 METs, Moderate PA = 4.0 METs and Vigorous PA = 8.0 METs.[16]

Analysis of IPAQ

Both categorical and continuous indicators of physical activity are possible from the IPAQ short form. However, given the non-normal distribution of energy expenditure in many populations, the continuous indicator is presented as median minutes or median MET-minutes rather than mean minutes or mean MET-minutes.

Categorical score

Regular participation is a key concept included in current public health guidelines for physical activity.[17] Therefore, both the total volume and the number of day/sessions are included in the IPAQ analysis algorithms. There are three levels of physical activity suggested for classifying

---

[16] Note that there is still some debate about whether 8 Mets for vigorous is sustainable, in occupational settings for several hours; we have no data on this, but it is likely to be less than that, maybe 7 METs or even less; however, for the moment, we suggest keeping with the compendium value of * METs.

[17] Pate RR, Pratt M, Blair SN, Haskell WL , Macera CA, Bouchard C et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* 1995; 273(5):402-7. and U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General.* Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, The Presidents' Council on Physical Fitness and Sports: Atlanta, GA:USA. 1996.

populations; these are the new proposed levels, which take account of the concept of total physical activity of all domains. The proposed levels are:
[i] 'inactive'
[ii] 'minimally active'[18]
[iii] 'HEPA active' (health enhancing physical activity; a high active category).

The criteria for these three levels are shown below.

1. Inactive (CATEGORY 1)
This is the lowest level of physical activity. Those individuals who not meet criteria for Categories 2 or 3 are considered **'insufficiently active'** [CATEGORY 1].

2. Minimally Active (CATEGORY 2)
The minimum pattern of activity to be classified as sufficiently active. is any one of the following 3 criteria:
a) 3 or more days of vigorous activity of at least 20 minutes per day OR
b) 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day OR
c) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 600 MET-min/week.

Individuals meeting at least one of the above criteria would be defined as achieving the minimum recommended to be considered **'minimally active'** [CATEGORY 2]. This category is more than the minimum level of activity recommended for adults in current public health recommendations, but is not enough for total PA. when all domains are considered. IPAQ measures total physical activity whereas the recommendations are based on activity (usually leisure-time or recreational) over and above usual daily activities.

3. HEPA active (CATEGORY 3)
A separate category labeled **'HEPA'** level, which is a more active category [CATEGORY 3] can be computed for people who exceed the minimum public health physical activity recommendations, and are accumulating enough activity for a healthy lifestyle. This is a useful indicator because it is known that higher levels of participation can provide greater health benefits, although there is no consensus on the exact amount of activity for maximal benefit. Also, in considering lifestyle physical activity, this is a total volume of being active which reflects a healthy lifestyle. It is at least 1.5-2 hours of being active throughout the day, which is more than the LTPA-based recommendations of 30 minutes.[19]

In the absence of any established criteria, the IPAQ scientific group proposes this new cut point, which equates to approximately at least 1.5-2 hours of total activity per day, of at least moderate-intensity activity. It is desirable to have a 'HEPA' activity category, because in some populations, a large proportion of the population may be classified as minimally active because the IPAQ instrument assess all domains of activity. Category 3 sets a higher threshold of activity and provides a useful mechanism to distinguish variation in sub-population groups.

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[18] "Minimally active" implies some physical activity but is not an optimal level of total HEPA.

[19] As Tudor-Locke and others have indicated, there is a basal level of around 1 hour of activity just in activity of daily living, and an additional 0.5 – 1 hour of LTPA makes a healthy lifestyle amount of total PA – hence, these new cut points are still consistent with the general LTPA based public health recommendations of at least half an hour per day of additional activity or exercise.

The two criteria for classification as 'HEPA active' are:
a) vigorous-intensity activity on at least 3 days achieving a minimum of at least 1500 MET-minutes/week **OR**
b) 7 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 3000 MET-minutes/week.[20]

Continuous Score

Data collected with IPAQ can be reported as a continuous measure and reported as median MET-minutes. Median values can be computed for walking (W), moderate-intensity activities (M), and vigorous-intensity activities (V) using the following formulas:

MET values and Formula for computation of Met-minutes

Walking MET-minutes/week = 3.3 * walking minutes * walking days
Moderate MET-minutes/week = 4.0 * moderate-intensity activity minutes * moderate days
Vigorous MET-minutes/week = 8.0 * vigorous-intensity activity minutes * vigorous-intensity days

A combined total physical activity MET-min/week can be computed as the sum of Walking + Moderate + Vigorous MET-min/week scores.

The MET values used in the above formula were derived from the IPAQ validity and reliability study undertaken in 2000-2001.[21] A brief summary of the method is provided above (see page 1).

As there are no established thresholds for presenting MET-minutes, the IPAQ Research Committee proposes that these data are reported as comparisons of median values and interquartile ranges for different populations.

IPAQ Sitting Question

The IPAQ sitting question is an additional indicator variable and is not included as part of any summary score of physical activity. Data on sitting should be reported as median values and interquartile range. To-date there are few data on sedentary (sitting) behaviors and no well-accepted thresholds for data presented as categorical levels.

Data Processing Rules

In addition to a standardized approach to computing categorical and continuous measures of physical activity, it is necessary to undertake standard methods for the cleaning and treatment of IPAQ datasets. The use of different approaches and rules would introduce variability and reduce the comparability of data.

There are no established rules for data cleaning and processing on physical activity. Thus, to allow more accurate comparisons across studies IPAQ has established and recommends the following guidelines:

1. Data cleaning

- time should be converted from hours and minutes into minutes
- ensure that responses in 'minutes' were not entered in the 'hours' column by mistake during self-completion or during data entry process, values of '15', '30', '45', '60' and

[20] Note: this replaces the previous IPAQ short form cut point of 1500 met-mins/ week

[21] Craig *CL, Marshall A, Sjostrom M* Et al. International Physical Activity Questionnaire: 12 country reliability and validity Med Sci Sports Exerc 2003; August.

‘90’ in the ‘hours’ column should be converted to ‘15’, ‘30’, ‘45’, ‘60’ and ‘90’ minutes, respectively, in the minutes’ column.

- time should be converted to daily time [usually is reported as daily time, but a few cases will be reported as optional weekly time [e.g. VWHRS, VWMINS. convert to daily time]
- convert time to met-mins [see above; days x daily time]
- must have the number of days for the ‘day’ variables; for the ‘time’ variables, either daily or weekly time is needed if don’t know or refused or data are missing in walking, moderate or vigorous days or minutes, then that case is removed from analysis.

2. Maximum Values for excluding outliers

This rule is to exclude data which are unreasonably high; these data are to be considered outliers and thus are excluded from analysis. All Walking, Moderate and Vigorous time variables which total at least or greater than .16 hours. should be excluded from the analysis.
The ‘days’ variables can take the range 0-7 days, or 8,9 (don.t know or refused); values greater than 9 should not be allowed and those data excluded from analysis.

3. Truncation of data rules

This rule is concerned with data truncation and attempts to normalize the distribution of levels of activity which are usually skewed in national or large population data sets. It is recommended that all Walking, Moderate and Vigorous time variables exceeding 4 hours or 240 minutes. Are truncated (that is re-coded) to be equal to 240 minutes in a new variable.[22] This rule permits a maximum of 28 hours of activity in a week to be reported for each category of physical activity. *This rule requires further testing, but is an initial manner proposed for classifying these population data.*

When analyzing IPAQ data and presenting the results in categorical variables, this rule has the important effect of preventing misclassification in the high active category. For example, an individual who reports walking for 2.5 hours every day and nothing else would be classified as HEPA active (reaching the threshold of 7 days, and = 3000 MET mins. Similarly, someone who reported walking for 90 minutes on 5 days, and 4 hours (240 mins) of moderate activity on another day and 70 minutes of vigorous activity on another day, would also be coded as HEPA active because this pattern meets the ‘7 day’ and ‘3000 MET-min’ criteria for ‘HEPA active’.

4. Minimum Values for Duration of Activity

Only values of 10 or more minutes of activity will be included in the calculation of summary scores. The rationale being that the scientific evidence indicates that episodes or bouts of at least 10 minutes are required to achieve health benefits. Responses of less than 10 minutes [and their associated days] should be re-coded to ‘zero’.

Summary of Data Processing Rules 1- 4 above

Data management rules 2, 3, and 4 deal with first excluding outlier data, then secondly, recoding high values to 4 hours, and finally describing minimum amounts of activity to be included in

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[22] Note that this is a different truncation rule to the earlier scoring protocol; we have previously used 2 hours as a truncation point for LTPA measures. This higher truncation point is proposed in order to allow people who walk for 2.5 hours per day and do nothing else to be categorized as ‘HEPA’ active; if data were truncated, these individuals would be recoded to 2 hours per day, and over 7 days, total 2772 MET-mins, due to the truncation rule. The new truncation rule allows 2.5 hours to be counted in full. The initial purpose of truncation was to normalize the distributions, and was based on expert judgments. It is now suggested that 4 hours / day be proposed as a truncation threshold for more inclusive ‘lifestyle PA measures’ such as IPAQ.

analyses. These rules will ensure that highly active people remain highly active, while decreasing the chances that less active individuals are coded as highly active.

5. Calculating Total Days for 'minimally Active' [category 2] and 'HEPA Active' [category 3]

Presenting IPAQ data using categorical variables requires the total number of days on which all physical activity was undertaken to be assessed. This is difficult because frequency in days is asked separately for walking, moderate-intensity and vigorous-intensity activity, thus allowing the total number of days to range from a minimum of 0 to a maximum of 21 days per week. The IPAQ instrument does not record if different types of activity are undertaken on the same day.

In calculating **'minimal activity'**, the primary requirement is to identify those individuals who undertake a combination of walking and/or moderate-intensity activity on <u>at least '5 days'/week</u>. Individuals who meet this criterion should be coded in a new variable called *"at least five days"*.

Below are two examples showing this coding in practice:
i) an individual who reports '2 days of moderate' and '3 days of walking' should be coded as a value indicating *"at least five days"*;
ii) an individual reporting '2 days of vigorous', '2 days walking' and '2 days moderate' should be coded as a value to indicate *"at least five days"* [even though the actual total is 6].

The original frequency of 'days' for each type of activity should remain in the data file for use in the other calculations.

The same approach as described above is used to calculate total days for computing the **'HEPA active'** category. The primary requirement according to the stated criteria is to identify those individuals who undertake a combination of walking, moderate-intensity and or vigorous activity on <u>at least 7 days/week</u>. Individuals who meet this criterion should be coded in a value in a new variable to reflect *"at least 7 days"*.

Below are two examples showing this coding in practice:
i) an individual who reports '4 days of moderate' and '3 days of walking' should be coded as the new variable *"at least 7 days"*.
ii) an individual reporting '3 days of vigorous', '3 days walking' and '3 days moderate' should be coded as *"at least 7 days"*. [even though the total adds to 9].

Summary: The algorithm(s) in Appendix 1 and Appendix 2 to this document show how these rules work in an analysis plan, to develop the categories 1 [inactive], 2 [minimally], and 3 [HEPA] levels of activity. A short form ['at a glance'] and a diagram showing these analytic steps for 'sufficient physical activity' and 'high active' categories are shown as appendix 1 at the end of his document.

APPENDIX 1
At A Glance IPAQ Scoring Protocol (Short Versions)

Categorical Score- three levels of physical activity are proposed

1. <u>*Inactive*</u>
   - No activity is reported OR
   - Some activity is reported but not enough to meet Categories 2 or 3.
2. <u>*Minimally Active*</u>

   Any one of the following 3 criteria

- 3 or more days of vigorous activity of at least 20 minutes per day **OR**
- 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day **OR**
- 5 or more days of any combination of walking, moderate-intensity or vigorous intensity
- activities achieving a minimum of at least 600 MET-min/week.

3. *HEPA active*

Any one of the following 2 criteria

- Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week **OR**
- 7 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 3000 MET-minutes/week

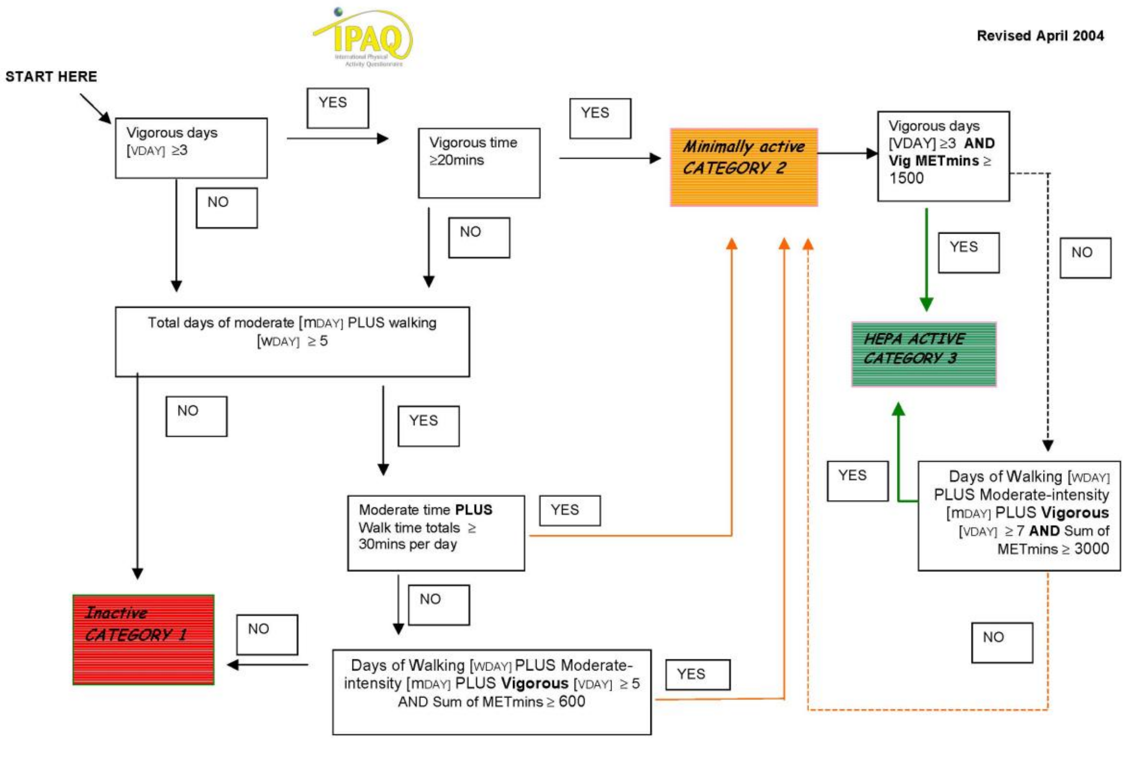
Continuous Score

Expressed as MET-min per week: MET level x minutes of activity x events per week

	Sample Calculation
MET levels	**MET-min/week for 30 min episodes, 5 times/week**
Walking = 3.3	METs 3.3*30*5 = 495 MET-min/week
Moderate Intensity = 4.0	METs 4.0*30*5 = 600 MET-min/week
Vigorous Intensity = 8.0	METs 8.0*30*5 = 1,200 MET-min/week
	TOTAL = 2,295 MET-min/week

Total MET-min/week = (Walk METs*min*days) + (Mod METs*min*days) + Vig METs*min*days)

Please review the document "Guidelines for the data processing and analysis of the international Physical Activity Questionnaire (Short Form)" for more detailed description of IPAQ analysis and recommendations for data cleaning and processing [www.ipaq.ki.se].



APPENDIX 2: Flow chart algorithm for the analysis of IPAQ short form

Appendix H – Acculturation SL-ASIA – Scoring

Name of Measure: The Suinn-Lew Asian Self Identity Acculturation (Suinn, Ahuna, & Khoo, 1992)

Purpose of Measure: To level of acculturation of Asian populations

Author(s) of Abstract: Richard M. Suinn, Ph.D., ABPP Emeritus Professor
Dept. of Psychology, Colorado State University

Dear Colleague:

You have my permission to use the SL-ASIA scale. It is duplicated below and on my web site: http://home.earthlink.net/~colosuinn/index.html. Please note that if you feel your sample is one that requires reading a translated version, this could mean that your sample is very restricted to a first generation. If so, then by definition you would not have enough subjects who represent the various levels of acculturation (low to middle to high). If so, then this restricted range will prevent you from testing any hypothesis regarding how "level of acculturation" or acculturation differences has effects.

Also note the usual principles regarding use of standardized tests: if you revise any part of the test - order of questions, wording of answers, etc. - then it may be questionable whether the test still is valid. Certainly, the question can be raised about whether the same norms can be used to interpret the results. If you choose to do such a revision, you should discuss the matter with a colleague who is a methodologist, or your advisor if you are a student.

After some thoughts about acculturation and its measurement, I have added questions 22-26 to the original 21 item scale. These questions can serve to further classify your research participants in ways that use current theorizing that acculturation is not linear, uni-dimensional but multi-dimensional and orthogonal. These new items were developed based on writings of those who felt that a linear, uni-dimensional scale was insufficient. Hence, we wrote some added items as a potential separate way of classifying the subjects...if the original scale did not turn out predictive. We have not obtained any validity/reliability info on these added items, but hope that users of the added items will share their results with me.

The following are suggestions for use of either the original 21 item scale or the newer items:

USING THE ORIGINAL 21 ITEMS:

In scoring these 21 items, add up each answer for each question on the scale, then obtain a total value by summing across the answers for all 21 items. A final acculturation score is calculated by then dividing the total value by 21; hence a score can range from 1.00 (low acculturation) to 5.00 (high acculturation). Because of the nature of the multiple choice content, it is possible to view low scores as reflective of high Asian identification, with high scores reflecting high Western identification. In other words, a low score reflects low acculturation, while a high score reflects high acculturation.

Another way of interpreting the total score relies upon recent discussions pointing out that there are actual three dimensions in acculturation. Thus, a person may be entirely assimilated into the new culture in all ways, for example, the Asian becomes completely identified as a part of the dominant Western society. This would be called "Western identified" or "assimilated" and would be represented in a SL-ASIA score of "5". Another person may retain identify with their ethnic heritage and refuse attempts to become integrated within the Western society. This would be called "Asian- identified" and would be represented in s SL-ASIA score of "1". Finally, there is now recognition that a person may be capable of assuming the best of two worlds, with denial to neither. The term used here is "bicultural" and would be reflected in a SL-ASIA score of "3". In addition to such an analysis of the total score, it is also possible to examine question number 20, which presents subjects with the opportunity to identify themselves as "very Asian," "bicultural," or "very Anglicized."

USING THE NEW ITEMS (Questions: 22/23, 24/25, OR 26)

1) Classifying by examining the answers to #22 and #23 together:

a) if #22 has "4" or "5" (high Asian values) and #23 has either "1", "2", or "3" (low Western values), then classify this person as Asian-identified; b) if #23 has "4" or "5" (high Western) and #22 has either "1", "2", or "3" (low Asian), then classify this person as Western-identified; c) if #22 has "4" or "5" (high Asian) and #23 has "4" or "5" (high Western), then classify this person as "bicultural"; d) if the subject has checked "1", or "2" for BOTH 22 and 23 (low Asian and low Western values), this person is denying any identification and may be alienated from both cultures.

Using these questions, you can re-examine your data with these items being used to re-classify or re-categorize your sample. For convenience call the scoring of the questions #22 and 23 the "SL-ASIA values score". Because the categorizing method uses a different set of variables then classification using the original 21 item SL-ASIA scores, you might obtain different results.

2) Classifying by examining the answers to #24 and #25 together:

a) if #24 has "4" or "5" (high Asian fit) and #25 has either "1", "2", or "3", (low Western fit) then classify this person as Asian-identified;
b) if #25 has "4" or "5" (high Western fit) and #24 has either "1", "2", or "3" (low Asian fit"), then classify this person as Western-identified
c) if #24 has "4" or "5" (high Asian fit) and #25 has "4" or "5" (high Western fit), then classify this person as "bicultural";
d) if the subject has checked "1", or "2" for BOTH 24 and 25 (low Asian and low Western fit) this person is denying any identification and may be alienated from both cultures.

As with use of items #22 and #23, this procedure involves categorizing and is not on a continuum. For convenience, call the scoring of items #24 and 25 the "SL-ASIA behavioral competencies score". The assumption is that "fitting" reflects the presence of behaviors that enables such a fit.

TABLE 1
SCORING OF QUES. 22/23 OR 24/25

		Answers to Questions 22 or 24				
		1	2	3	4	5
Q. 23 or 25	1	N	N	(A)	A	A
	2	N	N	(A)	A	A
	3	(W)	(W)	(B)	A	A
	4	W	W	W	B	B
	5	W	W	W	B	B

A=asian identified
B=bicultural
W=western
N=neither
(Alienated)
The scoring in parentheses are open to question. Either they can be used to score, or the alternative is to eliminate these persons from the analyses

3) Classifying by using item #26 is straightforward, since each possible answer is a category in itself:

a) answer 1 defines the person as Asian self-identified,
b) answer 2 is Western self-identified,
c) answers 3, 4, 5 are all bicultural-identified, but with sub-categories:
(1) answer 3 is "Bicultural, Asian self-identity"
(2) answer 4 is "Bicultural, Western self-identity"
(3) answer 5 is "Bicultural, bicultural self-identity"

Item #26 could therefore be scored on a continuum: Asian identified, Bicultural Asian, Bicultural/bicultural identity, Bicultural Western, and Western identified. In using item #26, for convenience call the scoring the "SL-ASIA self-identity score".

4) Item #26 might also be scored by another procedure, based on a very small pilot study we just completed:

a) answers using either 1 OR 3 would classify the person as "Asian identified"
b) answers using either 2 OR 4 would classify the person as "Western identified" c) answer using 5 classifies the person as "bicultural"

THEORETICAL COMMENT:

Let me suggest the following definitions (which is a simplified approach, but consistent with definitions used by some other writers):

Acculturation is a process that can occur when two or more cultures interact together. There are several possible outcomes of this process, including assimilation, whereby a host culture absorbs the immigrant culture, or multiculturalism, whereby both cultures exist side-by-side. On an individual level, exposure to another culture can lead a person to resisting change in his/her values and behavioral competencies, adopting the host culture's values and behavioral skills and styles as a replacement for his/her parent culture's values/behaviors, acquiring host culture values/behaviors while retaining parent culture values/behaviors with situational reliance determining which values/behaviors are in effect at different times.

Identity involves the individual's self-perception or subjective statement of his/her cultural character. By this definition, it is the individual who declares his/her "identity". It is therefore possible that a person's self-definition might be in contrast to the actual behavioral competencies or values possessed or expressed by the individual. For instance, an individual might fully possess the behavioral competencies necessary to "fit" and be accepted into a Western environment (job, school, residence, etc.), yet privately retain the identity of being "Asian".

Although the original SL-ASIA scale offers one method for measuring acculturation, these additional items (questions #22-26) might measure the topic in other ways. First, the items are not stated as uni-dimensional, linear but orthogonal. Secondly, research results might lead to different results using the different ways of classifying the participants:

- using the SL-ASIA 21 item scale, or
- using the SL-ASIA values scores to classify acculturation based upon values, or
- using the SL-ASIA behavioral competency scores to classify acculturation based upon behavioral skills that permit "fitting in", or
- using item #26 as a self-statement of identity, including three possible levels of bicultural, or
- using various scores in combination, e.g., high Asian values/high Asian behavioral competencies versus high Asian values/low Asian behavioral competencies; or high Asian values/high Asian self-identity versus high Asian values/Bicultural, bicultural self-identity, etc.

It is conceivable that new information might surface when the data are analyzed using one classification, but not another classification or scoring method. For example, it may turn out that identification based on self-identity is associated with different outcomes, than identification based on behavioral competencies or values. Further, each scoring method might lead to sub-categories. Consider the differences between a person who strongly believes in Western values and is able to strongly fit into a non-Asian group but who views him/herself as "Bicultural, Asian self-identity" versus a person who also strongly believes in Western values, is a strong fit into non-Asian environments but who views him/herself as "Bicultural, Western self-identity".

It is also possible that values scores and self-identity might represent a more stable prediction across diverse outcomes or settings, while predictions based on the behavioral competency scores might be situationally based. For instance, possibly behavioral competency scores can predict performance ratings at work, but not predict choice of spouse or sex role behaviors at home or on dates.

Not only am I encouraging research to study the differences when acculturation or identity is determined with the different methods of measurement or scoring, but I would also encourage the distinction between measuring performance versus satisfaction. Consider the following:

- An Asian-American client with strong Asian values and fits well into either Asian or Western environments (possesses Western behavioral competencies) and who self-identifies as an Asian- American ("Bicultural, bicultural self-identity ") is assigned to a non-Asian counselor who encourages self-disclosure. Our analysis would predict that although initial progress might be slow, this client will be able to work with the non-Asian counselor. This is based upon the client's possessing the Western behavioral competencies. Satisfaction ratings of counseling by the client, however, will probably be low.

- An Asian-American client with strong Asian values who fits poorly into Western environments and who self-identifies as Asian is assigned to a non-Asian counselor who encourages self-disclosure. Our prediction would be for an early termination. This is due to the conflict of values plus the inability of the client to engage in the Western behaviors required by the counselor.

Clearly, other factors can be expected to affect the ability to use acculturation or identity as a predictive variable. Free-choice versus restricted-choice is one dimension. With increased levels of restriction (e.g., savings too low to permit purchasing a home near a city with an Asian population), acculturation is - less influential as a predictive variable. With increased free-choice (e.g., numbers of eligible Asian and non-Asian dating partners), acculturation and self-identity might be more useful in prediction of behaviors. Consider:

- An Asian-American student needs electives for graduation. This student has high Asian values, possesses Western and Asian behavioral competencies, and self-identifies as "Bicultural, bicultural self -identity". This student could enroll in either an Asian-American Studies or Western Civilization elective and be satisfied with either set of courses.
- An Asian-American student needs electives. This student has high Asian values, possesses Western and Asian behavioral competencies, and self-identifies as Asian. This student would be more likely to select an Asian History course than a History of the Western World, if both were available as electives.
- An Asian-American student needs electives. This student has high Western values, possesses Western and Asian behavioral competencies, and identifies as "Bicultural, bicultural self-identity". This student would be more likely to select an Asian-American Studies elective than an Asian History or History of the Western World elective.

These views are theoretical predictions or hypotheses, based upon current beliefs about multi-dimensionality and orthogonality of acculturation. I am hopeful that those of you who are using the SL-ASIA will adopt the 26 item approach (especially if your research predictions are not upheld when using only the 21 item scores), and the various ways of analyzing your data. Please inform me of your results!

Sincerely,
Richard M. Suinn, Ph.D.
Professor of Psychology

References: Suinn, R. M., Ahuna, C., Khoo, G. (1992). The Suinn-Lew Asian Self-Identity Acculturation Scale: Concurrent and factorial validation. *Educational & Psychological Measurement*, 52(4), 1041-1046.

Appendix I: Calculation of Healthy Eating Index (HEI) 2015 Score

1. Download the 2013-2014 versions of the Food and Nutrient Database for Dietary Studies (FNDDS), the Food Patterns Equivalents Database (FPED), and the Food Patterns Ingredients Database (FPID) from the USDA's Agricultural Research Service website (www.ars.usda.gov).
2. Deconstruct each prepared food on the SAFFQ into its component parts with general proportions for each ingredient based on recipes posted online (note: water, herbs and spices were generally not enumerated in the list of ingredients; however, salt was included).
3. Map the Food Codes from the FNDDS to FPED and SR Codes from FNDDS to FPID for each deconstructed item on the SAFFQ.
4. Food/ingredient level multipliers were applied to whole foods and deconstructed foods based on the relative proportions of each ingredient, so that the weight of each food/ingredient summed to the serving size specified on the SAFFQ (this adjusted the serving size from the FNDDS to the serving size on the SAFFQ).
5. FNNDDS/FPED/FPID mapped table was joined to the FNDDS nutrient table to pull in nutrient value and description for each food (map on Nutrient Code).
6. FNDDS/FPED/FPID mapped table was joined to both the FNDDS portion size table and the FNDDS moisture and fat adjustment table to pull in portion sizes, portion descriptions (map on Portion Codes), and moisture and fat adjustments for uncooked ingredients (map on Food Code).
7. Join FNDDS/FPED/FPID mapped with nutrition information, portion sizes, and moisture and fat adjustments.
8. Map table from step 6 to the FPID table to pull in FPID food groups with equivalents for each food/ingredient (map on SR Code).
9. Pivot the nutrition information to get the total grams of each nutrient category (Carbohydrates, Energy, Fatty acids, Total Monounsaturated Fatty Acids, Total Polyunsaturated Fatty Acids, Total Saturated Fat, Fiber, Total Dietary Protein, Sodium, Sugars, Total Fat, and Alcohol) by FNDDS/FPED/FPID food/ingredient.
10. Convert SAFFQ serving size (weight in grams) of each food/ingredient to weight/100 grams.
11. Apply the food/ingredient multiplier to Food Group Equivalents from the FPID table to get an equivalent and nutrient value for each SAFFQ food item. This was done by taking the average/sum of the equivalents for each component of the FNDDS/FPED/FPID mapped food (e.g., if there were several versions of a food – such as full fat, low fat, and no fat - and the FFQ did not specify which one then the three were averaged to get an equivalent across all varieties; if there were several components of a deconstructed food then the ingredients were summed) and multiplying by the food/ingredient multiplier. This collapsed all food/ingredients to

the 163 food items on the SAFFQ giving food equivalents and nutrient values by FPED/FPID food groups for each SAFFQ food item.

12. Multiply equivalent of each SAFFQ food by FPED/FPID Food Group by the serving size reported consumed by each participant (obtained from PHRI's nutrient analysis) - this resulted in one table for each participant with 163 SAFFQ Food Items down the left column and FPED/FPID equivalent food groups and nutrient values across the top row.
13. Sum the equivalents and nutrient values for each FPED/FPID Food Group across all 163 SAFFQ food items to get one table of participants down the left column and FPED/FPID Food Groups across the top row with the inside of the table being equivalents applied to servings consumed for each participant.
14. Go to https://epi.grants.cancer.gov/hei/hei-methods-and-calculations.html
    a. Download the READ ME file to calculate HEI 2015 food categories from FFQ data from to calculate food group, nutrient, and energy intakes at the individual participant level for the 13 HEI 2015 categories: Total Fruit, Whole Fruit, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, Fatty Acids, Refined Grains, Sodium, Saturated Fats, and Added Sugars.
    b. Calculate the HEI 2015 categories as follows:
        - Calculation note for MONOPOLY: Monounsaturated fatty acids and polyunsaturated fatty acids are summed together (MONOPOLY = FATMONO + FATPOLY).
        - Calculation note for VTOTALLEG and VDRKGRLEG: VTOTALLEG sums together all vegetables and legumes (VTOTALLEG = MPED_V_TOTAL + MPED_LEGUMES); and VDRKGRLEG sums together dark green vegetables and legumes (VDRKGRLEG = MPED_V_DRKGR + MPED_LEGUMES). Note that legumes here are in cup equivalents (for vegetables), not in cup equivalents (as they would be for protein foods).
        - Calculation note for SFALLPROTLEG and SFSEAPLANTLEG*:* SFALLPROTLEG sums together all animal and plant proteins, including meat, poultry, fish, eggs, nuts, seeds, soy , and legumes (SFALLPROTLEG = MPED_M_MPF + MPED_M_EGG + MPED_M_NUTSD + MPED_M_SOY + PROTLEGUMES); while SFSEAPLANTLEG sums together all fish and plant proteins, including fish, nuts, seeds, soy, and legumes (SFSEAPLANTLEG = MPED_M_FISH_HI + MPED_M_FISH_LO + MPED_M_SOY + MPED_M_NUTSD + PROTLEGUMES). Note that legumes here are in ounce equivalents (for protein foods), not in cup equivalents (as they would be for vegetables). (PROTLEGUMES = MPED_LEGUMES*4; /*Convert cup equivalents of Legumes to oz. equivalents */)
    c. Down load the HEI 2015 Scoring Macro for SAS (version 1.0, 6/25/2017)

d. Apply definitions and calculations to calculate densities and total scores as follows:
   - Create 27 new variables: densities (per 1000 kcal) or percent (of total calories) for each of the 13 HEI 2015 components, scores for the 13 components of the HEI 2015, and a total HEI 2015 score.
   - Where,
     - "kcal" Specifies calorie amount
     - "vtotalleg" Specifies the intake of total veg plus legumes in cup eq.
     - "vdrkgrleg" Specifies the intake of dark green veg plus legumes in cup eq.
     - "f_total" Specifies the intake of total fruit in cup eq.
     - "fwholefrt" Specifies the intake of whole fruit in cup eq.
     - "g_whole" Specifies the intake of whole grain in oz. eq.
     - "d_total" Specifies the intake of total dairy in cup eq.
     - "pfallprotleg" Specifies the intake of total protein (includes legumes) in oz. eq.
     - "pfseaplantleg" Specifies the intake of seafood, fish and plant protein (includes legumes) in oz. eq.
     - "monopoly" Specifies the grams of mono fat plus poly fat.
     - "satfat" Specifies the grams of saturated fat.
     - "sodium" Specifies the mg of sodium.
     - "g_refined" Specifies the intake of refined grain in oz. eq.
     - "add_sugars" Specifies the intake of added sugars in tsp. eq.
     - "outdat" Specifies the name of the resulting dataset.
   - Apply the following formulas:

```
IF &kcal > 0 then VEGDEN=&vtotalleg/(&kcal/1000);
HEI2015C1_TOTALVEG=5*(VEGDEN/1.1);
IF HEI2015C1_TOTALVEG > 5 THEN HEI2015C1_TOTALVEG=5;
IF VEGDEN=0 THEN HEI2015C1_TOTALVEG=0;

IF &kcal > 0 then GRBNDEN=&vdrkgrleg/(&kcal/1000);
HEI2015C2_GREEN_AND_BEAN=5*(GRBNDEN/0.2);
IF HEI2015C2_GREEN_AND_BEAN > 5 THEN
HEI2015C2_GREEN_AND_BEAN=5;
IF GRBNDEN=0 THEN HEI2015C2_GREEN_AND_BEAN=0;

IF &kcal > 0 then FRTDEN=&f_total/(&kcal/1000);
HEI2015C3_TOTALFRUIT=5*(FRTDEN/0.8);
IF HEI2015C3_TOTALFRUIT > 5 THEN
HEI2015C3_TOTALFRUIT=5;
IF FRTDEN=0 THEN HEI2015C3_TOTALFRUIT=0;

IF &kcal > 0 then WHFRDEN=&fwholefrt/(&kcal/1000);
```

```
HEI2015C4_WHOLEFRUIT=5*(WHFRDEN/0.4);
IF HEI2015C4_WHOLEFRUIT > 5 THEN
HEI2015C4_WHOLEFRUIT=5;
IF WHFRDEN=0 THEN HEI2015C4_WHOLEFRUIT=0;

IF &kcal > 0 then WGRNDEN=&g_whole/(&kcal/1000);
HEI2015C5_WHOLEGRAIN=10*(WGRNDEN/1.5);
IF HEI2015C5_WHOLEGRAIN > 10 THEN
HEI2015C5_WHOLEGRAIN=10;
IF WGRNDEN=0 THEN HEI2015C5_WHOLEGRAIN=0;

IF &kcal > 0 then DAIRYDEN=&d_total/(&kcal/1000);
HEI2015C6_TOTALDAIRY=10*(DAIRYDEN/1.3);
IF HEI2015C6_TOTALDAIRY > 10 THEN
HEI2015C6_TOTALDAIRY=10;
IF DAIRYDEN=0 THEN HEI2015C6_TOTALDAIRY=0;

IF &kcal > 0 then PROTDEN=&pfallprotleg/(&kcal/1000);
HEI2015C7_TOTPROT=5*(PROTDEN/2.5);
IF HEI2015C7_TOTPROT > 5 THEN HEI2015C7_TOTPROT=5;
IF PROTDEN=0 THEN HEI2015C7_TOTPROT=0;

IF &kcal > 0 then SEAPLDEN=&pfseaplantleg/(&kcal/1000);
HEI2015C8_SEAPLANT_PROT=5*(SEAPLDEN/0.8);
IF HEI2015C8_SEAPLANT_PROT > 5 THEN
HEI2015C8_SEAPLANT_PROT=5;
IF SEAPLDEN=0 THEN HEI2015C8_SEAPLANT_PROT=0;

IF &satfat > 0 THEN FARATIO=&monopoly/&satfat;
FARMIN=1.2;
FARMAX=2.5;
if &satfat=0 and &monopoly=0  then HEI2015C9_FATTYACID=0;
    else if &satfat=0 and &monopoly  > 0 then
    HEI2015C9_FATTYACID=10;
    else if FARATIO >= FARMAX THEN
    HEI2015C9_FATTYACID=10;
    else if FARATIO <= FARMIN THEN HEI2015C9_FATTYACID=0;
    else HEI2015C9_FATTYACID=10* ((FARATIO-FARMIN) /
    (FARMAX-FARMIN));

IF &kcal > 0 then SODDEN=&sodium/&kcal;
SODMIN=1.1;
SODMAX=2.0;
IF SODDEN <= SODMIN THEN HEI2015C10_SODIUM=10;
  ELSE IF SODDEN >= SODMAX THEN HEI2015C10_SODIUM=0;
```

```
  ELSE HEI2015C10_SODIUM=10 - (10 * (SODDEN-SODMIN) /
(SODMAX-SODMIN));

IF &kcal > 0 then RGDEN=&g_refined/(&kcal/1000);
RGMIN=1.8;
RGMAX=4.3;
IF RGDEN <= RGMIN THEN HEI2015C11_REFINEDGRAIN=10;
  ELSE IF RGDEN >= RGMAX THEN
HEI2015C11_REFINEDGRAIN=0;
  ELSE HEI2015C11_REFINEDGRAIN=10 - (10* (RGDEN-RGMIN) /
(RGMAX-RGMIN));

IF &kcal > 0 then SFAT_PERC=100*(&satfat*9/&kcal);
SFATMIN=8;
SFATMAX=16;
IF SFAT_PERC >= SFATMAX THEN HEI2015C12_SFAT=0;
  ELSE IF SFAT_PERC <= SFATMIN THEN HEI2015C12_SFAT=10;
  ELSE HEI2015C12_SFAT= 10 - (10* (SFAT_PERC-SFATMIN) /
(SFATMAX-SFATMIN));

IF &kcal > 0 then ADDSUG_PERC=100*(&add_sugars*16/&kcal);
ADDSUGMIN=6.5;
ADDSUGMAX=26;
IF ADDSUG_PERC >= ADDSUGMAX THEN
HEI2015C13_ADDSUG=0;
  ELSE IF ADDSUG_PERC <= ADDSUGMIN THEN
HEI2015C13_ADDSUG=10;
  ELSE HEI2015C13_ADDSUG= 10 - (10* (ADDSUG_PERC-
ADDSUGMIN) / (ADDSUGMAX-ADDSUGMIN));

IF &kcal=0 THEN DO;
HEI2015C1_TOTALVEG=0; HEI2015C2_GREEN_AND_BEAN=0;
HEI2015C3_TOTALFRUIT=0; HEI2015C4_WHOLEFRUIT=0;
HEI2015C5_WHOLEGRAIN=0; HEI2015C6_TOTALDAIRY=0;
HEI2015C7_TOTPROT=0; HEI2015C8_SEAPLANT_PROT=0;
HEI2015C9_FATTYACID=0; HEI2015C10_SODIUM=0;
HEI2015C11_REFINEDGRAIN=0; HEI2015C12_SFAT=0;
HEI2015C13_ADDSUG=0;
END;

/**Calculate HEI-2015 total score**/
/*total HEI-2015 score is the sum of 13 HEI component scores*/

HEI2015_TOTAL_SCORE = HEI2015C1_TOTALVEG +
HEI2015C2_GREEN_AND_BEAN + HEI2015C3_TOTALFRUIT +
```

```
HEI2015C4_WHOLEFRUIT + HEI2015C5_WHOLEGRAIN +
HEI2015C6_TOTALDAIRY +
HEI2015C7_TOTPROT + HEI2015C8_SEAPLANT_PROT +
HEI2015C9_FATTYACID + HEI2015C10_SODIUM +
HEI2015C11_REFINEDGRAIN + HEI2015C12_SFAT +
HEI2015C13_ADDSUG;
```

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