# ABSTRACT

Title of Document: A STUDY OF DIETARY PATTERNS IN THE MEXICAN-AMERICAN POPULATION AND THEIR ASSOCIATION WITH OBESITY

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Data from the National Health and Nutrition Examination Survey (NHANES) indicate that the trend toward increasing overweight and obesity among Mexican-Americans is continuing. This large population subgroup has a high prevalence of obesity and associated chronic conditions. Ethnic groups have different dietary patterns based on their geographical locations and various cultural influences. We examined the dietary patterns of Mexican-Americans and their association with total and central obesity. We hypothesized that Mexican-American adults following a traditional diet would have a lower prevalence of obesity than those following a more typically American diet. Data from the NHANES 2001-2002 included 835 adults, aged 18 and older. Dietary patterns were defined by cluster analysis of food group variables, expressed as percentage contribution to total energy intake. Obesity was assessed by body mass index (BMI, $kg/m^2$) and central obesity by waist circumference. We defined four dietary patterns, each named after the food groups

that were most predominant relative to the other clusters: poultry and alcohol, baked products, traditional foodstuffs (such as tacos, tortillas, etc.), and meat. Surprisingly, we did not identify a "healthy pattern" group in this population, as has been generally observed in other ethnic groups. Contrary to our hypothesis, the traditional diet pattern was associated with higher values of BMI and waist circumference. More details on possible changes within the traditional pattern associated with availability of foods and industrialization, including use of fast food vs. home-prepared Mexican foods, are needed to better understand the observed association with obesity.

# A STUDY OF DIETARY PATTERNS IN THE MEXICAN-AMERICAN POPULATION AND THEIR ASSOCIATION WITH OBESITY

By

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**Thesis submitted to the Faculty of the Graduate School of the University of Maryland, College Park, in partial fulfillment of the requirements for the degree of Master of Science 2006**

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## DEDICATION

**To my loving husband David, whose love and guidance have accompanied me during my years in the Master's program.**

**To my devoted parents, Guido and Rina, whose lifetime of support has continually encouraged me to reach my goals.**

**To my siblings, Guido, Jr., and Melvin, whose hard work and professional lives have been constant inspirations in my life.**

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| NHANES | National Health and Nutrition Examination Survey |
| BMI | Body mass index |
| HEI | Healthy eating index |
| CSFII | Continuing survey of food intake by individuals |
| MEC | Mobile examination center |
| GED | Graduate equivalency degree |
| MET | Metabolic equivalent |
| SD | Standard deviation |
| WHO | World Health Organization |
| AHA | American Heart Association |

# CHAPTER 1: BACKGROUND AND SIGNIFICANCE

## 1.1. Mexican-American Population in the United States

The Hispanic population differs widely by region. Geographical location, history and development, and the availability of foods creates differences in the diet and food choices of Hispanic peoples. These various Hispanic populations keep their traditions and build other habits of their own once they immigrate. In order to get better information about these groups, the Census Bureau categorizes Hispanics into subgroups, such as Mexican, Puerto Rican, Cuban, Central and South American, and other origins (1). The largest and relatively most disadvantaged Hispanic subgroup in the United States is of Mexican origin (2- 5).

The term Mexican-American refers to anyone who is resident in the United States and who describes himself or herself as of Mexican origin. The U.S. Census Bureau defines origin as the heritage, nationality group, lineage, or country of birth of the person or the person's parents or ancestors before their arrival in the United States (1).

In the 1990s, Mexicans constituted more than half of the new Hispanic immigrants to the United States and by 2000 Hispanics as a whole totaled about two-thirds (66 percent) of all immigrants entering the United States. Hispanics constituted about 12 percent of the total U.S. population in 2000. Some estimates show that Hispanics may constitute up to 25 percent of the U.S. population by 2050. These changes take into account immigration and fertility as well (5).

Educational attainment is lowest among people of Mexican origin in the United States (5). For example, in 2000, 86.6 percent of native-born Americans had graduated from high school and the graduation rates for the foreign-born population in the United States varied from 94.9 percent for Africans, 83.8 percent for Asians, 49.6 percent for Hispanics. Mexican ranked lowest at 33.8 percent. As a result, Mexican immigrants and Mexican-Americans lag behind not only the native population but also other immigrant groups on a variety of economic indicators, including professional occupations, home ownership, and household income (5).

## 1.2. Health of the Mexican-American Population in the United States

The National Health and Nutrition Examination Survey (NHANES) data indicate that the incremental increase of obese and overweight Mexican-Americans previously observed between the 1982-1984 NHANES and the 1988-1994 NHANES III seems to be continuing in the 1999-2002 NHANES. In this most recent survey 73% of Mexican-American adults were overweight and 33% were obese (4).

Furthermore, this increasing obesity raises concerns about its health implications for Mexican-Americans. Obesity is a risk factor for many chronic diseases, including diabetes, hypertension, high cholesterol, stroke, heart disease, certain cancers, and arthritis. Of these conditions, diabetes may be the most closely linked to obesity. Its prevalence appears to parallel the high rate of obesity in the Hispanic population in general (6.7) and, because of the large proportion of the Hispanic population in the U.S. that is of Mexican origin, in the Mexican-American population in particular.

### 1.3. Obesity

Obesity is a worldwide epidemic (8,9,10,11), and it is also a disease. The WHO defines obesity as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired (12). If this excess of fat is in the waist area the risk for health problems is high (13). Obesity is widely recognized as a major risk factor for coronary heart disease because it raises blood cholesterol and triglycerides levels, lowers high density lipoprotein, raises blood pressure levels, and can induce type 2 diabetes (13).

Obesity results from an imbalance between the energy that we eat as food and the energy that we expend to keep our bodies in action. Numerous factors influence this imbalance. However, this discussion of factors in obesity will address three major topics: the genetic determinants of obesity, the distribution of body fat in obesity, and the influences of social factors. Stunkard (14) mentions that if the heritability on human obesity is no more than 33%, then 66% of the variances in BMI must be environmental. The World Health Organization (12) points out that the rising epidemic of obesity reflects changes in society and in behavioral patterns of communities over recent decades. Thus, economic growth, industrialization, urbanization, and the globalization of food markets are some of the forces that may underlie the epidemic.

### 1.3.1. How is Body Fat Measured?

Willet (15) points out that measurements of frame size may be useful in epidemiologic studies because they reflect an influence of diet in the past that may be difficult to measure in any other way.

Body mass index (BMI) and waist circumference measurement are two recommended ways to estimate body fat for populations and are widely used in epidemiological studies for their simplicity (12,13)

#### 1.3.1.1- Weight-height indices (body mass index)

There is general agreement among researchers and expert panels that Quetelet's index, also called body mass index, is the preferred method for assessing the body weight of children, adolescents, and adults. The body mass index formula evaluates body weight relative to height. It is a useful, indirect measure of body composition, because in most people it correlates highly with body fat (13). Garrow and Webster (16) showed that BMI correlated well with estimates of body composition from three methods -- body density, total body water, and total body potassium -- concluding that BMI is a convenient and reliable indicator of obesity. However, investigators have suggested combining the BMI index with waist circumference measurements for assessing the risk in adults for heart disease, stroke, type-2 diabetes, and premature death (16-20).

#### 1.3.1.2. Waist circumference

The waist circumference reflects the magnitude of abdominal adipose tissue deposits, as well as total fat mass, providing a measure of body fat distribution (21,22). Zhu et al. (23), in their study entitled "Race-ethnicity-specific Waist Circumference Cutoff for Identifying Cardiovascular Disease Risk Factors," found no significant difference in waist circumference among different ethnic groups for women or between black and whites for men. Observing that Mexican-American men have a lower risk for cardiovascular disease, the authors proposed a rounded cutoff of 90 to 100 cm for men and 85 to 95 cm for women for waist circumference assessment of risk. However, the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults of the National Institutes of Health suggest a cutoff value of 102 cm. for men and 88 cm. for women (21). The WHO recognizes that ethnic populations differ in the level of risk associated with a particular waist circumference but a globally applicable grading system of waist circumference has not been developed (12). Hence, in this study we assessed BMI and waist circumference using the National Institutes of Health guidelines as a reference (Table 1).

### 1.3.2. Measurement of Outcomes

The WHO graded the excess of fat and classified obesity to establish multiple comparisons between populations, to identified risk of morbidity and mortality and for intervention at individual and community levels (12). The National Center for Health Statistics in agreement with the World Health Organization (12) defines:

- BMI values less than 18.5 as underweight.
- BMI values from 18.5 to 24.9 as normal.
- Overweight as a BMI of 25 to less than 30 (consistent with the U.S. Dietary Guidelines for Americans). A BMI about 25 corresponds to about 10 percent over ideal body weight.
- Obesity as a BMI of 30 or greater, or about 30 pounds or more as overweight. Extreme obesity is defined as a BMI of 40 or greater.

A high-risk waist line is more that 88cm for women and 102cm for men.

Table 1. Classification of overweight and obesity by body mass index (BMI), waist circumference, and associated disease risk in adults

| | | | Disease risk* relative to normal weight and waist circumference | |
|---|---|---|---|---|
| | BMI ($kg/m^2$) | Obesity class | Men≤40 in. (≤102cm.) Women≤35in. (88cm.) | Men >40in. (>102cm.) Women>35in. (>88cm.) |
| Underweight | <18.5 | | - | - |
| Normal | 18.5-24.9 | | - | - |
| Overweight | 25-29.9 | | Increased | High |
| Obesity | 30-34.9 | I | High | Very high |
| | 35-39.9 | II | Very high | Very high |
| Extreme obesity | ≥40 | III | Extremely high | Extremely high |

From Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults (consistent with the criteria of the WHO) Washington, DC: National Institutes of Health, U.S. Department of Health and Human Services. 1998 (24).

*Disease risk for type-2 diabetes, hypertension, and cardiovascular disease. Increased waist circumference can also be a marker for increased risk even in persons of normal weight (24).

### 1.4. Dietary Pattern

The value of a varied diet is well recognized because people need many kinds of foods to meet their requirements for essential nutrients. However, lack of nutritional diversity is a particular problem among certain populations, especially in the developing world, where diets are based predominantly on starchy staples and often include few or no animal products and only limited seasonal fruits and vegetables (25). Recently, epidemiological investigations have used dietary patterns to understand the influence of diet over chronic diseases. Many studies support the value of dietary pattern analysis and some focus on the relationship of overall dietary patterns to health risk (2, 26-44). In fact cardiovascular disease and cancer have a substantial dietary basis, and estimates suggest that better eating habits – for instance, increasing the intake of vegetables and fruits -could result in considerable improvements in public health (45-48). Newby et al. (27), in a study of dietary patterns and corresponding changes in body mass index (BMI) and waist circumference, concluded that consuming a diet that is high in fruit, vegetables, reduced-fat dairy products, and whole grains while low in red and processed meat, fast food, and soda was associated with smaller gains in BMI and waist circumference. Furthermore, some ecological observations show that distinct eating patterns are associated with different diet-related disease rates. For example, Mediterranean and Asian diets have attracted considerable interest as alternatives to the Western diet (49-53) because Greece and Japan both have low rates of diet-related chronic diseases. The World Health Organization now suggests that dietary allowances for populations should be based on the totality of their diets rather than on the traditional focus on nutrients and recommends increased intake of vegetables and fruit (54).

Mexican-American preferences in food have differences and similarities from the typical American diet and from those of other ethnic groups. However, these traditional patterns are changing with the migration process (3,55,56), and globalization. Studies in Mexico show an increased availability of inexpensive calorie-dense foods in rural and urban areas (57). Total energy, cholesterol, saturated fat and total fat intakes were consumed in greater quantities in high socio-economic status. These patterns may be the contributing factor for the observed high rates of obesity and other conditions such as high serum glucose, triglycerides, blood pressure among others (57,58). In addition, low micronutrient adequacies reflected the poor consumption of fruits and vegetables throughout the country (57).

The nutrition environment in the United States has been changing rapidly. Over the past two decades, the habit of dining out has increased and typically those foods contain more fat, saturated fat and less fiber than foods prepared at home (59). Also, expanding portion size have become more common since 1970, and appears to contributing to the obesity epidemic (60).

Understanding traditional patterns of diet in the Mexican-American population, differences and similarities with the new environment would give epidemiologists and nutritionists better ways to promote good health and prevent diseases, particularly obesity.

## 1.5. Acculturation and Diet

Acculturation is a long-term process during which individuals simultaneously learn and modify certain aspects of their values, norms, and behavior, including diet and lifestyle (61,62). Structural and acculturation-related characteristics vary by ethnicity and generation (63,64). Pena and Bacallao (8) mention that people of developing countries tend to incorporate some elements when coming into contact with the cultural patterns of the developed countries. Those elements are part of an image of a developed country projected into a lesser developed one that often leads people to adopt inappropriate habits and lifestyles. Pena and Bacallao (8) concluded that the more succesful groups manage to adapt to these changes. In contrast, the poorer groups suffer from the conflict between their ability to make good choices and the "ideal image". As a result, those who have more limited cultural and social opportunities have not only micronutrient deficiencies but also excess body weight (8,10,11). As a consequence, these groups place themselves at risk of contracting infectious diseases and chronic non-communicable diseases associated with their diets.

Moreover, the process of acculturation is complex and is influenced by many factors. For Hispanic immigrants this process might include linguistic, social, cultural, and economic changes as well. Acculturation-related changes may increase the risk of obesity and chronic diseases because of altered meal composition and less physical activity (2, 3,8, 26, 65-67).

Although many researchers have studied acculturation, there is little agreement about how it should be assessed. Hazuda et al. (67) measured acculturation in the Mexican-American population on three scales, examining functional integration of subjects with mainstream society, the value placed on maintaining Mexican cultural identity, and their attitude toward traditional family structure and gender-role organization. Finch et al. (68) evaluated birth and duration in the United States as proxies for acculturation. These variables were categorized into three strata: 1) recent immigrants, defined as those less than ten years in the United States; 2) long-term immigrants, with ten years or more in the United States; and 3) those born in the United States. Lin et al. (26) assessed acculturation with a set of questions on the use of English and /or Spanish for speaking, reading, and writing. Also, Mazur et al. (65) measured acculturation as the language spoken at home by the household head. It was defined in three categories: 1) Spanish only; 2) Spanish and English; and 3) English only.

The San Antonio Heart Study (67) showed that culturally mediated factors have more influence on dietary patterns and chronic diseases in Mexican-Americans than do socio-economic factors. Furthermore, Aldrich et al. (69) examined whether the quality of Hispanic diets differed based on acculturation, using the 1994-1996 Continuing Survey of Food Intake by Individuals (CSFII) and the scores on the U.S. Department of Agriculture's Healthy Eating Index (HEI). Dividing the Hispanic survey respondents into Spanish speakers and English speakers they found that, despite their economic disadvantage, Spanish speakers eat more healthful diets than do non-Hispanic Whites and English-speaking Hispanics. However, the effects of acculturation, which accounts for economic improvement, changes diet quality. These trends have been observed not only in Mexican-Americans but also in groups in other countries, both developed and less developed, which show increases in obesity as they become more affluent (9-11,70,71). Another important finding in this study is that difference in fat, cholesterol, and fiber intake contribute to the higher HEI scores of Spanish speakers. Adult Spanish speakers average approximately 4.6 grams less total fat and 1.9 grams less saturated fat per day than non-Hispanic Whites. However, the cholesterol consumption of Spanish speakers exceeds recommended levels, while cholesterol consumption of the other groups stays below recommended levels. Interestingly, the authors contacted a sub-sample of the respondents of the CSFII to measure attitudes towards the importance of a healthful diet from the Diet and Health Knowledge Survey. Knowledge of nutrient content was measured by making the correct choices between pairs of foods on the basis of higher or lower fat content or other nutritional indicators. The higher HEI scores of Spanish speakers' were not the result of better nutritional knowledge.

## 1.6 Other Socio-economic Factors

### 1.6.1. The Gender Effect

Studies of Mexican-American populations show the different influences of acculturation upon men and women and suggest that the process generates more obesity in women (11,65). Some authors mention that in this particular population females have more limited opportunities, deal with heavier social responsibilities, and have an undervalued body image (8,10). Women spend significant parts of their time in occupational, household, and family care activities and less time in recreational and conditioning activities. Irwin et al. (72) evaluated physical activity of 146 women.

They measure all daily activities accounting for moderate-intensity physical activity and maximal treadmill duration accounting for vigorous-intensity physical activity. When examining the association between physical activity and metabolic syndrome, it was found that the odds of having metabolic syndrome was 82% lower among the most active women (≥491 MET minute/day of moderate-intensity physical activity) compared with the least active women (<216 MET-minute/day of moderate-intensity physical activity.)

### 1.6.2. The Income Effect

Even though NHANES data reveal that persons below the poverty line have a significantly greater risk of obesity (3, 8), and studies such as the one presented by Mazur et al. (65) suggest that socio-economic status is associated with poor diet, food insufficiency, and poor health, the relationship between income and obesity is not clear-cut. Aldrich et al. (69) note that despite lower incomes and educational attainments, the Hispanic population in the U.S. enjoys a health and mortality record that is more favorable than that the general population. This outcome contradicts expectations that would be formed from the lower income and education levels of Hispanics. It also was found that lower incomes were associated with less healthful diets among non-Hispanics, but with more healthful diets among first-generation Mexican-Americans. Among second generation Mexican-Americans, Aldrich et al. found no relationship between income and diet quality (69).

## 1.7. Cluster Analysis

Clustering techniques has been applied to a wide variety of research problems as for example: in medicine to cluster diseases or cures for diseases, in psychiatry to find the correct diagnosis of clusters of symptoms, in archeology for taxonomies of stone tools, funeral objects, etc. The term “cluster analysis” (first used by Tryon, 1939) cover a number of different algorithms and methods for grouping objects of similar kinds into their respective categories. Cluster analysis, as used in nutritional studies, is an exploratory data analysis tool defined as “the process of organizing objects into groups whose members are similar in some way” (73). Thus, using cluster analysis we will organize our observed data into meaningful structures. These structures will group individuals with similar dietary characteristics into groups based on Euclidean distance measures.

### 1.7.1. Euclidean Distance

This is a measure of a distance in the multidimensional space. The advantage of this method is that the distance between any two objects is not affected by the addition of new objects to the analysis. However the distance can be affected by differences in scale among dimensions from which the distances are computed. Thus, it is good practice to transform the dimensions before determining distances (74). By default, the FASTCLUS procedure uses Euclidean distances, so the cluster centers are based on least-squares estimation (75).

# CHAPTER 2: METHODOLOGY

## 2.1. OBJECTIVES OF THE STUDY

**2.1.1. Primary Goal:** The purpose of this study is to investigate which dietary patterns characterize the Mexican-American population in the United States and their association with obesity.

**2.1.2 Long-term Implication:** Knowing about the particular characteristics of diet and food selection of Mexican-Americans help us to understand how to promote good health and prevent diseases, obesity in particular.

## 2.2 EXPERIMENTAL DESIGN

### 2.2.1 United State National Survey Data

The National Center for Health Statistics of the Centers for Disease Control and Prevention has conducted a series of nationally representative health examination surveys in the United States, the National Health and Nutrition Examination Surveys (NHANES). For all surveys, the target population is the civilian, non-institutionalized population. For NHANES III and NHANES 1999-2002, Mexican-Americans were over-sampled, relative to their proportion of the population, in order to have a larger sample size and make better estimates for this group (76).

NHANES researchers also collected information on gender, age, current cigarette smoking, household income, educational level, and physical activity by questionnaire, which was described in detail elsewhere (76).

**2.2.2. Study Population** The study selected 835 Mexican-American adults, 18 years old and older.

Exclusion criteria: Pregnant or lactating women and subjects with implausible energy intakes (less than 600 Kcal or more than 4500 Kcal per day) were excluded.

### 2.2.3. Assessment of Variables

#### 2.2.3.1. Dietary Assessment

The dietary assessment in NHANES was made by 24-hour diet recall in a mobile examination center (MEC) by trained interviewers. Information from the 24-hour recall includes the names of foods, the times those were consumed, the type of meal or snack eaten, and where the food was consumed.

An in-person interview methodology was used for all dietary interviews. The dietary interviewer recorded the information reported by the respondents using a computer-assisted dietary software program that was developed for the survey. Instructions were provided to the respondents orally in English and/or Spanish. Measurement aids and visuals, including charts and drawings, were used by the respondents to quantify the foods and beverages that were reported (76,77).

Values of protein, carbohydrate, fat, saturated fat, and total sugar intakes were expressed as percentage of energy; cholesterol, and fiber intake were expressed in milligrams and grams respectively, and energy intake expressed in calories per day.

#### 2.2.3.2. Anthropometric Assessment

Weight (Kg.), height (m), and waist circumference (cm.) were obtained in the MEC by trained interviewers as well, and they were used for comparisons among the dietary pattern groups.

Measurements of body mass index (BMI) in $Kg/m^2$ and waist circumference in cm were analyzed to define the risk of overweight and obesity. For this study we followed the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults of the National Institutes of Health, U.S. Department of Health and Human Services (24).

#### 2.2.3.3. Assessment of Other Variables

In addition, the collection of demographic variables as for example level of acculturation was measured by the language used at home (only Spanish, more Spanish than English, both equally, more English than Spanish or only English). Education level [less than high school, high school diploma (including GED), and more than high school], household income in dollars, and smoking (yes, no) were obtained by a questionnaire at each interviewed home.

Finally, leisure time physical activity was measure by metabolic equivalent (MET) score for the activity. The scores were obtained from personal communication with the interviewer about the activities and the duration (78). Activities for which the person reported less than 10 minutes or more than 12 hour per day were excluded (79).

### 2.2.4. Statistical Analysis

Statistical Analysis was performed using SAS version 9.1 (SAS Institute, Inc, Cary, NC.) The data analysis requires either the interviewed sample weight or examined sample weight for 2001-2002 years. Also, as will be explained in detail in the discussion as follow, we used demographic and leisure-time physical activity data to adjust for potential confounding in regression analysis.

#### 2.2.4.1. Dietary Patterns

Data on food intake, obtained with 24 hours diet recall, were collapse into 60 items previously defined by Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging at Tufts University (Table 2). Then, we generated 36 food groups categorized by nutrient content (e.g. diet dairy products) and cooking method (e.g. tortillas made of corn or wheat). To define the dietary patterns we expressed the dietary intake in total energy values and ran cluster analysis procedure with FASTCLUS procedure with a predefined number of clusters from 3-7. Variation due to differences in gender, age, body size, and physical activity were diminished by standardizing the dietary intake to proportion of total energy (2).

Table 2. Short list of foods defined by Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging at Tufts University

| | | | |
|---|---|---|---|
| 1 | 'Milk and Milk Products' | 31 | 'Beef' |
| 2 | 'Lowfat Milk & Lowfat Products' | 32 | 'Pork' |
| 3 | 'Cream' | 33 | 'Lamb, Veal, Game' |
| 4 | 'Non-Dairy Creamer' | 34 | 'Processed Meat, Sausage, Franks' |
| 5 | 'Pudding, Custard, Cheesecake' | 35 | 'Fish' |
| 6 | 'Yogurt' | 36 | 'Liver & Organ Meats' |
| 7 | 'Cheese' | 37 | 'Cakes, Cookies, Pies, Doughnuts' |
| 8 | 'Ice Cream, Sherbet, Frozen Yogurt' | 38 | 'Ready-to-eat Cereals' |
| 9 | 'Peanut Butter' | 39 | 'Hot Breakfast Cereals' |
| 10 | 'Gelatin/Sherbet' | 40 | 'White Breads & White Products' |
| 11 | 'Butter' | 41 | 'Wheat Breads & Wheat products' |
| 12 | 'Margarine' | 42 | 'Corn Bread, Muffins' |
| 13 | 'Oils & Salad Dressings' | 43 | 'Other Grain Products' |
| 14 | 'Other Fats' | 44 | 'Rice' |
| 15 | 'Citrus Fruits' | 45 | 'Pasta' |
| 16 | 'Citrus Fruit Juices' | 46 | 'Tortillas/Tacos' |
| 17 | 'Other Fruits' | 47 | 'Potato Chips, Corn Chips, Popcorn' |
| 18 | 'Other Fruit Juices' | 48 | 'Pizza' |
| 19 | 'Fruit Drinks' | 49 | 'Diet Soft Drinks/Soda' |
| 20 | 'Orange Vegetables & Sweet Potato' | 50 | 'Soft Drinks/Soda' |
| 21 | 'Dark Green Leafy Vegetables' | 51 | 'Coffee & Tea' |
| 22 | 'Tomatoes & Tomato Products' | 52 | 'Alcoholic Beverages' |
| 23 | 'Other Vegetables' | 53 | 'Nuts & Seeds' |
| 24 | 'Potatoes' | 54 | 'Soups' |
| 25 | 'Other Root Crops' | 55 | 'Candy & Sugar' |
| 26 | 'Beans/Legumes' | 56 | 'Low-calorie Candy & Artificial Sugar' |
| 27 | 'Soybean and Soybean Products' | 57 | 'Condiments' |
| 28 | 'Plantains' | 58 | 'Supplements' |
| 29 | 'Eggs' | 59 | 'Water' |
| 30 | 'Chicken/Turkey' | 60 | 'Baby Food' |

### 2.2.4.2. Comparisons Across Dietary Patterns

The general linear model (GLM) procedure in SAS was used to assess comparisons across dietary patterns by regressing continuous descriptive variables and nutrient variables adjusted for the effect of age, gender, total energy intake, smoking (yes or no) income, education level, and physical activity. Multiple comparisons were adjusted with Tukey to balance type 1 and type 2 error. Also, comparisons between gender statistical descriptive data were analyzed by T-test, and comparisons across categorical variables were evaluated by chi-square test.

#### 2.2.4.3. Statistical Models Analyzed

**a. Energy and Nutrient Intakes Were Adjusted for:**

- **Model 1** The GLM analysis was adjusted by age, gender.
- **Model 2** The GLM analysis was adjusted by age, gender, income, education, and physical activity.

**b. In Addition, BMI and Waist Circumference Were Adjusted for:**

- **Model 1** The GLM analysis was adjusted by total energy intake and smoking.
- **Model 2** The GLM analysis was adjusted by total energy intake, smoking and physical activity.

Previous to the model design, an analysis of interactions was run in all variables, and variables that were not significantly different at 0.05 level, were dropped.

# CHAPTER 3: RESULTS

## 3.1. Characteristics of the Study Sample

From the 1200 Mexican-American adults interviewed in NHANES, 835 remained after removing pregnant women, those with extreme caloric intakes, and outliers (6 SD). Data from our sample of 835 subjects were unfortunately not complete, and so we selected 659 subjects with complete data for further analysis. Descriptive statistics were analyzed for these two samples to verify that they are representative of the same population. These values are shown in Table 3.

Table 3. Characteristics of the study sample

| Variables | Sample 1 | | Sample 2 | |
|---|---|---|---|---|
| Age (years) | 36.0 | (n =835) | 37.2 | (n =659) |
| BMI (kg/m²) | 27.8 | (n =803) | 28 | (n =659) |
| Waist-circumference(cm) | 93.9 | (n =803) | 94.5 | (n =659) |
| Smoking % | 24 | (n =778) | 23 | (n =6590 |
| Household income $ | 41 567 | (n =750) | 42 789 | (n =659) |
| Education % | | | | |
| Less than high school | 54.8 | (n =659) | 55.1 | (n =659) |
| High school diploma | 19.6 | (n =659) | 18.4 | (n =659) |
| More than high school | 25.6 | (n =659) | 26.5 | (n =659) |
| Total energy (Kcal) | 2198 | (n =835) | 2192 | (n =659) |
| Protein (gm) | 82.8 | (n =835) | 83.0 | (n =659) |
| Carbohydrates (gm) | 286.1 | (n =835) | 284.6 | (n =659) |
| Total fat (gm) | 76.9 | (n =835) | 77.2 | (n =659) |
| Alcohol (gm) | 8.9 | (n =835) | 8.5 | (n =659) |

Sample means and frequencies were calculated separately for women and men. Men constituted 52% of the sample, with an average age of 36 y, while women constituted 48%, with an average age of 37 y. Nutrient consumption was statistically different between the men and women. Subjects' characteristics by gender are provided in Table 4.

Table 4. Characteristics of the study sample by gender

| Variables | Men (n=343) | Women (n=316) |
|---|---|---|
| Age (years) | 36.1 ± 0.7 | 38.7 ± 0.8 |
| BMI (kg/m²) | 27.4 ± 0.3 | 28.7 ± 0.4** |
| Waist circumference (cm) | 97.5 ± 0.7 | 93.2 ± 0.8* |
| Smoking % | 26.8% | 13.9% *** |
| Household income $ | 43 047 ± 1457 | 42 483 ± 1572 |
| Education % | | |
| < than high school | 59.5% | 57.0% |
| High school diploma | 16.3% | 15.8% |
| > than high school | 24.2% | 27.2% |
| Total energy (Kcal) | 2454 ± 44 | 1875 ± 37.2*** |
| Carbohydrates (gm) | 319 ± 6.6 | 243 ± 5.3*** |
| Protein (gm) | 92.8 ± 2 | 71.4 ± 1.7*** |
| Total fat (gm) | 83.9 ± 2.1 | 69 ± 1.8*** |
| Saturated fat (gm) | 26.4 ± 0.8 | 22.3 ± 0.7*** |

Values are means ± SD
Asterisks indicate difference from women, *p<0.05, **p<0.01, ***p<0.001

### 3.2. Assessment of Dietary Patterns and Cluster Analysis

In order to run a cluster analysis, we aggregated the 60 items into 36 items or food groups, based on similarity of nutrient content (i.e., fat, carbohydrate, and protein) and cooking method (i.e., tortillas of wheat and corn). This procedure was done using SAS version 8.1 See Table 5.

Table 5. Foods categorized by nutrient content, cooking methods, and frequency of use

| | | |
|---|---|---|
| 1 | (1) | Milk and milk products |
| 2 | (5,8) | Dairy desserts (pudding, custard, cheesecake, ice cream) |
| 3 | (6) | Other dairy products (yogurt) |
| 4 | (7) | Cheese |
| 5 | (2) | Lowfat and lowfat products |
| 6 | (3,11) | Butter, cream, sour cream |
| 7 | (4,12,14) | Processed fat products (margarine, non-dairy creamer) |
| 8 | (13) | Oils, cooking oils, and salad dressings |
| 9 | (9,53) | Nuts and seeds, peanut butter |
| 10 | (15,16) | Citrus fruits, natural citrus fruit juices |
| 11 | (17,18) | Non-citrus fruits and natural non-citrus fruit juices |
| 12 | (20) | Orange vegetables (not sweet potatoes) |
| 13 | (21) | Dark green, leafy vegetables |
| 14 | (22) | Tomatoes and tomato products |
| 15 | (24,25,28) | Starchy vegetables (potatoes, sweet potatoes, plantain) |
| 16 | (23,57) | Other vegetables (onions, chilis, peppers) |
| 17 | (26,27) | Legumes (beans, lentils, garbanzos, soy products) |
| 18 | (29) | Eggs |
| 19 | (31,32,33) | Red meat |
| 20 | (30) | Poultry |
| 21 | (35) | Seafood and fish |
| 22 | (36) | Liver and organ meats |
| 23 | (34) | Processed meat (sausage, bacon) |
| 24 | (37) | Cakes, cookies and pies |
| 25 | (38,39) | Breakfast cereals |
| 26 | (42,46) | Tortillas, tacos, and corn products |
| 27 | (40,41) | Wheat products |
| 28 | (45) | Pasta |
| 29 | (43,44,58) | Grain products, rice, supplements |
| 30 | (47) | Chips and processed snacks |
| 31 | (48) | Pizza and other Italian dishes |
| 32 | (19,49,50) | Flavored, sweetened drinks (sodas and juices) |
| 33 | (51) | Coffee and tea |
| 34 | (52) | Alcoholic beverages |
| 35 | (54) | Soups |
| 36 | (10,55,56) | Candy, chocolate, jams, jellies. |

Also, because cluster analysis is an exploratory tool, it is necessary to select the number of clusters to be used in the analysis. We predefined the number of clusters from 3 to 7. This step was performed with FASTCLUS procedure in SAS

Version 8.2 (SAS Institute, Inc, Cary, NC.) Beforehand we removed the outliers, that is, subjects whose energy contribution from any food group was greater than or equal to six standard deviations from the mean. After examining each solution we defined the most meaningful group, which was composed of four dietary clusters. We named the four dietary patterns after the predominant food that contributed the relatively greater proportion of energy to each cluster (relative to the other clusters): poultry and alcohol, milk and baked products, traditional Mexican foods (such as tacos, tortillas, etc.), and meat (Table 6).

Across dietary pattern groups, average energy contributions for specific food groups differed. Notably, flavored, sweetened drinks seemed to be a favorite drink in all four groups, with a relatively large percentage of calorie intake coming from these drinks. Because of their prevalence throughout the groups, we did not select them to be a defining food for any one particular group.

Subjects in the poultry and alcohol group obtained energy from different food sources, with large percentages of energy from poultry (16.6%), alcohol (10.0%) and flavored, sweetened drinks (12.9%). Subjects in the milk and baked products group obtained higher percentages of energy from flavored, sweetened drinks (11.04%), cakes and cookies (8.6%), and milk (6.8%). Subjects in the traditional group obtained substantially higher percentages of energy from tortillas and tacos (35.0%), flavored, sweetened drinks (10.8%), and legumes (5.6%). Subjects from the meat group obtained relatively high amounts of energy from red meat (25.9%), flavored, sweetened drinks (10.2%), and traditional foodstuffs (9.1%).

Table 6. Energy (%) contribution from selected food groups by dietary pattern

| Food groups | Poultry and alcohol (n=154) | Milk and baked products (n=318) | Tortillas (n=180) | Meat (n=183) |
|---|---|---|---|---|
| **Dairy desserts** | 1.90 | 1.25 | 0.61 | 1.11 |
| **Processed fat** | 1.32 | 0.75 | 0.87 | 0.5 |
| **Oils, cooking oils** | 2.35 | 1.1 | 0.31 | 0.88 |
| **Orange vegetables** | 0.14 | 0.1 | 0.05 | 0.07 |
| **Starchy vegetables** | 4.14 | 2.19 | 2.03 | 3.4 |
| **Other vegetables** | 1.69 | 1.25 | 0.98 | 0.97 |
| **Poultry** | 16.56 | 1.56 | 1.42 | 1.49 |
| **Seafood and fish** | 1.86 | 1.24 | 1.3 | 0.89 |
| **Wheat products** | 6.5 | 5.08 | 1.88 | 4.67 |
| **Chips and processed snacks** | 3.66 | 3.31 | 2.5 | 3.4 |
| **Flavored, sweetened drinks** | 12.91 | 11.04 | 10.76 | 10.24 |
| **Alcoholic beverages** | 10.02 | 1.01 | 2.19 | 3.48 |
| **Milk** | 2.36 | 6.84 | 3.66 | 3.13 |
| **Other dairy products** | 0.01 | 0.12 | 0.05 | 0 |
| **Cheese** | 1.2 | 2.67 | 1.33 | 1.8 |
| **Butter, cream** | 0.22 | 0.25 | 0.14 | 0.16 |
| **Nuts, peanut butter** | 1.1 | 1.34 | 0.5 | 0.86 |
| **Citrus fruits** | 0.7 | 2.42 | 1.66 | 0.94 |
| **Non-citrus fruits** | 2.86 | 3.98 | 3.32 | 2.85 |
| **Green, leafy vegetables** | 0.06 | 0.07 | 0 | 0.03 |
| **Processed meats** | 1.67 | 2.84 | 0.96 | 1.18 |
| **Cakes, cookies** | 4.98 | 8.58 | 3.82 | 4.32 |
| **Breakfast cereals** | 1.81 | 3.02 | 1.63 | 1.66 |
| **Pastas** | 1.53 | 2.57 | 0.26 | 0.84 |
| **Grain products, rice** | 2.88 | 3.83 | 1.69 | 2.04 |
| **Pizza** | 0.47 | 5.5 | 0.43 | 1.1 |
| **Soups** | 2.02 | 5.06 | 2.3 | 1.94 |
| **Candy, chocolate, jams, jellies** | 2.36 | 2.95 | 1.94 | 2.75 |
| **Legumes** | 1.57 | 4.56 | 5.63 | 3.54 |
| **Eggs** | 1.58 | 4.11 | 4.49 | 2.24 |
| **Liver and organs** | 0.01 | 0.033 | 0.07 | 0 |
| **Tortillas, tacos** | 3.87 | 5.83 | 34.99 | 9.06 |
| **Coffee and tea** | 0.48 | 0.63 | 0.7 | 0.49 |
| **No-fat and low-fat products** | 0.17 | 0.47 | 0.15 | 0.51 |
| **Tomatoes** | 0.42 | 0.46 | 0.48 | 0.77 |
| **Red meat** | 2.63 | 1.91 | 4.88 | 25.91 |

Interestingly, subjects in all four groups obtained the lowest energy contributions from orange vegetables, dairy products other than whole milk, butter, green leafy vegetables, liver and organ meats, and low-fat products.

These groups of individuals were studied with regard to energy intake, nutrient intake, anthropometric outcomes, and demographic and lifestyle variables such as age, gender, level of education, and physical activity. We tested for differences across patterns by using PROG GLM software with Tukey adjustment for multiple comparisons across groups. The results are shown in Table 7.

The analysis of interactions shows no significant interaction between:

-- age and dietary pattern

-- gender and dietary pattern

-- income and dietary pattern

-- education and dietary pattern

-- physical activity and dietary pattern

-- language spoken at home and dietary pattern.

Table 8. P values when the interaction was removed

| Interaction | p value |
|---|---|
| Diet and smoking | 0.354 |
| Diet and gender | 0.325 |
| Diet and level of education | 0.349 |
| Diet and physical activity | 0.209 |
| Diet and calorie intake | 0.218 |
| Diet and income | 0.221 |
| Diet and age | 0.216 |

Table 7. Result of the GLM procedure. Comparison of anthropometric measurements, energy and nutrient intake among the four diet groups

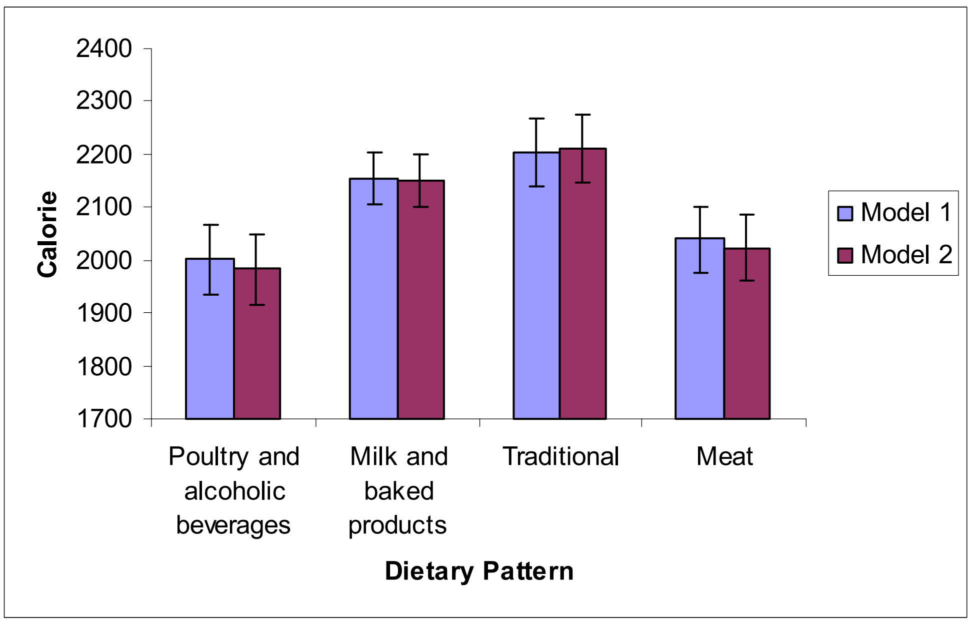
| Anthropometric measurements | N | Model | Poultry and alcoholic beverages | | Milk and baked products | | Traditional | | Meat | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error |
| BMI | 659 | 1 | 28.2 | 0.5 | 27.9 | 0.4 | 28.3 | 0.5 | 27.9 | 0.5 |
| | 659 | 2 | 28.3 | 0.5 | 28.0 | 0.4 | 28.3 | 0.5 | 27.9 | 0.5 |
| Waist circumference – women | 316 | 1 | 94.2 | 1.9 | 92.0 | 1.2 | 93.1 | 1.7 | 95.2 | 1.7 |
| | 316 | 2 | 94.4 | 1.9 | 92.0 | 1.2 | 93.3 | 1.7 | 95.3 | 1.7 |
| Waist circumference – men | 343 | 1 | 95.8 | 1.6 | 95.6 | 1.3 | 97.8 | 1.6 | 94.2 | 1.5 |
| | 343 | 2 | 95.8 | 1.6 | 95.6 | 1.3 | 97.8 | 1.6 | 94.3 | 1.5 |
| **Energy (kcal)** | 659 | 1 | 2001 | 67.3 | 2154 | 49.7 | 2202 | 64.0 | 2039 | 62.4 |
| | 659 | 2 | 1982 [a] | 67.0 | 2152 [ab] | 49.2 | 2212 [b] | 63.5 | 2023 [ab] | 61.9 |
| **Nutrients** | | | | | | | | | | |
| Protein (%) | 659 | 1 | 15.5 [c] | 0.4 | 14.2 [b] | 0.3 | 15.1 [bc] | 0.3 | 18.3 [a] | 0.3 |
| | 659 | 2 | 15.5 [c] | 0.4 | 14.2 [b] | 0.3 | 15 [bc] | 0.3 | 18.3 [a] | 0.3 |
| Carbohydrates (%) | 659 | 1 | 49.3 [b] | 0.9 | 55.2 [a] | 0.7 | 53.7 [b] | 0.9 | 46.4 [b] | 0.8 |
| | 659 | 2 | 49.5 [b] | 0.9 | 55.3 [a] | 0.7 | 53.6 [b] | 0.8 | 46.4 [b] | 0.8 |
| Fat (%) | 659 | 1 | 31.1 [b] | 0.7 | 31.6 [b] | 0.6 | 31.6 [b] | 0.7 | 34.3 [a] | 0.7 |
| | 659 | 2 | 30.7 [b] | 0.8 | 31.5 [b] | 0.6 | 31.9 [b] | 0.7 | 34.3 [a] | 0.7 |
| Saturated fat (%) | 659 | 1 | 8.6 [c] | 0.3 | 10.2 [b] | 0.2 | 9.8 [b] | 0.3 | 11.2 [a] | 0.3 |
| | 659 | 2 | 8.5 [c] | 0.3 | 11 [b] | 0.2 | 9.9 [b] | 0.3 | 11.1 [a] | 0.3 |
| Sugar (%) | 659 | 1 | 24.3 [b] | 0.9 | 27.3 [a] | 0.7 | 20.7 [c] | 0.9 | 20.8 [c] | 0.9 |
| | 659 | 2 | 24.6 [b] | 0.9 | 27.3 [a] | 0.7 | 20.5 [c] | 0.9 | 20.7 [c] | 0.9 |
| Fiber (g) | 659 | 1 | 13.6 [c] | 0.9 | 19.2 [b] | 0.6 | 23.3 [a] | 0.8 | 16.0 [c] | 0.8 |
| | 659 | 2 | 13.1 [c] | 0.9 | 19.2 [b] | 0.6 | 23.4 [a] | 0.9 | 16.0 [c] | 0.8 |
| Cholesterol (mg) | 659 | 1 | 271 [a] | 21.6 | 321 [ab] | 15.9 | 363 [b] | 20.5 | 320 [ab] | 20.0 |
| | 659 | 2 | 271 [a] | 21.7 | 322 [ab] | 15.9 | 362 [b] | 20.5 | 316 [ab] | 20.0 |

Energy and nutrient intakes were adjusted for: 1) Model 1: age, gender 2) Model 2: age, gender, income, and education.
BMI and waist circumference were adjusted for: 1) Model 1: total energy intake and smoking. 2) Model 2: total energy intake, smoking and physical activity.
Groups with a different letter are significantly different ($\rho<0.05$)

### 3.3. Energy Intake by Dietary Pattern

There was no significant difference with respect to energy among the four groups when adjusted for age and gender. However, when adjusted for age, gender, income, and education, the traditional group had the highest value (2211 Kcal) and is significantly different from the poultry group (ρ<0.05), which had the lowest value of energy intake per day (1982 Kcal).

Figure 1. Energy intake (%) by dietary pattern




Energy intake was adjusted for: Model 1(age, gender) and Model 2 (age, gender, income, and education)

### 3.4. Nutrient Intake by Dietary Pattern

Protein intake as a proportion of energy intake was significantly higher at ρ<.0001 in the meat group (18.3%) than in the other three groups. The poultry and alcoholic beverages group with 15.5% of their energy obtained from protein and the traditional group with 15.1% were next. The milk and baked products group had the least protein intake (14.2%), significantly different from the poultry group at $\rho<0.05$. The same results were found for the second model analysis.

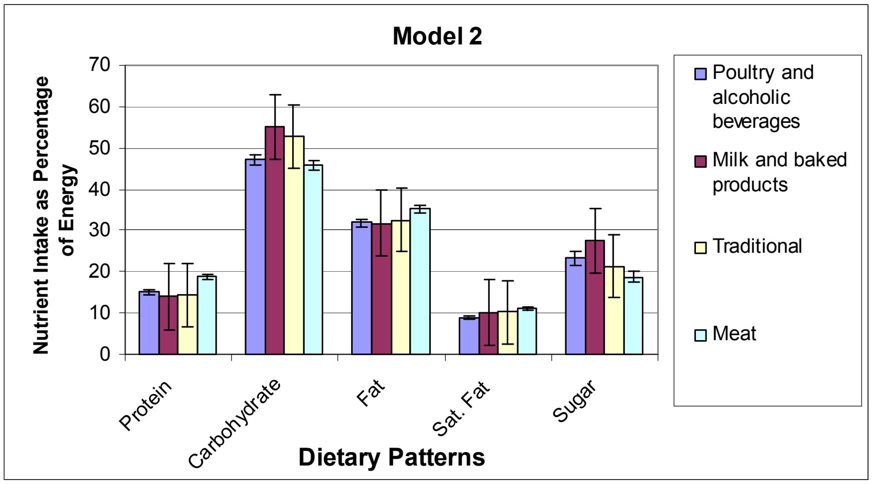
Higher intakes of carbohydrates were observed in the milk and baked products (55.2%), and traditional (53.7%) groups, significantly different from the poultry and alcoholic beverages and meat groups at $\rho<0.001$. The meat group had the lowest carbohydrate score (46.2%). Further adjustments did not change the results.

Total fat intake as a proportion of energy intake was significantly higher at $\rho<0.05$ in the meat group (34.3%) when compared with the traditional and milk and baked products groups, and to the poultry and alcoholic beverages group at $\rho<0.01$.

Saturated fat as a proportion of energy intake in the meat group was significantly higher (11.2%) than in the other three groups at $\rho<0.01$. The poultry and alcoholic beverages group had the lowest score (8.6%), significantly different from the milk and baked foods group and the traditional group at $\rho<.0001$, and to the meat group at $\rho<0.01$. When we adjusted for age, gender, income, and education intake, the values of saturated fat were not significantly different between the milk and baked products group and the traditional group.

Total sugar as a proportion of energy intake was high in the milk and baked products group (27.3%) and significantly different at $\rho<.0001$ when compared with the traditional (20.7%) and meat (20.8%) groups, and significantly different from the poultry and alcoholic beverages group at $\rho<0.05$.

Figure 2. Nutrient intake as proportion of energy

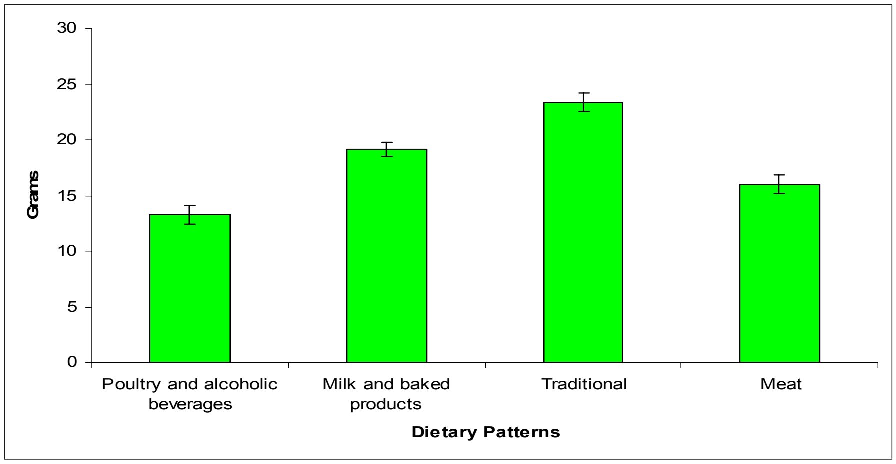



Nutrient intake was adjusted for Model 2 (age, gender, income, and education)

### 3.5. Other Nutrients

Fiber intake values were significantly higher in the traditional group (23.3 gm) at ρ<0.001 when compared with the other groups, ajusting for age, gender, income and education,. The poultry and alcoholic beverages group had the lowest value (13.3 gm), significantly different from the traditional and milk and baked products groups at ρ<.0001.

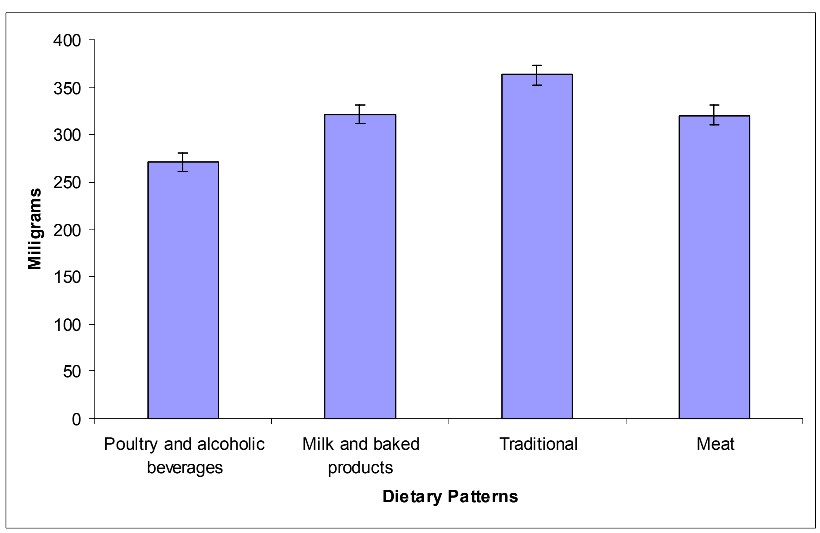
Figure 3. Fiber intake in grams by dietary pattern




Fiber intake was adjusted for Model 2 (age, gender, income and education)

The traditional group has the highest value of cholesterol (363 mg) significantly different from the poultry group which has the lowest dietary intake of cholesterol (271 mg), when adjusted for age, gender, income and education ($\rho<0.01$).

Figure 4. Cholesterol intake in milligrams by dietary pattern

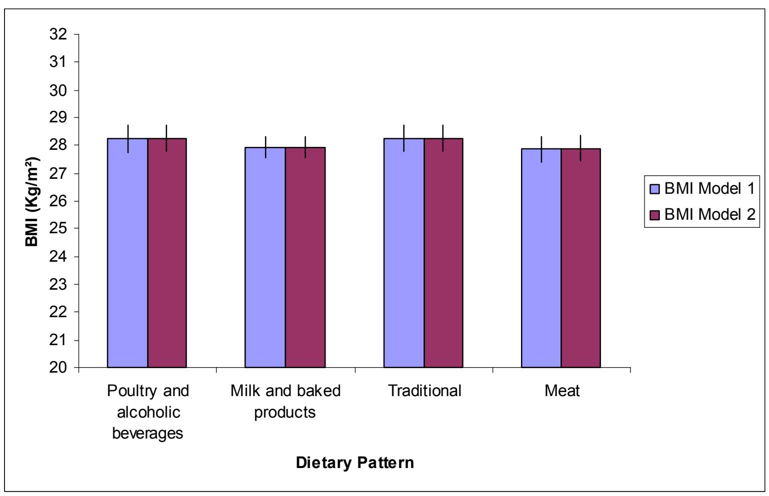



Cholesterol intake was adjusted for: Model 2 (age, gender, income and education)

### 3.6. Relationship of Dietary Patterns (Four Groups) and Anthropometric Measurements in the Mexican-American Population

Mean BMI values of the four groups were high, reaching levels of overweight and obesity, and there were no significantly different BMI scores among the four groups. BMI values are highest for subjects in the poultry and alcoholic beverages group.

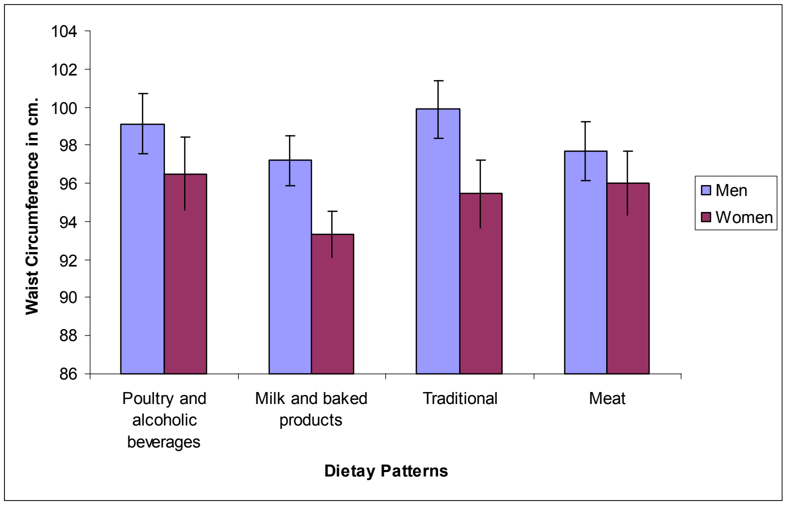
Figure 5. Body mass index (BMI) by dietary pattern




BMI was adjusted for: Model 1 (total energy intake and smoking) and Model 2 ( total energy intake, smoking and physical activity)

Waist circumference scores were analyzed separately for men and women. The analysis showed that there is no significant difference among the four groups for either men and women. However, the women's waist circumference scores in all four dietary patterns are far above the recommendations, putting the females group at high risk for chronic diseases.

Figure 6. Waist circumference by dietary pattern

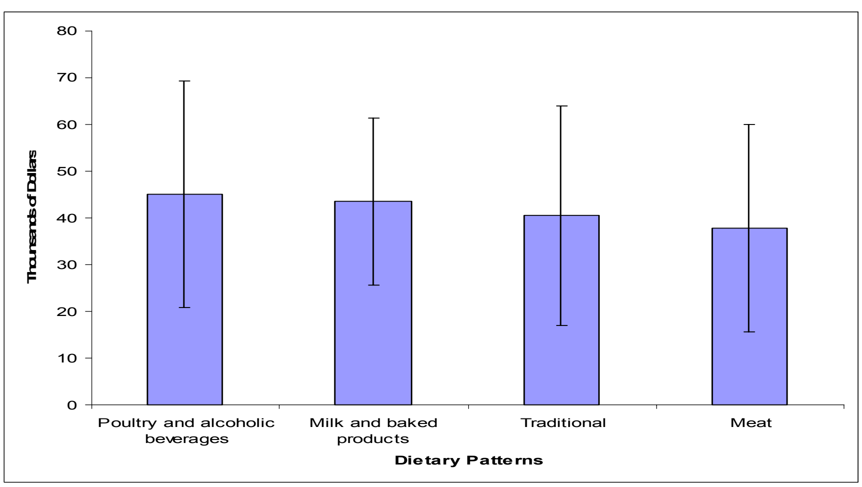



Waist circumference was adjusted for: Model 2 (total energy intake, smoking and physical activity).

## 3.7. Analysis of Other Socio-Demographic and Lifestyle Variables

Income values are not significantly different among groups.

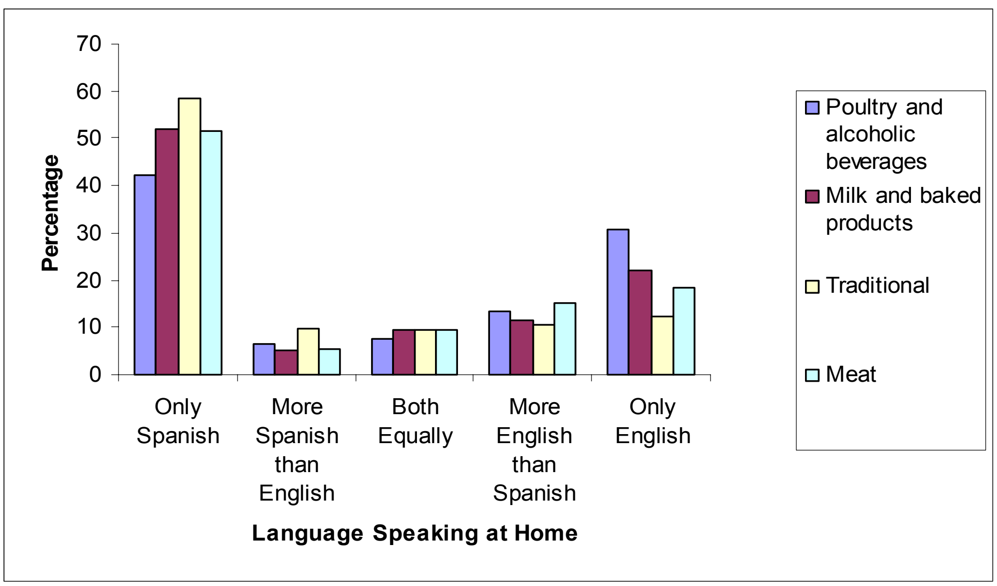
Figure 7. Household income level by dietary pattern



Five categories were used to classify the language usually spoken at home: (1) only Spanish; (2) more Spanish than English; (3) both English and Spanish; (4) more English than Spanish; and (5) only English. We found that more than 49% of the Mexican-American population speaks only Spanish at home (49.1%).

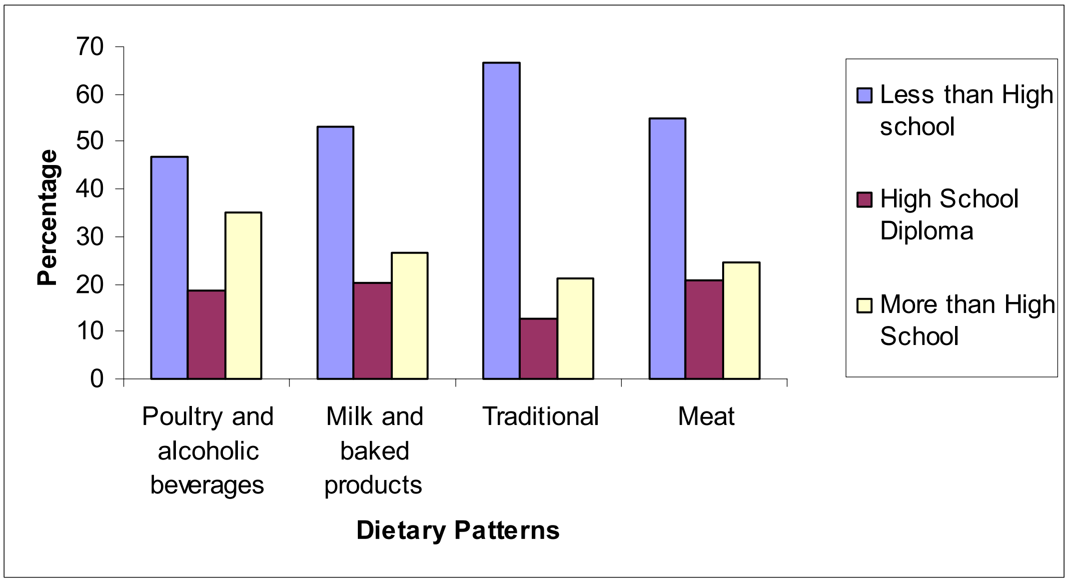
Of the four groups the traditional group had the highest number of subjects speaking only Spanish at home (57%), while the poultry and alcoholic beverages group has the highest number of subjects speaking only English (26.5%).

Figure 8. Language speaking at home by dietary pattern




We employed three categories to analyze the level of education of the subjects: (1) less than high school, (2) high school diploma (including G.E.D.), and (3) more than high school. Comparisons among groups show that the traditional group had the highest number of subjects with less than high school diploma (69%), while the poultry and alcoholic beverages group had the highest number of subjects with more than a high school education.

Figure 9. Level of education by dietary pattern




Physical activity scores are not significantly different among the groups (ρ<0.05).

Figure 10. Leisure-time physical activity scores by dietary pattern

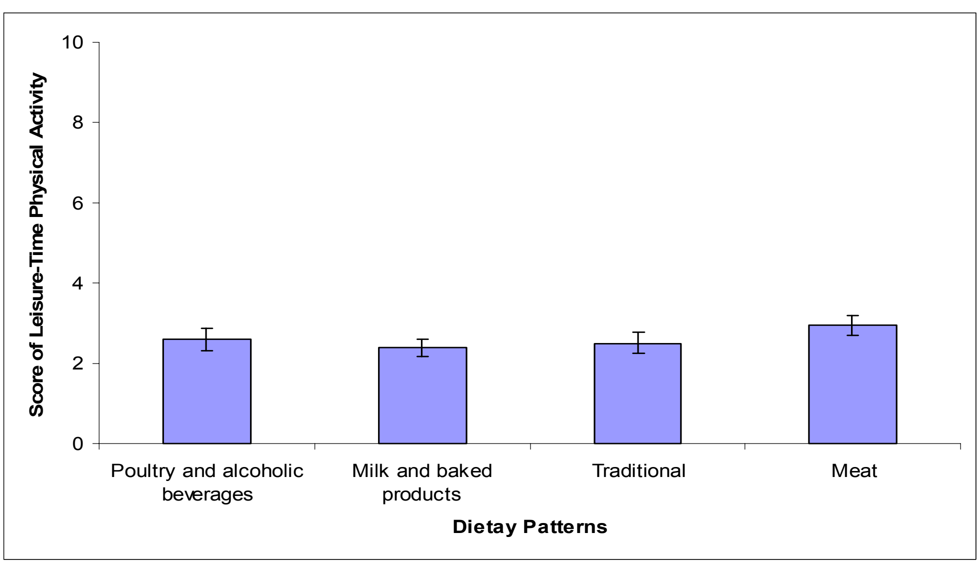


Table 9. Descriptive statistics of the four dietary patterns

| **Variable** | **Poultry and alcoholic beverages n=121** | **Milk and baked products n=255** | **Traditional n=142** | **Meat n=141** |
|---|---|---|---|---|
| % of men | 57.02 | 46.27 | 57.75 | 52.48 |
| % of women | 42.98 | 53.73 | 42.25 | 47.52 |
| Household income $ | 45 931 | 50 808 | 47 919 | 43 210 |
| Education % | | | | |
| < than high school | 52.07 [a] | 55.69 [a] | 69.01 [b] | 57.45 [a] |
| High school diploma | 15.70 | 17.65 | 9.86 | 19.86 |
| > than high school | 32.23 | 26.67 | 21.13 | 22.70 |
| Language spoken at home % | | | | |
| Only Spanish | 42.15 | 49.02 | 57.04 | 47.14 |
| More Spanish than English | 8.26 | 5.49 | 9.15 | 7.86 |
| Both equal Spanish and English | 9.09 | 12.55 | 10.56 | 12.86 |
| More English than Spanish | 14.05 | 12.16 | 11.97 | 12.86 |
| Only English | 26.45 | 20.78 | 11.27 | 19.29 |
| Leisure-Time Physical activity % | | | | |
| MET score 0 | 44.63 | 51.76 | 54.23 | 47.52 |
| MET score 2.5 - 5 | 33.06 | 33.33 | 28.87 | 30.50 |
| MET score 5-10 | 22.31 | 14.90 | 16.90 | 21.99 |

Any two groups with a different upper score letter are significantly different ($\rho<0.05$)

# CHAPTER 4: DISCUSSION

## 4.1. Cluster Analysis and Anthropometric Measurements

In our study we defined four dietary patterns in the Mexican-American population by using cluster analysis, and, surprisingly, did not identify a "healthy" pattern group in this population, as has been generally observed in other ethnic groups. Several studies suggest that a healthy dietary pattern may be composed of relatively high intakes of fruit, vegetables, reduced-fat dairy products, and fiber (80-89). Many of these studies show that these dietary patterns are associated with lower risk of disease, as well as lower BMI and waist circumference measurements.

All four clusters that are representative of an unhealthy diet may be reflected in higher mean values of BMI and waist circumference. In fact, a study entitled "Dietary patterns and changes in body mass index and waist circumference in adults" (27) concluded that a diet simultaneously high in fruits, vegetables, reduced-fat dairy products, and whole grains and low in red and processed meat, fast foods, and soda is associated with smaller gains in BMI and waist circumference.

Earlier studies showed that the prevalence of obesity and overweight are increasing in the Mexican-American population (4,90), and this trend seems to continue in the NHANES 2001-2002, where 30% of the sample were found to be obese and 43% were found to be overweight. In fact, the four dietary clusters identified in our study are characterized with high mean values of BMI. Women are of special concern because they show mean waist circumference values of 94 cm which is over the recommendation of 88 cm. (24). Extensive research has been done indicating that waist circumference is an indicator of cardiovascular disease risk (18-23). In addition, body fat distribution may be a factor significantly associated with morbidity and mortality (91,92), and the American Heart Association concluded that "too much fat, especially in the waist area, is indicative of higher risk for health problems, including blood pressure, high blood cholesterol, diabetes type 2, heart disease and stroke" (13).

The information we have about differences in dietary patterns among Mexican-American diet suggests that this population is at a high risk of chronic diseases, particularly cardiovascular disease and diabetes. Drinks sweetened with sugar are associated with high body fat and increased weight gain (93,94), and so the generous consumption of such flavored, sweetened drinks among Mexican-Americans is likely to be a prime contributor to the high incidence of overweight and obesity among them.

Studies carried out in Mexico point out that, deficiencies and changes in the diet are increasing obesity, as well as other chronic diseases (57,95,96). Warrix (95), in a study of Mexican diets, notes that the nutrients most likely to be inadequately provided in this population are calcium, iron, vitamin A, folacin, and vitamin C. This finding may be explained by the fact that dairy products, leafy green vegetables, and fruits are among the foods less consumed by Mexicans (96,97). As Mexicans immigrate to the United States this pattern seems to continue, for in our results leafy green vegetables, orange vegetables, liver and organ meats, dairy products, and fruits are the foods least likely to be consumed by each of the four groups. It is therefore important to note that traditional diets are not always healthy and that simple additions or modifications can greatly improve their nutritional worth.

### 4.2. Energy Intake

Significantly, energy intake expressed in calories is highest in the traditional dietary pattern group, when we adjusted for physical activity. The likely explanations are the high intake of flavored, sweetened drinks found in this group and the extensive use of fat to fry traditional Mexican dishes (3, 95). While those in the traditional dietary group had a strong preference for flavored, sweetened drinks and such fried foods as tortillas, one of the limitations of the model is that it was not adjusted for daily activity level. At least one study suggests that men and women underestimate their intakes (98). Especially underestimated are foods typical of the Mexican diet (such tortillas, sugar, and oil) (99). Thus, portion size may be another important factor in the balancing of energy requirements with proper weight gain. The World Health Organization notes that the fat and water content of foods are the main determinants of energy density in a diet. Lowering the intake of energy-dense drinks (i.e., ones high in free sugars) would undoubtedly contribute to a reduction in total energy intake. On the other hand, a higher intake of energy-diluted food (i.e. vegetables, fruit, and whole grain cereals) would contribute to a reduction in total energy intake even while improving micronutrient intake (54).

### 4.3. Macronutrient Intake

Was found no significant difference in protein, carbohydrate, fat, and sugar intake among the four clusters. However, the traditional cluster displays a significantly higher ($\rho<0.05$) fiber intake, probably because of a greater use of legumes and tortillas (3,95). This cluster is also high in cholesterol intake, with a mean intake of 355 mg per day, a quantity greater than the daily recommended intake of 300 mg per day (100). It is also significantly different from the poultry and alcoholic beverages group which had the lowest intake of cholesterol ($\rho<0.01$). Bermudez et al. found that ethnic differences in serum lipids appear to be associated with differences in dietary intakes (101). In the same study it was found that Hispanics had lipid profiles indicating a high risk of cardiovascular disease, and these results were supported by at least one other research study (102)

### 4.4. Acculturation

Although many researchers have studied acculturation, there is little agreement about how it is to be assessed. In this study we have addressed acculturation by the language used at home. Some studies test the reliability and validity of a "brief language-usage scale" as a measure of acculturation (103.104). However, the effect of acculturation in Latino health is not clearly defined. Lara et al (105), in a study of acculturation and Latino health, found that the effect of acculturation is complex. In some areas, dietary practice outcomes worsen with acculturation (2,3,55,56,63,107-109), while in others acculturation has a positive effect upon diet (11,66,67,68). With the intent to measure acculturation we evaluated language use at home. When we compared acculturation levels, we did not identify significant differences among the four dietary patterns. We estimated that differences in acculturation and diet may not have a clear explanation, since most typical Mexican foods are difficult to identify in the surveys. One limitation is that in the recent past, ethnic or Latino stores have proliferated rapidly, providing traditional foods to everyone regardless of their level of acculturation as measured by either the language used or the number of years in the U.S.

### 4.5. Education

Our results show that more than 55% of the Mexican-American population have less than a high school education. When comparing the four dietary clusters in this regard, although no significant difference ($p<0.5$) was noted, we found that the poultry-alcoholic beverages group had more years of education and that the traditional group had fewer years of education than the other clusters. Lappalainen et al. (110) found that patients having higher levels of education possessed more healthy diets than their less educated counterparts. In addition, it is demonstrated in other studies that having a healthier diet may not imply a better level of education. In fact, Aldrich et al (69) found that higher Healthy Eating scores of Spanish speakers are not the result of better nutritional knowledge. These results suggest that nutritional education may be a useful tool to diminish the risk of obesity in this population.

### 4.6. Income

We did not identify significant differences in household income among the four clusters ($p<0.05$). The average household income was $42,790, though without data about household size it is difficult to evaluate the economic status that such an income level provides.

Also, in our study, `we found that Mexican-American women do have average income statistically not significantly different from men. Women also have a higher risk of cardiovascular disease because of their higher waist circumference measurements. Olson (111) suggests that for economically disadvantaged women, purchasing food that is lower priced but higher in calories may contribute to increased weight gain.

### 4.7. Physical activity

Physical activity measured by leisure time activity score (MET), shows that there is no significant difference among the four clusters, with a low average of 2.5 in a score of zero to 18. One of the biggest changes that immigrants have to face upon arrival in the United States is the greatly reduced opportunity for physical activity as a consequence of industrialization. This transition may explain the lower average score in the Mexican-American population.

Studies have linked low physical activity to obesity (112,113). Obesity evolves when energy expenditure is lower than energy intake, and physical inactivity is believed to be an important etiological factor. Research conducted by the World Health Organization indicates that physical activity reduces the risk of cardiovascular disease, type-2 diabetes, and some cancers by reducing body fat, lowering blood pressure, and modifying glucose metabolism, among other things (114).

Dias-da-Costa et al. (115), in a study of leisure-time physical activity, concluded that higher income individuals are more likely to follow health promotion behavior and that leisure-time activities are reduced among lower-income individuals. We, however, did not find any association between leisure time physical activity and income among the four groups, though it is difficult to make associations, as physical activity scores and income levels are, on average, very low in this population. Thus, further studies are necessary to explain the apparently low levels of leisure-time physical activity in the Mexican-American population and to determine their etiology.

### 4.8. Potential limitations

The interpretation of the results may not be applicable to other Hispanic or age groups because the study focuses upon a specific population of adult Mexican-Americans.

It is necessary to account for methodological issues when we analyze dietary patterns, using either cluster analysis or factorial analysis. Subjectivity may always be present, not only because the analysis is exploratory in nature but also because it is based upon data that depend upon behavior and the way in which questions were asked. Researchers suggest that food frequency questionnaires or 24-hour diet recall are both useful for this kind of study. However, a single-day food recall may not be representative of the health outcomes of the population, as the foods that an individual reports as having eaten on any particular day might not accurately identify the food pattern with which he is properly associated, leading to a misclassification of some subjects. Although we analyzed a large sample size of 659 subjects, the data referred to a single day (24-hour recall), and so caution should be exercized in the interpretation of the results.

### 4.9. Strengths of the study

Our findings may be generalized to the overall Mexican-American population. NHANES employs trained personnel and this 2001-2002 survey over-sampled Mexican-Americans, permitting better estimates of the population.

Patterns of diet may provide a more comprehensive measure of dietary exposure for epidemiological research, and the knowledge of diet may be used to prevent rather to treat disease.

# CHAPTER 5: CONCLUSION AND IMPLICATIONS OF THE STUDY

The poor food choices of Mexican-Americans may result from both the lack of availability of certain foods and poor knowledge of nutrition. Glanz et al. (59) mention that the obesity epidemic may be continuing not only because of expanding portion sizes but also because of the nutrition environment, that is, the availability of food. Thus, the various nutrition environments in homes, at workplaces, in schools, and in neighborhoods generally may be the appropriate foci of future public health initiatives. We found that acculturation, measured by the language used at home and level of education, may not adequately explain the choice of diet in the Mexican-American population.

Moreover, the finding of no healthy pattern in this population as a result of poor choices suggests that nutrition education should be the basis of the intervention. It is vital that people be educated to understand that while cultural traditions can often be enriching, they can also be harmful when they come into contact with factors such as industrialization, new geographical realities, and the availability of different foods.

As the results of our study show, the traditional diet may benefit from some changes, such as the addition of leafy green vegetables, orange vegetables, liver and organ meats, dairy products, and fruits, and at the same time the reduction in the intake of alcohol, sweetened drinks, and various fats, the consumption of which people tend to increase as they become economically affluent. Furthermore, more research needs to be done on the traditional dietary pattern of Mexican-Americans to better understand possible changes associated with availability of foods and industrialization, including use of fast food vs. home-prepared Mexican foods.

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