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Karina L. Christopher, Student

Dr. John F. Watkins, Major Professor

Dr. John F. Watkins, Director of Graduate Studies

THE INFLUENCE OF TIME ON FOOD INTAKE PATTERNS:
AGE, PERIOD, COHORT DIFFERENCES

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in
Gerontology at the University of Kentucky

By
Karina L. Christopher

Lexington, Kentucky

Director: John F. Watkins, Professor of Gerontology

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ABSTRACT OF DISSERTATION

THE INFLUENCE OF TIME ON FOOD INTAKE PATTERNS: AGE, PERIOD, COHORT DIFFERENCES

The impact of diet and exercise on overall health and chronic disease risk has been well examined. Multiple studies show that Americans eat more now than they did fifty years ago. What isn't known is how much of an impact time has on food intake patterns of individuals in terms of different age groups, historic periods of structural influences, and birth cohorts.

In order to identify the impact of time on food intake this study examined time from multiple perspectives. The first aim of this study was to determine food intake patterns among age groups across five time periods using a cross-sectional approach. The second aim of this study was to use a cohort perspective to measure food intake patterns among three birth cohorts across five time periods. The third aim of this study was to break down observed food patterns by group characteristics such as ethnicity, gender, income, education level, and marital status. The final aim of this study was to analyze the findings from the first three aims through a time context using historic information to connect individuals with socioecological factors that influence age and period-specific food knowledge, perceptions, decisions, and behaviors.

Using data from five NHANES survey analyses confirms that total calorie and macronutrient intake has increased over the past fifty years. In addition, this study found that increased consumption occurred in all age groups. Within all five time periods, macronutrient intake declined with advancing age. When comparing birth cohorts over time, all cohorts in this study hit their peak intake of macronutrients and total calories in the years 2001 and 2011. Protein and fat intake was higher in those under the age of 50 while carbohydrate intake was highest in those over the age of 50. Using the life course framework, these factors were examined simultaneously. Results of this study are unique among food intake research because they incorporate not only socioecological influences but also life span and life course perspectives. This holistic approach will provide significant insight into food choice and behavior which has previously been absent from food intake studies.

KEYWORDS: nutrition, NHANES, life course, age, time, cohort

THE INFLUENCE OF TIME ON FOOD INTAKE PATTERNS:
AGE, PERIOD, COHORT DIFFERENCES

By

Karina L Christopher

John F. Watkins

Director of Dissertation

John F. Watkins

Director of Graduate Studies

December 1, 2016

DEDICATION
To My Little Angels

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Chapter 1: Introduction

Food has long been recognized as necessary for basic human survival, and for nearly a century there has been increasing research attention on the impacts of nutrition in general, and selected foods in particular, on health and wellbeing. True nutrition-focused work began in the early 20th Century, a period when average life expectancies at birth in the United States ranged between 50 and 60 years and infectious diseases ranked as the leading cause of death. By mid-Century, advances in technology, public health knowledge and practice, and understanding of nutrition and health paved the way for dramatic increases in life expectancy as infectious diseases gave way to chronic and degenerative health conditions—as conditions caused by over nutrition became dominant over those caused by under nutrition.

The bulk of nutrition research through the 20th Century sought to identify linkages between specific nutrients and/or nutrient levels and health outcomes, and such work remains popular as researchers employ tools ranging from laboratory-based animal models to population-based inferential analyses of human health and nutrition data. Clearly underrepresented in ongoing nutrition research are examinations of food intake variability, including most prominently the influences of ‘time,’ as expressed through age and the passage of calendar dates, and of ‘diversity,’ as captured by both the characteristics of people and the cultural, social, economic, and political elements of historic context. In short, knowledge and understanding of how and why food intake changes among different groups of people, from birth through death, and from the past through the present day, remains poor.

This dissertation reports on a study designed to employ the concepts of life span and life course to critically examine time-dependent patterns of food intake, with a central purpose of identifying and explaining variability in dietary behaviors by age and historic periods of influence. Existing diet scholarship offers minimal contextual consideration for age dynamics or life span effects on food intake. Dietary behaviors rely on a complex interaction between social, cultural, environmental, psychological, historical, and physiological factors. Extant research on food intake has measured dietary behaviors in concrete, but limited terms. Dietary behavior is often viewed as a basic action of food consumption with negligible consideration given to the process and dynamic outcomes of food choice.

Before offering a detailed overview of the specific aims of the study and methodological approach taken to address these aims, it is necessary to operationalize the central concepts employed, including: *nutrients and nutrition, notions of time; and life span life course distinctions*. Nutrition is the multidisciplinary study of factors that affect food choices, the chemical and physiological processes involved in processing and delivering the chemical components of food to cells within the body, and how those chemicals affect individuals (Pope, Nizielski, & McCook, 2015). The chemical substances found in food are called nutrients and are essential for bodily functions. The six classes of nutrients are carbohydrates, protein, lipids (fat), water, vitamins, and minerals. Macronutrients include carbohydrates, protein and lipids. Micronutrients include water, vitamins, and minerals. The macronutrients provide energy for the body and are needed in the highest amounts. Micronutrients do not provide energy but are

absolutely essential for maintaining the chemical processes that support bodily functions and survival.

Dietary Guidelines. Defining what the adequate amounts of each nutrient is for individuals of all ages has been the challenge of health professionals and dietitians for many years. Certain nutrients are known to be required in higher amounts during particular stages in the life span. For example, nutrient needs are higher for women during pregnancy and lactation. The challenge when recommending carbohydrates, protein, fat, water, vitamins, and minerals is that recommended intake levels are best given individually. This is a near impossible task with the population of the United States exceeding 323 billion people (Census, 2016). Providing guidelines that meet the needs of most individuals living in the United States based on sex and vague age ranges is currently the most feasible option.

Recommended macronutrient intake levels for adults in particular life stages and sex groups are provided by the Recommended Dietary Allowances (RDA). The RDAs were developed during World War II by the U.S. National Academy of Sciences in order to improve the health of Americans for national defense (Levenstein, 1993; Nestle, 2013). Currently the RDAs are a component of and established by the Dietary Reference Intakes (DRI), a committee of the Food and Nutrition Board of the National Academy of Sciences' Institute of Medicine. The DRI committee's oversight also includes the Estimated Average Requirements (EAR), Tolerable Upper Limits (UL), and the Adequate Intakes (AI). The EAR recommends the average daily nutrient intake levels for at least half of healthy individuals at a particular life stage and sex group. The UL and AI recommends safe intake levels of nutrients based on scientific evidence available. All

four DRI subcommittees provide revised recommendations every five to ten years based on experimental evidence and observations. Their recommendations are used to provide values on food labels, reduce chronic disease, and establish safe intake guidelines.

The current RDAs divide nutrient recommendations between men and women without any consideration for race. Age groups are divided into those aged 19-30, 31-50, 51-70, and over 70 years old. For example, the RDA encourages males and females aged 9-13 years to consume 34 grams of protein per day. Males over the age of 19 are encouraged to consume 56 grams of protein per day while women within that same age range, not pregnant or lactating, are encouraged to consume 46 grams of protein per day (DRI, 2005). According to the RDA, men and women (not pregnant or lactating) should all consume 130 grams of carbohydrate per day. No recommendations are given by the RDA for total fat intake. These recommendations are given for healthy individuals. In the presence of disease, food recommendations vary based on nutritional status and disease pathophysiology. The majority of chronic diseases require individuals to reduce total fat, saturated fat, *trans fat*, and carbohydrate intakes (specifically for diabetes). These recommendations come from organizations such as the American Heart Association, American Diabetes Association, and the Academy of Nutrition and Dietetics. Additionally, certain races of people exhibit higher incidence of certain chronic diseases due to genetic factors. A more tailored recommendation may be of benefit for reducing chronic disease rates.

Involving Time. It is important to discuss the multiple notions of time. Time can be defined as the “indefinite continued progress of existence and events in the past, present, and future, regarded as a whole” (Mish, 1997). Individuals define time

differently based on context, experience, and culture. First, time may be relative, in existential terms, to activities being engaged in or remembered. For example, children playing with friends may complain that time moves too quickly when they must end their play to return home. Students in a classroom may view time as moving too slowly when the subject they are learning does not interest them. Parents watching their child graduate from college may think to themselves ‘where has time gone?’ In these cases, time cannot be measured by standardized tools like clocks or calendars. Someone may think back on their life during the 1950’s and say “those were the best times.” Next is chronological time, which can be measured, for example, by seconds, minutes, hours, days, years, or decades. As a standardized metric, chronological time is ubiquitously used within empirical research

Time operates on multiple levels: historical, sociocultural, and biographical (Hendricks, 2012). An individual’s age is one piece of biographical time, representing a chronological progression from conception to death that is influenced, and at times limited, by genetics, health, and accidents. With age comes expected changes in biology including an increased risk of chronic disease and changes in physical characteristics. Poor health, regardless of the age at which it develops, can influence life expectancy. Social and psychological sciences also study changes at the individual level over time as developmental processes. Individuals move through developmental stages that often correspond to age levels. Erikson (1997), for example, identifies a series of stages of psychosocial development that occur from birth to death. Each new stage builds off of previous stages such that to move forward from one stage to the next requires completion or adaptation to the previous stages (Erikson & Erikson, 1997).

Historical time captures events that happen during a specific range of dates—a time period-- that differentially influence similarly aged groups of people. Historical events, food policy, and the food industry interact with other sociocultural and environmental factors that commonly result in distinct period affects. In this dissertation research, time periods will be analyzed over a fifty year span. Birth years represented in this dissertation study range from 1950 to 1991, but individuals born during this period will necessarily be influenced by previous (parents and grandparents) and future (children and grandchildren) generations. Within the five time periods covered in this study, select age groups will be examined for food intake patterns.

A birth cohort represents a group of individuals born during a specified period and that experiences similar contextual factors and share meanings based on historical events. Many of these meanings will be passed on to future generations. For example, living in the United States during World War II required rationing of sugar, meat, and canned goods. Due to the experience of food rationing, birth cohorts alive during World War II will attach new meanings to these rationed foods that differ from birth cohorts before or after World War II. Red meat, which was often sent overseas would be more valued following the war due to the perception that it would improve the health of soldiers overseas. The Great Depression is another major historical event that created new meanings of food for individuals. For example, parents after the Great Depression taught their children to clean their plates and when those children grew up to be parents they continued this meal enforcement. The cycle continues until someone, in the line of parental enforcers, no longer requires the child to clean their plate.

Sociocultural factors will impact the influence of time on each individual. Social structures and norms influence food intake patterns. Social norms in the United States establish certain meal times and patterns. Americans typically eat three meals a day consisting of breakfast, lunch, and dinner. While the timing of these meals is somewhat individualized, they can be predicted. For example, lunch is traditionally consumed between 11:00am and 1:00pm. The presence of snacks throughout the day can also vary based on sociocultural norms. The predictability of meal patterns can be made depending on social cohort inclusion. A social cohort is a group of individuals, regardless of age, that experience similar social influences (Hendricks, 2012). For example, individuals working together in an office building may all receive a lunch break from 12:00pm to 1:00pm. Social norms established in the work environment influence whether they bring their lunch, dine out, or work through their lunch break. Social norms will also dictate what food is appropriate to eat during the lunch breaks.

Culture plays a role in producing food identities and routines that develop over time. Individual food culture may influence the foods consumed during meals. Food culture evolves over time due to a combination of the introduction of new food types, social interactions, and shared food experiences. To continue the example of the workplace, a new employee brings foods to lunch out of a habit established prior to beginning the new job. Over time, as the new employee interacts with coworkers and observes other employee's eating behaviors, he/she begins to develop new lunch routines that slowly modify pre-existing habits. In addition, the coworkers may adopt new behaviors learned from the interactions with the new employee.

Engaging the Life Span and Life Course. As part of understanding time, it is important to distinguish between the life span and the life course. Life course is aging in context. It is a process and sequence of events, either intended or unintended, that occur in history and may influence future events (Alwin, 2012). The lack of longitudinal data on individuals and their offspring make studying this concept difficult. By utilizing the life course approach researchers are better able to analyze and explain change over time and identify what transformations those changes bring.

Giele and Elder (1998) identify four key factors that shape the life course: historical and geographic location, linked lives, human agency, and timing. The four factors may have direct or indirect influences of individuals from infancy to old age. Some early life experiences will shape later outcomes significantly, independent of events that occur in the interim. Maternal and infant food intakes and patterns can significantly impact the food choices and health of people as adults (Mennella, 2014; Uprichard, Nettleton, & Chappell, 2013). Other life experiences will occur in childhood and adolescence but the full effects of those events won't produce an outcome until late adulthood. For example, lack of physical activity and poor food intake has a cumulative effect on the health status of adults. Finally, life experiences may occur in young adulthood and influence outcomes in late adulthood. Changes in environments like food industry, availability, or economic resources impact any stage of life and may have long-term effects.

The first key factor of the life course is the historic and geographic location, which describes the effect of time and place on each cohort. This factor takes cultural, historical, and environmental situations and dynamics into account. In the context of

nutrition, the food culture will influence the procurement, preparation, presentation, consumption, and disposal of foods (Beokubetts, 1995; Jones, 2007). Historical changes impact each cohort differently. Historical changes might be wars that impact food distribution and rationing or famines that disrupt food supplies. Environmental changes may include food policies, kitchen spaces, and adaptable feeding devices. Environmental changes may include geographic or demographic characteristics (Alwin, 2012) but these occur within macro- or micro-level environments.

The factor of linked lives describes the sociological, psychological, and cultural aspects of people's lives through social networks and relationships. The process by which people interact and influence each other will create changes in the individual and their social environments. Put into a nutritional context, people within the same food culture are linked in terms of acceptable food habits, rituals, and meal formats (Douglas, 1984). For example, parents, families, and friends shape early preferences and food habits of children and adolescents (Berge, Arikian, Doherty, & Neumark-Sztainer, 2012; Harris & Ramsey, 2015; Larson, Neumark-Sztainer, Hannan, & Story, 2007; Loth, MacLehose, Larson, Berge, & Neumark-Sztainer, 2016; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). Children exhibit eating behaviors and attitudes of friends and peers but little is known about influences at different points in time.

Human agency is the ability of individuals to evoke change in the food culture. It is also important to recognize there are in fact structural influences in which individuals operate according to policies, laws, rules, societal constraints, norms, and expectations that have been developed in societies. People and groups adapt their behavior and goals based on environmental and social structures (Alwin, 2012; Giele & Elder, 1998). People

have been known to express different behaviors depending on the social eating episode (Nestle et al., 1998; Newcombe, McCarthy, Cronin, & McCarthy, 2012). Perhaps the presentation of a new fad diet will influence individuals within a culture to adapt their food intake. This ability to adapt to life situations and circumstances requires different levels of psychological development. The ability to adapt will differ between a child and an older adult due to previous learned experiences and autonomy.

The fourth principle that shapes lives is timing. People respond to events and transitions by engaging in behaviors or actions that are available within their developmental abilities. The timing of life events are either passive or active adaptations that enable people to reach their own individual or social goals (Giele & Elder, 1998). A woman who has a life goal of maintaining health and wellbeing will strive to maintain a healthy food intake despite pregnancy or menopause which are significant life events. Other life events may include marriage, education, employment, or disease.

Alwin (2012) suggests a fifth factor of the life course approach; the principle of life-span development. Life span development is a lifelong process and permeates the other four factors of the life course. The main focus is on processes, events, and experiences that sequentially occur throughout the life span. Life span, with its roots in biology, refers to the period of time from conception to death. Different life cycles have also been identified as potentially occurring throughout the life span. Life cycles may include childhood, adolescence, adulthood, and death. What is excluded in life span development is the consideration of factors that occur prior to conception or the legacy left behind after death.

The life span and life course have been used interchangeably, and often incorrectly, in studies of food intake behaviors. Most manuscripts related to life course nutrition do identify the impact of linked lives, timing, and human agency on food choices or patterns. In regards to linked lives, social eating has been identified as a strong factor in food behaviors. Life events including marriage, employment, and health impact transitions and trajectories at particular points of time (Falk, Bisogni, & Sobal, 1996; Furst, Connors, Bisogni, Sobal, & Falk, 1996). People adapt their food behaviors based on these life events to fit new individual and social goals. Despite the inclusion of some elements, inadequate attention has been given in current life span or life course nutrition research to cohort or period effects. In addition, life span development has been absent from life course nutrition research.

The Cornell food choice process model (Figure 1.1) has been at the forefront of understanding food choice within a life course framework (Falk et al., 1996; Furst et al., 1996; Sobal & Bisogni, 2009). This process model is rooted in a social constructionist perspective and hints at biological, social, cultural, and environmental factors. Application of the food process model has mainly been through research studies as a background for understanding food choice and identity. The food choice process model has been used by many as a foundation for understanding food choice in diverse populations (Dressler & Smith, 2013; Nansel, Lipsky, Liu, Laffel, & Mehta, 2014; van der Zanden, van Kleef, de Wijk, & van Trijp, 2014).

Despite providing a potentially good holistic foundation for critical examinations and explanations of food intake patterns and nutrition behavior, the actual application has been lacking. Current research utilizing the food choice process model does not

completely involve the complex interaction of life course key factors and pays minimal attention to time (age/period/cohort) affects. The process model somewhat acknowledges that events in the life course have an impact on food choice by identifying potential trajectories and transitions that inevitably occur over time (Giele & Elder, 1998).

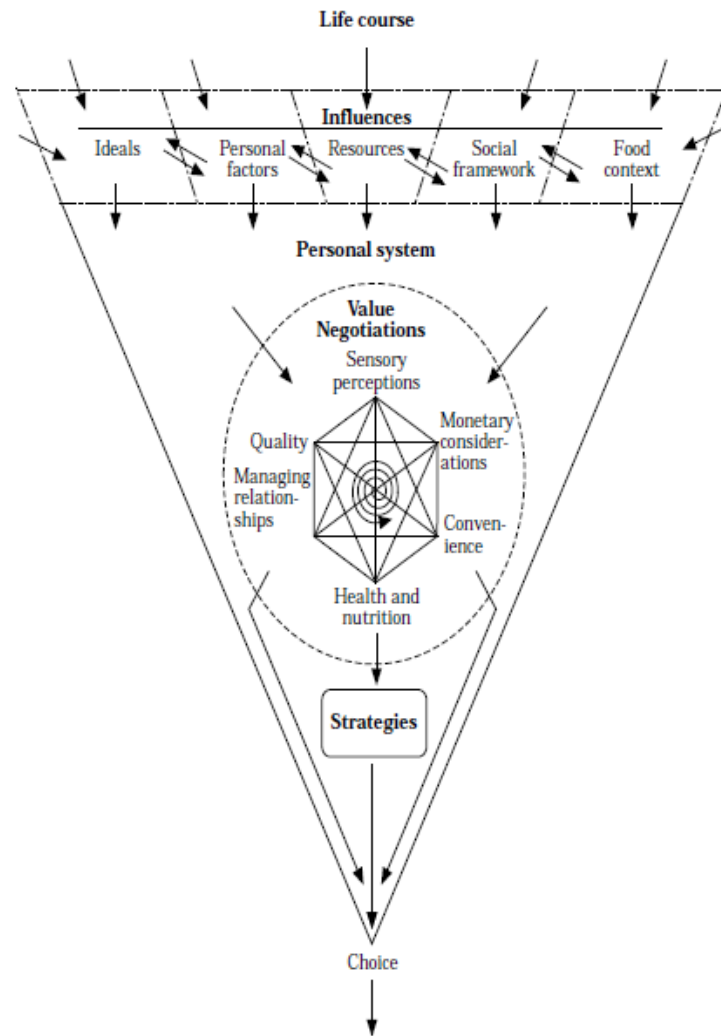


Figure 1.1 Cornell Food Process Model taken from Furst, Connors, Bisogni, Sobal, and Falk (1996), *Food choice: A conceptual model of the process*, *Appetite*, 26, pp 247-266.

Another aspect that is lacking in current conceptual and process models of nutrition is the influence of historical events. Changes in food industry or distribution impact food decisions (Guptill et al., 2013). The food industry has evolved significantly

over the last fifty years. Many areas of the United States historically relied on local farms for their food supply. Foods purchased in food stores were limited to basic necessities like flour, sugar, and salt. Now food is available from local, regional, and global food production markets. John van Willigen (2006) tells of a time when fresh oranges were prized in rural Kentucky because of their rarity. Now fresh oranges can be found year round and in nearly every food store.

Specific Aims. The majority of food behavior studies are done through randomized controlled trials, epidemiologic studies, or experimental models that are conducted at a set point in time. Through the use of population-based surveys and quantitative measures, conclusions have been made about differences in food intake between age groups. Longitudinal studies collecting information about food behavior and intake rarely include a diverse population and few have been ambitious enough to link multiple cohorts together over time to identify patterns or trajectories.

Multiple studies measure variations in food intake according to such characteristics as sex, race, income, education, and geographic place of residence. This population diversity is typically only measured in short time periods without consideration as to how these factors evolve and impact food intake differently over time. Additional qualitative studies related to food have been used to identify differences in food intake among those of different sex, ethnicity, income, education, and geographic regions. While differences are identified, it is unclear if these observed differences are consistent over time.

Lack of coordinated and holistic thought among nutrition researchers on the influence of complex elements of time on macronutrient needs creates a one size fits all

mentality for health care professionals. The growing incidence of chronic disease among Americans as a result of poor food choice and behaviors requires new insights and approaches. The purpose of this dissertation research was to determine the influence of an intentionally complicated notion of time on food intake patterns among different age groups and birth cohorts across a fifty year time span. Identifying patterns over both chronological age and calendar time and comparing them to socioecological and historical factors using a life course framework will improve our understanding of food choice and behavior.

This dissertation research utilized data from the National Health and Nutrition Examination Survey (NHANES), which provides the most valuable and applicable information for this project. This large population based study surveys United States citizens using multi-stage, stratified clusters of non-institutionalized civilian populations. NHANES encompasses a group of multiple studies beginning in the early 1970's and combining interviews and physical examinations to assess the health and nutritional status of adults and children in the United States. In the absence of a true longitudinal study, NHANES provides over fifty years of insight into food intake patterns in the United States. Carbohydrate, protein, fat, and total calorie intake can be calculated using the information collected during 24 hour recalls.

The aims of this study are to first, confirm food intake trends among age groups across multiple time periods. Five time periods will be examined to compare food intake trends among and between age groups. Carbohydrate, protein, fat, and total calorie intakes will be analyzed separately among age groups. This will highlight age and period

differences in food intake patterns. Based on extant nutrition studies, nutrient intake will decrease with advancing age.

The second aim of this study is to examine food intake across five points in time using a cohort perspective. The food patterns and trends that are observed among age groups and birth cohorts will be those that occur over the life span. It is expected that cohort-age patterns will be noticeably different than cross-sectional age patterns. In addition, it is expected that historical or period events will impact food intake more than chronological age.

The third aim of this study is to break down the food patterns revealed in the first two aims by group characteristics such as ethnicity, sex, income, marital status, and education level. These socioecological factors will also affect age and cohort food patterns. It is expected that sex and ethnicity will impact food choice due to sociocultural norms and roles. Women will consume higher amounts of carbohydrates due to intakes of feminine foods driven by sociocultural norms. Men will consume higher amounts of protein and fat due to these same sociocultural norms. Certain ethnic groups may develop food norms which influence foods that are acceptable to be eaten. Marital status could influence food intake by increasing social eating episodes and strengthening social norms. Income and education level will impact food intake by moderating the variety and availability of food choices.

Following the identification of patterns in food intake over time, trends and variations will be explained using the complex framework of the life course. Historical events that impact food production, preparation, availability, diversity, and policy will be compared to food intake patterns. Unlike other food intake and behavior studies, this

study will critically evaluate the effects of time on individual food choice. Through the linkage of life events, individual influences, and birth cohorts food patterns over time inform past, present, and future food choices.

Conclusion. This dissertation is divided into seven chapters. Chapters two and three offer a comprehensive literature review of factors that influence food choice and behavior. Chapter two is a critical assessment of current literature related to the social, cultural, environmental, physiological, and psychological influences on food intake. Each of these factors are examined individually in order to highlight their impacts on food intake and behavior. Chapter three provides a historical review of agriculture, technology, and food policy in the United States. The dynamic interaction between social, cultural, environmental, physiological, psychological, and historical factors play a role in individual food behavior.

Following my comprehensive review of factors that influence food choice, chapter 4 provides a review of relevant behavioral theories that have been used to predict and understand food behavior. The majority of these theories are rooted in psychosocial disciplines. A detailed description of the life span and life course perspectives are also included in this chapter. These frameworks, combined with the individual factors guiding food choice, provide the holistic context for examining food intake over multiple periods in time.

Chapter five describes the methodology and NHANES data employed to explore food intake among diverse individuals across multiple periods of time. Cross sectional, time sequential, and cohort sequential methods were utilized to meet the specific aims of this dissertation study. Chapter 6 provides the analytic results of NHANES data that

were used to answer my research question and specific aims. Results of this dissertation research will improve our understanding of the impact of time on food intake and behaviors. It will also clarify the role of age and life events on food intake.

The final chapter of this dissertation study includes the limitations to determining food intake without longitudinal data. In addition, the final chapter discusses future nutrition studies that should be conducted taking time into consideration. The unique multidisciplinary approach applied in this dissertation study will influence future food intake and behavior studies. Ultimately, nutrition recommendations will be provided to Americans that take into consideration age, period, and cohort affects thereby reducing the cookie cutter dietary guidelines that are in place today.

Chapter 2: Nutrition and Health

Many theories exist to explain why chronic diseases typically increase across the life span. Traditional theories for the adult development of chronic disease suggest that diseases emerge due to wear and tear on the body, declines in metabolic efficiency, or sedentary lifestyles that normatively accompany advancing age. The explanatory power of traditional age-related disease theories are increasingly threatened by the rising numbers of obese young people who have developed chronic disease. Chronic disease rates continue to be higher in those over the age of 65, but rates are climbing in young adults due to the high rates of childhood obesity (CDC, 2016). Type 2 diabetes, dyslipidemia, and atherosclerosis were historically adult onset diseases but with childhood obesity, they are increasingly identified in children and adolescents.

While researchers continue to fine tune their understanding of nutrient functions, they also investigate the impact of inadequate and excessive nutrient intakes on chronic disease risk. Excessive intakes of energy yielding nutrients encourage adipose tissue storage, and high levels of adipose tissue in the body can increase the risk of obesity, heart disease, diabetes, sleep apnea, stroke, osteoarthritis, some types of cancer, gallbladder disease, and poor mental health (CDC, 2015). Excessive macronutrient intake is not the only cause of obesity and high body fat mass. Lack of physical activity, hormone imbalances, certain diseases, drugs, genetics, and our built environment may also cause obesity (CDC, 2015). Nearly 35% of adults living in the United States are obese (CDC, 2015). Among those aged 65 and older, nearly 24% are obese (CDC, 2013). Obesity is defined as having a body weight higher than what is considered to be healthy based on the individual's height. Obesity is typically measured by body mass

index (BMI) which is an equation that factors in the individual's height and weight. A BMI over 30, for adults, is considered obese.

The health status of older adults has become a focus of many health agencies. Due to aging baby boomers and longer life spans, the populations of those over 65 years old is expected to double in the near future. According to the Centers for Disease Control and Prevention (2013), 20% of the population in 2030 will be over the age of 65. In the early 1900's the life expectancy for men and women was in the late 40's (CDC, 2014). Now, the life expectancy for adults living in the United States is over 78 years for men and women (CDC, 2014). The causes of death have changed significantly as well. In the early part of the twentieth century the leading causes of death for adults was infectious disease. Now, the top leading causes of death for adults over the age of 44 are heart disease and cancer (CDC, 2015). Older adults are more likely to have at least one chronic health condition, and treatment of comorbidities among seniors will account for nearly 66% of the country's healthcare budget (CDC, 2013).

With the growing number of older adults and the increased incidence of chronic disease due to obesity the government is shifting its focus from disease management to disease prevention and health promotion. As a result, diet and exercise are at the forefront of federal, state, and community agendas and programs. This requires all agencies to improve their understanding of food choice and behavior.

Six Classes of Nutrients

Nutrition is defined as the "act or process of nourishing or being nourished...and the science or study of the nourishment of human..." (Turley & Thompson, 2013). Humans are nourished by six basic nutrients; carbohydrates, lipids, protein, vitamins,

minerals, and water. To survive and grow we need adequate amounts of these six nutrients. Carbohydrates, lipids, and proteins are considered macronutrients because they provide energy for our body. Vitamins, minerals, and water are micronutrients, which serve to sustain necessary chemical processes in the body. Our needs for these six nutrients are met by food, which basically represents anything we eat that contains these nutrients.

Carbohydrates are essential for providing our body with energy and sparing the denaturation of proteins for energy. Carbohydrates are the primary source of fuel for the body and are readily available in the diet and relatively easy to consume. Carbohydrates can be found in fruits, vegetables, dairy foods, legumes, cereals, and grain products. In the United States, our intake of carbohydrates is higher than any other macronutrient due to the wide variety of carbohydrate sources (Austin, Ogden, & Hill, 2011). Carbohydrate food sources have been available, historically, in the American diet despite food shortages and fad diets. The minimum recommended intake of carbohydrates in the diet is around 130 grams per day, with a goal of 45%-65% of daily total calories coming from carbohydrates (USDHHS, 2015).

Protein is made up of amino acids, twenty of which are recognized by the body. These amino acids serve as building blocks for all working and structural molecules, including components of many organ systems in the body. Amino acids are found in a wide variety of foods including animal products, dairy, whole grains, nuts and seeds, and vegetables. The highest sources of protein consumed in the United States are found in poultry, red meat, milk, and cured meats (Phillips et al., 2015). Current recommendations for daily protein intake suggest 0.8 grams per kilogram of body weight,

which equates to about 8 grams of protein for every 20 pounds of body weight (Institute of Medicine, 2005). According to the Dietary Reference Intakes (2005), 10%-35% of daily total calorie intake should come from protein. Protein intake is modified based on activity level and the presence of certain diseases. Over the past 50 years, the consumption of protein foods, including meat, eggs, and nuts, has increased in the United States (USDA, 2015).

Lipids, also known as fats, are the most calorie dense of all the macronutrients. Fat includes three major classes: triglycerides, phospholipids, and sterols, with the majority of fat in our diet coming from triglycerides. There are multiple functions of fat in the body, including cushioning, thermoregulation, and long-term energy storage. Fat is naturally found in animal products, dairy, nuts and seeds, and some vegetables. It is also consumed when added during food preparation as a means of enhancing flavor and texture. The daily recommendation for fat intake has changed considerably over the years and more focus has been given recently to reducing the consumption of 'bad' fats (USDHHS, 2015). Daily consumption of total fats should be limited to between 25%-35% of total calories. Fats are encouraged to be consumed in low amounts due to their high calorie content and risk for poor health (USDHHS, 2015). However, lipids are essential and cannot be avoided entirely.

In the case of vitamins and minerals, there are still many details we don't know about safety and efficacy. Vitamins and minerals are found in a wide variety of foods including fruits, vegetables, meats, nuts, whole grains, and dairy. Fruits and vegetables are nutrient dense foods because they are rich in carbohydrates, vitamins, minerals, and fiber while also being low in total calories. Low fruit and vegetable consumption may

result in many vitamin and mineral deficiencies, which could lead to dysfunctions in metabolism, poor cellular growth, decreased bone mineral density, fluid imbalance, impaired muscle contraction, anemia, and a depressed immune system. Daily recommendations for vitamins and minerals are established by the Dietary Reference Intakes and vary based on age and sex. Studies of many vitamins and minerals lack sufficient scientific evidence to provide daily recommendations and will only offer Tolerable Upper Limits¹. Many vitamins and minerals, consumed in excess, can produce toxic effects in the body. For example, it is understood that excessive intakes of Vitamin E can increase the risk of prostate cancer (NCI, 2015).

Food Intake Studies

Humans have always required food to maintain life and good health. But there is more to food than just nutrition and more recently the shift has been eating for enjoyment rather than survival. Humans have adapted their eating behaviors based on multiple factors. Food intake, expressed in behavioral terms, involves a complex interaction between biological, psychological, social, cultural, and environmental elements. These five groups of elements influence the nearly 200 food-related decisions made each day (Wansink & Sobal, 2007). The degree to which these influences elicit a specific food behavior is unknown. Multiple research studies have investigated food intake patterns and behaviors. Most studies collect the ages of participants to report generalizations about age groups, but do not explore period or cohort effects. Furthermore, the majority of studies lump all older adults into one category generally defined as over the age of 60.

¹ Tolerable Upper Limits are the highest intake levels recommended for individuals of different ages and genders that likely pose no health risk.

Prospective and longitudinal data collection efforts have tracked specific nutrient and food intake patterns of individuals in the United States. The Center for Disease Control and Prevention funds two noteworthy studies; the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS). Despite the fact that NHANES and BRFSS have been surveying the American population for over thirty years, neither follows the same individuals throughout subsequent years. Current trends from NHANES data indicate that intake of energy-dense, nutrient-poor foods has increased (Block, 2004) and intake of healthy foods like fruit and vegetables falls below the recommended levels (Casagrande, Wang, Anderson, & Gary, 2007). Energy-dense, nutrient-poor foods are those that provide a large amount of calories without the added benefit of nutrient variety. Block (2004) identified sweets and desserts, alcoholic beverages, and soft drinks as specific nutrient-poor foods consumed in high amounts among Americans.

BRFSS trends support NHANES findings but, due to the nature of the telephone survey, only data on fruit and vegetable consumption are collected. The benefit to consuming high levels of fruits and vegetables moves beyond nutrient-density to the presence of phytochemicals that are beneficial for health. The BRFSS targets fruits and vegetables due to their ability to reduce the risk of chronic disease and help individuals maintain healthy body weight (BRFSS, 2014). BRFSS data collected between the early 1990's and 2000's indicate that adults over the age of 65 were more likely to meet recommended fruit and vegetable intake (Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008; Li et al., 2000). The intake of fruit and vegetables among older adults,

while still higher than other groups, is starting to decline according to BRFSS (Serdula et al., 2004).

The National Food Consumption Survey (NFCS) and the Continuous Survey of Food Intake by Individuals (CSFII), sponsored by the United States Department of Agriculture (USDA), have also attempted to study food trends. These studies began in the early 1980's and were repeated ten years later. The same participants were not surveyed at both points in time, and neither study was continued after 1998. The surveys collected food intake via 24-hour recall and a food behavior questionnaire. Results indicated that total calorie and macronutrient intake levels were highest among adults aged 20-39 (USDA, 1997). Consumption trends of some foods varied among age groups. For example, adults over the age of 60 reported less change in their consumption of calorie-rich beverages compared to younger adults (Nielsen & Popkin, 2004). Differences in food intake among sex and ethnic groups were also presented by the USDA surveys. Women, as a whole, had stable fruit and vegetable intake patterns during the two survey periods (USDA, 1997). Black women had the lowest milk intake among ethnic groups while Hispanic women had higher dairy food intake (Siega-Riz & Popkin, 2001).

A small number of longitudinal studies have followed the same group of people over time, adding to the pool of information related to life span trends. The Framingham Heart Study, the Nurses' Health Study, and the Coronary Artery Risk Development in Young Adults (CARDIA) study include assessments of food intake and physical activity levels. All three of these research efforts include data examining the relationship between nutrition and chronic disease. By following the same group of individuals over

time those data sets allow researchers to identify the development of chronic disease in relation to physical activity, food intake, and other health behaviors. Participants are recruited in limited regions of the United States and sample sizes are smaller than the previously mentioned government funded surveys.

The Framingham Heart Study was initiated in 1948 under the direction of the National Heart Institute. Little was known about heart disease and its risk factors in the 1940's, but death rates due to cardiovascular disease were climbing (Framingham, 2016). Approximately 5,000 men and women living in Framingham, Massachusetts were recruited for this study. These participants returned every two years for follow-up exams and questionnaires. In 1971, the study recruited a new class of participants from the children of the original cohort. The grandchildren of the initial cohort were also recruited in 2002. Despite the inclusion of multiple birth cohorts, data have not been used for cross-cohort studies. Results from the Framingham Heart study have provided groundbreaking evidence about the risk factors for cardiovascular disease. Two risk factors identified include physical inactivity and obesity (Framingham, 2016). Food trends reported by the Framingham Heart Study indicate that intakes of total carbohydrates have decreased over time, but intakes of total fat, sodium, and alcohol have increased (Makarem, Scott, Quatromoni, Jacques, & Parekh, 2014).

The Nurses' Health Study began in 1976 with funding from the National Institutes for Health, with a primary focus being on women's health and the impact of oral contraceptives (NHS, 2013). The Nurses' Health Study went through two revisions, in 1989 and 2010, to include larger samples of nurses and identify more women's health issues. Each cohort completed follow-up questionnaires every two years. Several

reported findings related to diet and health. Based on the results of the Nurses' Health Study, high intakes of red meat increase the risk of developing colon and breast cancer (NHS, 2013). Results also suggest that high intakes of various vitamins and minerals may decrease the risk of developing colon cancer, pathological cognitive decline, and eye disease (NHS, 2013). High intakes of fruits and vegetables in non-obese young women lead to healthier weight status across the life span (He et al., 2004).

The CARDIA study, sponsored by the National Heart, Lung, and Blood Institute, began in the 1980's with a group of 5,000 men and women aged 18-30 years (CARDIA, 2016). These participants completed a questionnaire every two years. The most recent follow-up of these initial participants and their health status was conducted in 2010-2011. The primary focus of this study was to identify risk factors in the development of heart disease. Physical activity, diet, and other lifestyle factors were collected from each participant throughout the years. Despite its focus on heart disease, the CARDIA study also discovered the relationship between diet and physical activity in the risk for developing diabetes, nonalcoholic fatty liver, inflammation, and hypertension (CARDIA, 2016). CARDIA results highlight the food environment as being a major factor in diet quality and adherence to fruit and vegetable intake (Boone-Heinonen et al., 2011). Another major finding based on CARDIA results was that maintaining a healthy lifestyle in young adulthood would promote better cardiovascular health into middle adulthood (Liu et al., 2012).

Another study aimed at exploring the relationship between nutrition and health over chronological time is the NuAge study. This recently established longitudinal study is conducted in Quebec, Canada, and is limited to residents of that area. The NuAge

study began in 2003 and continues to be funded by the Canadian Institutes of Health Research in Quebec, Canada. 900 men and 900 women born between 1921 and 1935 are followed every five years. The results of the initial five year assessment highlights the importance of adequate nutrition in older adults despite changes in health status and quality of life (Vesnaver, Keller, Payette, & Shatenstein, 2012). As with other longitudinal studies, NuAge is limited in the span of ages and quantity of participant enrollment. In addition, no cross-cohort or time sequential analysis is conducted.

The Five Dimensions of Food Intake

Most disciplines agree that nutrition impacts health. Research studies are often focused on a single factor contributing to the behavior; however, there are multiple factors working simultaneously. The five factors most commonly highlighted by food choice and behavior researchers fall within social, cultural, environmental, physiological, and psychological dimensions.

Social Factors. Individuals live and interact with others within a socioecological sphere. Within an interpersonal level, individuals interact with family members, close friends, and peers. These interpersonal relationships exist within a network or community that exhibits influence on the behavior of the individual (Bronfenbrenner, 1974; McLeroy, Bibeau, Steckler, & Glanz, 1988). Depending on where this network or community is located geographically, the influence on food intake may vary considerably, and factors that influence one socioecological level will impact all other levels. Individuals are influenced by their network or group, social modeling, and social norms.

Interpersonal spheres of influence will impact food intake throughout the life span. The emerging social network can be a time and age sensitive barrier or motivator of food intake. The food relationships within the social network are ever-changing constructs that are rooted in social or commensal eating. Commensal eating primarily considers a family meal but also includes meals eaten with friends or neighbors. Commensal eating episodes could be a family meal at Thanksgiving or a neighborhood picnic on the Fourth of July. Social eating², like commensal eating, can create kinship and friendship patterns (Sobal & Nelson, 2003). Often foods prepared and presented for commensal eating episodes are shared among individuals. These shared foods encourage social interaction and a sense of belonging (Kauppinen-Raisanen, Gummerus, & Lehtola, 2013).

Food is often important at times of feasting, or even commensal and social eating, to help shape and control social behavior (Mennell, Murcott, & Vanotterloo, 1992). Social behavior may also be mediated by family roles and norms. For example, one family member's role at the Thanksgiving meal may be to carve the turkey whereas other members assume standing roles of providing certain 'traditional' items ranging from gravy to elaborate casseroles. Social norms are also expressed by the seating arrangement of members during the meal (Russell, Firestone, & Baron, 1980; Schrieff, Tredoux, Finchilescu, & Dixon, 2010) or in the quantity of food ordered at a restaurant (Cavazza, Graziani, & Guidetti, 2011). Participation in commensal eating is not consistent across the life span. Changing family dynamics as children move towards adolescence can have profound impacts on the frequency and meanings of commensal

² Social eating episodes occur when a group of individuals eat together while following specific social norms and eating patterns (Douglas, 1972; Douglas, 1984).

eating. For example, older adults often prefer to eat with immediate family members in their home rather than outside their homes with friends (Sobal & Nelson, 2003).

Social modeling is also a way that interpersonal relationships can influence food intake. Social modeling creates a desire in the individual to mimic the eating patterns of those within their social network (Stroebele & De Castro, 2004). Social modeling has been widely researched in children, adolescents, and younger adults as a contributor for food choices. Within these age groups, peers, friends, and parents are all models of eating behaviors (Harris & Ramsey, 2015; Hermans, Herman, Larsen, & Engels, 2009; Houldcroft, Haycraft, & Farrow, 2014; Loth, MacLehose, Larson, Berge, & Neumark-Sztainer, 2016). Consumption of fruits and vegetables among school-aged children increases after positive peer modeling occurs in schools (Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). Healthy food modeling will produce healthy food choices. Parental modeling and parenting styles reinforce positive eating behaviors in children and adolescents, which may influence young adulthood eating behaviors (Berge, Wall, Loth, & Neumark-Sztainer, 2010; Blissett, 2011; Guidetti, Cavazza, & Conner, 2016; Kremers, Brug, de Vries, & Engels, 2003; Sleddens et al., 2014).

Community level settings like work, school, and other neighborhood functions can influence eating. During these community and social eating experiences we will monitor our food intake based on the appearance and location of the event. When eating with others who are considered to be attractive or in areas that are more aesthetically pleasing, individuals will eat more (Stroebele & De Castro, 2004). The impact of the social network on food intake also varies based on sex. Men who have nominal social interactions and live alone are more likely to have less variety in their diets compared to

women in similar social circumstances (Conklin et al., 2014). Women who are within the interpersonal sphere of men, influence men's food intakes by increasing the consumption of healthy foods (Sidenvall, Nydahl, & Fjellstrom, 2000).

While all of these social factors are identified by multiple research studies, they do not take into consideration how social relationships evolve across a person's life span. The growing, and eventually large, social networks that typify youth and young adulthood narrow and become more meaningful as we age (Carstensen, Fung, & Charles, 2003; Carstensen, Isaacowitz, & Charles, 1999; Tornstam, 1997). Interpersonal relationships in late adulthood may influence food choice and behavior differently from younger age groups. Older adults who have fewer social contacts and live alone will often have a less varied diet and lower food intakes (Dean, Raats, Grunert, Lumbers, & Food Later Life, 2009).

Cultural Factors. Cultural influences may dictate what foods are acceptable to eat, what foods are available, and how those foods are prepared or presented. Culture includes beliefs, social roles, and traits of a specific ethnic or social group (Mish, 1997). For example, Black's living in the Southeastern United States consider their diet to be 'soul' food and this diet may be sampled by, but is rarely adopted by, other ethnic groups (Smith et al., 2006; Yang, Buys, Judd, Gower, & Locher, 2013). In addition, horsemeat is considered a delicacy in Europe but would not be culturally accepted in the United States. Food plays a role in determining acceptable eating behavior in a specific culture (Lévi-Strauss, 1968, 1969, 2013). Depending on culture, you may eat with utensils like chopsticks or you may eat with your fingers only. Culture will also establish rules about watching others eat and eating in the presence of others of different social class (Mead,

1970). The food culture ultimately determines particular gender roles, aversions, preferences, and traditions.

Food aversions and preferences are influenced by food modeling and peer support that occurs in a particular culture (Harris, 1985; Houldcroft et al., 2014). Many food aversions and preferences in a food culture may, over time, become stereotypical of specific ethnic groups or geographic regions (Meyer-Rochow, 2009). Food taboos, aversions and preferences can become a tradition if the behavior is repeated. Jewish food traditions prohibit the consumption of pork products and only Jews eat foods prepared through Kosher methods (Meyer-Rochow, 2009). Some foods carry certain symbolic meanings and therefore are avoided from one generation to the next. In some parts of Africa, protein-rich foods like milk and eggs are viewed as negatively influencing future behavior if consumed, and they are avoided by children (Meyer-Rochow, 2009).

Food can also maintain culture and transmit cultural traditions to others within their social environment (Fischler, 2011; Harris, 1985). Immigrants to the United States, for example, prepare foods that are familiar to their culture, and in many cities Japanese, Mexican, and even Mediterranean food markets emerge to meet the needs of these cultures. Local restaurants may be owned by immigrants to introduce cultural foods, often modified for an American food market, to natives and to meet the needs of immigrants who desire to eat their native foods. People may choose food based on cultural factors and not on the nutritional and health benefits of the food (Fischler, 2011). Food culture evolves and adapts based on changes in climate, local ecology, and geographic area (Twiss, 2012). An example of this phenomenon can be found in the study conducted by D'Sylva and Beagan (2011), who explored the role of food and food

practices in Catholic Goan women living in Canada. What they discovered through qualitative interviews was that the traditional foods of Goa, India, when prepared in Canada, helped Goan women maintain their ethnic identity. In addition, this traditional food preparation helped their children, who likely never lived in Goa, understand the cultural identity of Goa, India (D'Sylva & Beagan, 2011).

Depending on the culture, food can be considered masculine or feminine. In Western food cultures, milk, vegetables with seeds, warm and bright colored foods, chicken, fish, and eggs are considered feminine foods (Jones, 2007). Masculine foods include tubers (like potatoes), red meat (Jones, 2007), and alcohol (Gal & Wilkie, 2010; Newcombe, McCarthy, Cronin, & McCarthy, 2012). Some cultures consider vegetarian diets, which typically avoid animal protein, to be less masculine (Ruby & Heine, 2011).

Environmental Factors. The environment surrounding an individual influences food choice. The built environment encompasses multiple physical, geographical, and economical levels. These occur at both macro and micro levels. Macro level factors come from government policy, food technology, food industry and manufacturing, agricultural development, and economic situations (Gustafson et al., 2013; Jia, Moriarty, & Kanarek, 2009; Seeman & Crimmins, 2001). Government policies influence food intake and choice through food guidelines, regulations, and production. Policies like the Supplemental Nutrition Assistance Program, Farm Bill, and Dietary Guidelines all influence the food culture of Americans³. The Farm Bill directly affects the agricultural production of food and distribution in the United States. The Dietary Guidelines for Americans provide suggestions for daily food intake levels to maintain health and reduce

³ Details regarding all of these food policies can be found in Chapter 3 – America's Food Legacy.

the risk of chronic disease. The Supplemental Nutrition Assistance Program provides benefits for low-income families to receive a wide variety of foods from food retailers and farmers markets.

Changes in food production and distribution also affect food choices (Guptill, Copelton, & Lucal, 2013). The food industry produces over 20,000 new food products annually (ERS, 2016) and spends nearly \$33 billion dollars on food marketing (Nestle, 2013). The United States food industry produces foods using ingredients that are available locally, regionally, and internationally. Food marketing policies target all age groups, with significantly higher levels of focus on children, adolescents, and younger adults (Schwartz, Kunkel, & DeLucia, 2013; Williams, Crockett, Harrison, & Thomas, 2012). To further influence food intake food marketing has evolved over the years to include more health-related claims (Kim, Cheong, & Zheng, 2009).

Geographic location is another macro level factor that influences food intake. Geographic areas characterized by low energy-dense foods and minimal nutritional variety are called food deserts. Food deserts can be found in rural areas (Alviola, Nayga, Thomsen, & Wang, 2013), areas of low population density (Auchincloss, Roux, Brown, Raghunathan, & Erdmann, 2007), and in urban areas with low income and public housing (Cannuscio et al., 2013; Caspi, Kawachi, Subramanian, Adamkiewicz, & Sorensen, 2012). The lack of nutritionally beneficial food availability in food deserts is often accompanied by a higher prevalence of fast food and convenience stores (Alviola et al., 2013). The availability of food within a community or neighborhood is part of the built environment.

Micro-level factors include the location where the meal takes place, the layout of the room, utensils used for eating, and the presentation of the food, which can all influence food intake (Sobal & Wansink, 2007). The location of our kitchens in relation to the rest of the home and its ease of accessibility will influence eating. How the food is artfully arranged and displayed on the plate or the portion and package size will affect the enjoyment of the eating episode (Sobal & Wansink, 2007). These factors may negatively impact food intake in the face of limited mobility or required adaptive equipment to prepare and consume foods.

Personal wealth, or lack thereof, is another micro level environmental factor. Income level influences the variety, accessibility, preparation, and presentation of certain foods. For example, kitchen equipment and utensils are costly and preparation of recipes may be limited by what is available in a particular kitchen. You cannot zest a lemon for the risotto if you do not have a zester. Also, low income individuals and government food assistance participants are more likely to purchase poor quality foods (Butler & Raymond, 1996; Caspi et al., 2012; Darmon, Lacroix, Muller, & Ruffieux, 2014; Leung et al., 2012). Low-income status can increase the likelihood of food insecurity. Older adult's nutritional variety and adequacy is often impacted due to their low-income status (Dean & Sharkey, 2011; Quandt & Rao, 1999; Quandt, Vitolins, DeWalt, & Roos, 1997). The National Council on Aging (2014) estimates that over "23 million Americans aged 60 and older are economically insecure" while the National Foundation to End Senior Hunger (2012) reported that over 15 percent of older adults are at risk of hunger.

Physiological Factors. Multiple physical and biological factors will impact food intake patterns. Hormones and signals from the central nervous system regulate hunger

and satiety. Hunger is a response of no food present in the stomach and slowed gastrointestinal motility. The stomach, noticing the lack of food, releases ghrelin, a hormone that targets the hypothalamus and stimulates hunger (Cummings et al., 2001; Sanger, Hellstrom, & Naslund, 2011). Hunger is also increased due to shifts in insulin and glucagon. Glucagon is a hormone released from the pancreas to signal the cells to release glucose for energy production. Insulin is released from the pancreas following a meal to encourage cells to gather glucose from the blood (Murphy & Bloom, 2006). There are also multiple enteric nerves along the vagus nerve that respond to neuropeptides released during and after a meal (Huda, Wilding, & Pinkney, 2006). These enteric nerves send signals to the hypothalamus to regulate hunger.

Other signals reach the hypothalamus to stimulate satiety or fullness. The longer satiety signals are sent the less the person will feel hunger. One of the most prominent 'stop' signals comes from leptin, a hormone produced by adipose tissue in response to lipid uptake following a meal (Wilson & Enriori, 2015). Other hormones like peptide yy are released to control appetite and reduce food intake (Huda et al., 2006). Ultimately, all nerve impulses and hormones that suppress appetite are sent to the hypothalamus.

The brain decides whether or not to consume a certain food based on nerve impulses received from the mouth and nose. The brain receives messages from the mouth in the form of taste and texture. There are five specific senses that respond to the taste of food in our mouth; sweet, sour, salty, bitter, and umami (Rolls, 1997).

Associated taste buds are strategically placed on our tongue to collect taste from foods. An individual's sensitivity to particular tastes, along with learned behaviors, hormones, and hedonics, will influence food selection (Loper, La Sala, Dotson, & Steinle, 2015).

Not all individuals respond to tastes equally. Bitter tastes are interpreted differently based on genetic markers on the tongue (Dinehart, Hayes, Bartoshuk, Lanier, & Duffy, 2006). They may also differ based on sex. Women with a specific genetic code that responds to bitter foods will also avoid sweet or high fat foods (Duffy & Bartoshuk, 2000). Chemosensory perception of taste differs across the lifespan. During pregnancy, mothers can transfer the flavors of the foods they eat through the amniotic fluid to the fetus (Mennella, 2014; Mennella, Jagnow, & Beauchamp, 2001). Changes in taste perception occur as a normal part of aging and result in diminished taste identification among older adults (Koehler & Leonhaeuser, 2008; Schiffman, 1997; Schiffman & Graham, 2000).

The taste of foods combined with the odor of those foods create an overall flavor. The perception of taste requires functioning olfactory senses and develops following associative learning (Small & Prescott, 2005). Exposure to the same odor over time will create an expectation for what that food should taste like. Similar to taste, the ability to smell is reduced as a natural process of aging (Schiffman, 1997; Schiffman & Graham, 2000). The combined effect of impaired vision, smell, and taste reduces the food intake of older adults and can negatively impact appetite.

Chemosensory perceptions are not the only physiological factor that influences food intake. Certain types of diseases and health conditions can acutely or chronically alter food intake. Food allergies are one example of a physiological condition that alters food choice. Nearly 160 foods can cause allergic reactions, with the eight most common foods being milk, eggs, fish, shellfish, tree nuts, peanuts, wheat, and soybeans (FDA, 2015). Depending on individual response, exposure to the allergen could result in hives,

skin rash, swelling of the lips or tongue, coughing, dizziness, difficulty breathing, or unconsciousness (FARE, 2015). Food allergies typically manifest in childhood, with over 20% outgrowing their food allergy in adolescence (Gupta, Lau, Sita, Smith, & Greenhawt, 2013). Those who have a food allergy are required to avoid the offending food and cross contamination to minimize the allergic response (McCloud & Papoutsakis, 2011). Depending on the type of allergy this could significantly reduce the variety of food choices. For example, individuals with an allergy to wheat would need to avoid hundreds of food products including most grain products, batter-fried foods, candy, breakfast cereals, salad dressings, sauces, and processed meats (FARE, 2015).

Another physiological factor affecting food intake is the presence of an acute or chronic illness. Medical nutrition therapy for acute or chronic diseases vary depending on the disease pathophysiology and symptomology. In some cases, individuals are required to avoid particular foods that may exacerbate the illness. In other instances, individuals may be required to change their eating patterns and preparation methods to maintain good nutritional status. Medical nutrition therapy is initiated during the disease process and may help manage or delay the progression of disease. Each nutrition intervention is individualized based on genetics, lifestyle, food preferences, and disease type. Depending on the nature of the disease, changes in food intake and variety may be permanent. Failure to follow recommended diet changes could result in worsening symptoms or accelerated disease progression. Heart disease and diabetes are better controlled when individuals limit their intake of saturated fats, sodium, and simple carbohydrates⁴.

⁴ Simple carbohydrates have a high glycemic index and include items like cookies, candy, white bread, and sugar sweetened beverages.

Many prescribed medications for chronic disease alter olfactory response. Adults over the age of 60 are prescribed the highest number of drugs of any age group. The National Center for Health Statistics (2010) estimated that more than 76% of adults over the age of 60 used two or more prescription drugs within one month's time. Medications may affect olfactory senses and oral function through altering the production of saliva, blocking the perception of food flavors, imparting a bitter taste, or increasing zinc deficiency.

Some conditions, like dysphagia (i.e., difficulty swallowing) and altered gastrointestinal function, require the use of artificially provided nutrition. In these instances, food is often fed enterally into the stomach or small intestine with either a gastrostomy tube (G-tube), jejunostomy tube (J-tube), percutaneous endoscopic gastrostomy (PEG) tube, or percutaneous endoscopic gastro-jejunostomy (PEG-J) tube. Enteral feedings provide nutrition for the individual when they have a functioning gastrointestinal tract but are unable to maintain adequate oral food and fluid intake. Enteral feedings are identified as negatively impacting social networks and identity (Walker, 2005). Individuals with a dysfunctioning digestive system receive nutrients intravenously in the form of total parenteral nutrition (TPN).

Oral diseases will impact chemosensory perception and the enjoyment of eating. Edentulism, periodontal disease, or xerostomia (dry mouth) may require individuals to consume foods of varying textures like mechanical soft, or ground foods which can significantly alter the mouth feel, or tactile sensation, of foods. Without adequate mastication, or chewing, olfactory volatiles cannot be adequately released and therefore may inhibit the flavor of foods.

Psychological Factors. Chef's worldwide know that people eat with their eyes first. The color and organization of food on the plate is one of the first factors to influence food choice and willingness to eat (Zampini, Sanabria, Phillips, & Spence, 2007). Colors, in and of themselves, can affect psychological functioning (Elliot & Maier, 2007). Flavor is a combination of taste and smell perception. While these are both controlled by oral and olfactory receptors, they require psychological interpretation. For example, red foods may trigger the brain to stop or to avoid eating. In studies where researchers have modified the color of the food item, the taste buds are often confused and people incorrectly identify the flavor. For example, one study gave a cherry-flavored, green colored drink to participants. These participants incorrectly identified the flavor of this beverage as lemon-lime (Shankar, Levitan, Prescott, & Spence, 2009). Another task of this study was to identify the taste of a chocolate candy when the color of the coating was changed from one item to the next. Participants in this study perceived the brown coating to taste more chocolatey compared to the same candy coated with another color (Shankar et al., 2009).

Positive or negative feelings with food can be a secondary result of self-identity, body image, and memory or nostalgia. Self-identity is shaped by food intake and routines within a food culture (Jastran, Bisogni, Sobal, Blake, & Devine, 2009). People identify themselves by the food they cook, serve, and consume (Jones, 2007). Food identity is a combination of health status, values, family circumstances, and social environment (Bisogni, Connors, Devine, & Sobal, 2002). Food identities that can be displayed by individuals are the dieter, the health fanatic, the picky eater, the nonrestrictive eater, and the inconsistent eater (Blake & Bisogni, 2003; Blake, Bisogni,

Sobal, Devine, & Jastran, 2007). Food identity changes based on life events, sex roles, and cultural norms. Women often change their food identity when they become a wife, mother, or grandmother (Blake & Bisogni, 2003). Men can display different food identities depending on whether they are home with family or in a social environment (Newcombe et al., 2012).

Body image can also play a role in identity development and food intake patterns. Men and women conceptualize their ideal body image and rate their body shape satisfaction in different terms. Men, regardless of age, are more concerned with maintaining physical strength (Abell & Richards, 1996; Baker & Gringart, 2009; Clarke & Bennett, 2013; Clarke, O'Malley, Johnston, Schulenberg, & Lantz, 2009; Halliwell & Dittmar, 2003). This drive to maintain or develop lean body mass may produce higher intake of protein food sources. In Western cultures, women prefer thinner bodies and identify themselves as more attractive and socially acceptable if they are thin (Clarke et al., 2009; Ferraro et al., 2008). In order to accomplish a thinner body women may restrict foods or make food decisions based on what they perceive as potentially causing weight gain.

Food and meals often evoke memories or nostalgia. A memory is a dynamic process, and in the case of food can be “conscious or unconscious, publicly validated or privately concealed” (Holtzman, 2006). An eating episode will create a memory based on the sensory characteristics of the food and social interactions (Parma, Castiello, Köster, & Mojet, 2014). The eating experience can leave a lasting positive or negative memory. Foods that do not taste good will produce a stronger memory than foods that

elicit a positive response (Holtzman, 2010). Food memories will influence food intake, with negative memories producing food avoidance.

Food nostalgia establishes a symbolic connection to past food consumption elements like recipes, food products, or food practices (Vignolles & Pichon, 2014). For diasporic individuals, food can be a way to symbolize ethnic integrity (Duruz, 1999) and maintain memories of their native foods and practices (Mannur, 2007). Many immigrants maintain cultural food practices, combined with native foods, because of nostalgia and a desire to relive food memories. Nostalgia can also be attached to food items or brands. The positive associations with food brands (i.e., Coca-Cola, Twinkies, or Heinz Ketchup) and items can remain constant throughout the life span and become ingrained as a food preference (Vignolles & Pichon, 2014).

Memories and nostalgia can be affected by the aging process, yet very little is known about why food memories evolve across the life span. Evolving memories over time can affect the meaning of food in terms of relationships, food restriction, importance, and sharing (Monturo & Strump, 2014; Uprichard, Nettleton, & Chappell, 2013). Memory can also be altered due to dementia or Alzheimer's disease (Suto et al., 2014).

Conclusion

Quantifiable metrics of food consumption and demographic characteristics serve as the data foundation in most nutrition studies. While such data affectively inform the total amount and variety of food consumed, they cannot adequately inform food behavior or choice. Qualitative data collection methods are required to better understand the

factors influencing food and eating preferences and habits. Both forms of research have been used to identify factors that influence food intake and behavior.

Knowledge of the impact of nutrition on health is evolving. With improvements in research methods and evaluation we will continue to identify the role each nutrient plays in health promotion and disease prevention. Significant gaps still remain in understanding food intake across the life span and its impact on future health. Studies that track individuals over time currently have a narrow focus and participants do not adequately represent Americans as a whole. Baseline data on the food intake patterns of Americans over time are lacking and needs to be better understood prior to continuation of disease risk studies.

Current food intake studies have a limited view of the factors that influence food intake. Social, cultural, environmental, physiological, and psychological factors are identified separately but not holistically to understand food choice or behavior. The narrowed focus of food intake researchers produces conclusions that lack age, period, and cohort perspectives. In order to fully understand the factors that influence food intake and behavior a holistic exploration of contextual factors is crucial, and to promote health and prevent chronic disease, improved understanding of food choice and behavior is necessary.

Chapter 3: America's Food Legacy

The passage of time has a far greater impact on food choice than has been acknowledged by researchers. Food diversity historically evolves and leaves a food legacy for future generations. Foods legacy touches each individual, family, community, and society at large. This diversity is a process that occurs as a result of progress within food production and preparation. Throughout the United States individual foods hold different meanings from one region to the next. Within these regions, diversity can be found between genders, ethnicities, social classes, and education levels. This phenomenon is not new. The United States food culture is multiethnic and has been this way since colonial times. The amount of food produced depends on the agricultural system in place and the policies that govern production. The ability to secure and prepare food depends on what is yielded by agriculture and human's capacity to afford and then prepare what is available.

This dissertation study acknowledges multiethnicity and identifies the key factors that affect food choice over time. Combining observed food intake patterns with events that have occurred since colonization of the Americas allows for a critical analysis of the influence that time has on food intake and behavior. A multitude of historical events have occurred since the first explorer set foot on North American soil, and this dissertation study will focus on the major historical events that are most likely to impact current and future food choices. It is very possible that other regional events, natural disasters, and food policies excluded by this study have impacted the diverse foodways of the United States. However, an all-inclusive reciting of events is not necessary to

ascertain time and period affects and to demonstrate how the addition of context may expand food intake analysis.

Early American Foodways

When European explorers first arrived on North American soil they were seeking power and wealth. Some scholars believed that the earliest explorers were from northern Europe but found the conditions and climate to be too harsh for settlement (Fiske, 1907). Spain was the first to clearly send explorers across the unknown expanse of ocean in search of gold and trade routes to China. The Spanish reached the “new world” and were surprised to find it inhabited, not by the Chinese as expected, but by a population of people who slightly resembled people in India. These natives, called Indians, were found throughout all of the Americas by each European explorer who ventured across the ocean.

Early North American Foodways. Native Americans were the first inhabitants to have diverse foodways. Depending on their regional location, each Indian tribe produced and prepared food differently from other tribes. Hunter-gatherer and early agricultural practices were dependent on the soils and wildlife native to that region. The hunter-gatherer tribes placed minimal effort on farming practices (Hayden, 2009) and consumed a naturally higher animal-based diet than tribes that were primarily agricultural (Bellwood, 2001; Fiske, 1907). Hunter-gatherers were also more likely to live in areas that had unproductive soil and exhibited a nomad lifestyle (Fiske, 1907). The Native Americans who established villages were those most likely to have access to fertile soil that could sustain their nutritional needs, with diets supplemented by hunting.

Lured to the Americas by dreams of colonization and expansion, a host of European countries set sail for this new land. The French, British, Dutch, and Spanish monarchies sent ships across the ocean searching for their own claims to resources and trade routes. These explorers landed in different places throughout North America. Regardless of where they landed, they encountered Native Americans, sometimes harsh and always foreign lands, and a largely unforgiving and poorly understood landscape (Fiske, 1907; McWilliams, 2004). The first generation of settlers struggled to cultivate the land enough to produce adequate food supplies to survive the long, harsh winters or hot, humid summers (McWilliams, 2004, 2005b). The environment and climate of the Americas was vastly different from their native lands.

France, England, and Spain were the primary countries to establish colonies in North America. The French colonized the northern most areas of North America and the land touching the Mississippi River (Fiske, 1907). The British maintained control over the seaports along the eastern United States. Spain primarily focused its attention on the southeastern areas of North American and the islands of the Caribbean. Portugal also sailed west in search of land but settled on land in South America.

Throughout all these regions, settlers had a tumultuous relationship with the indigenous people. Initially, the settler's survival relied upon the assistance of Native Americans who had well-established agricultural and related food preparation methods. But not all Native American tribes were so forthcoming with their practices. Many tribes were not willing to submit their lands to the foreigners and were hesitant to share their practices with those who would benefit from them and, ultimately, flourish (Fiske, 1907). In addition, the settlers who had produced food in their native country often viewed the

Native American's style of agriculture to be barbaric (McWilliams, 2005b). The settlers, for example, were accustomed to men working the land and the native's use of women in these roles was shocking. Initially, European ships supported agricultural growth by importing foods. Outward from Europe and Africa came chickens, pigs, cattle, sheep, coffee, rice, sugar, and yams (Gabaccia, 1998).

America, by the seventeenth century, had developed new multiethnic foodways that combined the agricultural practices of the Native Americans and settlers. Agricultural production relied not only on farming practices but also on necessary soils, climates, and seed availability. Food production and preparation methods of the earliest settlers usually mimicked the methods of their homeland. Differences within each English colony existed as well due to the influence of the colony governors and agricultural policies (Wright, 1957). These policies controlled regional and international trade and exportation of goods produced in the colonies. Such spatial differences were further enhanced by the incorporation of slaves. The increased exportation of agricultural products like sugar, rice, and tobacco required more labor, often fulfilled by slaves (Fiske, 1907; Gabaccia, 1998; McWilliams, 2005b; Mintz, 1985). The majority of the slaves were brought to the Americas from West Africa and were key to establishing plantation systems (McWilliams, 2002), which were the first agricultural process to produce mass quantities of foods available cross-regionally and for exportation. Throughout all agricultural areas, slaves were found in larger amounts in areas where farmland was most valuable, with the exception of the Northern colonies that eventually would have legislation preventing slavery (Wright, 2003).

The colonies within the Chesapeake Bay region utilized agricultural and preparation methods that combined English, West Indian, and African foodways. Tobacco was the major cash crop in this region and many plantations required slaves for mass cultivation. The agricultural food practices evolved from the processes utilized by the natives into a process that was similar to English methods. The influence of African food culture produced very little impact in this region due to the rigorous demands of the tobacco crop (McWilliams, 2005b). Slaves primarily received their foods from the plantation master but would, on occasion, produce and prepare food with their own native methods. The primary foods available in this region included Indian corn, pork, beef, dairy, rice, wild game, pumpkin, peaches, watermelon, peanuts, and yams (McWilliams, 2005b).

The foodways of the Carolina's differed considerably from those in the Chesapeake Bay region. The climate of the Carolina's was similar to that of West Africa where many of the slaves had been raised. Because of this, rice was the major cash crop and was produced with the expertise of the African slaves. The African influence left its mark on food production and preparation. Food staples in this region were a combination of English, Native American, and African influences. African slaves produced pumpkins, gourds, beans, potatoes, and corn, which were consumed by slaves and the master's family (Gabaccia, 1998; McWilliams, 2005b). Pork was consumed more regularly than beef, with many slaves also consuming wild game. While rice was the primary starchy food consumed, corn and potatoes became increasingly popular. Corn was consumed in the form of corn on the cob or as grits. Wheat bread, while consumed, was more likely to be replaced by griddle cakes.

Moving north into New York and Pennsylvania, food staples changed dramatically. In this region, food intake was influenced by Native Americans as well as English, Dutch, and German immigrants. Relationships between early settlers and the Iroquois tribe were initially peaceful. The Iroquois used English weapons to gain power over other Indian tribes and establish military position. In return, the Iroquois advanced the agricultural and hunting ability of the early settlers. The destruction of the Iroquois came as a result of their increased infatuation with rum (Fiske, 1907).

New York and Pennsylvania, were also unique among other colonies because of wheat production which did not require slaves and was easily transported, processed, milled and shipped (McWilliams, 2005b). Wheat allowed for more agricultural diversity because it could be grown alongside other grains. While farms were less plantation-style they still had work for a handful of slaves to do in the fields. Because of the smaller population of African slaves, their influence on the food culture in this region was insignificant.

Eventually the pig became the primary protein source in this Northern region due to the strong influence of Dutch and German native foods (Harris, 1985). Stewing, which often contained an assortment of fruits or vegetables mixed with pork, became a popular food preparation method due to Dutch and German influence (Gabaccia, 1998). Quakers also settled in this region and influenced food intake practices. Unlike other settlers, the Quakers believed that food intake should be “simple, basic, and modest” (McWilliams, 2005b, p. 169). William Penn, a Quaker, was the first to coin the phrase “are you living to eat or eating to live” (McWilliams, 2005b, p. 170). The Quaker’s influence on this

region was the notion that food should not be consumed in excess; rather, it should be moderate and frugal (McWilliams, 2005b).

Other diversity among food cultures was present in North America during colonial times. Florida and much of the land surrounding the Gulf of Mexico was influenced by more equatorial Native American and Spanish foodways. This ethnic combination inspired foods such as the tamales, tortillas, beans, and chile-laden meals (Pilcher, 2014). The French contributed to the regional foodways of those living around the Mississippi River and Canada. Throughout French settlements, pockets of Dutch, Scottish, Irish, and German immigrants eventually made their mark on the food culture. As with other places, these regions utilized native cooking methods for food preparation to consume local foods produced by agricultural and hunting methods.

With success in food preparation came regionally produced cookbooks and recipes that shared the tastes and smells of the immigrant's homeland (Sutton, 2001). The first recorded cookbook, *American Cookery*, was published in 1796 and represented the food culture of the northern colonies. In this cookbook, British techniques were used to prepare local ingredients (Gabaccia, 1998). Additional cookbooks were written by Quaker's, Dutch, and German authors. While many of these cookbooks contain native ethnic foods, many also included Native American food preparation and production methods. The majority of recipes found in these early American cookbooks relied upon America's agriculture for ingredients (Gabaccia, 1998).

Regional unification. By the mid-eighteenth century, many of the white Americans had been born in America and were very unlikely to personally know their parents', or grandparents' native food cultures (Gabaccia, 1998; McWilliams, 2005b).

This birth cohort likely was proud of their current food culture because it had been cultivated out of adversity. It wasn't long until the colonials generated their own culinary meaning of food. James McWilliams (2005b) suggested that it was this strong "sense of choice..and...identity as British Americans" (p.320) that initiated the conflict between the British Americans and England. England's desire to maintain control over the colonists exerted itself through such methods as taxation.

Following the Seven Years War, England passed several food-related taxes in the colonies. The Molasses Act of 1733, the Sugar Act of 1764, and the Quartering Act of 1765 were all tax laws initiated by England to control the trade of goods. The Molasses Act and Sugar Act were unsuccessful due to smuggling by American merchants (McWilliams, 2005a). The Quartering Act required colonial authorities to provide food, drink, and lodging (quarters) to any redcoat stationed in their villages. In 1765, England also passed the Stamp Act to control the tea trade. Tea was a staple in the diets of many colonists and was imported from the West Indies and other tea-producing countries.

It was the Tea Act of 1773 that seemed to be the event that ended peaceful relations with the colonists and England. The Tea Act would allow British control over the tea trade and required the colonists to pay taxes on tea imports. This led to the Boston Tea Party, an event in which a group of protesting New Englanders, dressed as Mohawk Indians, dumped over 300 chests of tea into the Boston Harbor. The threat to the agricultural economy and political freedom gave rise to the rallying cry of the American Revolution: "no taxation without representation" (McWilliams, 2005b).

The Industrialization of Agriculture

By the end of the seventeenth century and early in the eighteenth century the colonial economy grew by an annual rate of 3.5%, and nearly 85% of the food produced was consumed by colonists (McWilliams, 2005a). To reach this level colonists and slaves had to clear land, plant fields, raise livestock, and establish trade routes intra-regionally. Relationships with the Native Americans worsened due to this expansion and produced significant strife. The colonist's adaptation to the American soil and improved agricultural practices meant that assistance from the native inhabitants was no longer viewed as necessary. The colonies were able to produce enough beef, wheat, rum, fish, corn, and butter to feed themselves year round, as well as export these goods (McWilliams, 2004). By the mid-1800's, Louisiana, Texas, and Florida became part of the United States population and with that brought additional land for food production along with cultures that would have profound effects on future foodways.

Agricultural preparation and preservation. There are multiple advancements in agricultural production and preparation that occurred by the end of the eighteenth century. Women played a primary role in food production, which shifted the perspective of the woman's role in everyday life. Women's assistance with food production and preparation was a routine practice for the natives although completely foreign to the earliest settlers. However, by the eighteenth century, the majority of settlers owned land and women often aided in food production (McWilliams, 2004). Women had a role in selling food at local markets and influenced the economic food market (McWilliams, 2009). This role did not diminish the expected role of food preparer and home maker (Gabaccia, 1998).

The earliest settler homes usually comprised one room that included a fireplace for heating and food preparation. Primitive kitchen equipment was initially used in the colonies and included an iron pot and skillet, a pothook and spit. Food was cooked over an open fire in a stone-based, ventilated place in a kitchen or located outside as seasons permitted. The minimal diversity in kitchen equipment greatly influenced the food prepared and consumed by colonists (McWilliams, 2005b). Colonial kitchens evolved as agricultural development and food exportation increased. Kitchen equipment was imported from Europe and often included items such as silver eating utensils, kettles, porcelain bowls, brass pans, tablecloths, coffee mills, kitchen knives, and specialized baking pans (McWilliams, 2005b). Home design also changed. Many kitchens were moved to a separate room and, on large plantations, were completely out of sight and managed by slaves. Social class dictated the nature of the kitchen, including the types of utensils, size of the space, and even the presence of slaves tasked with food preparation.

Heating improvements can be linked with the modification in the kitchen space. In the eighteenth century, Benjamin Franklin designed a stove that became very popular in the United States. Franklin's stove was an iron fireplace that retained heat and pulled air from outside (McWilliams, 2005b). Benjamin Thomson, also known as Count Rumford, modified Franklin's stove by providing a device that could cook and heat in one unit and no longer required an open fireplace for food preparation (Andrews & Andrews, 1974). The majority of foods, prior to the wood stove, were one-pot dishes. However, as heating techniques improved due to stove innovations, cooks could prepare multiple dishes at one time. Kitchen pottery was very likely dominated by metal pots, but with the evolution of the stove cooks could use other materials made of ceramics and

glass. Further advancements in science allowed for innovations in equipment like convection ovens. Improvements in cooking devices allowed for significantly shorter cooking times and consequently, less total time spent in food preparation.

A key role that women took in food preparation was that of preservation. With increased agricultural production, colonists needed a way of preserving food for regional distribution and year round availability. Food could be preserved through drying, salting, sugaring, and fermentation. Eventually, canning became a method of preservation due to the ability to control heat and advanced hermetic sealing technology. Throughout history, man was able to preserve food through the addition of pungent or strong spices, drying, fermentation and extreme cold. The Native Americans were among the many cultures throughout the world to maintain these methods when the colonists first arrived to North America. Colonists continued these food preservation practices until advancements in technology were available.

Ice as a preservation method was not ideal because it would eventually melt and, at that point, could accelerate food spoilage (Freidberg, 2009). Ice was used in storage houses and transport railway cars to preserve meat, dairy, and butter during shipment (McLachlan, 1975). Much of the ice had been shipped from northern America to the southern regions. Manufactured ice was also used as a means of maintaining cold storage for ships that transported goods across the ocean. The icebox refrigerator was invented in 1801 by Thomas Moore in Maryland (NIFA, 2014). This improved cold storage to a degree but was not as convenient as mechanical refrigeration, which was patented in 1853 and first became significant to the meat industry (Goodwin, Grennes, & Craig, 2002). Not until the 1890's was widespread use of mechanical refrigeration was utilized

by perishable goods producers. The butter industry was able to ship their product nationwide without spoilage and make butter available year round independent of dairy producing cycles (Goodwin et al., 2002). Dairy foods, viewed by colonists as especially nourishing, held great meaning. Milk and cheese were viewed as important for digestive health and included in many dishes as a means of strengthening and maintaining good health (Eden, 1999). Through advancement in cold storage, a variety of foods were available year round and families could rely less on seasonal food production.

William Underwood, an English Immigrant living in Boston, Massachusetts was one of the first in America to can food for preservation. The metal cans were initially made of tin-plated steel until the 1950's when they began manufacturing aluminum cans (Risch, 2009). Underwood first canned meat in 1817. Following his success, other food industries canned salmon, lobsters, and oysters in 1819 (McLachlan, 1975). During the Civil War, American soldiers were fed out of cans and no longer required cooks to follow them on the battle front (Tunc, 2012). The invention of the pressure cooker in America in 1874, made canning more convenient. By the end of the 19th century, canning permitted farmers to sell their goods to expanded regional markets. It was during this time in American history that scientists could apply the germ theory to food packaging and preservation.

Following World War II, the focus on packaging was not only for food safety but also for food quality. Plastics, which had been developed for war applications, were now used to package foods (Risch, 2009). These plastics came in many forms and enveloped sandwiches, bread, snack foods, and other shelf-stable products. Plastics, along with other manufactured storage materials, allowed for a wider variety of foods to be available

year round that had a longer shelf life and were less likely to spoil. Drying foods became a means of increasing shelf stability and shortening cooking times. Popular dried foods were typically carbohydrate-rich like pasta, rice, noodles, and potato flakes. Dried foods were less likely to spoil without the presence of water for bacteria to grow. Dried foods could be packaged and shipped to regional and global markets.

The health benefits of preserved foods has been in question throughout the late 20th century and into the 21st century. Foodborne illnesses caused by bacteria like listeria, botulism, and salmonella can still grow and thrive in preserved foods not prepared appropriately or in safe conditions. The health of preserved foods is also in question. While some preservation methods, like canning, can increase levels of certain nutrients, other preservation methods may destroy certain nutrients during processing (Kapica, 2013). For example, nutrients like riboflavin and ascorbic acid are higher in frozen foods compared to the same foods consumed fresh (Bouzari, Holstege, & Barrett, 2015). Beta carotene, a phytochemical found in foods like sweet potatoes, are found in lower amounts in preserved foods compared to fresh foods (Bouzari et al., 2015).

Another concern related to nutrients found in preserved foods is related to the sodium content. High sodium intake has been associated with an increased risk of high blood pressure. Some methods of food preservation, like drying or curing, require salt during preparation. However, many preserved foods can be made with ‘low salt’ or ‘no salt added’ options. Ultimately, food preservation methods like drying and canning are a good way to provide nutrient dense foods to a wide variety of people, regardless of income or cooking ability. Frozen, canned, and dried foods altered food culture by allowing cooks the opportunity to prepare quicker meals and within a single baking dish.

Agricultural Technology and Policy. Following the American Revolution, the United States of America had the freedom to create their own laws and taxes. Agriculture was the largest industry and the food culture varied among regions. Advancements in preservation and storage led to mass production of certain foods. The first food industries created products grown on farms and sold to the rapidly growing urban markets. Some of the early food industries produced fresh meat, high-grade flour, sugar, salt, glucose, starch, and biscuits. Agricultural exports were also growing during the early 1800's. According to the National Institute of Food and Agriculture, agricultural exports grew to \$40 million dollars per year between 1810 and 1819.

Farm machinery and technology grew exponentially in the nineteenth century. In 1830, harvesting wheat with a walking plow, brush harrow, and sickle required around 250 labor-hours to produce 100 bushels. These labor-hours were completed by farmers and slaves. Farmers comprised over 60% of the labor force in the United States in the early 1800's (NIFA, 2014). To improve productivity, steel plows were invented during the 1830's. By the late 1800's a two-horse straddle-row cultivator was patented and farm production increased. Horses now became the power behind crop cultivation and harvesting, shifting the labor-hours to under 50. By the end of the 1800's, steam and gasoline tractors were invented. With the widespread use of farm machinery by the mid 1900's, one farmer could supply food for nearly 10 people and up to 100 people by the 1990's (NIFA, 2014).

Throughout the nineteenth and twentieth centuries, multiple food products were developed that could be shipped to all regions of the United States. Some of these food items remain in production today and are now found in all areas of the United States. For

example, Spam is a processed meat developed by Hormel Foods in 1926. During World War II, Spam, a protein rich food that did not require refrigeration, was shipped overseas from the Minnesota factory to feed American troops. Following the war, Hawaiian natives adopted Spam into their food culture. There are many other foods that have withstood the test of time and become favorites in the United States and throughout the world. Coca-Cola, Kellogg's, Gold Medal Flour, Van Camp, Armour & Co., and Swift & Co. are just a few of these companies that created regional staple food products. The introduction of these foods to all regions created some uniformity in foodways across the United States.

Coca-Cola was developed in 1886 by a pharmacist, John Pemberton, during a time when the soda fountain was a cultural success. Following the influence of Asa Griggs Chandler, a brilliant marketer, and Coca-Cola's signature glass bottle the product became an American icon. By the 1920's Coca-Cola was a huge success and, to aid with purchasing, it packaged bottles into the six-pack. During World War II, Coca-Cola became a symbol of America and was shipped to Europe to be placed in the hands of as many soldiers as possible (Guptill, Copelton, & Lucal, 2013).

Dr. John Harvey Kellogg supported the idea that good health and fitness were a result of good diet and exercise. He began testing a grain cereal product on patients at his sanitarium. By 1902, he developed corn flakes and founded the Kellogg Toasted Corn Flake Company. A spin off of Kellogg's corn flakes was a cereal produced by his previous sanitarium patient, Charles Post. Post also founded his own cereal company and created Grape Nuts and Post Toasties (Gifford, 2002). It wasn't long until public opinion established breakfast cereals as an essential breakfast food.

With the increasing popularity and production of these branded foods came the need to begin food marketing (Smith, 1973). Companies began to create advertisements strategically placed in food markets or newspapers. Gold Medal flour, Coca-Cola, and Van Camp's canned beans developed incentives to convince consumers to like standardized foods (Gabaccia, 1998). Cookbooks were also published by these companies as a means of teaching housewives how to incorporate their products into recipes. Gold Medal Flour used to print a coupon with the bag of flour that could be redeemed for a *Gold Medal Flour Cook Book*. These cookbooks also, conveniently, included multiple pages with Gold Medal product advertisements. By the beginning of the 20th century, Armour & Co., American Sugar, Swift & Co., National Biscuit, and United Fruit were the top agricultural processing companies in the US (Smith, 1973). Following the Great Depression, New Deal and World War II, giant food corporations developed and gave rise to national branding and retailing (Blanke, 2007). This increased the standardization of food availability nationwide.

A national, unified cuisine occurred following the Revolution, not only because of food preservation but from food socialization as well. During the early nineteenth century, farmers in many states were opposed to a centralized agricultural planning system. Despite this, President Abraham Lincoln founded the United States Department of Agriculture (USDA) in 1862 (FSIS, 2016). This government entity would be responsible for controlling agricultural production and ultimately the foods available to people living in the United States. Initially, the USDA was focused on research, financing agricultural exploration in foreign lands, exploring new botanical species, and generally establishing new agricultural practices in the United States.

As mass food production increased and consumers began to increase the purchasing of processed foods the need to insure food safety increased. President Lincoln appointed a chemist, Harvey Wiley, to oversee the Division of Chemistry, which would eventually become the Food and Drug Administration. The objective behind the Division of Chemistry was to raise public awareness about food safety, develop standards for food processing, and campaign for the “Pure Food and Drug Act”. It would take Wiley 44 years to finally get the act passed (FSIS, 2016). This oversight organization would insure that all food produced would be safe throughout every region of the United States.

Infected cattle from other countries and the United States were being consumed due to lack of restrictions and oversight. By 1884, after much failure in improving oversight into the health of imported cattle, the USDA Bureau of Animal Industry (BAI) began to oversee the health of livestock. As a result of the BAI oversight, quarantine stations were utilized to prevent foreign animal diseases from entering the US food supply. This also opened the door to pass laws in 1890 requiring the inspection of meat before exportation to other countries.

With the growth of urban areas came the decrease in animal husbandry. Feeding the large urban populations required meat from other regions to be shipped to urban areas for processing. The majority of this meat was processed by meat packing plants that, unfortunately, were identified as being a source of infectious disease. Upton Sinclair, author of *The Jungle*, highlighted the working conditions of people in the Chicago meatpacking facilities. So appalling were the conditions described in his book that public opinion of the meat industry plummeted. President Theodore Roosevelt, after much

persuasion from Mr. Sinclair, passed the Federal Meat Inspection Act and the Pure Food and Drug Act in 1907. Both of these new laws required oversight into the branding and safety of food produced by the food industry. In addition, meatpacking facilities were required to maintain strict sanitation and safety regulations.

By 1930, the oversight of food safety all fell under the Food and Drug Administration (FDA). In 1938 the Food Drug and Cosmetic Act was passed that aimed to eliminate any hazardous food packaging and enforced food standards. The Delaney Law required allowed the FDA to have more control over additives like pesticides, colors, and carcinogens (FDA, 2009). Currently the FDA is responsible for protecting the health of Americans by assuring the safety, efficacy, and security of food. The control over food additives and safety has been threatened over the years by government, food lobbyists, and regulatory reform.

War and the Regulation of American Foodways

Regional food diversity, despite widespread trade of industry produced foods, was still present throughout the United States during the twentieth century. Food intake continued to be influenced by what was agriculturally produced and available. Food preparation varied depending on whether the food was preserved or fresh, what equipment was used, and regional ethnicity. New agricultural regions developed due to the political expansion of the United States, advances in soil science, mechanized agriculture, and irrigation technology. Within each region there were areas of differential urban and rural development. Some urban areas lost their agrarian lifestyles and relied upon the food industry and regional farmers to provide their food. Still, diversity continued to be influenced by immigrants. The United States opened Ellis Island in 1892

as a federal immigration station and immigrants from Europe swarmed the island until its closing in 1954. During Ellis Island's peak years, 1900-1914, 5,000 to 10,000 people passed through the immigration station each day. The rate of immigration declined in 1914 due to World War I.

World War I. World War I increased the demands of food production and altered the preparation of foods in the United States. Following America's entrance into war in 1917, President Woodrow Wilson organized a massive domestic propaganda campaign with the aid of his 'four-minute men' (Tunc, 2012). These men prepared public service announcements for movie-going audiences in various settings, on a variety of pro-America topics, but eventually the focus turned to production, conservation and consumption of food in the United States. Victory



Figure 3.1 WWI Propaganda

gardens became a trend to produce a self-sustaining food supply for Americans (Figure 3.1). Small gardens and animal husbandry became common place city parks, school lots, and workplaces (Tunc, 2012). Also encouraged during this time was increased food preservation methods like drying and canning, which would allow a stable food supply year round. Conserving food became a "patriotic duty" and even the identity of many American citizens and non-citizens (Tunc, 2012).

Despite the increased focus on food production, food shortages were prevalent nationwide during World War I. Eggs and butter were in short supply because these foods were shipped overseas to the troops and many dairy farmers were men serving in

the war. Food substitutes included whale and porpoise in place of red meat, and honey, molasses, or maple syrup took the place of sugar. Also invented during this time period were ‘dump cakes’⁵, which cooks prepared while eggs and butter were in short supply. Spaghetti, in multiple variations, became a staple because of America’s alliance with Italy during the war.

The American diet went through considerable change during World War I. As a by-product of President Wilson’s ‘eat less’ campaign, red meat, oils, and white wheat flour was shipped to Europe to keep the troops well fed. Based on vitamin and mineral research at that time it was believed that good nutrition would aid soldiers. Women, who were the primary food production experts in the home, were encouraged to participate in ‘wheatless Mondays and Wednesdays, meatless Tuesdays, and porkless Thursdays and Saturdays’ (Gifford, 2002; Tunc, 2012). So began the absolute understanding that there should not be any food waste and everyone should finish their meals with a clean plate. Women, with their efforts in food preparation and preservation, increased their social status and influence within socially accepted gender roles of the time. There is little doubt that propaganda involving food during World War I was more influential than during any other war in American history. Propaganda signs were so well received that they were utilized again during World War II. These food intake initiatives were an attempt to regulate food procurement, preparation and consumption in the United States.

Food purchasing, which had previously been done with the aid of small, local markets, underwent a major change during World War I. Prior to the war, food shoppers presented a list of desired goods to a shop keeper who collected the items from available

⁵ Dump cakes typically included just 1 cup of sugar and 5 tablespoons of canola oil dumped into a pie plate along with other ingredients such as flour, baking soda, salt, cocoa, vinegar, vanilla, and water.

stock. In 1916, Clarence Saunders opened the first Piggly Wiggly (Tunc, 2012). This food store was larger than traditional grocery stores and became entirely self-service. The self-service concept created more competition among food manufacturers, and self-service stores allowed food purchasers an opportunity to make their own choices about brands or products. After the end of World War I the number of canned foods increased significantly and most Americans purchased factory-produced canned goods. It wasn't until 1937 that shopping carts were invented to allow shoppers to purchase more food at each trip (Guptill et al., 2013).

World War II. World War II also disrupted food production and preparation but in slightly different ways. The traditional role of women changed very little from colonial times to the early 1900's (Forste & Fox, 2012; Nelson, Sapp, Berkman, Li, & Sorensen, 2011). The enormity of this role depended on the income of the family and agrarian lifestyle. In regions where agriculture was the main industry, women had a larger role in the production and preservation of foods (Van Willigen & Van Willigen, 2006). However, these traditional roles changed during World War II when government propaganda was used to bring women into the labor force. While it is noted that many women returned home at the end of the war, this propaganda was a turning point in the social roles of women. Women learned to manage work life while also maintaining their house work, indeed, the number of women in the workplace grew nearly 10 percent from 1940 to 1950 (Goldin, 1991), as domestic role responsibilities remained unchanged.

With women spending more time working outside of home, alternative methods were used to feed families. Women relied more on convenience, frozen, and canned foods than in times past. These foods took some of the labor away from the food

preparer. Advancements in kitchen equipment and technology also modified food production. Equipment used for storage and food preparation now became electric. Men also started to take on more of a cooking role in the form of outdoor grilling. Grilling provided men with a masculine role of food preparation supported by cookbooks and popular magazines (Miller, 2010). Red meat and potatoes, long viewed as masculine foods, were commonly prepared on outdoor grills (Miller, 2010).

During World War II, butter, sugar, red meat, coffee and canned goods were rationed. As with World War I, the focus was on feeding the soldiers so that they might have the energy to fight (Gifford, 2002). During this time organ meats, peanut butter, cheese, eggs, and soybeans were promoted as good protein alternatives. This heightened awareness about red meat enhancing strength in the fighting men led to the public perception that red meat was essential (Gifford, 2002).

The Socialization of Agriculture

The United States was largely agrarian at the start of the twentieth century. Foods were openly traded throughout the nation and enough food was produced to maintain the nutritional status of all Americans. It was understood by legislators and physicians that good nutrition was the key to good health. Providing adequate amounts of food to all Americans was a priority to maintain the United States as a world power. In order to do this, agricultural production had to be regulated to meet the nutritional needs of the people. Food policies were initiated to influence agricultural food production and development. Food intake guidelines were also created to insure that everyone consumed adequate amounts of these agriculturally produced foods to maintain good health.

In 1900, 41 percent of the workforce were agricultural employees who produced about five commodities per farm on small farms with about 100 acres (Dimitri, Effland, & Conklin, 2005). By the year 2000, the size of farms increased dramatically to nearly 400 acres, and farmers produced about one commodity per farm (NIFA, 2014). Some of this is a result of technological developments and increasing availability of chemical agents aiding production. Another factor contributing to changes in agricultural production was consumer demand. Consumer demand by the year 2000 was for convenient, ethnic, and health-based foods (Dimitri et al., 2005). The increase in global markets also introduced new consumers. Finally, agricultural policies produced a market-oriented philosophy in food production. This philosophy initiated commodity programs and was responsible for the shift in agricultural production.

Changing Agricultural Practices through Policy. Food production relies on crops that are able to yield enough food and animals that can develop with the feed they are provided. These are threatened in times of drought and natural disasters. During the Great Depression, food availability was lower due to financial crisis and droughts. Not all areas of the United States were similarly affected by the droughts and some food production was maintained. The financial crisis combined with lower local food production caused food prices to be at record lows while still being produced in surplus in some areas. People, due to financial restrictions, skipped meals or ate meager dinners. Malnutrition was common place, especially in urban areas. The USDA, in order to control over-production, ordered the plowing under of crops and destruction of pigs to steady farm prices in 1933 (Moran, 2011). After the public outcry against the slaughtering of animals, President Franklin Roosevelt organized the Federal Surplus

Relief Corporation to set up commissaries under the oversight of the USDA. The USDA distributed three purchasing guides for consumers. They recommended the number of daily and weekly servings individuals should get from each of the food groups in order to maintain adequate health.

The Great Depression also gave rise to the Food Stamp Plan. Supported by grocers and wholesalers, this program would allow for a chain of food purchasing. Wholesalers would purchase surplus commodities from farmers, those wholesalers would then sell the goods to grocers for housewives of all classes to purchase. Families on government relief funds could then obtain color-coded food stamps to purchase specified agricultural commodities. Some foods included in the subsidies were pork, eggs, pears, citrus, tomatoes, grapefruit, and cabbage (Moran, 2011). These foods were overproduced in areas less affected by draught and the financial crisis. Produce was shipped to markets that had never seen such foods before. The food consumption patterns of Americans during the Great Depression was highly influenced by the surplus commodities.

The Food Stamp Act of 1964, an update of the earlier Food Stamp Plan, allowed low-income households to receive food products associated with surplus crop production. Low-income families received stamps or coupons that could be redeemed for nutritious food at any food retailer participating in the program (FNS, 2016). Initially the program was limited to certain areas of the country, but in 1971 eligibility was expanded to the national level (Grieger & Danziger, 2011). The food stamp program provided food for low-income people of all age groups. The food stamp program also benefited the farmers by providing a market for their products (Jensen, 2002). With the aid of this program, older adults, in particular, were able to improve their nutritional status, which may have

suffered due to their lower incomes (Butler & Raymond, 1996). The Food Stamp Program grew annually as a result of the 1964 revision and, within ten years, nearly 15 million people were enrolled in the program (FNS, 2016).

Success of the food stamp program meant that the government was spending over 20 million dollars annually by the end of the 20th century. Amendments to the food stamp program occurred periodically throughout the 1970's, 1980's, and 1990's to adjust for poverty line changes and to reduce the reporting impact of abuses made by participants. The demand for revisions to the food stamp program occurred as the number of those hungry and malnourished in America increased (Levenstein, 1993). By the late twentieth century, participation had peaked at 29 million people per month. This peak was a result of the 2002 Farm Bill, the Food Security and Rural Investment Act, which improved the access and rules for participation. In 2007, the population of those receiving food stamps was 26.5 million people. Forty-nine percent of recipients were children and nine percent were adults over the age of 60 (FNS, 2016).

The Food and Nutrition Act, passed by Congress in 2008, aimed to strengthen the agricultural economy, improve utilization of food abundances, and improve nutritional status of low-income individuals (FNS, 2008). Within the mandates of this law was the new Supplemental Nutrition Assistance Program (SNAP), which replaced the old food stamps. States were required to provide nutrition education (SNAP-Ed) for all SNAP recipients. Major revisions to this program included a new electronic benefit transfer (EBT) card in the place of the coupons, an increase in the minimum monthly benefit from \$10 to \$14, and disqualification for participants who cash in their benefits for cash or who intentionally sell food received through their benefits (FNS, 2016). The Farm Bill

underwent revisions again in 2014 to promote fruit and vegetable purchases and earmark additional funds to make nutritious food more available to participants (USDA, 2014). The new program also intended to support local farmer's markets and provide new resources for organic farmers.

The United States government instituted several other policies in the 20th century that impacted food availability and production. One of these was the National School Lunch Act of 1946 (USDA, 1965), which provided financial aid to schools that were in need of facilities to feed their students (FNS, 2016). Its purpose was to “safeguard the health and well-being of the Nation’s children and to encourage...consumption of nutritional agricultural commodities” (FNS, 2016). Schools were responsible for identifying students who were in need of receiving meals at a reduced rate. The earliest menus contained milk, protein-rich food, vegetable or fruit, whole grain bread product, and butter. In 1965 an amendment to the original act expanded the food choices by adding more dairy foods. These lunch programs not only fed the students but also included nutrition education components (USDA, 1965). Reimbursement for snacks to be served to children during after-school education and enrichment programs was added in 1998 (FNS, 2013). Foods were selected from a list of entitlement food identified by government. Additional foods were only offered as they became available through agricultural surplus.

The National School Lunch program underwent further revisions in 2010 adding breakfast options for schools (USDA, 2016). These revisions were part of the Healthy Hunger-Free Kids Act. Schools that had more than 75% of their student population as low-income people could apply to provide free lunches to all students enrolled regardless

of household income. Meals served as part of this program had to meet one-third or more of the RDA for key nutrients (FRAC, 2016). In addition to allowing breakfast to be served in schools, the law also created the Summer Food Service Program, which allowed non-profit institutions the opportunity to apply for grants to purchase foods to feed children during the summer months when schools were closed.

Another government policy that has impacted food intake, specifically for those aged 60 years and older, is the Older Americans Act. The Older Americans Act (OAA) was originally enacted in 1965 as a response to concern by policymakers about the lack of services for older adults. Originally, the act provided grants for states to be used toward community planning and social services (Colello & Napili, 2016). It wasn't until 1972 that the national nutrition program for the elderly was passed. Following additional amendments in 1973 and 1978, local state agencies planned and coordinated services for older adults, including nutrition services (Colello & Napili, 2016; ACL, 2014). Older adults participating in the program can receive meals that provide at least one-third of the Recommended Dietary Intakes established by the Institute of Medicine as well as the Dietary Guidelines for Americans (ACL, 2014). Nutritious meals are provided either through congregate meal sites or home-delivered meals.

Older adults that participate in the nutrition programs sponsored by the OAA are less likely to be hungry and food insecure and may even have improved health. While participation in congregate meal sites has declined slightly since the 1980's, home-delivered meal participation has increased (CRS, 2004). Current data suggests that over half of those receiving home-delivered meals live alone and the food they receive through this service is more than half of their food for the day (ACL, 2014). Overall, the program

has been a success and has allowed for improved nutritional intake among adults over the age of 60 who participate in OAA nutrition programs. .

Food Consumption Guidelines. Food intake guidelines are maintained by multiple departments within the USDA. The earliest recommendations for healthy diets were provided in the late 1800's following the research of W.O. Atwater (Beecher, Harnly, Wolf, Stewart, & Holden, 2009). Atwater was an employee of the USDA and was tasked with providing dietary standards for America. Atwater identified, through his research on adult males, that overeating fatty foods could be detrimental to the health of individuals (Atwater, 1894). He added to this work by noting that food composition and intake influenced health. Atwater aided in the development of the first food guidelines in 1917, which contained five food groups: flesh foods, fat foods, starchy foods, watery fruits and vegetables, and sweets (Haughton, Gussow, & Dodds, 1987). The US National Academy of Sciences created a committee in 1940 to advise the government about nutrition problems (Nestle, 2013). Out of this committee's work the Recommended Dietary Allowances (RDA) were established. The RDA provided recommendations for energy and eight nutrients. These recommendations were revised every five to ten years based on available scientific evidence. Other food advice was offered during the 1940's as a result of World War II. The USDA distributed the *National Wartime Nutrition Guide*, which identified seven (Basic Seven) food groups (Nestle, 2013). As part of this new food guide (Figure 3.2), the USDA recommended butter and fortified margarine as



Figure 3.2 Basic 7 Food Guide

its own food group that should be included into the diet daily (Gifford, 2002). Other Basic Seven food groups were: green and yellow vegetables; oranges, tomatoes, grapefruit; potatoes and other vegetables and fruit; milk and milk products; meat, poultry, fish, or eggs; and bread, flour and cereals.

Food guides evolved during the first half of the twentieth century in response to nutrition research, economic concerns, food supply concerns, nutrition education, and historical events (Haughton et al., 1987). Following World War II, American diets were identified as lacking nutrients that may be beneficial for health. Using the RDA recommendations as a guide, the Basic Four Food Group Guide was created. This new food guide changed the organization of the Basic Seven and eliminated the butter and margarine group (Haughton et al., 1987). The new food guide would inform Americans about food amounts that would meet 100% of the RDA recommendations and improve their health status. The Basic Four food groups were broken up into the milk group, meat group, vegetable and fruit groups, and bread and cereal group. This Basic Four concept reigned until the 1990's.

The USDA and Senate Select Committee on Nutrition and Human Needs developed new food guides and dietary guidelines in the late 1970's to address the increase in heart disease, diabetes, hypertension, and obesity (Schneeman, 2003). In 1977 The Dietary Goals for the United States were presented. These goals called for an increase in carbohydrate intake while consuming less total fats, saturated fat, cholesterol, sugar, and salt (Nestle, 2013). In order for Americans to accomplish these goals, all regions would need to eat more fruits, vegetables, lean meats, and whole grains while eating less red meat, eggs, high sugar foods, and salt. In 1979, the Healthy People

campaign was initiated by the surgeon general. The Healthy People recommendations were to eat more complex carbohydrates, fish, and poultry while eating less red meat and sugar.

Following these recommendations, the USDA issued its first Dietary Guidelines in 1980. The Dietary Guidelines provided Americans with evidence-based recommendations for improving food and physical activity choices that promoted health and reduced the risk of chronic disease (Rahavi, 2015). The Dietary Guidelines for Americans are revised every five years based on recommendations from a committee of nutrition experts (Rowe, 2014). Over time the Dietary Guidelines were revised to include more guidelines and focus more on improving dietary choices rather than avoiding particular foods (Schneeman, 2003).

By the late 1980's the USDA's Human Nutrition Information Service (HNIS) began drafting a food pyramid based off of the 1980 Dietary Guidelines (Nestle, 2013). This food pyramid provided a visual tool for all Americans that would convey the concepts of variety, portion, and moderation. The Food Guide Pyramid was released in 1992 (Figure 3.3) after much debate and public insight (Nestle, 2013). In 2005 the pyramid went through a face lift. The new pyramid, referred to as MyPyramid (Figure 3.3), not only emphasized different food portions but also encouraged physical activity. Unlike the previous pyramid, this new pyramid required the use of online resources to obtain a personalized meal plan based on age, sex, and activity level. First Lady Michelle Obama initiated the MyPlate, which came out along with the 2010 Dietary Guidelines, to replace the MyPyramid.

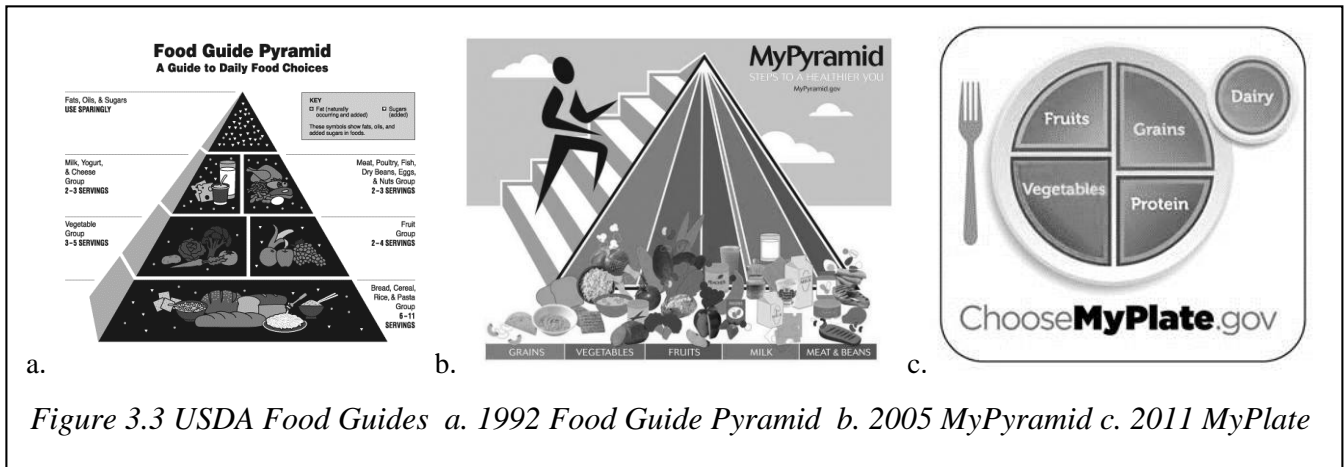


Figure 3.3 USDA Food Guides a. 1992 Food Guide Pyramid b. 2005 MyPyramid c. 2011 MyPlate

All of these food recommendations were presented to encourage increased food intake of some nutrients while consuming less of others without consideration for diverse foodways. Diet recommendations influence consumer choice. For example, if recommendations suggest consuming more whole grains, agricultural production of these foods will increase. The recommendations also influence food preparation. Encouraging more plant-based and low-fat meals will modify how many foods are prepared. All of these recommendations are provided regardless of food diversity. They aim to unify all food cultures into one American foodway.

Despite the many government based nutritional advice many people sought out other sources of information. Diet, by definition, is the food and drink regularly consumed or provided in a specific culture (Mish, 1997). Dieting has been a practice since the beginning of time. It may come in the form of fasting for religious reasons or as punishment. Dieting may be required for individuals who specific diseases that required nutritional modifications. Dieting has also historically been motivated by vanity or body image. More recently, dieting has been associated with weight loss. Whatever the motivation, the search for diets has often resulted in failure and questionable approaches

(Mullin, 2010). Some radical “fad” diets are those that promote weight loss through low carbohydrate, high protein intakes. Some examples include the Atkins Diet which was first introduced in the 1970’s and the South Beach Diet introduced in the late 1990’s. Both of these ‘fad’ diets were marketed by physicians and fueled the desire by many to consume low carbohydrate meals in order to achieve weight loss (Balart, 2005). While fad diets are popular, some studies suggest that macronutrient intake while on fad diets does not vary significantly from normal intake (French, Jeffery, & Murray, 1999; Leong, Gray, Haszard, & Horwath, 2016). The long-term impact of fad diets is not well understood due to the fact that most individuals do not maintain a fad diet long-term (Astrup, Larsen, & Harper, 2004; Balart, 2005; French et al., 1999; Leong et al., 2016; Roberts, 2001).

Our Legacy

Despite efforts to unify the American food system, regional differences still exist. Multiethnic foodways are prevalent throughout the United States. This fact has not changed despite the length of time that has passed since the first settlers came to the Americas. The difference between the foodways in the United States now is that there is more variety of foods available and diversity of food preparation due to increased efficiency and technology. There are many modern innovations and events that influence future food diversity. Advanced technology is a recent innovation currently being studied as a means to affect agriculture and food preparation. With the increased social marketing and media influence in our lives one can only imagine the affect it will have on our food choice. With improvements in technology and social media the food industry has had to come up with new and creative means of getting the public’s attention and

influencing food choices. Contemporary marketing focuses less on magazine and newspaper advertisements and more on web-based advertisements. Also, recipes are now shared freely on Facebook, Twitter, and Pinterest rather than being passed down in families from one generation to the next or through cookbooks.

Agricultural production will likely look vastly different in the future. One farmer in America can now produce enough food to feed approximately 155 people worldwide (USDA, 2012). But this production is threatened by the out-migration of individuals from rural areas to urban areas. Following the Great Recession of 2007 and 2009, job and population growth in rural areas has been far behind urban areas (USDA, 2013). The rural population is older, on average, than urban areas and makes nearly \$12,000 fewer dollars per year (USDA, 2013). This does not necessarily mean that urban areas do not produce food. There has been an increase in small, urban farming that can supply small amounts of food to be sold locally. Urban farming includes community gardens, rooftop gardens, and edible landscapes. Urban farming not only improves the health of those living in the urban area but also supports energy conservation, nutrient recycling, economic revitalization, and community socialization (Krishnan, Nandwani, Smith, & Kankarta, 2016). Time will tell if urban agriculture will increase the consumption of fruits and vegetables enough to influence macronutrient intakes (Algert, Baameur, & Renvall, 2014; Gudzone et al., 2015).

By the end of 2016, the FDA will have required that all restaurant-type foods, sold by a chain restaurant, include total calorie information on all menu items. The impetus behind this rule is to better inform consumers of their food choices while eating meals away from home. Nearly one third of Americans eat their meals away from home

and many of these foods are calorie dense (FDA, 2016). Eating just one meal away from home each week may cause the individual to gain approximately two each pounds each year (McGuire, 2011). The ability of menu labeling to influence food intake is not yet known. Perhaps agricultural production will shift based on consumer choice based on menu labels.

Another new food policy in the works is the soda tax. Since 2009, senators have been suggesting that a tax on sodas and sugar-sweetened beverages may be a way to manage obesity rates. While many states have attempted to pass this legislation, very few have actually been successful. In the fall of 2015, Berkeley, California was the first city to pass the tax on soda. Residents of Berkeley will spend nearly 1 cent more per ounce than they did before (NPR, 2015). Could production of sugar and corn be impacted with decreased purchasing of sugar-sweetened beverages?

Based on historical evidence, food diversity will continue to evolve throughout the United States. While regional differences may be less evident, the American foodway will always include multiethnic foods. Within each region, a variety of foods will be available and multiple preparation techniques will be used based on that availability. Recent changes to agricultural practices due to food policy and consumer demand may also impact food availability in the future. Looking back, Americans are adept at adopting new food practices and open to incorporating new foods into their diets.

Chapter 4: Theoretical Concepts

Multiple areas of our lives are influenced by food intake. The various choices we make about food manifest as behaviors, which are dynamic and require a holistic and integrated approach to understand. Multiple behavioral models have been used to understand and predict food choices and behaviors observed across the life span. Such approaches generally offer only a narrow view of the contextual factors that influence food intake and rarely do they consider the impact of time (or birth cohort) on food behaviors. The gaps in behavioral models and basic age and life span conceptualizations can be filled using a life course approach. This chapter begins with coverage of commonly used theories that start to explain food intake behaviors. Notions of a critical life course are then introduced, with particular attention given to how life course could link with extant theories to foster improved understanding and explanation of life span nutrition patterns.

Health Behavior Theories

The ability to change unhealthy behaviors to more favorable behaviors as a means of preventing chronic disease and promoting lifelong health is a focus of many health professionals. At their core, most health behavior models involve the individual making decisions based on the influences of social, psychological, and cultural factors. Currently, the majority of health behavior theories have been tested in children, adolescents, and young adults. Few behavioral theories track behaviors across the entire life span. Those that do extend to older adults have been limited to providing interventions for older adults; particularly those with cardiovascular disease or diabetes (Purdie & McCrindle, 2002). However, there are limitations to using health behavior

theories as a foundation for explaining behaviors over time or in the older adult population.

Most health behavior theories rely on the development of individuals. The definition of human development varies among psychology, sociology, biology, and gerontology. Many theories related to human development are focused on changes that occur from birth to older adulthood. Older adulthood, for many theorists, is a time of senescence and decline with little social or psychological development. Erik Erikson, considered 'old age' to be a time of detachment and inevitable death (Erikson & Erikson, 1997). Other theorists propose that social networks and interactions decrease in older adulthood (Cumming & Henry, 1961; Neugarten, 1979). Even among gerontologists there has been debate about development among older adults. Laura Carstensen (1999) suggests that social interactions continue regardless of time unless that time is perceived as limited. When time becomes limited, individuals reorganize their life goals and this is more likely to occur in old age due to the perception that time is running out (Carstensen, Fung, & Charles, 2003; Carstensen, Isaacowitz, & Charles, 1999). Lars Tornstam believes that the final stage of life is a process of gerotranscendence in which the individual redefines time, self, and relationships (Tornstam, 1999, 2005). Ultimately, Tornstam believes that development in older age is not homogenous and can be either obstructed or accelerated by life events and crises (Tornstam, 2005).

Development, as defined in this dissertation research, is a complex process that occurs regardless of age and can be influenced by social, psychological, cultural, and historical events. The social, psychological, and biological alterations that occur throughout the life span vary based on the dynamic interaction of these elements. For

example, changes in cognitive functioning or procedural learning may occur in older adults as a result of dementing conditions, hindering the ability to change following an intervention (Purdie & McCrindle, 2002). Older adults often experience changes in home environment, social networks, and family, which may significantly impact behavior.

Research that seeks to explain health behaviors encompasses a large array of health domains, including formal care access and utilization (Mannava, Durrant, Fisher, Chersich, & Luchters, 2015), self-care (Strom, Lynch, & Egede, 2011), and physical activity (Kosma & Cardinal, 2016; Newham, Allan, Leahy-Warren, Carrick-Sen, & Alderdice, 2016). With regard to food intake, the Socioecological Model, Theory of Planned Behavior, and Social Cognitive Theory provide the strongest potential for critical application.

Ecological Model. Multiple variants of ecological models have been used to explain food intake and choice. Bronfenbrenner (1974) first introduced the ecological model as a way to describe human development and its complex interactions between environments over time. The ecological model emphasizes the importance of relationships between each system (Bronfenbrenner, 1974): microsystems, mesosystems, exosystems, and macrosystems. Building on Bronfenbrenner's original work, McLeroy (1988) renamed the levels to intrapersonal factors, interpersonal processes, institutional factors, community factors, and public policy. From these modifications, behaviorists have labeled a socioecological model based on the influence of society on behavior. Socioecological models identify these levels defined by McLeroy as individual, interpersonal, organization or community, and societal sectors of influence. At each level of the socioecological model, examples of influences on food choice can be identified

(Figure 4.1). Recognizing that the embedded levels interact with each other, changes in one level will necessarily impact other levels. Furthermore, we need to acknowledge that these complex interactions between scales of influence transpire across multiple time scales.

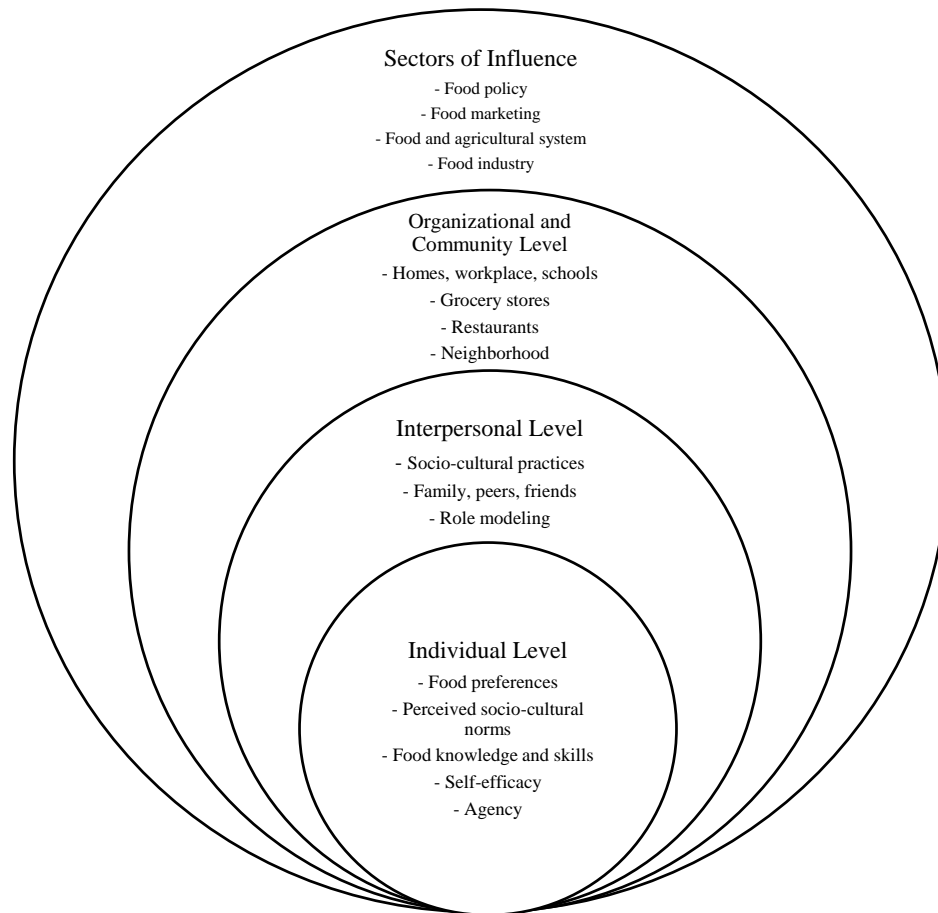


Figure 4.1 Socioecological Model

The ecological model is a framework that includes multiple systems and their impact on food choice (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). The ecological model and its counterpart, the socioecological model, efficiently explain the socio-cultural determinants of health behavior and food choice. All levels described by the socioecological model have been shown to influence food intake. However, few scholars have been ambitious enough to study all levels concurrently. For example,

living in close proximity to a grocery store (organizational level) increases the variety and nutrient-density of foods purchased and consumed (Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007). Individuals often get their identities (individual level) from their food intake and routines within their culture (interpersonal level) (Jastran, Bisogni, Sobal, Blake, & Devine, 2009; Jones, 2007; Powell et al., 2007). While the socioecological perspective is appropriate for examining factors that impact health and nutrition (McLaren & Hawe, 2005), it does not adequately explore the impact of time, with necessary critical attention, on the individual development of food choices. In addition, there is no consideration for the food history or food-related legacy of each socioecological level's impact on the individual.

Theory of Planned Behavior. The theory of planned behavior was developed to study and explain human action. According to the theory of planned behavior, actions are guided by three considerations; behavioral beliefs, normative beliefs, and control beliefs (Ajzen, 2002). Behavioral beliefs produce an attitude toward a specific behavior. For example, the belief that healthy food tastes bad, is expensive, and hard to cook indicates a negative attitude toward healthy food. Normative beliefs are a result of what we perceive to be the social norms regarding a particular behavior. They typically are a result of behaviors we consider to be important in response to the more important people in our lives, who may include family members, friends, peers, religious figures, health care providers, or other individuals we may wish to satisfy (Hayden, 2014). Food choices made by children are often modeled after their peers and friends food intake (Houldcroft, Haycraft, & Farrow, 2014). Perceived behavioral control represents one's perception of how easy or difficult it would be to perform a health behavior. An

individual who believes they have the ability to purchase and prepare healthy food will be more likely to put such behaviors into action.

All three of these pillars, when combined, influence a behavioral intention (Figure 4.2). Intentions to perform a behavior can be informed by attitudes about that behavior. An attitude is formed based on the belief or value placed on a specific behavior. If the behavior is viewed as positive, then there is a good chance that the behavior will be repeated. Behavioral control is impacted by individual beliefs that help or hinder the person's ability to perform a behavior (Ajzen, 2002). Individuals who are aware of the need to purchase nutrient-dense foods but do not have access to these types of foods in their built environment may feel like they have no control over their food choices.

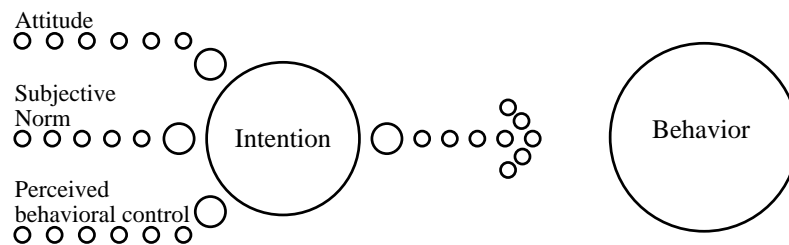


Figure 4.2 Theory of Planned Behavior

There are several weaknesses in using the theory of planned behavior when studying older adults in general, and food intake in particular. The theory of planned behavior does not account for previous life experiences or changes that may occur in the decision-making process over time. There is also little attention given to determining the timeline between intentions and behaviors. Once the intention to eat healthier is established, little is known about how long the behavior will be sustained into the future. In addition, very little attention is given to environmental or economic influences. Food

choices made as a result of intention and behavioral control may not be sustained across the life span.

Despite the weaknesses in the theory of planned behavior it has been used by multiple researchers as a means of explaining or predicting food behavior. The theory of planned behavior has been applied to multiple food contexts, including eating behaviors (Zoellner, Estabrooks, Davy, Chen, & Wen, 2012). For foods that have been shown to have health benefits, like fruits and vegetables, multiple studies investigate the intention to eat these foods and how healthier foods influence behavior (Kothe & Mullan, 2015). Individuals, regardless of sex, who have a more favorable view of consuming fruits and vegetables will have higher intakes (de Bruijn, Wiedemann, & Rhodes, 2014; Emanuel, McCully, Gallagher, & Updegraff, 2012; Kothe & Mullan, 2015).

Social Cognitive Theory. The social cognitive theory shares a lot of its constructs with the theory of planned behavior. Social cognitive theory is based on the complex interaction between the three areas of personal factors, the environment, and behavior (Bandura, 1998). Bandura (1986) describes the environment as an inoperative construct that is only actualized when action is appropriate. The environment exists around the individual and can be physical, socio-cultural, or built. Environmental influences partially influence which form of behavior is developed and activated. Changes found in personal, environmental, and behavioral areas can produce changes in the behavior.

The theory of planned behavior and social cognitive theory both share the notion that efficacy is a major basis for action (Bandura, 1998). Self-efficacy simply means that people will perform a behavior if they believe they can do it. Self-efficacy develops through mastery experiences, vicarious experiences, and social persuasion (Bandura,

1998), which build the self-belief that an individual will have success or failure. An individual's efficacy is based on performance attainments, observing the performances of others, social influences, and the person's perceived physiological state (Bandura, 1986). The expected outcomes of a behavior depend on the person's efficacious beliefs. Self-efficacy is nurtured by familial sources, peers, school settings, transitional experiences throughout adolescence and adulthood.

Self-efficacy combined with outcome expectations influence behavior through the use of self-regulatory behaviors (Anderson, 2007). Self-regulatory behaviors cannot occur without the ability to set goals, plan, and monitor the behavior. Self-regulation is also developed by way of life experiences and social influences. Through modeling and observation of others within their social network, people gain knowledge about themselves and standards of behavior. People shape their extraneous environments by self-regulated behavior (Bandura, 1986).

Social cognitive theory is often used in interventions to promote healthy eating. Self-efficacy is strongly correlated with behavior and often explains dietary behaviors in cross-sectional and longitudinal studies (Lubans et al., 2012). For example, young adults with high self-efficacy are more likely to read food labels which, in turn, produce more healthy food choices (EunSeok et al., 2014). Self-regulation is the best predictor of nutrition out of all of the social cognitive theory constructs. Improving self-regulation will directly improve eating behaviors (Annesi & Tennant, 2013). Self-regulation may also impact eating behaviors without the presence of the other constructs (Anderson, 2007). Due to the fact that the social cognitive theory is highly focused on the learning and biological factors that impact behavior, it fails to address personal, environmental, or

historical influences. In addition, the impact of time, whether it be chronological or period affects, is absent from the social cognitive theory.

Life Span

Health behavior approaches to explaining development of and general actions associated with specific domains of health remain widely used. Yet careful reading of the literature suggests that clear notions of age and period variability have been poorly addressed in the representative theories. Concepts of life span provide an immediate point of critical expansion.

Alwin (2012) describes the life span as the time ranging from birth to death. Developmental changes that occur across the life span are a result of biological, psychological, social, historical, and evolutionary influences (Alwin, 2012). Life span has been used within scholarship as a means of reporting changes that occur in a person's life over chronological time. Areas such as human development, aging, and the life cycle can be described well within the context of the life span. The impact of nutrition on various life stages has been the focus of researchers for many years. Research on the role nutrition plays in health promotion, disease prevention, and disease progression continues to be a priority among life span researchers (Ohlhorst et al., 2013).

The benefit of using a life span approach is that it identifies patterns that occur from birth to death among individuals, which can drive further research and theoretical elaboration. Multiple national studies report food intake patterns across the life span. The Nurses' Health Study, Framingham Heart Study, and federally funded studies that track populations of people over time include individuals that are living. Observations are made regarding food behaviors and intake patterns during an individual's life span

and individual changes in health and food intake are reported by the participant with the aim of determining patterns. Life span research has the ability to compare differences among age groups over a period of time to identify changes in eating behaviors and patterns. These age changes across the life span can then be analyzed to determine if they are the result of social, cultural, historical, environmental, or physical factors.

What life span or life cycle research cannot affectively do is describe and explain the motivation behind patterns or differences among cohorts. In addition, life span research does not take into account factors that influence individuals prior to conception or the legacy left behind by the individual after death. All too often researchers infer life span or developmental changes in food intake from age-specific data that is analyzed at a single point in calendar time. Similarly, age-specific changes are assumed from comparisons of defined age groups over multiple calendar time points. This short sightedness is primarily due to a lack in longitudinal data collection with a view towards contextual organization. Food intake research uses retrospective methods to make inferences into life span transitions. Life span does not adequately describe the full range of influence of a lived life within a social, biological, cultural, and environmental context. Currently no study sufficiently analyzes the historical factors that lead to a behavior or the impact certain behaviors will have on future generations.

Life Course

A life course way of thinking offers an improved temporal framework for examining the combined and interacting period, cohort, and age effects on food intake patterns. The life course also builds on what can be obtained in research across a life span by adding a multidimensional, contextual perspective that extends the basic

concepts of environment and structural influence. The life course allows for a broader consideration of time and situates the individual within a social network. The life course recognizes the influence of interconnected life spans and identifies the complexity of individual life spans.

There are four elements identified by Elder and Giele as essential for life course analysis: an individual's cultural background; their social integration; individual goal orientation; and strategic adaptation to events (Giele & Elder, 1998). Trajectories, which typically define how an individual or group moves through life, represent the array of psychological, social, cultural, environmental, and physical events that take place throughout individual lives. These events may be able to intentionally or unintentionally influence future events or behaviors (Alwin, 2012). Social trajectories may include transitions (e.g., changes that center on such events as childbirth, high school graduation) as part of the trajectories that give meanings to events (Elder, 1998). Meanings that develop with each trajectory are a reflection of personality, age, experience, and context (Hendricks, 2012).

Conceptual models using the life course exist through the works of a small group of researchers (Figure 4.3), who commonly recognize that individuals are influenced by cultural, social, economic, psychological, and biological forces that are both stable and dynamic (Bisogni, Jastran, Shen, & Devine, 2005). Through qualitative interviews these researchers have explored pieces of the life course as they inform interactions between influences. Multiple trajectories have been identified that describe movement through such spheres as family (including marriage, child bearing, and spouse death), education and work, and physical health. These trajectories are defined retrospectively through

qualitative methods, which relies on individual acknowledgement of changes in food choices or the events that shaped their food patterns.

Life course researchers conclude that many trajectories initiate changes in food behaviors to achieve appropriate individual and social goals (Bisogni, Connors, Devine, & Sobal, 2002). Meanings people attach to food are typically explored using a life course approach, but without comparisons between cohorts (Bisogni et al., 2002; Bisogni et al., 2005; Furst et al., 1996). Insufficient assessment of changes due to place, cohort affects, and cultural background has led many researchers to conclude that food choices change very little over time (Devine, 2005). Cumulative experiences throughout life influence not only the individual but also those within their socioecological spheres. The historical context should create period affects that influence food intake.

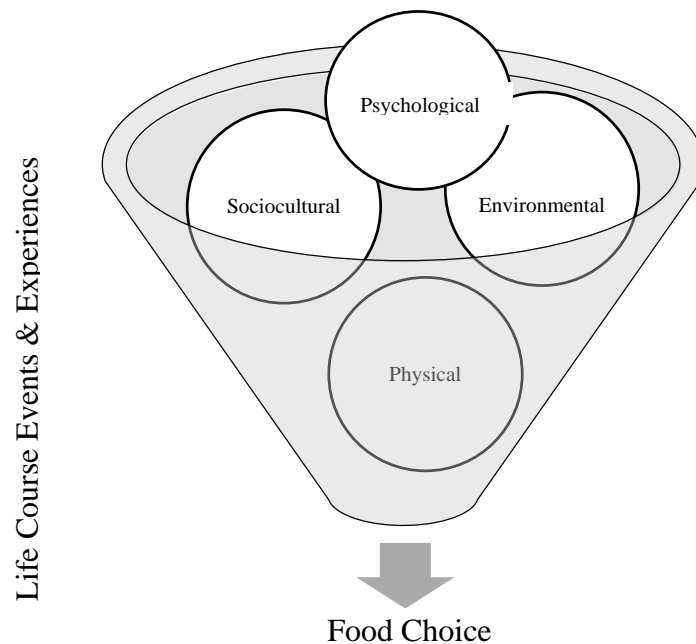


Figure 4.3 Life Course Food Intake Model

Engaging Life Span and Life Course in Nutrition Research

Combining health behavior models with the life course generates a construct by which food intake patterns observed across the life span may be explained. The various factors described by health behavior models certainly impact an individual's food choices, but many additional factors occur prior to birth and following death and with complex time-dependent interaction in between. Depending on the historical events in one's life, these factors will produce individual differences as will the peculiar individual constructs of future goals and aspirations. Building on the current work by the researchers at Cornell, this dissertation research includes significantly more consideration of historical influences with the inclusion of how food choices impact the lives of others.

Glen Elder (1999) observed that significant historical events, like the Great Depression, create trajectories in the lives of those who lived through them. The nature of and extent to which meanings and trajectories developed following significant life events are not uniform across cohorts, socioeconomic status, or sex (Elder, 1999). Combining the health behavior models with life course concepts may shed light on these variations. All levels of the ecological model influence the individual's attitude or intention to perform a behavior that occurs before, during, or after a significant life event. This adaptation in attitude and self-efficacy will impact extra-individual factors.

Analysis utilizing contemporary national data will provide insight into life span changes in food patterns. Food patterns ultimately influence overall health and wellness which is a particular concern as we age due to the increase in chronic disease. Without full longitudinal data identifying food intake patterns and demographic characteristics, complete and necessarily complex life course research is impossible. Social, cultural, environmental, psychological, physiological, and historical factors influencing food

intake within each socioecological sphere across the life span will provide considerable insight into events that lead to changes in food trajectories. Extant research on our food legacies will fill in the gaps in understanding how individuals impact the food choices of others.

Chapter 5: Data Considerations and Research Design

The multiethnic food culture enjoyed by people living in the United States produces an intricate pattern of food choices and consequent food-related trajectories for individuals and groups as they move through life. Fully understanding the relationship between food choice and time requires study of food intake from multiple perspectives within the analytic framework of the life course. Also necessary is critical exploration of age and cohort effects on food choices made over time. Combining these ingredients will provide a contextually improved understanding of food choice dynamics.

Specific Aims

The first aim of this study is to determine age and period differences in food choice over time. Based on extant research, my hypothesis is that individuals have higher intakes of total calories and macronutrients in younger adulthood compared to older adults regardless of time period. This study will identify whether the age trends recently reported have remained consistent over a fifty year time frame. It is also hypothesized that, regardless of age, total calorie and macronutrient intake has progressively increased over the past half century, a trend that has been commonly suggested in numerous studies (Austin, Ogden, & Hill, 2011) and government reports (USDA, 1997).

A second aim of this study is to involve a true cohort perspective in examining age-related calorie and macronutrient changes over time. Previous research has, at best, addressed age and period as independent time variables, and findings from such research have been widely used to inform development of health understanding, interventions, and policy. Cohorts, as considered in this second aim, are defined by the dependent relationship between chronological age and historic periods; individuals (or age-defined

groups) get older in exact and direct relation to the passage of historic time.

Consequently, this second aim recognizes that influences on food decisions and intake will change over the life span and, simultaneously, due to the evolution of extra-individual forces that act differentially across ages. It is hypothesized that, generally, cohort age patterns will be noticeably different than cross-sectional age patterns observed at any point in historic time. By acknowledging age-period dependence it is further hypothesized that cohort age patterns will exhibit lower variation than period-age patterns.

A third aim is to examine age-period-cohort differences while controlling for population diversity. Diversity, for purposes of this research, comprises sex, race or ethnicity, education level, marital status, and poverty to income ratio (PIR). I hypothesize that food intake is mediated by sex, ethnicity, income, education level, and marital status. Sex will influence food intake through cultural norms and roles as well as the perception of masculine and feminine foods. Ethnicity has been minimally explored in its relationship to food choice but some studies suggest that ethnicity influences food intake by cultural norms and socioeconomic status. Income and education level both influence food intake by moderating food availability and preparation techniques. Individuals who eat meals with others tend to eat more (de Castro, 2010; Stroebele & De Castro, 2004). Therefore, my hypothesis is that those who are married or live with a partner will have higher food intakes compared to those who are divorced, widowed, or never married. When controlling for each of these variables, age differences will still be significant.

The final aim of this study is to analyze the age and cohort food intake patterns in time context, using historic information, to situate individuals and groups with the socioecological factors that influence specific food knowledge, perceptions, decisions, and behaviors. Attempts have been made to use the life course approach as a lens through which food intake patterns can be viewed. However, the framework, as it has so far been employed, is inadequate. Current life course studies are limited to events that occur within the individual's life span. Very little consideration is given to historical or future food choices, and to period and age specific situations that inform preferences and result in food-related habits and behaviors. The integration of the results from the first three aims in this study allow for a critical analysis of food choice within the life course context.

Data Considerations

Obtaining food intake through a reliable and valid method has been a struggle for food-related researchers. Multiple methods have been used in the past to collect nutrient intake including food frequency questionnaires, 24 hour recalls, and food logs. With all of these methods there is room for error due to recall bias, response bias, and reporting error (Krebs-Smith et al., 2000). Self-reported food intake methods frequently underestimate daily calorie consumption (Seale & Rumpler, 1997). More reliable information on food intake can be obtained by food frequency questionnaires and 24 hour recalls. In addition, adequate training of data collectors may decrease the occurrence of over reporting and estimation error (Howat et al., 1994).

Food frequency questionnaires and 24 hour recall have been used in a variety of ethnicities, age groups, and sex (Freedman et al., 2014; Gersovitz, Madden, &

Smiciklaswright, 1978; Thompson et al., 2015). 24 hour recalls have been shown, in some studies, to be a better predictor of true food intake compared to food frequency questionnaires (Carroll et al., 2012; Freedman et al., 2014; Zhang et al., 2015). Older adults may be even more inaccurate when providing nutrient intake. This may be due to the fact that there is memory involved in the recall of food frequency questionnaire or their inability to accurately estimate amounts of consumed foods (Ervin & Smiciklas-Wright, 2001).

Current longitudinal studies, like the Nurse's Health Study and the Framingham Heart Study, do not place an emphasis on possible age or cohort effects. The Framingham Heart study, for example, includes multiple generations in their study but does not compare life span changes in each cohort. In most longitudinal studies, due to improvements in statistics and methodology, variables shift, lose focus, or are modified over time. Some modifications could be in data collection while others may be in data inclusion. Longitudinal studies related to health and nutrition evolve based on current understanding of pathophysiology and nutritional science as well as shifting research interests, priorities, and funding.

In order to adequately and precisely identify food intake patterns in a life course context, a true longitudinal study is most appropriate. The ideal longitudinal study would obtain consistently measured food intake patterns, behaviors, and nutrient intake from birth to death. Information would be collected defining the ecological influences of food intake in the lives of individuals. A questionnaire examining the food-related behaviors, socio-cultural food practices, food procurement, and consumption patterns of individuals and groups within each socioecological sphere. In addition, the influence of each

individual's food intake on those within the interpersonal ecological level before, during life, and following death would be explored. Furthermore, capturing periods of life characterized by rapid changes in food intake that are both normative and pathological will better inform life course factors. Finally, data collection would occur over a sufficiently long time period to afford comparisons of the full age spectrum of multiple cohorts. Unfortunately, there is no study available at this time that follows a sufficiently representative, nation-wide sample of diverse individuals living in the United States or anywhere else.

The National Health and Nutrition Examination Survey (NHANES) is the best data set available to address the aims of this dissertation study. NHANES collects demographic, nutrition, and behavior-related questions from individuals of all ages throughout the United States, and is well suited to provide observations between cohorts over time. NHANES is regulated by the National Center for Health Statistics, a division of the US Department of Health and Human Services. In 1956, Congress passed the National Health Survey Act in order to provide statistical data on illness and disability in the United States. As part of the Act, data would need to include individual interviews, clinical tests and physical examinations, as well as health care facilities. The first surveys, as part of this initiative, were called the National Health Examination Survey (NHES) and were conducted in the 1960's. The focus of the NHES surveys was on chronic disease, but did not investigate nutrition and its relationship to health status. Following research-based confirmation of the link between diet and disease, the NHANES surveys were initiated.

The sampling employed by NHANES seeks to achieve representation of the U.S. population, specifically individuals of all ages living in the United States (CDC, 2015). NHANES is unique among other nutrition and health surveys because it combines face to face interviews with physical examinations. Food intake data are collected by 24 hour recalls and food frequency questionnaires; two valid and reliable methods for a diverse population. Physical examinations and demographic information is collected by trained professionals to maintain consistency. Individuals at a higher risk of malnutrition have been oversampled throughout the NHANES surveys due to the higher risk of chronic disease (Table 5.1). The groups considered to be at a high risk have evolved from the first NHANES survey to the continuous NHANES surveys. The majority of data collected are freely available to the public. As a means of further promoting confidentiality, some data became unavailable in the continuous NHANES surveys. Individuals excluded throughout all NHANES surveys are those living in institutionalized settings, active-duty military personnel, and U.S. citizens living outside of the 50 states and the District of Columbia. All NHANES surveys use multi-stage, stratified, clusters of non-institutionalized civilian populations (CDC, 2015).

*Table 5.1
National Health and Nutrition Examination Survey Sample Summary.*

Survey	Years	People Surveyed	Age Groups	Comments
NHANES I	1971-1974	~28,000	1-74 yrs	Oversampled low income, preschool children, women of childbearing age, and the elderly.
NHANES II	1976-1980	~25,000	6 mos – 74 yrs	Oversampled those living below the poverty level
NHANES III	1988-1994	~33,994	2 mos - older	Oversampled African Americans, Mexican Americans, and the very old and young.
Continuous NHANES	1999-present	5,000/yr	2 mos - death	Oversampled those aged 60 years and older, African Americans, and Hispanics

NHANES has provided information about the health and disease risk of the American population throughout the past fifty years. For the purpose of this study NHANES I, NHANES II, NHANES III, and the continuous data from years 2001-2002 and 2011-2012 are used for analysis. It should be noted that the exact year of the examination was not reported by researchers during any NHANES survey, therefore the assumption is made in this dissertation research that there will be no sudden and dramatic changes in food intake patterns and demographics during the collective NHANES survey time periods. This assumption can be supported by analyzing continuous NHANES datasets 1999-2012 to determine single-year variation in food intake patterns.

NHANES I. NHANES I data were collected primarily in Mobile Examination Centers (MEC). Individuals were only examined in their home if they were unable to visit the MEC. Multiple questionnaires and physical exams were conducted during this visit. Household interview data collected by NHANES researchers were the primary source of information used for this study. Within the household interview, participants reported on sex, race, ethnicity, annual household income, household size, marital status, highest grade level attended, and 24-hour recall. Height and weight measurements were also obtained during the household interview. Researchers identified race as either 'white,' 'black,' or 'other' races. Native American, Eskimo, or Asian ethnicities were classified as 'other.' Mexican Americans were recorded as 'white.' Marital status was reported by each participant as 'married,' 'divorced,' 'widowed,' 'separated,' 'never married,' 'under 17,' or 'blank.' Within the General Medical Health Supplement data set, participants were asked to report on their overall health. Participants were asked to choose either 'excellent,' 'very good,' 'good,' 'fair,' 'poor,' or 'blank' health rating.

Income status was determined by the PIR ratio. This ratio was calculated by determining the total household income and the minimum income necessary to maintain a family nutritionally. Data from the Census Bureau and the Department of Agriculture were used to calculate the poverty index and food economy plan. Poverty ratios offer a rather simple means of standardizing economic well-being over time. Basic dollar values of income vary considerably in terms of purchasing power because of a wide array of economic/market forces, including shifts in supply and demand, periods of recession, and product innovations. Dollar metrics for poverty are similarly affected. The income to poverty ratio, although not perfect, allows many economic/market forces, that vary over time, to mathematically cancel out in a calculation of economic well-being, thus providing a time-standardized metric.

NHANES 24-hour recall interviews were conducted by trained personnel, usually a dietitian, and involved face-to-face interviews on a limited number of participants. To aid participants in reporting serving sizes, three dimensional food portion models were employed. Multiple sources were used to determine nutrient information for foods reported by each participant. The U.S. Department of Agriculture's (USDA) Handbook No. 8, USDA's House and Garden Bulletin No. 72, Tulane University's master diet list, or *Bowes and Church's Food Values of Portions Commonly Used* were all used for nutrient analysis. All of these resources were first published in the 1960's and revised throughout the years based on foods that were currently available for consumption in the United States. Any food not found in these sources was analyzed based on food manufacturer nutrient information.

NHANES II. NHANES II data collection mimicked that of NHANES I when obtaining information from participants. Very little changed in survey methodology between NHANES I and NHANES II. Nutrient values for foods reported by the participant were obtained either from the food manufacturer or from the revised US Department of Agriculture's Handbook No. 8. Race categories were categorized in the same manner as in NHANES I. At the time of analysis some computerized statistical software was available to code and analyze NHANES II data. However, as with NHANES I, SAS statistical software was not universally used during data collection and analysis.

NHANES III. NHANES III was completed in two phases. The first phase was conducted between 1988 and 1991 while the second phase was completed from 1991-1994. Significant changes were made in obtaining demographic information beginning with NHANES III. Oversampling of children aged two months to five years, adults aged 60 and older, Mexican-Americans, and non-Hispanic blacks occurred during these two phases. With the new inclusion of Mexican-Americans, researchers now collected race and ethnicity data separately. Participants reported ethnicity as either Aleut, Eskimo, American Indian, Asian or Pacific Islander, Black, White, and Other. Ethnicity was reported as either Mexican/Mexican-American or Latin American/Spanish, which together provided the 'race-ethnicity' variable used for data analysis in this dissertation research. In addition, individuals reported highest grade level completed and new grade level variables were collected. Marital status variables were revised to also include 'living as married,' 'married with spouse at home,' and 'married with spouse away.'

Continuous NHANES. Beginning in 1999, NHANES surveys became ongoing and annual. With this new wave of data collection, NHANES data could be used to provide the prevalence of selected diseases and risk factors; monitor trends in diseases, behaviors, and environmental exposures; and explore emerging public health needs (CDC, 2015). The design of survey sampling evolved over time as well to sample individuals over two months old, more locations, and additional minorities.

Data from continuous surveys are released to the public on a two-year cycle and content varies throughout subsequent years based on the emerging health issues. Target age groups, minorities, and data collection methods are revised or reviewed prior to each survey. Demographic data collection varied between the 1999-2012 continuous surveys. Race and ethnicity was reported as either Non-Hispanic black, Mexican-American, Non-Hispanic white, Other Hispanic, or Other. The oversampling of the minority groups varied from 1999-2006 and 2007-2012. Other methods, including the household interview questionnaire, maintain the demographic questions related to marital status, annual household income, and education level initiated in NHANES III. Specific examples of variable changes throughout the five survey time periods can be found in Table 5.2.

Food recalls are collected during two stages of the examination process. Due to the fact that this 2-step method was not consistently utilized in previous NHANES surveys, only the primary 24 hour recall data were used for this dissertation study. Food guides were used to help participants identify portion sizes. These food guides consisted of commonly used household items like plates, measuring cups, bowls and rulers. The USDA Food Model Booklet was also used as an aid for reporting portion sizes.

Table 5.2
Select NHANES Variable Changes over Time

	NHANES I	NHANES II	NHANES III	2001 NHANES	2011 NHANES
Race/Ethnicity	Negro White Other	Black White Other	Non-Hispanic White Non-Hispanic Black Mexican American Other	Mexican American Other Hispanic Non-Hispanic Black Non-Hispanic White Other Non-Hispanic	Mexican American Other Hispanic Non-Hispanic Black Non-Hispanic White Other Non-Hispanic
Marital Status	Divorced Married Never Married Married Separated Under 17 Widowed	Divorced Married Never Married Separated Widowed	Divorced Married Spouse in Household Married Spouse not in Household Never Married Widowed Living as married Separated	Married Widowed Divorced Separated Never Married Living with Partner	Married Widowed Divorced Separated Never Married Living with Partner
Education Level	1st grade 2 nd grade 3 rd grade 4 th grade 5 th grade 6 th grade 7 th grade 8 th grade 9 th grade 10 th grade 11 th grade 12 th grade First year of College Second year of college Third year of college Fourth year of college Graduate School Special School	Grade 1 Grade 2 Grade 3 Grade 4 Grade 5 Grade 6 Grade 7 Grade 8 High School 1 High School 2 High School 3 High School 4 College 1 College 2 College 3 College 4 College 5+	Grade 1 Grade 2 Grade 3 Grade 4 Grade 5 Grade 6 Grade 7 Grade 8 High School 1 High School 2 High School 3 High School 4 College 1 College 2 College 3 College 4 College 5+	Less than 9 th grade 9-11 th grade (Includes 12 th grade with no diploma) High School/GED Some College or AA degree College Graduate or above	Less than 9 th grade 9-11 th grade (Includes 12 th grade with no diploma) High School/GED Some College or AA degree College Graduate or above

Following collection of 24 recall data, foods were re-coded in order to be entered into a nutrient composition database. For years 1999-2002, the University of Texas Food Intake Analysis System was used for coding and then combined with the USDA Nutrition Database to report nutrient intake. This database evolved throughout the years due to advances in computer technology, increases in food availability, evolution of food industry, and accuracy of nutrient composition. More recent nutrient analysis is done by

the use of the USDA's Food and Nutrient Database for Dietary Studies (FNDDS). This database is updated on a two-year cycle.

Data Preparation

All data available from the National Center for Health Statistics, including NHANES, are in SAS statistical format.⁶ NHANES data are released as SAS transport files that can be viewed and transported into multiple other statistical software applications. The National Center for Health Statistics provides web-based tutorials to analyze all NHANES survey periods, which made the initial analysis relatively easy to complete. Additional coding and analysis required the aid of the University of Kentucky, Applied Statistics Lab. With their assistance, I was able to create time-integrated data sets and write new code to produce the results that would answer my research questions (See Appendix B). Other resources utilized during analysis of the NHANES data were the "Sample Design" and "Analytic Guidelines" documents available for public use by the National Center for Health Statistics. These documents provided insight into variables, methods, and organizations used by researchers of each NHANES survey.

NHANES has undergone natural revisions to its data collection and analysis processes over the years. Some revisions, like poverty to income ratio and ethnicity, are necessary to capture changes in the United States population. Other changes are due to improvements in computing power, statistical methods, and analysis. Throughout the NHANES surveys, improvements have been made in collecting data among minorities and older adults. In addition, more precise methods of analyzing nutrient intake have been available through computerized databases. Income levels have changed over time

⁶ SAS, a statistical analysis software program, was founded in 1976.

due to nation-wide economic changes in inflation and cost of living. Fortunately, little has changed in the collection of food intake through 24-hour recalls or body composition measurements (height and weight).

Accounting for these changes over time, while maintaining consistency in analysis, requires additional coding of several data elements. Annual household income data, by itself, changes significantly over time. Annual income was initially written into the code to be used for population diversity. However, due to changes in mean household income over the fifty years used in the study new code was written to include PIRs. By using the PIR, the impact of income can be more critically assessed because it is calculated based on the income levels at the time of the study. This ratio allows standardization across time with the understanding that it represents the annual income levels at the time of the study.

Adjusting education variables during coding was also required due to a societal shift in focus and priority of educational levels. The focus on collecting education level changed from reporting the last grade attended to the last grade completed. Researchers also asked each grade level separately in the early survey years but did not in the more recent years. Therefore, grouping education levels together allows for more streamlined analysis over time. Finally, reporting marital status changed in more recent years to also include non-traditional relationships. Participants could now report 'living with a partner' or 'married but living apart'.

Minor revisions to the original data were required in the early NHANES survey years. After importing the NHANES I and II data sets into SAS, modification to the nutrient intake, PIR, and education level was required. Researchers coded these variables

without moving the decimal point two places to the left, which required adjustment prior to analysis. PIR and education level were grouped categorically based on the method presented by Casagrande and others (2007). The revised categorical groupings were maintained throughout all survey year analyses. The general health rating reported by the participant was included in the final data set. This variable was included to support the idea that health status changes over with advancing age and may play a role in overall food intake. However, due to the fact that general health rating was not able to be linked to participants who reported food intake it was not used in the generalized linear models.

Unlike previous NHANES survey data sets, the continuous data sets can be downloaded and directly imported into SAS for analysis. Navigating through the variables and their measurements was streamlined due to web-based documentation rather than the scanned documents with hundreds of pages describing methodology and recording. The majority of demographic and 24 hour recall variables were consistent throughout all NHANES surveys.

Prior to analyzing all NHANES surveys, data sets were merged and sorted to include only variables of interest for this study (Appendix A). New categorical variables (Table 5.3) created from continuous data during analysis remained consistent throughout all waves of NHANES surveys. New variables created were BMI, BMI group, age group, percent carbohydrate, percent fat, and percent protein. Variables that contained values for 'blank' or 'unknown' responses were coded as '88,' '8888,' '88888,' '99,' '9999,' or '99999.' All missing or erroneous data were coded as "." to allow monitoring of their incidence while excluding them from statistical calculations. During some waves

of NHANES data collection, there were no individuals over the age of 81 who completed 24-hour recall data.

*Table 5.3
New Categorical NHANES Variables*

Variable	Categories						
Poverty to Income Ratio	≤ 0.50	0.50-1.00	1.00-1.25	1.25-2.50			
Age Group	20 – 30	31-40	41-50	51-60	61-70	71-80	>81

In all data sets, mean intakes for total calorie, protein, fat, carbohydrate, and fiber intakes were calculated. Frequencies of demographic values including ethnicity, sex, PIR, education level, marital status, and general health rating per age group were analyzed. Chi square tests, statistical graphs, and histograms were created. However, due to the large sample size and wide distribution of nutrient values such analytics provided questionable insight. Generalized linear models were used to determine food intake patterns of total calorie, protein, carbohydrate, fat, and fiber while controlling for demographic variables. All codes can be found in Appendix B.

Research Design

Focusing on macronutrient and total calorie intakes of those aged 20 to over 80 years using NHANES data provides food choice patterns over time. In order to identify significant changes, time periods were analyzed at ten year intervals. Mean intake values for total calorie, protein, fat, and carbohydrates were tracked during five NHANES time points; 1971, 1981, 1991, 2001, and 2011, respectively. NHANES did not include a year variable for each study participant. NHANES II did not collect any data in 1981 but very little difference is expected in food intake from the conclusion of the study in 1980 and

the following year. At each ten year interval, birth cohorts and age groups were analyzed. In this way, cross sectional, time sequential and cohort sequential observations could be made.

Dominant analytical perspectives of employing time can be illustrated using the Lexis diagram (Keyfitz, 1968) as a basic template. (Figure 5.1) Such a diagram plots calendar year (time t) on the horizontal axis against age (x) on the vertical axis. With regard to nutrition research, Line A illustrates a *period perspective*, perhaps the most common approach found in the literature, in which total food intake, specific nutrient intake, calories, or even body weight or BMI are examined at a given time point or compared over calendar time, with little to no attention to specific age variations. Line B shows an *age perspective* that seeks to identify variability of a characteristic as age increases. Most existing studies employ only a single calendar time reference, with consistent data availability determining if multiple years of age-specific information can be compared (Lines B₁ and B₂). A common feature for both Line A and Line B is that either age or calendar time remain fixed, respectively, or are at best treated independently.

Line C, termed a 'life line' in Lexis analyses, shows a *cohort perspective* in which age and calendar time remain continuously linked and faithful to the premise that, for every year that passes we get a year older. Unlike period comparisons of age structure (Lines B₁ and B₂), a cohort perspective acknowledges developmental influences over the life span in terms of how such influences inform later life characteristics and outcomes. Furthermore, comparisons across cohorts (e.g., Lines C₁ and C₂) allows for analytical inclusion of changing contexts that may have differential affects across age groups.

Figure 5.1 Analytical Time Perspectives

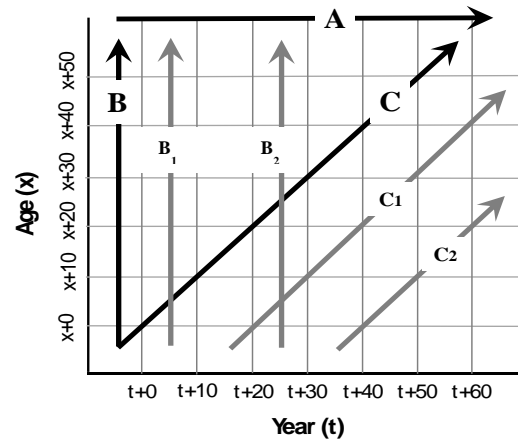
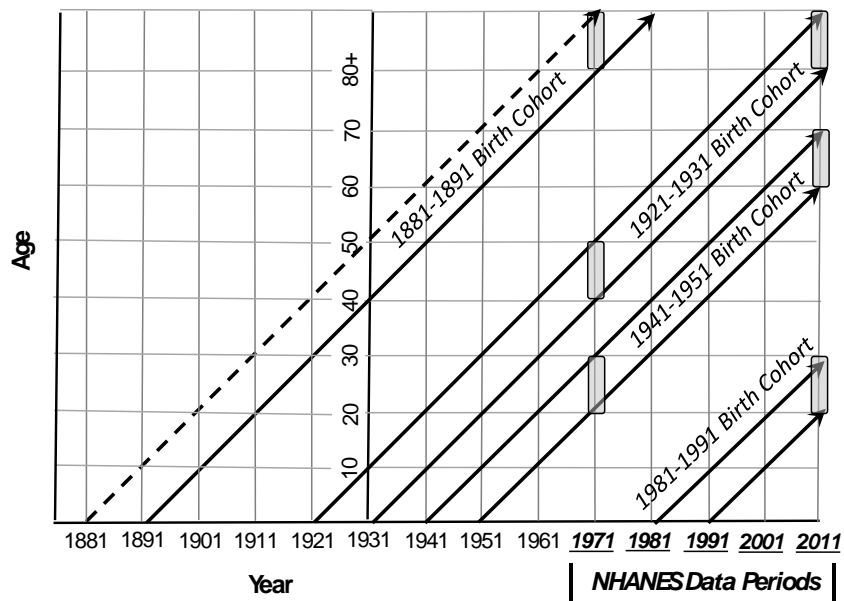


Figure 5.2 Cohort Extremes in Study Design



Observed food intake that is influenced by population diversity can be explored during each time period. A generalized linear model will determine whether demographic variables influence food intake patterns. During the regression analysis, variables are added in a step-wise manner to observe changes in mean intakes.

Macronutrient variables are continuous and widely distributed so chi-square tests are not appropriate.

Following one cohort over time allows for age and developmental affects to be accurately placed in dynamic social and life span context (Figure 5.2). A cohort-sequential method will be used to identify the influence of birth cohort on food choice. Three birth cohorts will be tracked across five points in time. Other birth cohorts will be tracked across time periods but only at three or four points in time.

*Table 5.4
Birth cohort trends over time*

Age Group	NHANES I	NHANES II	NHANES III ^a	NHANES 2001-2002	NHANES 2011-2012
71-80			Cohort D	Cohort C	Cohort B
61-70		Cohort D	Cohort C	Cohort B	Cohort A
51-60	Cohort D	Cohort C	Cohort B	Cohort A	Cohort E
41-50	Cohort C	Cohort B	Cohort A	Cohort E	
31-40	Cohort B	Cohort A	Cohort E		
20-30	Cohort A	Cohort E			

Table 5.4 illustrates the comparison structure for birth cohort analysis of NHANES data. Not all cohorts can be tracked at five separate time periods. The five birth cohorts identified in Table 5.3 will be tracked across at least three time periods. Cohorts A and B are the only two groups that have five time periods of measurement in this dissertation study. Cohort A birth years are between 1951 and 1961. Cohort B's birth years are between 1941 and 1950. Cohorts C, and E are examined at four time periods. Cohort D birth years are 1921 to 1930. Cohort E birth years are 1956 to 1946.

Other cohorts included in this study were born between 1891 and 1920 and 1962 and 1992.

Patterns observed among different age groups and birth cohorts will then be viewed through a life course framework. Macronutrient patterns will be compared to historical events to identify food meanings and trajectories. Projections will be suggested for food behaviors in the future based on current events and patterns observed over the previous fifty years.

Conclusion

Determining food intake patterns over the life span requires a contextual longitudinal study. This method of study has not been done nor has any current longitudinal study accounted for age or birth cohort changes. NHANES provides the groundwork to identify age and cohort related changes, which can then be placed within a life course framework. This critical recognition of time and its importance in food-related behaviors is essential to understanding current and future food choices.

Chapter 6: Dissertation Results

In the absence of a true longitudinal database, a long-term population study was used for this dissertation. NHANES provides comprehensive data on a large sample of diverse people living in the United States. The majority of NHANES data is accessible to the public and provides sufficient information to allow observations about eating patterns for fifty years.

The National Center for Health Statistics provides adequate and organized instructions for using NHANES data. The majority of data collection maintained consistent methodology and reporting. All participants were given a sequence number and methods of organizing the thousands of participants remained relatively constant for all fifty years of data collection. Throughout the years, a few improvements in methodology and data collection required revisions of some survey content. In most cases, the changes made were explained in the provided documentation of each survey. Nutrient analysis, for example, evolved as food availability expanded and food composition became more precise. Income and education levels progressed as national income rates increased and education attainment changed. The reporting of race and ethnicity also changed as minority populations grew and their relationship with chronic disease became more understood.

The research design for this dissertation study required assumptions about minimal change occurring in food intake during one to two year differences. NHANES did not include a year variable and to establish ten year periods for the study I made the assumption that 1980 and 1981 would be similar. In order to support this assumption all continuous NHANES years were analyzed to identify changes in eating patterns. Their

analysis confirmed that minimal change occurs in food intake patterns within a five year time span. Therefore using the specified time points for analyzing time sequential, cross sectional, and cohort sequential food intake patterns is appropriate.

One frustration with using NHANES data is the variability within certain data items over time points. Natural changes in data collection caused some inconsistencies across survey periods and presented a challenge to establish meaningful and comparable time series data. NHANES I and NHANES II only collected race as three variables; black, white, and other. Beginning with the NHANES III, ethnicity was also collected and continued to include more minorities throughout subsequent years. Also, due to normal changes in income and education variables, tracking these variables over time was inconsistent. PIRs were collected but this data item was reported as a continuous variable making it inappropriate for use in many statistical methods. Educational level collection in the early years involved asking participants which grade they had last attended. This changed in the continuous NHANES to asking participants which grade level they had last completed. This modification in reporting may impact the understanding of education level influence on nutrient intake.

Throughout all fifty years' worth of data, mean values could be calculated for total calorie, carbohydrate, protein, and fat intakes. Despite the fact that the validity of this reporting may be in question due to changes in analysis methods (Archer, Hand, & Blair, 2013), it still provides enough evidence to support food intake patterns over time. The impact of ethnicity, sex, education level, income, and marital status on food intake cannot be reported across all NHANES years. NHANES III data were collected in such a way that participants reporting these diversity factors did not complete a 24 hour recall.

What the NHANES III participants did complete during the household exam was the food frequency questionnaire, which was not used to calculate total calorie and nutrient intake levels analyzed in this dissertation study.

Demographic Characteristics

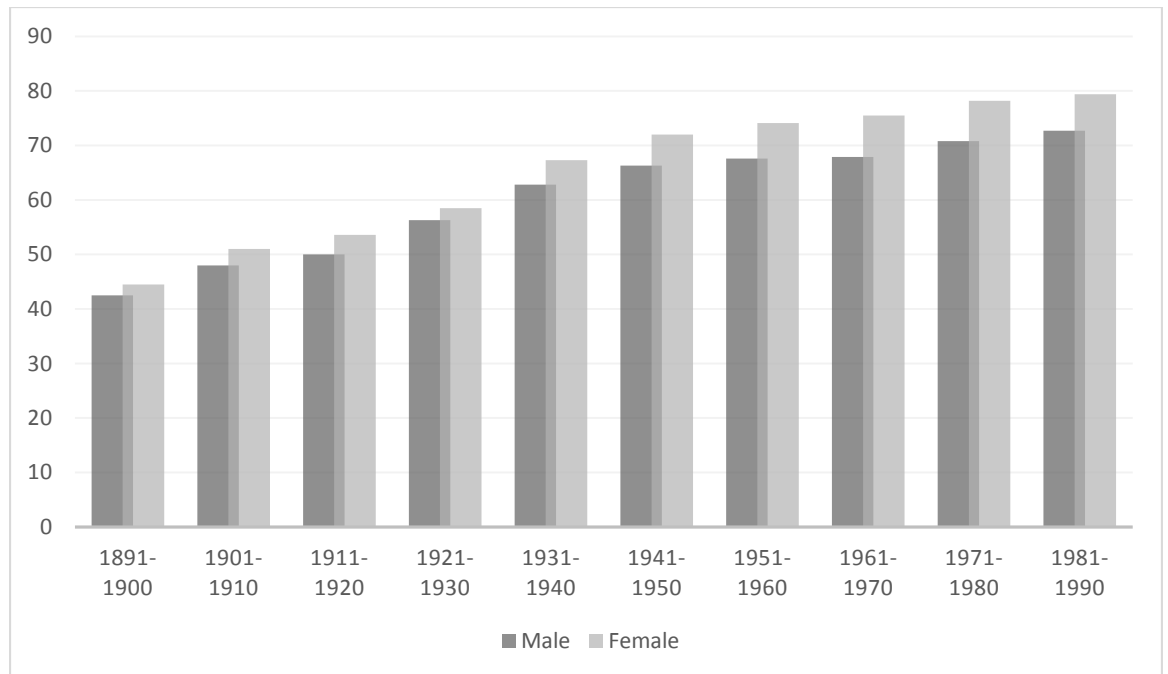
NHANES collects information from hundreds of people at multiple regions throughout the United States. The goal of NHANES throughout all fifty years has been to oversample those individuals at a higher risk of disease and malnutrition. Throughout all waves of NHANES, there has been a good representation of men and women aged 20 to 80 years old. While the continuous surveys put no limit on the age of the older adults, very few adults were reported to be over the age of 80 who also completed the 24 hour recall.

NHANES demographic distribution in ethnicity and sex mimics the population of those living in the United States during each survey year. According to the United States Census Bureau (2015), the population of the United States in 1890 was nearly 62.9 million people, which was a 20% increase from 1790. By 1970, the population had increased to 203.1 million people (Census, 2015). Over 87% of the population in the 1900's was white, while the distribution between male and female was nearly equal (Census, 1975). By the 2010 census, the population of the United States had grown to 308.7 million people (Census, 2015). The highest share in 2010, by age, was the category aged 45 to 64 years old (26% of the total population). In 2011, women (about 51%) slightly outnumbered men. Beginning in 2000, the census bureau began collecting more details about race and ethnicity, allowing responders to choose from 57 possible race-ethnicity combinations. The 2010 census reported that 77% of respondents reported

white alone or combined with another ethnicity, over 12% Black alone or combined with another ethnicity, and 12% Hispanic (Census, 2015).

The life expectancy of birth cohorts included in this dissertation research changed considerably (Figure 6.1). The oldest birth cohorts, those born in the late 1800's, naturally had the shortest life expectancy of all birth cohorts in this study. Their life expectancy at birth would have been between the ages of 45 and 50 years for men and women. The average life span increased over time due to improvements in healthcare, increased infant survival rates, and a decrease in deaths due to infectious disease. By the 1970's, newborns were expected to live past 60 years old. Females were projected to outlive males by ten or more years (CDC, 2015). Today, the life expectancy at birth of individuals is well over 70 depending on sex and ethnicity.

Figure 6.1 Life Expectancy of Birth Cohorts



NHANES I Demographics. The demographics of participants from the NHANES I are presented in Table 6.1. In all age groups, the majority of participants (over 50%)

were female. Over eighty percent of survey participants were considered white, which was reflective of the population living in the United States during the 1970's (Census, 1975). The majority of participants were married, but the number of widows and widowers increased as participant age increased. Divorce and separation were lowest in those over the age of 61.

*Table 6.1
National Health and Nutrition Examination Survey I (1971-1975) Demographics*

	20 – 30 y N (%)	31 – 40 y N (%)	41 – 50 y N (%)	51 – 60 y N (%)	61 – 70 y N (%)	71 – 80 y N (%)
Sex						
Male	20,490 (32.93)	13,509 (30.97)	14,724 (40.56)	13,735 (40.57)	25,112 (48.80)	9,681 (47.64)
Female	41,742 (67.07)	30,104 (69.03)	21,578 (59.44)	13,971 (50.43)		
Race^a						
White	51,223 (82.31)	36,764 (84.30)	30,904 (85.13)	23,874 (86.17)	44,159 (85.81)	17,438 (85.81)
Black	9,955 (16.00)	6,165 (14.14)	4,980 (13.72)	3,592 (12.96)	6,899 (13.41)	2,755 (13.56)
Other	1,054 (1.69)	684 (1.57)	418 (1.15)	240 (0.87)	403 (0.78)	128 (0.63)
Marital Status						
Married	40,180 (64.56)	36,315 (83.27)	29,539 (81.37)	22,099 (79.76)	35,081 (68.71)	11,564 (56.91)
Widowed	256 (0.41)	585 (1.34)	1,403 (3.86)	2,453 (8.85)	10,873 (21.13)	6,702 (32.98)
Divorced	2,612 (4.20)	2,352 (5.39)	2,031 (5.59)	1,282 (4.63)	1,646 (3.20)	562 (2.77)
Separated	2,289 (3.68)	1,847 (4.23)	1,303 (3.59)	806 (2.91)	955 (1.86)	132 (0.65)
Never Married	16,843 (27.06)	2,483 (5.69)	2,004 (5.52)	1,054 (3.80)	2,859 (5.56)	1,310 (6.45)
Education Level						
< High School	12,216 (19.76)	12,402 (28.87)	13,434 (37.82)	13,622 (49.83)	31,395 (62.82)	13,787 (70.53)
High School Diploma	25,449 (41.16)	18,824 (43.83)	13,667 (38.48)	8,957 (32.77)	9,428 (18.86)	3,371 (17.24)
> High School	24,164 (39.08)	11,726 (27.30)	8,419 (23.70)			
Poverty to Income Ratio						
≤ 0.5	67,429 (95.16)	47,963 (95.55)	40,409 (95.72)	31,253 (95.75)	56,164 (95.46)	22,004 (95.37)
0.5-1.0	610 (0.86)	315 (0.63)	268 (0.63)	184 (0.56)	626 (1.07)	283 (1.23)
1.0-1.25	213 (0.30)	159 (0.32)	101 (0.24)	70 (0.21)	217 (0.37)	131 (0.57)
1.25-2.5	1,103 (1.56)	823 (1.64)	528 (1.25)	376 (1.15)	881 (1.50)	356 (1.54)
> 2.5	1,501 (2.12)	937 (1.87)	912 (2.16)	757 (2.32)	945 (1.61)	298 (1.29)
General Health Rating						
Excellent	375 (36.98)	411 (32.03)	312 (21.21)	226 (15.63)	180 (13.80)	44 (11.34)
Very Good	305 (30.08)	364 (28.37)	376 (25.56)	326 (22.54)	259 (19.86)	76 (19.59)
Good	250 (24.65)	367 (28.60)	491 (33.38)	497 (34.37)	426 (32.67)	123 (31.70)
Fair	69 (6.80)	113 (8.81)	230 (15.64)	288 (19.92)	305 (23.39)	96 (24.74)
Poor	14 (1.38)	28 (2.18)	62 (4.21)	109 (7.54)	134 (10.28)	48 (12.37)

^aIndividuals of Asian, Native American or Eskimo race were identified as "Other". Mexicans were considered "White."

Education levels were highest in the younger adult groups, with three times more adults under the age of fifty having additional education after high school graduation. NHANES I intentionally oversampled those of low income so it wasn't surprising that ninety-five percent of participants were below 50% poverty. Also not surprising was that, as an individual ages, the general health rating declines. Adults under the age of 40 rated their health as either excellent or very good more than 60% of the time.

NHANES II Demographics. There was very little difference in demographic characteristics from NHANES I to II (Table 6.2). Over 50% of the NHANES II participants were white and females. Younger age groups were more likely to continue their education following high school graduation. All poverty to income levels were represented in this sample but oversampling was still present for those below 50% poverty. Younger adults had the highest representation of those who were above 250% poverty. The General Health Rating trends remained consistent from NHANES I to NHANES II, and younger adults were more likely to rate their health as excellent or very good. Adults over the age of 50 were more likely to report their health as fair or poor.

NHANES III demographics. Demographic trends observed during the first two NHANES surveys remained consistent in NHANES III (Table 6.3). The majority of participants were non-Hispanic white females. The exception to this was those aged 20 to 30 years who were comprised of more non-Hispanic black and Mexican American's. In all age groups, the number of black participants nearly tripled compared to the numbers surveyed by NHANES I and II. However, the survey identified other ethnicities and the "white" category no longer included Mexicans in its population. Trends in marital status, education level, and general health rating remained unchanged.

*Table 6.2
National Health and Nutrition Examination Survey II (1976-1980) Demographics*

	20 – 30 y	31 – 40 y	41 – 50 y	51 – 60 y	61 – 70 y	71 – 80 y
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Sex						
Male	1,364 (47.54)	844 (47.74)	698 (47.00)	795 (46.55)	1,524 (48.06)	379 (43.92)
Female	1,505 (52.46)	924 (52.26)	787 (53.00)	913 (53.45)	1,647 (51.94)	484 (56.08)
Race^a						
White	2,423 (84.45)	1,543 (87.27)	1,285 (86.53)	1,488 (87.12)	2,807 (88.52)	755 (87.49)
Black	376 (13.11)	187 (10.58)	166 (11.18)	198 (11.59)	309 (9.74)	100 (11.59)
Other	70 (2.44)	38 (2.15)	34 (2.29)	22 (1.29)	55 (1.73)	8 (0.93)
Marital Status						
Married	1,899 (66.19)	1,427 (80.71)	1,237 (83.30)	1,329 (77.81)	2,238 (70.58)	505 (58.52)
Widowed	99 (3.45)	30 (1.70)	58 (3.91)	174 (10.19)	598 (18.86)	256 (29.66)
Divorced	166 (5.79)	131 (7.41)	91 (6.13)	103 (6.03)	127 (4.01)	31 (3.59)
Separated	97 (3.38)	69 (3.90)	47 (3.16)	46 (2.69)	53 (1.67)	11 (1.27)
Never Married	600 (20.91)	105 (5.94)	51 (3.43)	55 (3.22)	151 (4.76)	53 (6.14)
Education Level						
< High School	446 (15.68)	422 (24.13)	507 (34.63)	716 (42.90)	1,640 (53.07)	532 (63.64)
High School Diploma	1,050 (36.91)	702 (40.14)	552 (37.70)	589 (35.29)	853 (27.61)	155 (18.54)
> High School	1,349 (47.42)	625 (35.73)	405 (27.66)	364 (21.81)	597 (19.32)	149 (17.82)
Poverty to Income Ratio						
≤ 0.5	7,966 (74.07)	5,780 (77.07)	4,933 (77.55)	5,707 (77.87)	10,733 (78.02)	3,020 (78.60)
0.5-1.0	426 (3.96)	214 (2.85)	135 (2.12)	181 (2.47)	446 (3.24)	177 (4.61)
1.0-1.25	181 (1.68)	74 (0.99)	67 (1.05)	60 (0.82)	226 (1.64)	88 (2.29)
1.25-2.5	895 (8.32)	594 (7.92)	442 (6.95)	435 (5.94)	1,075 (7.81)	334 (8.69)
> 2.5	1,289 (11.96)	838 (11.17)	784 (12.33)	946 (12.91)	1,276 (9.28)	223 (5.80)
General Health Rating						
Excellent	1,286 (36.14)	741 (33.76)	468 (24.62)	336 (15.27)	508 (12.00)	141 (11.29)
Very Good	1,167 (32.80)	623 (28.38)	450 (23.67)	472 (21.45)	793 (18.73)	207 (16.57)
Good	836 (23.50)	601 (27.38)	585 (30.77)	721 (32.77)	1,319 (31.16)	370 (29.62)
Fair	234 (6.58)	182 (8.29)	236 (15.04)	430 (19.55)	1,054 (24.90)	344 (27.54)
Poor	35 (0.98)	48 (2.19)	112 (5.89)	241 (10.95)	559 (13.21)	187 (14.97)

^aIndividuals of Asian, Native American or Eskimo race were identified as “Other”. Mexicans were considered “White.”

*Table 6.3
National Health and Nutrition Examination Survey III (1988-1994) Demographics*

	20 – 30 y	31 – 40 y	41 – 50 y	51 – 60 y	61 – 70 y	71 – 80 y
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Sex						
Male	3,769 (46.85)	3,089 (44.65)	2,390 (47.21)	1,926 (47.86)	2,417 (48.75)	1,917 (47.24)
Female	4,276 (53.15)	3,830 (55.35)	2,672 (52.79)	2,098 (52.14)	2,541 (51.25)	2,141 (52.76)
Race^a						
Non-Hispanic White	2,109 (26.22)	2,245 (32.45)	1,836 (36.27)	1,946 (48.36)	2,239 (45.16)	2,659 (65.52)
Non-Hispanic Black	2,527 (31.41)	2,403 (34.73)	1,549 (30.60)	1,048 (26.04)	1,216 (24.53)	757 (18.65)
Mexican American	3,060 (38.04)	1,987 (28.72)	1,451 (28.66)	835 (20.75)	1,333 (26.89)	534 (13.16)
Other	349 (4.34)	284 (4.10)	226 (4.46)	195 (4.85)	170 (3.43)	108 (2.66)
Marital Status						
Married	1,932 (46.32)	2,346 (65.38)	1,813 (68.99)	1,441 (68.33)	1,655 (63.48)	1,190 (54.49)
Widowed	6 (0.14)	33 (0.92)	104 (3.96)	162 (7.68)	496 (19.03)	740 (33.88)
Divorced	132 (3.16)	326 (9.09)	346 (13.17)	258 (12.23)	203 (7.79)	90 (4.12)
Separated	219 (5.25)	288 (8.03)	185 (7.04)	126 (5.97)	122 (4.68)	65 (2.98)
Never Married	1,867 (44.76)	581 (16.19)	223 (8.49)	103 (7.88)	119 (4.56)	83 (3.80)

*Table 6.3
National Health and Nutrition Examination Survey III (1988-1994) Demographics*

	20 – 30 y N (%)	31 – 40 y N (%)	41 – 50 y N (%)	51 – 60 y N (%)	61 – 70 y N (%)	71 – 80 y N (%)
Education Level						
< High School	1,300 (31.68)	1,015 (28.89)	820 (32.26)	802 (39.84)	1,281 (52.07)	1,159 (56.65)
High School Diploma	1,499 (36.53)	1,191 (33.90)	823 (32.38)	661 (32.84)	678 (27.56)	470 (22.97)
> High School	1,304 (31.78)	1,307 (37.20)	899 (35.37)	550 (27.32)	501 (20.37)	417 (20.38)
Poverty to Income Ratio						
≤ 0.5	838 (10.42)	564 (8.15)	448 (8.85)	396 (9.84)	562 (11.34)	530 (13.06)
0.5-1.0	2,123 (26.39)	1,511 (21.84)	863 (17.05)	661 (16.43)	900 (18.15)	728 (17.94)
1.0-1.25	560 (6.96)	493 (6.84)	301 (5.95)	192 (4.77)	397 (8.01)	338 (8.33)
1.25-2.5	2,353 (29.25)	1,814 (26.22)	1,185 (23.41)	888 (22.07)	1,357 (27.37)	1,310 (32.28)
> 2.5	2,171 (26.99)	2,557 (36.96)	2,265 (44.75)	1887 (46.89)	1742 (35.14)	1152 (28.39)
General Health Rating						
Excellent	802 (19.23)	673 (18.76)	439 (16.70)	290 (13.76)	286 (10.98)	191 (8.75)
Very Good	1,133 (27.16)	985 (27.45)	596 (22.68)	465 (22.07)	487 (18.69)	423 (19.39)
Good	1,576 (37.78)	1,330 (37.07)	973 (37.02)	741 (35.17)	891 (34.20)	725 (33.23)
Fair	630 (15.10)	516 (14.38)	523 (19.90)	470 (22.31)	697 (26.76)	581 (26.63)
Poor	30 (0.72)	84 (2.34)	97 (3.69)	141 (6.69)	244 (9.37)	262 (12.01)

*Race was self-reported and a combination of race and ethnicity. Asian, Native American and Pacific Islander included in "Other".

NHANES III included more participants from other income groups with less than 20% of the study population below 50% poverty. The older the individual, the more likely they were to be widowed, have less than a high school education, and report a poorer health rating similar to the population of people in NHANES I and II. However, the NHANES III study population was more educated overall compared to the previous two studies, with higher rates of 'never married' individuals at each age groups and fewer 'married' participants. There were also changing trends in health rating. The participants in this study reported their health as very good or good more often than any other rating. Those rating their health as excellent declined by half from the previous two studies. This shift in health rating could be a reflection of increasing obesity rates, increased awareness of the impact of chronic disease, or simply a fatalistic attitude.

NHANES 2001-2002. The demographics for the two year period of this continuous NHANES survey cycle maintained trends that were observed in the three

previous surveys. The participants were evenly split between male and female, with some age groups having more women and other age groups having more men (Table 6.4). Non-Hispanic whites were still the majority but due to oversampling there were greater numbers of Mexican American participants than any previous NHANES. Due to this oversampling of Mexican American and Hispanic individuals, the distribution of race and ethnicity in this study is not reflective of national diversity.

Table 6.4
Continuous National Health and Nutrition Examination Survey (2001-2002)
Demographics

	20 – 30 y N (%)	31 – 40 y N (%)	41 – 50 y N (%)	51 – 60 y N (%)	61 – 70 y N (%)	71 – 80 y N (%)
Sex						
Male	5,780 (40.44)	5,698 (44.95)	6,564 (50.61)	5,469 (51.34)	5,055 (48.12)	4,147 (52.45)
Female	8,513 (59.56)	6,977 (55.05)	6,406 (49.39)	5,183 (48.66)	5,451 (51.88)	3,759 (47.55)
Race^a						
Mexican American	4,238 (29.65)	2710 (21.38)	3,010 (23.21)	1,334 (12.52)	2,380 (22.65)	1,039 (13.14)
Other Hispanic	672 (4.70)	568 (4.48)	602 (4.64)	445 (4.18)	263 (2.50)	180 (2.28)
Non-Hispanic White	6,402 (44.79)	6,357 (50.15)	6,477 (49.94)	6,724 (63.12)	5,556 (52.88)	5,633 (71.25)
Non-Hispanic Black	2,373 (16.60)	2,289 (18.06)	2,535 (19.55)	1,729 (16.23)	2,022 (19.25)	920 (11.64)
Other	608 (4.25)	751 (5.93)	346 (2.67)	420 (3.94)	285 (2.71)	134 (1.69)
Marital Status						
Married	7,924 (55.44)	9,335 (73.65)	9,559 (73.70)	7,786 (73.09)	7,321 (69.70)	4,638 (58.67)
Widowed	NA	107 (0.84)	82 (0.63)	357 (3.35)	1,483 (14.12)	2,280 (28.84)
Divorced	250 (1.75)	1,075 (8.48)	1,331 (10.26)	1,630 (15.30)	1,052 (10.01)	667 (8.44)
Separated	193 (1.35)	514 (4.06)	671 (5.17)	320 (3.00)	352 (3.09)	117 (1.48)
Never Married	5,926 (41.46)	1,644 (12.97)	1,327 (10.23)	547 (5.14)	324 (3.08)	203 (2.57)
Education Level						
< High School	1,315 (11.23)	1,100 (9.89)	1,412 (12.63)	782 (8.35)	1,723 (19.45)	1,580 (23.64)
High School Diploma	3,507 (29.94)	2,802 (25.19)	2,798 (25.02)	2,214 (23.63)	2,387 (26.94)	1,974 (29.54)
> High School	6,892 (58.84)	7,223 (64.93)	6,971 (62.35)	6,374 (68.03)	4,749 (53.61)	3,129 (46.82)
Poverty to Income Ratio						
≤ 0.5	1,101 (7.70)	726 (5.73)	788 (6.08)	785 (7.37)	1,028 (9.78)	624 (7.89)
0.5-1.0	3,186 (22.29)	1635 (12.90)	1,313 (10.12)	916 (8.60)	986 (9.39)	978 (12.37)
1.0-1.25	870 (6.09)	732 (5.78)	761 (5.87)	587 (5.51)	761 (7.24)	655 (8.28)
1.25-2.5	3,764 (26.33)	2,784 (22.67)	2,668 (20.57)	1,442 (13.54)	2,421 (23.04)	2,257 (28.55)
> 2.5	5,372 (37.58)	6,708 (52.92)	7,440 (57.36)	6,922 (64.98)	5,310 (50.54)	3,392 (42.90)
General Health Rating						
Excellent	2,254 (17.38)	1,927 (16.32)	1,644 (13.18)	1,588 (15.34)	1,263 (12.36)	692 (8.96)
Very Good	4,210 (32.46)	4,545 (38.49)	4,322 (34.65)	3,150 (30.42)	2,836 (27.76)	1,922 (24.9)
Good	4,640 (35.77)	3,844 (32.55)	4,116 (33.00)	3,435 (33.18)	2,666 (35.89)	3,197 (41.41)
Fair	1,704 (13.14)	1,313 (11.12)	1,963 (15.74)	1,710 (16.52)	2,028 (19.85)	1,421 (18.41)
Poor	162 (1.25)	179 (1.52)	427 (3.42)	471 (4.55)	422 (4.13)	481 (6.31)

^aRace was based on self-reported race and ethnicity.

Divorce rates continued to go up for those in middle adulthood compared to prior NHANES. Married and widow trends remained stable. Nearly a third of the participants had at least a high school diploma or GED. Those who completed some education following high school doubled in all age groups. PIR indicated that fewer people were living below the poverty line than what was reported in the first two NHANES cycles. Over 30% of the participants in each age groups were over 250% poverty. Younger adults still report 'excellent' health ratings more often than those over the age of 60, however, the majority of adults in all age groups report 'very good' or 'good' ratings more than 50% of the time. This continues to suggest that increasing rates of obesity and chronic disease has impacted the health rating of adults.

NHANES 2011-2012 demographics. The continuous NHANES survey for years 2011 and 2012 maintained the diversity observed during the 2001 to 2002 years (Table 6.5). However, Mexican Americans represented a smaller percentage of the population surveyed compared to the 2001 cycle. The distribution of race and ethnicity in this study population was more reflective of the distribution of Americans as a whole. Compared to all other NHANES demographics, those surveyed in 2011 and 2012 had the lowest rate of marriage between the ages of 20 and 30. The rate of divorce between the ages of 40 to 70 continued to grow compared to the previous NHANES years.

The number of people continuing their education past high school also continued to trend up, with more than 64% of adults between the ages of 20 and 70 having more education after high school. PIR trends remained stable from those reported in the 2001 to 2002 continuous NHANES. Excellent health ratings for all age groups continued to decline. Good health ratings were reported more often by individuals of all ages.

Table 6.5
Continuous National Health and Nutrition Examination Survey (2011-2012)
Demographics

	20 – 30 y N (%)	31 – 40 y N (%)	41 – 50 y N (%)	51 – 60 y N (%)	61 – 70 y N (%)	71 – 80 y N (%)
Sex						
Male	7,072 (50.70)	6,505 (50.50)	5,812 (47.33)	6,446 (48.60)	6,029 (49.91)	5,454 (49.77)
Female	6,878 (49.30)	6,375 (49.50)	6,469 (52.67)	6,814 (51.40)	6,050 (50.09)	5,504 (50.23)
Race^a						
Mexican American	1,501 (10.76)	1,731 (13.44)	1,267 (10.32)	1,218 (9.18)	959 (7.94)	406 (3.71)
Hispanic	1,394 (9.99)	1,119 (8.69)	1,088 (8.86)	1,509 (11.38)	1,577 (13.06)	668 (6.1)
Non-Hispanic						
White	4,539 (62.54)	5,283 (41.02)	4,721 (38.44)	4,416 (33.30)	4,182 (34.62)	7,027 (64.13)
Non-Hispanic Black	3,481 (24.95)	2,214 (17.19)	3,035 (24.71)	4,054 (30.57)	3,850 (31.57)	1,907 (17.40)
Other	3,035 (21.76)	2,533 (19.67)	2,170 (17.67)	2,066 (15.58)	1,511 (12.51)	950 (8.67)
Marital Status						
Married	5,231 (37.50)	9,362 (72.69)	8,128 (66.18)	8,108 (61.13)	7,326 (60.65)	5,992 (54.68)
Widowed	14 (0.10)	118 (0.92)	167 (1.36)	540 (4.07)	1,542 (12.77)	3,469 (31.66)
Divorced	239 (1.71)	725 (5.63)	1,504 (12.25)	2,284 (17.22)	2,042 (16.91)	859 (7.84)
Separated	243 (1.74)	341 (2.65)	575 (4.68)	782 (5.90)	248 (2.05)	212 (1.93)
Never Married	8,223 (58.95)	2,333 (18.11)	1,907 (15.53)	1,548 (11.67)	900 (7.45)	423 (3.86)
Education Level^b						
< High School	293 (2.32)	677 (6.10)	807 (7.54)	1,121 (9.63)	1,324 (12.44)	1,904 (20.57)
High School						
Diploma	2,446 (19.40)	2,149 (19.37)	2,543 (23.77)	2,794 (24.01)	2,498 (23.47)	2,567 (27.73)
> High School	9,869 (78.28)	8,266 (74.52)	7,349 (68.69)	7,724 (66.36)	6,823 (64.10)	4,785 (51.70)
Poverty to Income Ratio^c						
≤ 0.5	1,046 (7.50)	879 (6.82)	1,032 (8.40)	1,292 (9.74)	956 (7.91)	1,224 (11.17)
0.5-1.0	4,252 (30.48)	2,576 (20.00)	2,099 (17.09)	2,554 (19.26)	1,789 (14.81)	1,687 (15.40)
1.0-1.25	1,060 (7.60)	1,078 (8.37)	819 (6.67)	802 (6.05)	871 (7.21)	1,208 (11.02)
1.25-2.5	2,844 (20.39)	2,683 (20.83)	2,275 (18.52)	2,557 (19.28)	2,874 (23.79)	2,818 (25.72)
> 2.5	4,748 (34.04)	5,664 (43.98)	6,056 (49.31)	6,058 (45.68)	5,589 (46.27)	4,021 (36.69)
General Health Rating						
Excellent	1,961 (15.10)	1,469 (13.11)	1,169 (10.64)	1,054 (8.69)	1,013 (8.62)	912 (8.58)
Very Good	4,601 (35.42)	3,650 (32.57)	3,232 (29.41)	3,202 (26.39)	3,230 (27.48)	2,604 (24.51)
Good	4,962 (38.21)	4,348 (38.80)	4,587 (41.74)	4,518 (37.24)	4,503 (38.32)	4,319 (40.65)
Fair	1,352 (10.41)	1,521 (13.57)	1,692 (15.40)	2,806 (23.13)	2,471 (21.03)	2,301 (21.66)
Poor	112 (0.86)	218 (1.95)	309 (2.81)	552 (4.55)	535 (4.55)	488 (4.56)

^aRace was based on self-reported race and ethnicity.

Macronutrient Intake Patterns

Macronutrient intake was consistently measured using 24 hour recalls across all NHANES years. While not all surveyed participants completed the 24 hour recall, the number of those who did represented a large majority of the study population. The 24 hour recall was completed as part of the household questionnaire. Beginning with the continuous NHANES, two 24 hour recalls were obtained from participants. To maintain consistency, only the initial 24 hour recall was used for this analysis.

Table 6.6 presents the number of participants who completed a 24 hour recall during each NHANES. More participants completed the 24 hour recall during the continuous NHANES. The proportion of those completing the food recall over the age of 71 was much lower in the early NHANES due to a lower total older adult population consistent with the aging population in the United States. Not all NHANES participants completed the 24 hour recall in addition to other questionnaires. General Health Rating scores were collected as part of the medical history questionnaire and cannot be linked to 24 hour recall participants.

*Table 6.6
Number of NHANES respondents completing 24-hour recall based on age.*

	20 – 30 y	31-40 y	41 – 50 y	51 – 60 y	61 – 70 y	71 – 80 y	> 81 y
Survey	n	n	n	n	n	n	n
NHANES I	3530	2316	1887	1451	2808	1114	--
NHANES II	2869	1768	1485	1708	3171	863	--
NHANES III	3749	3233	2355	1837	2182	1674	949
NHANES 2001-2002	14179	12588	12895	10607	10423	7805	5210
NHANES 2011-2012	13828	12747	12163	13152	11953	10809	--

Mean nutrient intake analysis provides data that allows immediate analysis of nutrient intakes by age as time passes and birth cohorts age over consecutive NHANES. Mean nutrient intake tables are categorized by chronological age and calendar years. This allows for age differences to be examined by looking at individual year columns of the table. Period differences are completed by comparing columns across calendar years. Changes in cohorts over time can be identified by looking at the tables in right-upward diagonals, changes in cohorts over time can be examined.

Total Carbohydrate Intake. Based on NHANES analysis, the mean intake of carbohydrates consumed was above the minimum requirement for adults (130 grams), with total mean grams of carbohydrate consumed over the fifty years has increasing considerably (Table 6.7). This increased consumption is maintained across all age groups and birth cohorts. Over time, individuals between the ages of 20 and 30 consumed the highest amounts of carbohydrates compared to other age groups. After the age of 30, all age groups consumed fewer mean grams of carbohydrates, with those over 70 consuming the least amount during each time period.

Peak carbohydrate intakes varied between birth cohorts but this may be due to time affects. The oldest two cohorts, from years 1911 to 1931, consumed their highest mean carbohydrates over the age of 60. Those born in 1941 hit their peak carbohydrate intakes between the ages of 50 and 60. Total carbohydrate intake declines about 25% from age 20 to age 70 regardless of the time period. Across all time periods, there is an increase in carbohydrate consumption. From 1971 to 2011 carbohydrate intake increased nearly 30% in all age groups. Both 1951 and 1961 birth cohorts peaked between the ages of 40 and 50. All cohorts increased their intake, despite advanced age, approximately 10% over the time periods. Cohorts B and C increased the most with a 14% increase.

The increased carbohydrate consumption can be due to multiple causes. First, there is an increased availability nation-wide of sugar-sweetened beverages and convenience foods. Eating food away from home increased and with that, larger portion sizes of carbohydrate-rich foods were consumed. Despite the fact that older adults consume less total carbohydrates than younger adults, their intakes have increased over time suggesting that some food habits may be firmly rooted. Also, sugar-sweetened

beverages and convenience foods are easy to consume and prepare for older adults who may have limited mobility.

Table 6.7
Mean Total Carbohydrate Intake (grams) per Day

Chronological Age	70	168.15	174.3	206.01	226.05	234.10
	60	174.24	180.74	215.31	237.91	245.56
	50	188.69	189.15	232.08	274.67	268.42
	40	192.87	204.72	254.93	289.85	285.93
	30	202.27	221.17	275.27	320.29	310.10
	20	222.71	246.70	293.17	333.18	315.67
		1971	1981	1991	2001	2011
		Calendar Year				

The percent of total calories consumed from carbohydrates stayed within the recommended range (45%-65%) among all age groups and birth cohorts across the fifty years (Table 6.8). Throughout all time periods the percent of calories consumed as carbohydrates was lowest in those aged 40-50. Across age, these percentages follow a reverse bell curve, with higher intakes during younger and older adulthood. While total grams of carbohydrate intake has increased overall, percentages are still within the recommended ranges. This suggests that there is an increase, over time, in total calorie consumption.

Table 6.9 provides least square carbohydrate means of each age group, controlling for sex, race, PIR, marital status and education level. Regardless of these mediators, carbohydrate intake decreases after the age of 40. Peak carbohydrate intakes across all years is between the ages of 20 and 30. Differences among each age group varied throughout the fifty years. NHANES I, II, and III showed no significant difference in

mean carbohydrate intake between the two oldest age groups. However, in all other NHANES years differences between all age groups mean carbohydrate intake was significant ($p < 0.05$).

Table 6.8
Mean Percent of Calories Consumed As Carbohydrate

Chronological Age	70	50.00	48.42	51.29	51.07	51.29
	60	49.42	46.09	50.75	50.30	49.66
	50	49.45	44.00	49.40	49.72	49.50
	40	47.44	43.17	48.80	49.00	49.27
	30	51.34	44.15	48.98	50.31	49.91
	20	53.33	45.27	49.64	52.51	49.68
		1971	1981	1991	2001	2011
		Calendar Year				

This table shows similar trends from what was provided in Table 6.7. Age groups, across all five time periods, increased their intake of carbohydrates at least 30%. Those aged 41 to 50 increased their intake of carbohydrates the most across all five time periods by nearly 34%. Within each time period, as individuals aged they decreased their carbohydrate intake nearly 30%. Also of note, in 2001, as people aged they decreased their intake 39%, the highest of all time periods. Cohorts A, B, C, D, and E increased their intake of carbohydrate by at least 8%. Cohorts B and E consumed at least 10% more carbohydrates across multiple time periods. Based on the consistency of the findings from Table 6.7 and 6.9 it would appear that individual characteristics like sex, race, education level, marital status, and income do not influence carbohydrate intake more than time, period, or cohort affects.

Table 6.9

Mean Total Carbohydrate Intake (grams) by age group, adjusted for sex, ethnicity, poverty to income ratio, marital status, and education level.

Age Group	NHANES I Carbohydrate Intake (SE)	NHANES II Carbohydrate Intake (SE)	NHANES III ^a Carbohydrate Intake (SE)	NHANES ^d Carbohydrate Intake (SE)	NHANES ^e Carbohydrate Intake (SE)
≥ 81	--	--	198 (4) ^{*c}	205 (5) [*]	--
71-80	167 (11) ^{*b}	172 (6) ^{*b}	202 (3) [*]	216 (5) [*]	238 (4) [*]
61-70	172 (11) [*]	174 (5) [*]	214 (3) [*]	238 (5) [*]	250 (4) [*]
51-60	186 (11) [*]	184 (5) [*]	230 (3) [*]	272 (5) [*]	275 (4) [*]
41-50	196 (11) [*]	199 (5) [*]	256 (3) [*]	286 (5) [*]	296 (4) [*]
31-40	212 (11) [*]	215 (5) [*]	280 (2) [*]	320 (5) [*]	306 (4) [*]
20 - 30	230 (11) [*]	240 (4.9) [*]	298 (2) [*]	338 (5) [*]	323 (4) [*]

* $p < 0.05$

^aNHANES III not adjusted for marital status and education level.

^bNo significant difference between age groups 61-70 and 71-80.

^cNo significant difference between age groups 71-80 and >81.

^dContinuous NHANES 2001-2002.

^eContinuous NHANES 2011-2012.

Comparing mean carbohydrate intake patterns for each demographic variable revealed significant results (Table 6.10). Differences in sex remained significant ($p < 0.05$) throughout all fifty years. During that time, men consumed more total carbohydrates than women despite the fact that carbohydrate intake increased over time in both sex.

Throughout the past fifty years mean carbohydrate intake has increased in all race and ethnic groups. There are significant ($p < 0.005$) differences in carbohydrate intake between whites and blacks during NHANES I, II, and III. NHANES III found significant differences in Mexican American, White, Black and Other ethnicities. An exception to this pattern is found between white and other ethnicities. Analytics of 2001 NHANES also produced significant results between most ethnic groups. However, there was little

difference between Mexican Americans and other Hispanics or Other ethnicities, and little difference was found between non-Hispanic whites or non-Hispanic blacks in the 2001 NHANES. The 2011 NHANES also revealed significant results between most ethnic groups. However, non-Hispanic whites did not significantly differ from the other Hispanic or Mexican American groups and the non-Hispanic blacks did not differ from the other Hispanic group.

The influence of marital status on carbohydrate intake, regardless of age, sex, race-ethnicity, PIR, and education level, varied over the years. NHANES I results indicate a significant ($p < 0.005$) difference between divorced individuals and married, never married, or widowed individuals. NHANES II analysis produced no significant difference between marital groups. Results from the 2001 and 2011 analysis identified considerably more differences among different marital statuses. All marital groups exhibited significant ($p < 0.005$) differences in status, with the exception of just a few groups. 2001 NHANES data showed no differences between married individuals and those who were never married or had been living with a partner. In addition, 2001 NHANES data revealed no difference between those who were divorced and those who were never married, or those who were married and those living with a partner. 2011 NHANES data indicated no significant differences between those who were never married and those who were married or those who were widowed and divorced.

Table 6.10
Mean total carbohydrate intake (grams) based on demographics

	NHANES I Least Square Means (SE)	NHANES II Least Square Means (SE)	NHANES III Least Square Means (SE)	NHANES ^b Least Square Means (SE)	NHANES ^c Least Square Means (SE)
Sex					
Male	231 (11.2)*	237 (4.3)*	277 (1.9)*	306 (5.1)*	320 (3.8)*
Female	157 (11.2)*	158 (4.8)*	202 (1.8)*	230 (5.1)*	243 (3.8)*

Table 6.10
Mean total carbohydrate intake (grams) based on demographics

	NHANES I Least Square Means (SE)	NHANES II Least Square Means (SE)	NHANES III Least Square Means (SE)	NHANES ^b Least Square Means (SE)	NHANES ^c Least Square Means (SE)
Race^a					
Mexican American	NA	NA	235 (1.9)*	265 (5.1)	285 (4.1)
Other Hispanic	NA	NA	NA	268 (5.5)	281 (4.0)
Non-Hispanic					
White	NA	NA	249 (1.7)	274 (5.0)	289 (3.9)
Non-Hispanic					
Black	NA	NA	228 (1.9)	273 (5.2)	287 (3.9)
White	199 (10.9)	187 (4.9)	NA	NA	NA
Black	181 (11.0)	201 (8.0)	NA	NA	NA
Other	201 (13.2)	205 (4.3)	247 (4.8)	261 (5.6)	264 (4.0)
Marital Status					
Married	198 (2.7)	200 (2.8)	NA	261 (1.0)	278 (1.0)
Widowed	206 (3.8)	205 (3.9)	NA	279 (1.9)	297 (2.0)
Divorced	185 (4.6)	196 (4.7)	NA	268 (1.9)	297 (1.7)
Separated	195 (5.1)	195 (6.1)	NA	291 (2.9)	271 (2.8)
Never Married	203 (3.6)	199 (4.1)	NA	264 (1.7)	280 (1.4)
Living with Partner				263 (2.3)	285 (1.9)
Education Level					
< High School	187 (11.2)	193 (4.9)	NA	263 (5.2)*	273 (4.1)*
High School					
Diploma	199 (11.2)	202 (4.9)	NA	269 (5.1)*	288 (3.9)*
> High School	196 (11.3)	197 (5.0)	NA	273 (5.1)*	284 (3.9)*
Poverty to Income Ratio					
< 0.5	194 (11.2)	192 (6.7)	240 (3.1)	263 (5.3)	285 (4.1)
0.5-1.0	NA	195 (5.1)	236 (2.3)	262 (5.2)	288 (3.9)
1.0-1.25	NA	203 (6.0)	234 (3.7)	266 (5.4)	282 (4.2)
1.25-2.5	NA	201 (4.9)	243 (2.1)	283 (5.1)	276 (3.9)
> 2.5	NA	197 (4.9)	246 (2.1)	267 (5.1)	276 (3.9)

* $p < 0.05$

^aNHANES I and II include Mexicans as “Other”

NA – Not Available

^bContinuous NHANES 2001-2002.

^cContinuous NHANES 2011-2012.

Unlike other demographic variables, the PIR did not follow an exact pattern.

While mean carbohydrate intake increased in all levels over time the differences between the mean intakes varied significantly. NHANES II did not reveal any significant differences between any of the PIR levels. NHANES III did suggest significant ($p < 0.005$) differences between the 50%-125% poverty level and those over 125% poverty. The 2001 NHANES results revealed a significant difference between those between 125%-250% poverty and all other levels. There were some significant differences

between those over 250% poverty and the other groups with the exception of those between 100%-125% poverty. The 2011 NHANES analytics revealed a significant ($p < 0.005$) difference between groups over 125% and those below 125% poverty.

Total Protein Intake. Mean protein intakes (Table 6.11) over time have trended upwards. Individuals consumed at least 15% more protein in 2011 than they did in 1971 across all age groups. Those aged 30 to 40 and 60 to 70 consumed more than 20% more protein than other across the fifty years. Life span trends during the 1971, 1981, and 1991 surveys, indicate the highest mean protein intake was reported by those between the ages of 20 and 30. As individuals age, during each time period, protein intake declines at least 26%. Beginning with the 2001 survey, the highest protein consumption was reported by those between 30 and 40 years.

Table 6.11
Mean Total Protein Intake (grams) per Day

Chronological Age	Calendar Year				
	1971	1981	1991	2001	2011
70	57.58	56.48	64.59	69.38	71.09
60	62.53	64.12	69.60	75.38	79.03
50	72.52	70.35	75.97	84.43	85.89
40	75.49	76.76	81.52	89.67	89.08
30	75.50	78.93	85.78	96.21	96.85
20	78.93	85.61	90.15	94.25	95.77

Protein intake over time among birth cohorts, revealed the highest consumption of protein between the ages of 40 and 50 years. Cohorts A and E were the only two that had minimal change to their mean protein intake during their subsequent years. Cohorts B, C, and D all had decreased intake levels over time. Cohort B consumed 6% less, cohort C 8% less, and cohort D 11% less protein over time.

These mean protein intake trends suggest that intake decreases with advancing age regardless of period. Protein foods are often difficult to consume due to changes in dentition, income, and taste. Also, high protein foods like red meat are limited in the presence of chronic diseases like heart disease. Despite the decreased intake observed in older adults, they still consume more than the recommended intake levels based on mean weights (Table 6.12).

Table 6.12 represents the mean weights of each age group and time period. For each mean protein recommendations have been calculated based on the current recommendation of 0.8 grams of protein per kilogram of body weight. This provides a reference for describing mean total protein intake levels. Based on the calculated protein recommendations, mean total protein intake levels were around 20 grams higher than recommended levels.

*Table 6.12
Mean Weight in kilograms (kg) and recommended protein intake based on 0.8 grams/kilogram*

		Weight (kg)/ Grams protein (g)	Weight (kg)/ Grams protein (g)	Weight (kg)/ Grams protein (g)	Weight (kg)/ Grams protein (g)	Weight (kg)/ Grams protein (g)
Chronological Age	70	70 kg/ 56 g	70 kg/ 56 g	70 kg/ 56 g	68 kg/ 54 g	75 kg/ 60 g
	60	71 kg/ 57 g	72 kg/ 57 g	71 kg/ 57 g	80 kg/ 64 g	82 kg/ 65 g
	50	74 kg/ 59 g	74 kg/ 59 g	74 kg/ 59 g	83 kg/ 67 g	83 kg/ 66 g
	40	73 kg/ 58 g	75 kg/ 60 g	73 kg/ 58 g	83 kg/ 66 g	84 kg/ 67 g
	30	71 kg/ 57 g	74 kg/ 59 g	71 kg/ 57 g	79 kg/ 63 g	82 kg/ 66 g
	20	67 kg/ 54 g	69 kg / 55 g	67 kg/ 54 g	77 kg/ 61 g	78 kg/ 62 g
		1971	1981	1991	2001	2011
Calendar Year						

Table 6.13 presents the percent of calories from protein over the five year time periods. Unlike mean carbohydrate intake, no patterns can be identified in the percent of

calories consumed from protein. The percent of total calories that are consumed from protein fell within the recommended levels.

Table 6.13
Mean Percent of Calories Consumed As Protein

Chronological Age	70	12.91	15.72	16.23	15.69	15.88
	60	13.32	16.23	16.41	16.11	16.15
	50	14.61	16.30	15.98	15.50	15.94
	40	13.45	16.17	15.49	15.21	15.57
	30	16.09	15.69	15.05	15.18	15.77
	20	15.81	15.58	14.81	14.74	15.30
		1971	1981	1991	2001	2011
		Calendar Year				

Differences between age groups, when controlling for sex, race-ethnicity, income, marital status, and education level, were significant. Across all NHANES periods, the mean protein intake varied significantly ($p < 0.05$) between all age groups when controlling for population diversity (Table 6.14). There were only two exceptions to these results. During NHANES II, no significance was found between those in the 31-40 and 41-50 age groups. The 2001 and 2011 continuous NHANES revealed no difference between the 20-30 and 31-40 age groups.

When comparing results from Table 6.11 to those in Table 6.14 there are different trends. While food intake declines during each time period with advancing age it is more than 30% when controlling for diversity. During 2001, there is 38% decrease in protein intake between 20 and 70 year olds. Comparing the same age groups across fifty years shows less differences in protein intake compared to what is reported in Table 6.11. Those aged 60 and younger, across all fifty years, increased their protein intake around 10%. However, those over 61 increased their protein intake by over 13%, with those

aged 61 to 70 consuming 16% more protein. Differences among birth cohorts were also higher than what was reported by Table 6.11. Cohorts A and E consumed 5% less protein across the time periods. Cohorts B, C, and D consumed nearly 20% less protein over the subsequent years. Unlike the changes seen in carbohydrates, it appears as if protein intake is more influenced by sex, race-ethnicity, income, education, and marital status. Socioecological level influences may mediate protein intake more than carbohydrate intake. This is not surprising due to the fact that protein foods are often more costly and are traditionally influenced by sociocultural norms.

Table 6.14
Mean Total Protein Intake (grams) by age group, adjusted for sex, race-ethnicity, poverty to income ratio, marital status, and education level.

Age Group	NHANES I Protein Intake (SE)	NHANES II Protein Intake (SE)	NHANES III^a Protein Intake (SE)	NHANES^d Protein Intake (SE)	NHANES^e Protein Intake (SE)
≥ 81	--	--	61 (1.4)*	56 (1.8)*	--
71-80	60 (4.4)* ^b	--	66 (1.1)*	61 (1.7)*	69 (1.3)*
61-70	64 (4.3)*	66 (2.0)* ^b	70 (0.9)*	69 (1.7)*	76 (1.3)*
51-60	74 (4.4)*	72 (2.1)*	77 (1.0)*	77 (1.7)*	82 (1.3)*
41-50	79 (4.4)*	78 (2.1)*	82 (0.9)*	82 (1.7)*	87 (1.3)*
31-40	82 (4.4)*	80 (2.0)*	88 (0.8)*	90 (1.7)*	93 (1.3)*
20 - 30	84 (4.3)*	86 (1.9)*	92 (0.8)*	91 (1.7)* ^c	93 (1.3)* ^c

* $p < 0.05$

^aNHANES III not adjusted for marital status and education level.

^bNo significant difference between age groups 61-70 and 71-80.

^cNo significant difference between age groups 20-30 and 31-4.

^dContinuous NHANES 2001-2002.

^eContinuous NHANES 2011-2012

Table 6.15 presents data illustrating the influence of each diversity factor on protein intake. Throughout all NHANES years, men consumed significantly more protein ($p < 0.05$) than women. Differences between ethnic groups were inconsistent over time. During the 1971, 1981, and 1991 survey, “other” ethnicities consumed the highest

amount of protein. Analytics for 2001 indicate the highest intakes were from non-Hispanic whites, while for 2011 non-Hispanic blacks consumed the most protein. This suggests instability in eating patterns among ethnic groups over time. NHANES I results suggest a significant ($p < 0.05$) difference between white and black ethnic groups. NHANES II reaffirmed this trend but also revealed significant differences between “other” races and blacks. NHANES III analytics showed significant differences between all ethnicities except for Mexican Americans and non-Hispanic whites. Results for 2001 revealed significant differences between other Hispanics and all other ethnicities. Non-Hispanic whites were also significantly different from Mexican Americans and other ethnicities. Results from 2011 indicated significant differences between all ethnicities except non-Hispanic whites and non-Hispanic blacks.

The influence of marital status changed significantly across all five time periods. During the 1971 survey, significant ($p < 0.05$) differences in protein intake were reported by those who were widowed compared to married, never married, or separated individuals. 1981 survey analytics did not indicate any significant differences in marital status and protein intake. However, by the continuous NHANES, a majority of marital statuses were significantly different from each other. Those who had never been married in 2001 had significant differences in protein intake from married, widowed, and separated adults. Married and widowed individuals in both 2001 and 2011 had significantly ($p < 0.05$) different protein intakes.

Table 6.15
Mean total protein intake (grams) based on demographics

	NHANES I Least Square Means (SE)	NHANES II Least Square Means (SE)	NHANES III Least Square Means (SE)	NHANES ^b Least Square Means (SE)	NHANES ^c Least Square Means (SE)
Sex					
Male	89.6 (4.3)*	90.9 (1.9)*	91.3 (0.6)*	89.3 (1.7)*	97.7 (1.2)*
Female	57.9 (4.3)*	57 (1.9)*	61.8 (0.6)*	60.9 (1.7)*	68.7 (1.2)*
Race^a					
Mexican American	NA	NA	75.9 (0.7)	76.3 (1.7)	87 (1.3)
Other Hispanic	NA	NA	NA	69.8 (1.8)	84.6 (1.3)
Non-Hispanic					
White	NA	NA	75.6 (0.6)	77.5 (1.7)	82.3 (1.2)
Black	NA	NA	73.8 (0.7)	76.8 (1.7)	82.9 (1.3)
White	75.6 (4.2)	75.2 (1.7)	NA	NA	NA
Black	70.5 (4.2)	70.2 (1.9)	NA	NA	NA
Other	75.2 (5.1)	76.7 (3.1)	80.8 (1.6)	75.3 (1.9)	79.2 (1.3)
Marital Status					
Married	73.6 (1.1)	71.2 (1.1)	NA	78.7 (0.3)	86.7 (0.3)
Widowed	76.8 (1.5)	73.5 (1.5)	NA	82.8 (0.6)	91.1 (0.7)
Divorced	73.5 (1.7)	70.1 (1.8)	NA	79.6 (0.6)	89.4 (0.6)
Separated	71.8 (2.0)	71.8 (2.4)	NA	82.3 (1.0)	91.4 (0.9)
Never Married	72.9 (1.4)	73.2 (1.6)	NA	80.4 (0.6)	86.5 (0.5)
Living with Partner	NA	NA	NA	80.1 (0.8)	88.2 (8.3)
Education Level					
< High School	69.5 (4.3)	70.6 (1.9)	NA	73.2 (1.7)	80.1 (1.3)
High School					
Diploma	74.4 (4.3)	75.2 (2.0)	NA	75.8 (1.7)	84.8 (1.2)
> High School	77.4 (4.3)	76.2 (1.9)	NA	76.5 (1.7)	84.6 (1.2)
Poverty to Income Ratio					
< 0.5	74 (4.3)*	73.4 (2.6)	76 (1.1)	77.7 (1.8)	83.3 (1.3)
0.5-1.0	NA	71 (2.0)	76 (0.8)	71.3 (1.7)	82.6 (1.3)
1.0-1.25	NA	73.6 (2.3)	74.2 (1.3)	73.8 (1.8)	83.4 (1.3)
1.25-2.5	NA	74.7 (2.0)	77 (0.7)	77.4 (1.7)	83.5 (1.3)
> 2.5	NA	77.4 (1.9)	79.6 (0.7)	75.4 (1.7)	83.1 (1.3)

^aNHANES I and II include Mexicans as “Other”

^bContinuous NHANES 2001-2002.

^cContinuous NHANES 2011-2012.

* $p < 0.05$

NA – Not Available

The impact of education on protein intake supports existing research. Individuals with less than a high school diploma consumed less protein over time compared to more educated individuals. NHANES I analytics revealed significant differences in protein intake between all education levels. Beginning with NHANES II, significant differences were only found between those who had less than a high school education and those who had a high school diploma or advanced education. Differences between income groups

did not remain consistent over time. NHANES II and III produced significant differences in protein intake for those who had a PIR over 250% poverty. However, beginning in 2001, no significant difference in mean protein intake was seen among all PIR levels.

Total Fat Intake. Mean intakes of total fat is presented in Table 6.16. Over the fifty years of NHANES, total fat intake increased among all age groups. The highest total fat intake was reported by those between the ages of 20 and 30 between the years 1971 and 1991. After 2001, the highest mean fat intake was reported by those aged 30 to 40. Mean fat intake decreased nearly 30% with advanced age during each time period. During 1981 and 1991 fat intake decreased nearly 35% between ages 20 and 70. Despite this, fat intake increased among age groups across the five time periods by approximately 15%. Those aged 30 to 40, and 60 to 70, consumed 18% more fat from 1971 to 2011. Trends among birth cohorts were not consistent over time nor did they follow any sort of pattern. However, all birth cohorts consumed less fat when tracked over multiple time periods. Cohorts B and C consumed 11% less fat over time while the other cohorts consumed around 8% less fat.

Table 6.16
Mean Total Fat Intake (grams) per Day

Chronological Age	70	58.43	58.03	60.83	67.94	68.45
	60	62.59	65.88	64.25	73.45	76.82
	50	71.69	72.89	73.26	87.41	83.37
	40	76.94	82.38	81.18	92.09	89.13
	30	77.38	84.71	88.50	96.63	94.83
	20	82.64	90.39	92.56	91.60	94.63
		1971	1981	1991	2001	2011
		Calendar Year				

The percent of total calories consumed from fat (Table 6.17) often fell within the recommended ranges of 25% to 35%, however, no age group consumed less than 30%.

For the 1971 and 1981 year analyses many of the levels were above recommended ranges. The highest percentage of fat calories were found in those aged 20-40 in 1971. 1981 trends suggest that the percent of calories consumed from fat had hit its peak because after that time period percentages were below 35. Trends or patterns in percent fat intake are not discernable throughout the five survey time periods. Tracking birth cohorts over time showed adults under the age of 40 consuming the highest percentage of fat with consumption decreasing after the age of 40.

*Table 6.17
Mean Percent of Calories Consumed As Fat*

		1971	1981	1991	2001	2011
		Calendar Year				
Chronological Age	70	30.88	34.97	33.15	33.79	33.00
	60	31.48	36.13	32.59	34.11	33.49
	50	34.45	36.46	33.60	34.11	33.2
	40	33.12	37.31	33.77	34.2	33.07
	30	39.00	36.63	34.03	33.50	32.99
	20	38.36	35.74	33.79	31.81	32.66

Mean intakes of total fat adjusted by sex, race-ethnicity, income, marital status and education level are presented in Table 6.18. Throughout all five time periods of data collection, significant differences ($p < 0.05$) in total fat were found. The only age groups without significant differences in NHANES II analytics were between ages 31-40 and 41-50. Fat intakes were highest across most years for those aged 20 to 30. The percent of change between age groups at each period and over fifty years was similar to those calculated in Table 6.16. However, there was a 44% difference in fat intake between the ages of 20 and 70 during 1991. In addition, those over the age of 70 had the highest increase in fat intake (nearly 20%) from 1971 to 2011. Gradual declines in total fat

intake were observed for all age groups while tracking across multiple time periods or with cross-cohort comparisons. Cohort fat intake changes were also higher when controlling for diversity. Cohorts B, C, and D had the highest decrease in fat (20%) while cohort A consumed 12% less fat. Cohort E had the smallest decrease in fat intake (8%) over the time periods. These cohort differences could be due to the presence of chronic disease, which often requires decreased fat intake. Cohort E is one of the younger cohorts and total fat intake declined between the ages of 51 and 60 during the 2011 survey.

*Table 6.18
Mean Total Fat Intake (grams) by age group, adjusted for sex, race-ethnicity, poverty to income ratio, marital status, and education level.*

Age Group	NHANES I Fat Intake (SE)	NHANES II Fat Intake (SE)	NHANES III^a Fat Intake (SE)	NHANES^c Fat Intake (SE)	NHANES^d Fat Intake (SE)
≥ 81	--	--	51 (1.6)*	55 (1.9)*	--
71-80	55 (5)*	57 (2.6)*	56 (1.2)*	60 (1.9)*	65 (1.4)*
61-70	59 (5)*	63 (2.3)*	60 (1.0)*	70 (1.8)*	74 (1)*
51-60	68 (5)*	70 (2.4)*	69 (1.2)*	80 (1.8)*	80 (1.4)*
41-50	76 (5)*	80 (2.4)*	78 (1.1)*	86 (1.8)*	87 (1.4)*
31-40	80 (5)*	82 (2.3)* ^b	86 (0.9)*	93 (1.8)*	90 (1.4)*
20 - 30	84 (4.9)*	87 (2.2)*	91 (0.9)*	90 (1.8)*	92 (1.4)*

* $p < 0.05$

^aNHANES III not adjusted for marital status and education level.

^bNo significant difference between age groups 31-40 and 41-50.

^cContinuous NHANES 2001-2002.

^dContinuous NHANES 2011-2012

Table 6.19 presents the mean fat intake for each race-ethnicity, sex, education level, marital status, and PIR. Significant ($p < 0.05$) differences between male and female were consistently revealed over time. Mean intakes of fat increased in both sexes over

the fifty year time period, with men constantly consuming more fat than women. Differences among ethnic groups varied over time. NHANES I and II revealed significant ($p<0.05$) differences in fat intake between white and black races. Beginning with NHANES III, significant ($p<0.05$) differences were indicated between all ethnic groups. The only exception to this observation was during the 2001 survey, which showed that there was no significant difference in Mexican American and other Hispanic ethnic group's fat intake. Whites and non-Hispanic whites consumed the highest amounts of fat compared to other ethnic groups until 2011, after which non-Hispanic blacks consumed the highest amounts of fat. The lowest fat intake was consumed by those considered "other" in all five NHANES periods.

Marital status differences were not consistent over time. NHANES I revealed significant ($p<0.05$) differences in fat intake between widowed adults and married or separated adults. NHANES II revealed no significant differences among marital statuses. 2001 results indicated significant ($p<0.05$) differences between married adults and all other statuses. In addition, 2001 also indicated that those individuals who have never married consumed significantly different mean fat intakes compared to widowed and separated adults. 2011 results revealed significant ($p<0.05$) differences between nearly all age groups. Divorced and widowed adults in 2011 did not differ significantly nor did those never married compared to those living with a partner. Widowed adults consumed more fat than other marital statuses in 1971, 1981, 1991, and 2011 time periods. During 2001, separated adults consumed the most fat.

Table 6.19
Mean total fat intake (grams) based on demographics

	NHANES I Least Square Means (SE)	NHANES II Least Square Means (SE)	NHANES III Least Square Means (SE)	NHANES ^c Least Square Means (SE)	NHANES ^d Least Square Means (SE)
Sex					
Male	88.2 (5.0)*	91.6 (2.2)*	84.5 (0.7)*	89.6 (1.8)*	94.2 (1.4)*
Female	52.7 (4.9)*	54.7 (2.2)*	55.8 (0.7)*	62.6 (1.8)*	68.6 (1.4)*
Race ^a					
Mexican American	NA	NA	68.3 (0.8)*	75.5 (1.8)*	84.3 (1.5)* ^b
Other Hispanic Non-Hispanic	NA	NA	NA	74.6 (2.0)*	76.6 (1.5)*
White Non-Hispanic	NA	NA	76.9 (0.7)*	81.8 (1.8)*	87.2 (1.4)*
Black	NA	NA	74.2 (0.8)*	80.5 (1.8)*	88.4 (1.4)*
White	74.9 (4.8)	79.6 (1.9)	NA	NA	NA
Black	67.1 (4.8)	72.4 (2.2)	NA	NA	NA
Other	69.4 (5.8)	67.5 (3.6)	61.2 (1.9)*	68.2 (2.0)*	70.5 (1.5)*
Marital Status					
Married	72.4 (1.2)	70.4 (1.3)	NA	74.6 (0.4)	80.3 (0.4)
Widowed	75.3 (1.7)	73 (1.8)	NA	79.2 (0.7)	85.7 (0.7)
Divorced	74.1 (2.0)	69.1 (2.1)	NA	78 (0.7)	87.3 (0.6)
Separated	70 (2.2)	69.6 (2.8)	NA	80 (1.1)	77.3 (1.0)
Never Married	72.7 (1.6)	72.1 (1.9)	NA	76.5 (0.6)	81.4 (0.5)
Living with Partner	NA	NA	NA	79.5 (0.8)	82.2)
Education Level					
< High School	68.3 (4.9)	71.2 (2.2)	NA	72.1 (1.9)*	84.3 (1.5)*
High School Diploma	71.5 (4.9)	74.8 (2.2)	NA	79.3 (1.8)*	86.4 (1.4)*
> High School	71.6 (5.0)	73.4 (2.2)	NA	77 (1.8)*	84.6 (1.4)*
Poverty to Income Ratio					
< 0.5	70.5 (4.9)*	71.4 (3.0)	68.5 (1.2)	75 (1.9)	80.6 (1.5)
0.5-1.0	NA	71.5 (2.3)	67.9 (0.9)	73.1 (1.9)	80 (1.4)
1.0-1.25	NA	73.3 (2.7)	68.4 (1.4)	73.7 (1.9)	83.7 (1.5)
1.25-2.5	NA	74.5 (2.2)	72.1 (0.8)	80.3 (1.8)	80.5 (1.4)
> 2.5	NA	75 (2.2)	73.9 (0.8)	78.4 (1.8)	82.2 (1.4)

NA – Not Available

* $p < 0.05$

^aNHANES I and II include Mexicans as “Other”

^bNo significant difference between Mexican American and Other Hispanic ethnic groups.

^cContinuous NHANES 2001-2002.

^dContinuous NHANES 2011-2012

Fat consumption was significantly ($p < 0.05$) different between those with less than a high school education and those with at least a high school diploma during NHANES I and II. This changed in 2001 and 2011 when all education levels had significantly different mean fat intake levels. Throughout all five time periods, adults who had less than a high school diploma consumed the least amount of protein.

PIR patterns were not stable over the five time periods. Earlier NHANES period results indicate less significant differences among PIR groups, while more recent results suggest more significant differences. NHANES II indicates significant ($p < 0.05$) differences between PIR 50% and 100% poverty levels and those above 125% poverty. NHANES III analytics revealed significant differences between those above 125% poverty and those less than 125% poverty. 2001 analytics suggest differences among all PIR levels with the exception of those between 100% and 125% and the groups less than 100%. This trend continued in the 2011 data collection period. However, during the 2011 data collection no differences were found between those who had less than 100% PIR and those who were between 125% and 250% poverty. In general, those who live below 100% poverty consume less total fat grams than those above 100% poverty.

Total Calorie Intake. Table 6.20 represents the mean total calorie intake of participants over the five NHANES survey periods. Total calorie intakes increased throughout all age groups over the fifty years. Also, throughout all fifty years, total calorie intakes decreased with advancing age. During the 1971 data analysis, only those between the ages of 20 and 30 consumed over 2,000 calories per day. By 1981, those between the ages of 20 and 40 consumed over 2,000 calories per day. It wasn't until 2001 that those aged 50 to 60 had mean total calorie intakes over 2,000 per day. Throughout all five time periods, those over the age of 70 never consumed over 2,000 calories per day. The highest total calorie intake for 1971, 1981, and 1991 was found between 20 and 30 years old. In 2001 and 2011, those aged 30 to 40 had very similar calorie intakes to those between 20 and 30 years. Across all time periods, after the age of 40, total calorie intake declined.

Table 6.20
Mean Total Calories (kilocalories) per Day

Chronological Age	70	1445	1460	1621	1788	1836
	60	1538	1603	1728	1912	2007
	50	1741	1759	1914	2250	2203
	40	1834	1942	2126	2402	2365
	30	1871	2043	2294	2579	2534
	20	2008	2237	2420	2576	2575
		1971	1981	1991	2001	2011
		Calendar Year				

During each time period intake declined from age 20 to 70 by approximately 30%. The only exception to this was in 1981 when consumption decreased 35% from age 20 to 70. Over fifty years, total calorie intake increased over 20% in all age groups. The highest increase was for those aged 30 to 40 who consumed 26% more total calories in 2011 compared to 1971. Changes in birth cohorts was less than 1% across subsequent time periods. That being said, there were higher percent changes during middle adulthood for cohorts A, B, and E. Cohort A increased their total calorie intake nearly 10% between the ages of 20 and 50 years. After the age of 50, cohort A decreased their consumption so that by the time they turned 70 their total calorie intake had decreased 0.05% from the age of 20. Cohort B increased their total calories by 4% between the ages of 30 and 40 while cohort E increased their calories by 7% between the ages of 20 and 40.

The mean total calorie intakes when adjusted for individual diversity showed similar results (Table 6.21). Regardless of sex, race-ethnicity, income, marital status, and education level, the highest total calorie intakes were for those between the ages of 20

and 40 years. Total calorie intake declined after the age of 40 across all five time periods. Those over the age of 51 consumed less than 2,000 total calories per day. There are significant differences in mean calorie intake among all age groups within each of the five NHANES time periods.

*Table 6.21
Mean Total Calorie Intake (kilocalories) by age group, adjusted for sex, race-ethnicity, poverty to income ratio, marital status, and education level.*

Age Group	NHANES I Total Calorie Intake (SE)	NHANES II Total Calorie Intake (SE)	NHANES III^a Total Calorie Intake (SE)	NHANES^b Total Calorie Intake (SE)	NHANES^c Total Calorie Intake (SE)
≥ 81	--	--	1479 (32)*	1505 (47)*	--
71-80	1445 (102)*	1426 (49)*	1570 (25)*	1665 (46)*	1677 (39)*
61-70	1532 (101)*	1524 (42)*	1704 (21)*	1865 (45)*	1863 (39)*
51-60	1708 (102)*	1682 (45)*	1894 (23)*	2174 (45)*	2061 (39)*
41-50	1870 (101)*	1860 (46)*	2130 (21)*	2314 (46)*	2249 (39)*
31-40	1979 (101)*	1945 (45)*	2327 (18)*	2530 (46)*	2395 (39)*
20 - 30	2079 (100)*	2121 (43)*	2446 (17)*	2511 (46)*	2411 (40)*

* $p < 0.05$

^aNHANES III not adjusted for marital status and education level.

^bContinuous NHANES 2001-2002.

^cContinuous NHANES 2011-2012.

Similar to Table 6.20, within each time period total calorie intake decreased over 30% from age 20 to 70. During 1991, the total calorie intake between 20 to 70 year olds declined 36%. Across all fifty years each age group increased its total calories by roughly 17%. The biggest difference in total calorie intakes between Table 6.20 and 6.21 is found in the birth cohorts. Each birth cohort consumed at least 10% fewer total calories as time passed, with the exception of cohort E, which consumed only 3% fewer total calories. Cohort A only consumed 2% more total calories between the ages of 20 to 50, which is less than the 10% observed in Table 6.20. Also, cohort B had a 4% increase

in total calories between the ages of 30 and 50. Cohort E had a 9% increase in total calories between the ages of 20 and 30.

The combined results presented by Tables 6.20 and 6.21 suggest that the highest calories are consumed among middle aged adults. Total calorie intake declines from middle adulthood into older adulthood regardless of time period. The increased consumption of carbohydrates, protein, and fat gave rise to increased total calorie consumption over the fifty year time span. Also, the higher intakes of macronutrients during 1991 and 2001 explain how total calorie intakes are highest during the 2001 survey. Of the total calories consumed across the fifty years, nearly 50% of them came from carbohydrates, 15% from protein, and 35% came from fat. Young and middle adults may be more influenced by social networks, income, and other socioecological factors. In addition, those in middle adulthood are likely raising children, in the work force, and consuming foods away from home. As individuals age, social interactions are reduced, appetite is decreased, and chronic diseases are more prevalent.

Table 6.22 provides information about mean total calorie intake for sex, race-ethnicity, marital status, education level, and income levels. Across all five points in time, men consume more total calories than women. Mean calorie intake differences between males and females are significantly different ($p<0.05$) over each time period. Total calorie intake based on race-ethnicity varied throughout NHANES time periods. Non-Hispanic whites consume the most total calories compared to other ethnic groups regardless of time period. By 2001, there is less total calorie difference between ethnic groups and by 2011, all groups were consuming more than 2000 calories per day. In NHANES I, II, and III, white participants had significantly ($p<0.05$) different total calorie

intakes compared to blacks. In NHANES III, whites also had significantly ($p<0.05$) different intakes compared to the “other” group. 2001 NHANES results suggest no significant ($p<0.05$) differences in calorie intakes between non-Hispanic white and non-Hispanic black participants. The 2001 NHANES also found no significant difference between Mexican Americans and other Hispanics. 2011 NHANES results similarly indicate that all ethnic groups had significantly ($p<0.05$) different intakes with the exception of non-Hispanic white and non-Hispanic black participants.

There were no consistencies in total calorie intake based on marital status. During 1971 and 1981, those who were widowed or never married had the two highest mean total calorie intakes. In 2001, those who were widowed and separated had the highest mean total calorie intake. By 2011, those who were widowed or divorced had the two highest mean total calorie intakes. Despite the fact that widowed adults had one of the highest total calorie intakes in each time period, they did not consistently consume the most overall. Significant differences in total calorie intake among marital groups was not consistent across the five time periods. NHANES I suggests significant ($p<0.05$) differences between widowed participants and those who reported their status as either married, never married, or separated. NHANES II found no significant differences among the marital groups. 2001 NHANES analysis revealed married participants consumed significantly ($p<0.05$) different levels of total calorie compared to all other marital statuses. Additional significant differences in 2001 NHANES results were discovered between widowed and divorced or those never married; divorced and separated participants; separated and never married or living with a partner; never married and those living with a partner. 2011 NHANES analysis revealed significant

differences between all marital groups with the exception of married and separated; widowed and divorced; separated and never married participants.

Table 6.22
Mean total calorie intake (kilocalories) based on demographics

	NHANES I Least Square Means (SE)	NHANES II Least Square Means (SE)	NHANES III Least Square Means (SE)	NHANES ^b Least Square Means (SE)	NHANES ^c Least Square Means (SE)
Sex					
Male	2178 (93.6)*	2253 (41.2)*	2293 (14.7)*	2431 (38.0)*	2565 (29.0)*
Female	1351 (93.0)*	1386 (41.1)*	1548 (14.0)*	1706 (38.0)*	1859 (29.0)*
Race^a					
Mexican American	NA	NA	1879 (15.7)	2049 (38.4)	2244 (31.2)
Other Hispanic	NA	NA	NA	2018 (41.4)	2172 (30.5)
Non-Hispanic					
White	NA	NA	2017 (13.6)	2169 (37.8)	2317 (29.4)
Non-Hispanic					
Black	NA	NA	1904 (15.3)	2153 (38.5)	2314 (29.7)
White	1849 (90.8)	1921 (36.5)	NA	NA	NA
Black	1679 (92.0)	1768 (41.7)	NA	NA	NA
Other		1921 (36.5)	1881 (37.6)	1954 (41.9)	2013 (30.3)
Marital Status					
Married	1774 (22.8)	1758 (24.4)	NA	2019 (7.7)	2196 (8.1)
Widowed	1869 (31.7)	1840 (33.8)	NA	2180 (14.2)	2343 (15.4)
Divorced	1798 (38.3)	1763 (40.4)	NA	2133 (14.1)	2371 (13.3)
Separated	1773 (24.6)	1788 (52.7)	NA	2223 (22.3)	2191 (21.5)
Never Married	1803 (29.6)	1818 (35.6)	NA	2107 (12.6)	2237 (10.8)
Living with Partner	NA	NA	NA	2159 (17.4)	2276 (15.0)
Education Level					
< High School	1692 (93.3)	1767 (41.9)	NA	2015 (38.8)	2092 (31.2)
High School					
Diploma	1794 (93.6)	1861 (42.7)	NA	2103 (38.3)	2294 (29.3)
> High School	1809 (94.0)	1830 (42.8)	NA	2087 (38.1)	2250 (29.1)
Poverty to Income Ratio					
< 0.5	1765 (93.0)	1775 (57.0)	1899 (24.8)	2100 (39.8)	2217 (30.7)
0.5-1.0	NA	1774 (43.9)	1886 (18.5)	1975 (39.0)	2212 (29.9)
1.0-1.25	NA	1844 (51.2)	1875 (28.9)	1999 (40.4)	2232 (31.7)
1.25-2.5	NA	1846 (41.8)	1947 (16.6)	2168 (38.3)	2183 (29.8)
> 2.5	NA	1858 (41.7)	1994 (16.4)	2101 (38.2)	2216 (29.6)

^aNHANES I and II include Mexicans as “Other”

NA – Not Available

^bContinuous NHANES 2001-2002.

^cContinuous NHANES 2011-2012.

Differences in education level remained stable after 1981. In 1971, as education level increased, mean total calorie intakes increased. However, by 1981, those with a high school diploma had higher mean total calorie intakes than those with less than a high school diploma and those with more education following high school diploma. Those with less than a high school diploma consistently consumed fewer mean total calories

than the other two education levels analyzed by this dissertation study. Significant ($p<0.05$) differences in total calorie intake between education levels were found in all five time periods. In NHANES I, II, 2001, and 2011, significant differences were found between those with less than a high school diploma and those with a high school diploma or more education. In NHANES I, II, and 2001, no significant differences in calorie intake were found between those with a high school diploma and those with education after high school.

PIR analysis suggests that those with lower income and below 100% poverty consume the lowest amounts of mean total calories. Although especially obvious in 1971, 1981, and 1991. This trend started to change in 2001 with those below 50% poverty consuming more total calories than those below 100% poverty. By 2011, those in all categories below 100% poverty consumed more mean total calories than those above 100% poverty. Significant differences between poverty levels were not consistent across the five time periods. NHANES II results show significant ($p<0.05$) differences between 50%-100% poverty and both poverty levels $>125\%$. NHANES III had significant ($p<0.05$) differences between $>250\%$ poverty and all other poverty levels. In addition, NHANES III analyses found significant differences between 50%-125% poverty levels and 125%-250% poverty. Unlike the previous NHANES, the 2001 NHANES supported significant differences among all poverty levels with the exception of those 50%-100% and 100%-125% or those $<50\%$ and $>250\%$. The 2011 NHANES did not show similar results to the 2001 trends with those between 125% and 250% being significantly ($p<0.05$) different than all other groups. In addition, 2011 NHANES

analysis found significant ($p < 0.05$) differences between those 125%-250% and those >250% poverty.

Discussion

Lack of consideration among researchers on the critical influence of time on macronutrient needs creates a one size fits all mentality for health care professionals. This study utilized a multidisciplinary perspective to distinguish age, period, and cohort effects on food intake. Changes in food intake and behavior occur as a result of the complex interaction between multiple factors. Existing food intake and behavior scholarship provides minimal consideration for age dynamics, life span affects, or linked birth cohorts. The results of this study begin to fill in these gaps left by previous nutrition scholars.

Life Span Effects on Food Intake. The first aim of this study was to determine differences in food intakes over time. By measuring macronutrient intake levels at five points in time over a fifty year span, period and age differences were identified. Trends in food intake support my hypothesis, that younger adults consume more macronutrients and total calories than older adults. Adults aged 20 – 40 years old consume the highest amounts of carbohydrates, fat and protein across all time periods. After the age of 40, macronutrient intake declines with the lowest intake occurring after the age of 71. Total calorie intake is highest among those between the ages of 20 to 30 years old. After the age of 30, regardless of the time period, total calorie intake declines. Regardless of time, individuals over the age of 60 consume less than 2,000 mean total calories per day. Regardless of age or time, macronutrient and total calorie intakes have increased since 1971, with the greatest total amount consumed in 2001. These food intake trends support

the preliminary findings of other studies (Johnston, Poti, & PoPkin, 2014; Wakimoto & Block, 2001).

The second aim of this dissertation study was to identify trends in food intake among birth cohorts tracked over time. Similar macronutrient intake patterns were found across all birth cohorts. All birth cohorts consumed their highest intakes of each macronutrient during the 2001 and 2011 survey years. When comparing birth cohorts, peak intakes of carbohydrates are reported during 2001 and 2011 in adults between the ages of 41 and 80. This trend is not present for fat and protein intake. Protein and fat intake decreases among all birth cohorts over time with the highest intakes occurring before the age of 51. My hypothesis was that these cohort differences would be present due to a variety of historical events. There are a variety of historical events that occurred in the twentieth century that have impacted our food intake and contributed to the increased consumption. All of these will be discussed in detail as part of the life course discourse. Based on the trends observed among birth cohorts, historical events may have an even greater impact on food intake than age. Comparing birth cohorts, while controlling for population diversity, provided new insight into food intake trends.

The third aim of this study was to identify food intake patterns among age groups and birth cohorts across multiple time periods while controlling for population diversity. Food intake patterns were analyzed while adjusting for sex, race-ethnicity, education level, marital status, and income. Significant differences between age groups macronutrient and total calorie intake is found regardless of time period. There are two exceptions to this finding. In regards to total carbohydrate and protein intake, no significant differences were observed during the 1970's between the oldest age groups.

This suggests that at that time, older adults were more heterogeneous in their intakes of carbohydrate and protein. This further suggests that age is a significant factor in food choice and behavior.

By controlling for population diversity, other macronutrient trends over time are observed. Throughout all five time periods, adults aged 20-40 consume the highest amounts of carbohydrate, protein, and fat. After the age of 40, all macronutrient intake declines and those over the age of 70 have the lowest macronutrient intakes. Following the same age group over time revealed that carbohydrate, protein, and fat intakes were highest in the 2011 NHANES. Total calorie intakes are highest in those aged 20-30 and peaked during the 2001 NHANES period. Birth cohort macronutrient trends were also analyzed when controlling for population diversity. Total carbohydrate intake increased over time among all birth cohorts, while protein and fat intake decreased. Tracking total calorie intake of each birth cohort over time did not reveal similar results. Adults over the age of 30 during the first NHANES consumed fewer total calories over the subsequent NHANES time periods. However, the youngest birth cohort in NHANES I consumed their highest amount of total calories between 50 and 60 years of age (2001 NHANES).

Based on extant research, socioeconomic status and sex influence food choice and behavior. The majority of food intake patterns observed in this dissertation study confirm what others have reported in food intake studies. Men consume more macronutrients and total calories over the life span compared to women, which supports extant research (Johnston et al., 2014; Wakimoto & Block, 2001). This trend is stable over time. Measuring trends between various ethnicities is a challenge due to the inconsistency in

reporting through the five time periods. Significant differences observed among the different ethnic groups may be due to cultural differences in food preparation, consumption, and preferences. Factors such as ethnicity may influence food intake by moderating which foods are appropriate and acceptable for the food culture. For example, non-Hispanic whites had the highest intakes of carbohydrates and fats when compared with other ethnic groups.

My hypothesis that significant differences in food intake among the various marital statuses was not supported by this dissertation research. My assumption was that individuals who are married or living with a partner would naturally live with another individual which would influence food intake. However, without more details about the social network of each marital status this cannot be examined.

Individuals with lower education and income levels are more likely to report food insecurity and limited food availability (Dean & Sharkey, 2011; Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007). With lower education levels comes poor food literacy, which impairs an individual's ability to navigate the food system and make decisions based on provided recommendations (Vidgen & Gallegos, 2014). Based on demographic data in this study, a large number of the older adults have a lower education level and are below the poverty line. Controlling for these factors when analyzing age differences was crucial due to the fact that extant research suggests older adults with low education and income levels consume fewer nutrients and total calories overall (Kuczmarski & Weddle, 2005; Locher et al., 2005; Nicklett & Kadell, 2013; Quandt & Rao, 1999; Quandt, Vitolins, DeWalt, & Roos, 1997). These disparities often lead to an

increased consumption in nutrient poor and processed foods. Typically, these types of foods are higher in carbohydrates, fat, and total calories.

Trends in carbohydrate intake over time among different education levels revealed higher intakes of total carbohydrates as education level increased. In NHANES I food intake was significantly ($p < 0.005$) different between those with less than a high school education and those with a high school diploma or additional schooling. NHANES II supported these findings and also suggest a significant difference in mean intake of carbohydrates between those with a high school diploma and those with education after high school. Both 2001 and 2011 NHANES data indicate significant ($p < 0.005$) differences between all education levels.

The results of this study indicate that total carbohydrate intake has shifted since 1971. In the twentieth century, individuals above 100% poverty consumed more total carbohydrates. But this is shifting to those under 100% poverty in the twenty-first century. This trend is not observed for total fat, protein, and calories, all of which are consistently higher over time for those over 100% poverty. With regards to education level, throughout all time periods individuals who had at least a high school diploma consumed more macronutrients and calories than those who did not have a high school diploma. This may be due to poor food literacy, availability, and low income levels of those with a lower education level.

Food Intake Through the Life Course Lens. The final aim of this dissertation study was to explain these observed food intake patterns using a framework of the life course. Previous scholarship on nutrient intake gives very little consideration of historical or life events. Multiple historical actions have caused individuals to have

longer life spans, improved access to foods, and improved efficiency of meal preparation. Since colonial times, agricultural production has been able to supply the macronutrients needed for the United States population (Fiske, 1907; McWilliams, 2005a). With changes in the food supply and foodways in the United States, food holds different meanings for each individual. These different meanings could influence macronutrient intake. Figure 6.3 presents a timeline of historical events that have impacted food intake over time. Within this figure is each birth cohort examined by this dissertation study.

Without a doubt, the advances in agriculture have influenced food intake. The development of improved efficiency and crop production has allowed for the production of food which surpasses the daily requirements for the United States population (NIFA, 2014). These advancements evolved rapidly during the twentieth century. During the nineteenth and twentieth centuries much of the United States population maintained agrarian lifestyles. They often produced foods to maintain their own nutritional needs and supplemented these needs with goods sold in grocery stores (Gabaccia, 1998). Food availability was based on what the local land could produce and from regional imports. This may explain why macronutrient and total calorie intakes were lowest during the first three NHANES time periods. Adults had less access to foods and likely experienced a time of low agricultural production.

Another agricultural factor that has influenced macronutrient and total calorie intakes relates to government subsidies and commodities. Throughout the nineteenth century the government increased support for farmers producing carbohydrate foods like corn, wheat, and soybeans (Gabaccia, 1998; McWilliams, 2005b). This increased production and availability of such carbohydrate foods, which could be processed and

packaged into shelf stable food products. Also, due to the increased production of these carbohydrate foods, a wider variety of products would have been available for consumers to choose from in grocery stores. In addition, food stamp and the supplemental nutrition assistance program improved access to foods, especially those created through agriculture (Levenstein, 1993). This would explain why those with lower incomes and in poverty had similar food intakes to those above the poverty line in more recent NHANES time periods.

The decreased consumption of protein and fat over the time periods and birth cohorts is likely due to the dietary recommendations that were provided during the twentieth and twenty-first centuries. The Basic Seven⁷, Basic Four⁸, and The Food Guide Pyramid⁹ food groups for good health were early twentieth century guidelines that suggested higher intakes of whole grains, fruit, vegetables, and dairy products (Nestle, 2013). All of these food groups contain carbohydrates and may have produced the high carbohydrate intakes of the participants in the first two NHANES time periods. More recent diet recommendations suggested decreasing consumption of fats to maintain heart health, which explains the decreased consumption of fat over time. Additional diet recommendations influenced macronutrient intake throughout the five NHANES time periods. These recommendations have also influenced macronutrient distribution by encouraging carbohydrate-rich foods and decreasing consumption of fat. Such

⁷ Basic Seven food groups as presented in the 1940's by the *National Wartime Nutrition Guide*.

⁸ Basic Four Food Group Guide created after World War II and provided recommendations until the 1970's.

⁹ Food Guide Pyramid was initiated in 1992.

recommendations were provided by Healthy People¹⁰, and the Dietary Guidelines for Americans¹¹.

The lower macronutrient and total calorie intake levels during the 1970's may also be a result of experiencing the world wars and Great Depression. During these major historical events food was rationed and availability was minimal (Elder, 1999). Depending on the age this food scarcity and crisis would have produced significantly different food meanings. Children growing up during these times would have known no other times of food plenty and may have the perception that a lack of food variety or availability was the norm (Elder, 1999). Therefore, they would grow into adults accustomed to consuming less macronutrients and total calories. Adults during these times may have been parents and providing for their families would have added additional strain and perhaps more significant understanding of the significance of food choices. Food consumption may have been viewed as a means for survival rather than pleasure. Certain foods that were rationed during the wars, like red meat and dairy, would have been viewed as especially important diet components. Perhaps this is why protein and fat intakes were higher in the first two NHANES time periods.

Another factor that occurred as a result of the world wars was the increased role of women in the workplace (Goldin, 1991). The traditional role of the women, to be a housewife and food preparer, conflicted with the working woman. Because of this dual role combined with other dynamic changes to family structure, there was an increased demand for convenience and packaged foods.

¹⁰ The Healthy People campaign was initiated in 1979 and are revised every ten years.

¹¹ The Dietary Guidelines for Americans were issued in 1980 and are revised every five years.

The increased awareness and provision of nutritional services for older adults beginning in the 1970's with the amendments to the Older Americans Act could have caused nutrient intake levels for those over 60 to increase. This nutrition program may have met the nutritional needs of many participants in this study who were targeted by NHANES due to age and income status. That being said, the number of older adults participating in the OAA nutrition program is not high enough to suggest that it may be significantly impacting the intake reports of those included in the NHANES results. In addition, there is little evidence to suggest that due to the initiation of the nutrition program more awareness of older adult hunger which led to local or state programs to improve nutritional status.

Increased consumption of macronutrients and total calories is directly related to the increased availability, production, and variety of food. The enormous growth of the fast food and restaurant industry is also a piece to this food overabundance scenario (An, 2016; Guthrie, Lin, & Frazao, 2002; Larson, Neumark-Sztainer, Laska, & Story, 2011; McCrory et al., 1999; McGuire, 2011; Seguin, Aggarwal, Vermeulen, & Drewnowski, 2016; Todd, Mancino, & Lin, 2010). Food is encouraged everywhere an individual looks; internet, television, print advertisements, and neighborhoods. This growth requires individuals to make more food decisions now than they ever had the opportunity to in times past. The most heavily marketed foods tend to be those calorie and carbohydrate-rich. Also, such foods have a longer shelf life and thus are more likely to be found at small/convenience markets (as in food deserts).

Regardless of the life event, significant events in the lives of the NHANES participants impacted food intake by redefining food. The beliefs and food meanings of

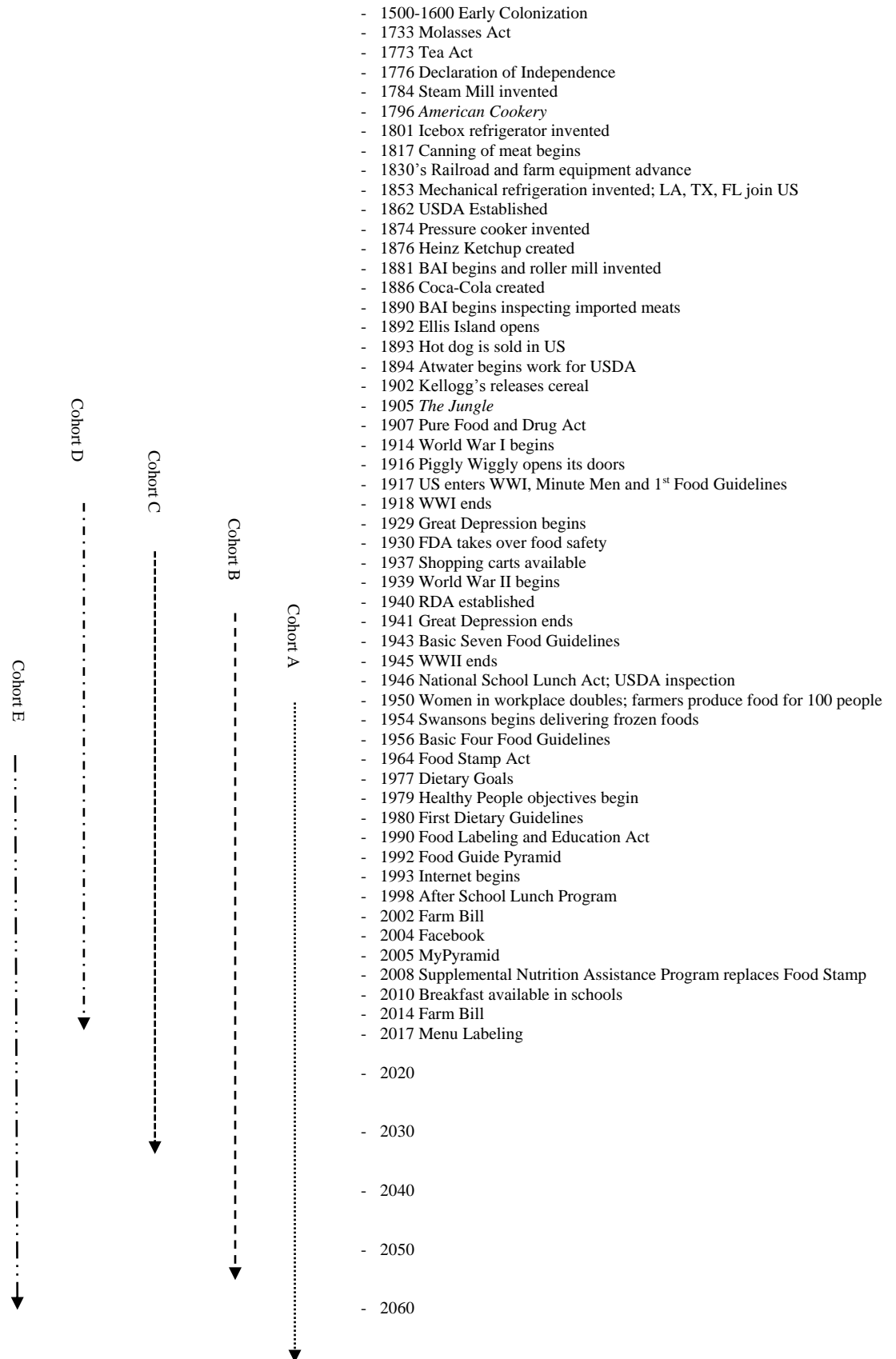
each individual will be relayed to their children and maintained in the future until that child becomes an adult and can create their own new food meaning. The life events each person experiences will either reinforce or alter the food meaning. For example, parents during the Great Depression would have held the belief that all food on the plate should be consumed and not wasted. This perception may have been reinforced due to the fact that their parents likely lived through a time when they produced their own foods and what was consumed depended on agricultural success. The Great Depression parents would have instilled this “no waste” belief onto their children. When those children grew into adulthood they may have learned about healthy eating through their school system and the food recommendations available at that time. This would have either reinforced their belief that no food should be wasted, or created the new meaning that certain foods should be consumed in moderation only and food waste was acceptable.

Conclusion

Food intake has clearly increased over the past fifty years. Macronutrient and total calorie increases can be found in all age groups and birth cohorts. These increases occur regardless of age and appear to be the influence of historical and period affects. Life span food intake trends can be analyzed by NHANES data over the past fifty years. As people age, they consume lower amounts of macronutrients and total calories. Younger adults consume more macronutrients and total calories than older adults regardless of the time period. The variability among birth cohorts can be explained by events that have occurred over time in the lives of the participants. The results of this study highlight the importance of considering age and time on future food intake studies.

The inclusion of age and time will provide significant insight into food choice and behavior which has previously been absent from food intake studies.

Figure 6.2. Birth cohort and food history timeline.



Chapter 7: Closing Remarks

This dissertation study is the first of its kind to combine life span and life course concepts to critically examine time-dependent changes in food intake related to age and historic period influences. Americans have a longer life expectancy now compared to 100 years ago due to increased nutrient availability and decreased infectious disease mortality. Despite advances in biomedical and health science research, Americans continue to suffer from being overweight and obese. Improved communication through technology and community education programs have been unsuccessful in blunting the number of children, adolescents, and adults that develop obesity. The United States population is developing and dying from chronic diseases that could be reduced by maintaining a healthy weight and participating in physical activity.

This study adds to the existing research focusing on food intake patterns over time. With the inclusion of historical and socioecological factors, this study provides more contextual consideration than what has previously been done by life span nutrition researchers. Historical, social, environmental, cultural, psychological, physiological, and agricultural factors all influence eating behaviors across the life span. All of these factors influence the meaning of food for each person and will direct food intake and behavior. As meanings of food change over time, food intake evolves. Some patterns are due to age and period affects; other food intake patterns are a result of individual factors.

Results of this study indicate that despite improved nutrient labeling, increasing availability of diverse and fresh produce, and food policy, Americans are consuming more macronutrients and total calories in recent years than they did fifty years ago. Younger adults are more likely to consume higher amounts of carbohydrates, fat, protein,

and total calories compared to older adults. This is of special interest as overconsumption of macronutrients and calories can lead to obesity and chronic disease. During a time in United States history when obesity rates are above 17% in children and 30% in adults, intervention programs should be focused on children, adolescents, and young adults. Older adults, who are more likely to have a chronic disease, are naturally consuming fewer macronutrients and total calories. Nutrient recommendations for adults over fifty years old should make note of these food intake patterns and make adjustments as needed. Adults over the age of 50 are less likely to need weight loss intervention due to decreased nutrient intakes.

Also new to nutrition research is the incorporation of population diversity to observed age and cohort food intake patterns. This is the first study to explore group characteristics while controlling for age across multiple time periods. The results of this study suggest that the food intake patterns observed across time are stable even when controlling for group characteristics. Perhaps age influences food intake more than sex, race-ethnicity, income, education level, or marital status.

The results of this study also highlight the importance of including historic information in addition to period-limited socioecological factors when examining food intake patterns, which are not stable among age groups over time. Various factors such as agricultural development, government policy, and food industry growth, evolve over time and will change food intake and behavior. Evidence of this has been illustrated here with the peak total carbohydrate intakes occurring among individuals during a time of agricultural efficiency and overproduction of corn.

Study Limitations

Research that seeks to understand the complex factors affecting food intake has long been constrained by data availability and design issues. Critically involving time in analyses has further been hindered by data consistency and computing power. Research presented in this dissertation was able to overcome some barriers that have hindered previous life span nutrition research. Age, period, and cohort changes emerged from a study design based on recent advances in life course methods, and inclusion of contextual data during analysis was informed by social theory.

Limitations exist when using NHANES data to analyze trends over a span of fifty years. NHANES primarily focuses on individuals who are at a high risk for malnutrition. Because of this focus, the surveys' sample may be limited and provide data that do not adequately represent the population as a whole. This is especially true for NHANES I, which included over 95% of participants who were below 50% poverty. Individuals with low incomes have limited food diversity and availability due to economic and geographic constraints (Ahn, Smith, Hendricks, & Ory, 2014; Alviola, Nayga, Thomsen, & Wang, 2013; Powell et al., 2007).

It is clear from historical evidence that regional food diversity is present in the United States (Gabaccia, 1998; Harris, 1985; Levenstein, 1993; McWilliams, 2005a, 2005b). NHANES I, II, and III all contained regional data that were not analyzed in this study because it was unavailable for public use in NHANES continuous datasets. As a consequence, regional food influences are not factored into food intake. While ethnicity can represent some cultural differences, without attention to regional characteristics, the influence of food culture cannot be completely represented. Regional differences in food

availability due to agricultural production and availability, among other things, could well have influenced some of the data represented in the NHANES.

Macronutrient and total calorie analysis has been identified as a weakness of NHANES (Archer, Hand, & Blair, 2013). This is due to the changing process of food analysis throughout all NHANES years. Misreporting and response error are always factors in decreasing the validity of food recall data. Also, due to changes in food production, nutrient content varied from one year to the next. Nutrient analysis likely improved over the NHANES years due to enhanced food composition analysis making more recent analyses more reflective of true macronutrient content. Also, commercially prepared foods and meals eaten away from home changed considerably over the fifty years. Hundreds of new food products are available for consumers annually (Guptill, Copelton, & Lucal, 2013). Many food products have altered their ingredients enough to change macronutrient intake or do not provide complete nutrient composition.

Certain inconsistencies in data collection throughout all NHANES also presented a limitation. The collection of race and ethnicity varied considerably, inhibiting cultural analysis. Changes in reporting marital status may further affect results. For example, it is not clear what category individuals who live with a partner would have selected prior to its inclusion in reporting. Marital status changes and classifications may impact social and economic food decisions. A realistic time perspective would suggest that individuals may likely relate to more than one marital status over their life span.

The dominant limitation of this study is that it is not truly longitudinal nor does it sufficiently address life course influences. While the NHANES results can be analyzed over time, they do not follow the same participants or families. So, whereas cohort

groups can affectively be tracked, group composition will change through survey periods. Consequently, there is no way to truly access individual food intake patterns and life span events. The historical events identified in this dissertation study may exclude other historical and individual life events that have significantly altered food meanings and decisions.

Future Directions

Despite the limitations to using NHANES, this study is a spring board from which future studies can examine life span and life course food intake patterns. NHANES is an appropriate source of information related to macro- and micro-nutrient intake levels for a large number of diverse Americans. Until a true, life course, longitudinal study can be funded, NHANES can and should inform food intake researchers who, using life span and life course concepts, can determine age, period, and cohort changes.

Future exploration into food intake patterns among cohorts can be completed utilizing datasets from the Framingham Heart Study and the Nurses' Health Study. Both of these studies have followed cohorts over time and would provide an opportunity to conduct cross-cohort food intake comparisons. The Framingham Heart Study also includes familial cohorts which would provide insight into interpersonal level factors on food intake. This secondary data could be analyzed using this dissertation is research methods to determine age, period, and cohort food intake patterns. Cohort comparisons identified using these other established studies can be integrated with the results found using the NHANES data. In addition, the physical activity and disease indicators collected in the Framingham Heart Study and Nurses' Health Study can be compared to those same variables collected by NHANES.

Figures 7.1 and 7.2 (generated from total fat intake tables found in chapter 6) provide a visual representation in support of cohort and life course research design as well as the need for more than 50 years' worth of data to adequately capture the dynamics of life span nutrition changes. Figure 7.1 focuses on two birth cohorts, 1931-1940 and 1941-1950, compared to an age cross-section. While both indicate that overall total fat intake has declined across calendar time, there are differences in total fat intake between birth cohorts. Individuals aged 20-29 years in 1971 consumed more total fat than those aged 30 to 39 years supporting the theoretical notion that biological, social, psychological, historical, and environmental factors are at play in food intake.

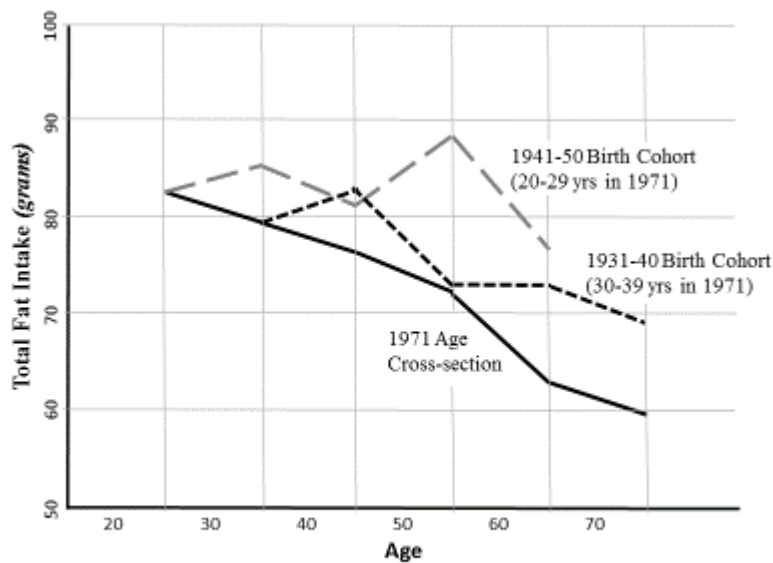


Figure 7.1 Comparison of 1971 age cross-section with selected cohort age changes: total fat intake

Figure 7.2 includes three birth cohorts, 1941, 1951, and 1961, across three comparison points at each age. The left three birth cohorts are those born in the mid-20th century and covers early to mid-adulthood. The three birth cohorts on the right are those born in the early 20th century between the World Wars and covers middle to late

adulthood. Similar to Figure 7.1, total fat intake has declined among individuals over calendar time with obvious differences. By following birth cohorts across chronological time, differences can be highlighted which reflect more realistic food intake patterns. In addition, socioecological, biological, environmental, and life span factors can be used to explain the variability.

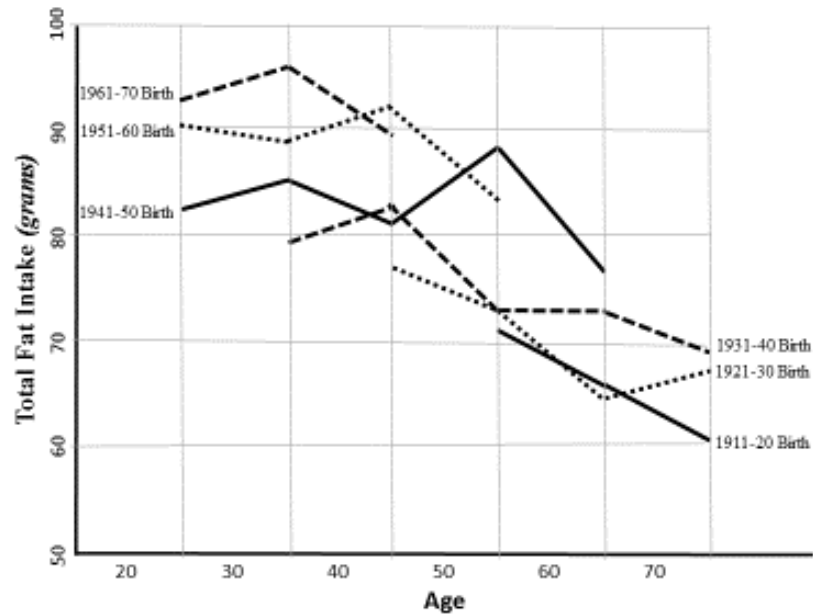


Figure 7.2 Cross-cohort age comparisons of total fat intake

With the foundational information reported by this study, future research can determine additional food intake associations to the presence of chronic disease. For example, NHANES collects data on the presence of disease for each individual and, in some cases, collects whether or not food intake is changed due to this disease. Future research could identify diseases that are most likely to modify food intake and disrupt intake patterns. Currently, psychosocial factors have been identified as disrupting food intake for a variety of chronic diseases like cancer, Type 1 diabetes, and kidney disease (Johansson, Hickson, & Brown, 2013; Luyckx, Berg, Bijttebier, Moons, & Weets, 2015;

Oberholzer et al., 2013; Walker, 2005). Combining quantitative measures with qualitative interviews will further inform how chronic disease impacts food intake and behavior. Does chronic disease impact food intake similarly regardless of age, period, or birth cohort?

Future studies could use NHANES open access regional data combined with the unavailable regional data to determine regional differences and patterns of food intake. Differences in food intake exist regionally depending on religion (Feeley-Harnik, 1995), gastronomy (Fischler, 1980), ethnic identity (D'Sylva & Beagan, 2011), and food symbolism (Jones, 2007). The regional areas of the United States likely express additional differences in population diversity. Through identification of cultural food influences on intake, health and food professionals working in those regions can improve patient centered care. In addition to regional food culture information, country of birth influences on food intake could be measured as another potential cultural factor. This would provide insight into the long term impact of native food culture on future food intake patterns. Comparing age and birth cohorts would further inform researchers as to the long term effects of food culture.

The impact of physical activity on food intake is an important factor to consider in future intake pattern studies. Physical activity participation changes throughout the life span based on socioecological factors (Bennett, 1998; Erkelenz et al., 2014; Hirvensalo & Lintunen, 2011; Lunn, 2010; Malina, 1996). NHANES does not consistently collect physical activity levels throughout all of the years included in this dissertation. However, the continuous NHANES data is more consistent and in the future, resting metabolic rates

(MET) could be used to determine physical activity compared to food intake patterns.

Age, period, and birth cohort differences in physical activity could be analyzed over time.

This dissertation study only focused on the macronutrients, without any consideration for subclasses within these three nutrients. Future studies could be done looking at age, period, and cohort differences of specific nutrients like saturated fat, cholesterol or fiber. These nutrients have been identified in multiple studies as playing a role in chronic disease development and management. In addition, future studies could look at individual vitamin and mineral intake over multiple time periods. Some extant studies focus on food groups (Block, 2004; Casagrande, Wang, Anderson, & Gary, 2007; Wright et al., 2007), but further research needs to be conducted to identify age, period, and cohort differences on specific nutrients.

Another opportunity for future NHANES database usage is to analyze changes in body mass index (BMI) over time. NHANES does not provide pre-calculated BMI throughout all surveys, however, it can be easily calculated in SAS using the provided heights and weights of each participant. Utilizing the research design of this dissertation study, changes in BMI can be compared among age and birth cohorts over time. An example of age differences in mean BMI across the five NHANES time periods is found in Table 7.1. In addition, these changes can be examined while controlling for the same population diversity included in this dissertation study. BMI could also be placed into categories of underweight, normal weight, overweight, and obese to calculate chi-square tests for the different diversity variables. Finally, the trends in BMI can be explained using the life course framework.

Societal changes that have occurred over the last twenty years due to technology may significantly disrupt currently observed food intake patterns. It is unclear how social modeling and eating will be impacted by programs like Facebook, Twitter, and Snapchat. How does social modeling normally evolve over the life span and how what impact will technology have on it in the future? Technological advances has provided new media and advertising outlets that impact our social structures and networks. How will these changes impact social modeling and even social eating? Will all of these changes in technology impact age groups in the same way?

*Table 7.1
Mean Body Mass Index by Age and Time Period*

Age Group	NHANES I	NHANES II	NHANES III	NHANES ^a	NHANES ^b
71-80	25.92	26.19	26.77	27.56	27.81
61-70	26.13	26.19	27.90	28.83	29.41
51-60	26.47	26.41	28.43	29.00	29.63
41-50	25.93	26.15	28.25	28.84	29.77
31-40	25.33	25.54	27.52	27.79	28.49
20 - 30	23.85	23.91	25.69	27.14	27.05

^aContinuous NHANES 2001-2002.

^bContinuous NHANES 2011-2012

With the expansion of data analyzed through quantitative methods, future studies could include qualitative techniques to determine historical events, social networks, and life span food intake changes. These individuals could be followed over time to determine true life course patterns in food intake. Inclusion of family members would also provide great insight into food behaviors. This true longitudinal study would need to be conducted throughout all regions of the United States and include individuals of all ethnicities and all socioecological levels.

Conclusion

This dissertation study paves the way for future studies examining food intake and behavior in the United States. A multidisciplinary approach, combined with a critical examination of time and life events, is the most informative method to utilize when examining food choice. Controlled studies indicate that metabolism of nutrients decreases from middle adulthood to late adulthood suggesting that total calorie requirements should be lower during the second half of life. Research also suggests that biological cues of hunger, satiety, and sensory perception decline with advancing chronological age. However, based on evidence from NHANES data used in this study indicates remarkable variability from what is biologically necessary.

Age and time influences food intake more than what is currently presented by nutrition researchers. Psychosocial and environmental forces may also explain the observed variability. Understanding why nutrition changes, by age and over calendar time, is important for assessing, not just the United States population's general health status, but the affective implementation and assessment of any nutrition service or intervention. Necessary understanding of change requires more nuanced and critical treatments of time than has so far been employed in research. In order to improve the health status of Americans by reducing obesity and physical inactivity, researchers and health professionals should eliminate silo thinking and incorporate more multidisciplinary, life course thinking.

APPENDIX A: NHANES VARIABLES

	NHANES I (1971- 1974)	NHANES II (1976- 1980)	NHANES III (1988- 1994)	NHANES 2001-2002	NHANES 2011-2012
Age	N1DR0034	N2DR0047	HSAGEIR	RIDAGEYR	RIDAGEYR
Sex	N1DR0104	N2DR0055	HSSEX	RIAGENDR	RIAGENDR
Race/Ethnicity	N1DR0103	N2DR0056	DMARETHN	RIDRETH1	RIDRETH1
Marital Status	N1DR0105	N2DR0259			DMDMARTL
Highest Grade of School	N1DR0112	N2DR0062	HFA8R		DMDEDUC2
Weight (lb)	N1BM0255	N2BM0407			
Height (in)	N1BM0270	N2BM0422			
Health Status	N1GM0340	N2AH0426	HAB1	HSD010	HSD010
METS				PADMETS	PADMETS
BMI			BMPBMI	BMXBMI	BMXBMI
Calories	N1DR0246	N2DR0376	NCPNKCAL	DRXTKCAL	DRITKCAL
Total Protein	N1DR0254	N2DR0384	NCPNPROT	DRXTPROT	DRITPROT
Total CHO	N1DR0270	N2DR0400	NCPNCARB	DRXTCARB	DRITCARB
Total Fiber	N1DR0278		NCPNFIBE	DRXTFIBE	DRITFIBE
Total Fat	N1DR0262	N2DR0392	NCPNTFAT	DRXTTFAT	DRITTFAT
Percent kcal from fat			NCPNKF		
Percent kcal from pro			NCPNKP		
Percent kcal from CHO			NCPNKC		

APPENDIX B: SAS CODES

NHANES data sets can be analyzed using multiple approaches. What follows are the chief codes used to generate macronutrient and total calorie intake for individuals at different age levels and birth cohorts. Food intake and total calorie was also compared while controlling for individual characteristics. The results based on the code included in this appendix were primarily used to generate the tables found in chapter six. This code can be used to aid future researchers building upon what is reported in this study. It should be noted that not all code is included below due to the enormity of code used to organize NHANES data.

NHANES I

```
proc sort data=d_4111;
by seqn;
run;
```

```
proc sort data=d_4704;
by seqn;
run;
```

```
proc sort data=d_4091;
by seqn;
run;
```

```
proc sort data=d_4703;
by N1NC0001;
run;
```

```
proc sort data=d_4151;
by seqn;
run;
```

```
proc sort data=d_4701;
by seqn;
run;
```

```
data "C:\NHANES\Data\NHANESI";
merge D_4111 D_4704 d_4091 d_4703 (rename=(n1NC0001=seqn)) d_4701;
by seqn;
run;
```

```
data NHANESI;
set D_4111 D_4704 d_4091 d_4703 (rename=(n1NC0001=seqn)) d_4701;
keep N1GM0340 N1DR0254 N1DR0262 N1DR0270 N1DR0278 N1DR0246 N1DR0034 N1DR0101
N1BM0101 N1GM0101 N1DR0103
```

```

N1DR0104 N1DR0105 N1DR0112 N1BM0104 N1BM0105 N1BM0112 N1BM0255 N1BM0270
AGEGROUP N1FF0328 N1FF0336
N1FF0344 N1FF0352 N1FF0112 N1FF0103 N1FF0104 N1FF0105 PROTEIN FAT CARBS CALORIES
N1BM0147 bmigroup POVERTY grade
bmi weight height percentfat percentpro percentcarb;
if N1DR0101 ge 20 & N1DR0101 le 30 then agegroup=1;
if N1DR0101 ge 31 & N1DR0101 le 40 then agegroup=2;
if N1DR0101 ge 41 & N1DR0101 le 50 then agegroup=3;
if N1DR0101 ge 51 & N1DR0101 le 60 then agegroup=4;
if N1DR0101 ge 61 & N1DR0101 le 70 then agegroup=5;
if N1DR0101 ge 71 & N1DR0101 le 80 then agegroup=6;
if N1DR0101 ge 81 then agegroup=7;
if N1BM0101 ge 20 & N1BM0101 le 30 then agegroup=1;
if N1BM0101 ge 31 & N1BM0101 le 40 then agegroup=2;
if N1BM0101 ge 41 & N1BM0101 le 50 then agegroup=3;
if N1BM0101 ge 51 & N1BM0101 le 60 then agegroup=4;
if N1BM0101 ge 61 & N1BM0101 le 70 then agegroup=5;
if N1BM0101 ge 71 & N1BM0101 le 80 then agegroup=6;
if N1BM0101 ge 81 then agegroup=7;
if N1GM0101 ge 20 & N1GM0101 le 30 then agegroup=1;
if N1GM0101 ge 31 & N1GM0101 le 40 then agegroup=2;
if N1GM0101 ge 41 & N1GM0101 le 50 then agegroup=3;
if N1GM0101 ge 51 & N1GM0101 le 60 then agegroup=4;
if N1GM0101 ge 61 & N1GM0101 le 70 then agegroup=5;
if N1GM0101 ge 71 & N1GM0101 le 80 then agegroup=6;
if N1GM0101 ge 81 then agegroup=7;
if N1FF0101 ge 20 & N1FF0101 le 30 then agegroup=1;
if N1FF0101 ge 31 & N1FF0101 le 40 then agegroup=2;
if N1FF0101 ge 41 & N1FF0101 le 50 then agegroup=3;
if N1FF0101 ge 51 & N1FF0101 le 60 then agegroup=4;
if N1FF0101 ge 61 & N1FF0101 le 70 then agegroup=5;
if N1FF0101 ge 71 & N1FF0101 le 80 then agegroup=6;
if N1FF0101 ge 81 then agegroup=7;
if N1FF0328 =9999999 then N1FF0328 =.;
if N1FF0336 =9999999 then N1FF0336 =.;
if N1FF0344 =9999999 then N1FF0344 =.;
if N1FF0352 =9999999 then N1FF0352 =.;
/*if want >100 calorie etc then if n1dr0246 =9999999 | n1dr0246 lt 100 then n1dr0246 =.*/
IF N1BM0147 =999 THEN N1BM0147 =.;
Poverty0 = (n1bm0147/100);
IF Poverty0 le 0.05 THEN POVERTY = 1;
IF Poverty0 gt 0.05 & poverty0 le 1.00 THEN POVERTY = 2;
if poverty0 gt 1.00 & poverty0 le 1.25 then poverty = 3;
if poverty0 gt 1.25 & poverty0 le 2.5 then poverty = 4;
if poverty0 gt 2.5 then poverty = 5;
protein =(N1FF0336/100);
fat =(N1FF0344/100);
carbs =(N1FF0352/100);
calories =(N1FF0328/100);
if n1dr0034 =88 then n1dr0034 =.;
if n1dr0112 =88 | n1dr0112 =99 | n1dr0112 =77 then n1dr0112 =.;
if n1ff0105 =8 then n1ff0105 =.;
if n1ff0122 =88 | n1ff0122 = 99 then n1ff0122 =.;
weight =(n1bm0255/100);
height =(n1bm0270/10);
bmi =(weight/(height**2))*703;

```



```

percentfat =((N1DR0262*9)/N1DR0246)*100;
percentpro =((N1DR0254*4)/N1DR0246)*100;
percentcarb =((N1DR0270*4)/N1DR0246)*100;
if bmi lt 18.5 then bmgrou=1;
if bmi ge 18.5 & bmi lt 25 then bmgrou=2;
if bmi ge 25 & bmi lt 30 then bmgrou=3;
if bmi ge 30 then bmgrou=4;
if n1ff0112 eq 21 | n1ff0112 eq 22 | n1ff0112 eq 23 | n1ff0112 eq 24 | n1ff0112 eq 25
| n1ff0112 eq 26 | n1ff0112 eq 27 | n1ff0112 eq 28 | n1ff0112 eq 29 | n1ff0112 eq 30 | n1ff0112 eq 31 |
n1ff0112 eq 32 | n1ff0112 eq 33 then grade = 1;
if n1ff0112 eq 34 then grade = 2;
if n1ff0112 eq 41 | n1ff0112 eq 42 | n1ff0112 eq 43 | n1ff0112 eq 44 | n1ff0112 eq 45 then grade = 3;
run;

```

```

PROC SORT DATA=NHANESI;
BY AGEGROUP;
RUN;

```

```

proc freq data=NHANESI;
  tables n1bm0255;
  tables weight;
run;

```

```

ods rtf file="C:\NHANES\Data\NHANESIMEANS3.15.rtf";
PROC MEANS DATA=NHANESI;
BY AGEGROUP;
VAR N1GM0340 N1DR0101 N1BM0101 N1GM0101 N1DR0103
N1DR0104 N1DR0105 N1DR0112 percentfat percentpro percentcarb bmi
CARBS PROTEIN FAT CALORIES n1bm0147 grade poverty height weight;
RUN;
ods rtf close;

```

```

ods rtf file="C:\NHANES\Data\NHANESIMEANS3.11.rtf";
PROC MEANS DATA=NHANESI;
BY AGEGROUP;
VAR N1GM0340 N1DR0254 N1DR0262 N1DR0270 N1DR0278 N1DR0246 N1DR0034 N1DR0101
N1BM0101 N1GM0101 N1DR0103
N1DR0104 N1DR0105 N1DR0112 N1BM0255 N1BM0270 percentfat percentpro percentcarb bmi
N1FF0328 N1FF0336 N1FF0344 N1FF0352 CARBS PROTEIN FAT CALORIES n1bm0147 grade;
RUN;
ods rtf close;

```

```

ods rtf file="C:\NHANES\Data\NHANESIfreq3.rtf";
proc freq data=NHANESI;
by AGEGROUP;
tables N1DR0104 /out=sex;
tables N1DR0103 /out=ethnicity;
tables N1DR0105 /out=marital_status;
tables N1DR0112 /out=grade_level;
tables N1DR0034/out=income_level;
tables N1GM0340 /out=health_status;
tables poverty /out=poverty;
tables grade /out=gradelevel;
run;
ods rtf close;

```

```

ods csv file="C:\NHANES\Data\NHANESIdemo.csv";
proc print data=gender;
run;
proc print data=ethnicity;
run;
proc print data=income_level;
run;
proc print data=health_status;
run;
proc print data=grade_level;
run;
proc print data=marital_status;
run;
proc print data=gradelevel;
run;
proc print data=poverty;
run;
ods csv close;

proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var CALORIES;
output out=kcal mean=meankcal mode=modekcal stddev=stdkcal;
run;
ods csv file="C:\NHANES\Data\NHANESIkcal12.1.15mean.csv";
proc print data=kcal;
run;
ods csv close;

proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var PROTEIN;
output out=PROT mean=meanprot mode=modeprot stddev=stdprot;
run;
ods csv file="C:\NHANES\Data\NHANESIprot12.1.15mean.csv";
proc print data=prot;
run;
ods csv close;

proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var carbs;
output out=carb mean=meancarb mode=modecarb stddev=stdcarb;
run;
ods csv file="C:\NHANES\Data\NHANESIcarb12.1.15mean.csv";
proc print data=carb;
run;
ods csv close;

proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var fat;
output out=fat mean=meanfat mode=modefat stddev=stdfat;
run;
ods csv file="C:\NHANES\Data\NHANESIfat12.1.15mean.csv";

```

```
proc print data=fat;  
run;  
ods csv close;
```

```
proc means data=NHANESI mean mode stddev;  
by AGEGROUP;  
var N1DR0278;  
output out=FIB mean=MEANFIB mode=MODEFIB stddev=STDFIB;  
run;  
ods csv file="C:\NHANES\Data\NHANESIfibmean.csv";  
proc print data=FIB;  
run;  
ods csv close;
```

```
proc freq data=NHANESI;  
tables agegroup*bmi/ norow nopercnt chisq;  
run;
```

```
ods rtf file="C:\NHANES\Data\GLM.AGE.demo.KCAL.4.2016.rtf";  
proc glm data=NHANESI;  
class agegroup n1dr0105 grade n1dr0104 n1gm0340 poverty;  
model calories=agegroup n1dr0105 grade n1dr0104 n1gm0340 poverty/ss3;  
lsmeans agegroup n1dr0105 grade n1dr0104 n1gm0340 poverty/ pdiff stderr;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.AGE.demo.KCAL.3.2016.rtf";  
proc glm data=NHANESI;  
class agegroup grade ;  
model calories=agegroup grade /ss3;  
lsmeans agegroup grade / pdiff stderr;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.AGE.demo.pro.3.16.rtf";  
proc glm data=NHANESI;  
class agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY;  
model PROTEIN=agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ss3;  
lsmeans agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ pdiff stderr;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.AGE.demo.CARB.3.16.rtf";  
proc glm data=NHANESI;  
class agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY;  
model CARBS=agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ss3;  
lsmeans agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ pdiff stderr;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.AGE.demo.FAT.3.16.rtf";  
proc glm data=NHANESI;  
class agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY;  
model FAT=agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ss3;  
lsmeans agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ pdiff stderr;  
run;
```

```

ods rtf close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.KCAL.3.16.rtf";
proc glm data=NHANESI;
class agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY;
model CALORIES=agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ss3;
lsmeans agegroup n1ff0105 GRADE n1ff0103 n1ff0104 POVERTY/ pdiff stderr;
run;
ods rtf close;

proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var N1DR0254;
output out=PRO mean=MEANPRO mode=MODEPRO stddev=STDPRO;
run;
ods csv file="C:\NHANES\Data\NHANESIpromean11.30.15.csv";
proc print data=PRO;
run;
ods csv close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.fat.12.2.15.rtf";
proc glm data=NHANESI;
class agegroup n1ff0105 n1ff0112 n1ff0103 n1ff0104;
model fat=agegroup n1ff0105 n1ff0112 n1ff0103 n1ff0104/ss3;
lsmeans agegroup n1ff0105 n1ff0112 n1ff0103 n1ff0104/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.carb.12.2.15.rtf";
proc glm data=NHANESI;
class agegroup n1ff0105 n1ff0112 n1ff0103 n1ff0104;
model carbs=agegroup n1ff0105 n1ff0112 n1ff0103 n1ff0104/ss3;
lsmeans agegroup n1ff0105 n1ff0112 n1ff0103 n1ff0104/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.healthstatusI.rtf";
proc freq data=nhanesI;
table agegroup*N1GM0340/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.INCOMEI.rtf";
proc freq data=nhanesI;
table agegroup*N1DR0034/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.RACEI.rtf";
proc freq data=nhanesI;
table agegroup*N1DR0103/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.SEXI.rtf";
proc freq data=nhanesI;

```

```
table agegroup*N1DR0104/ norow nopercnt chisq;
run;
ods rtf close;
```

NHANES II

```
proc sort data=d_5020;
by seqn;
run;
```

```
proc sort data=d_5701;
by seqn;
run;
```

```
proc sort data=d_5317;
by seqn;
run;
```

```
data "C:\NHANES\Data\NHANESII";
merge d_5301 d_5020 d_5701 d_5317;
by seqn;
run;
```

```
proc contents data="C:\NHANES\Data\NHANESII";
run;
```

```
data NHANESII;
set d_5301 d_5020 d_5701 d_5317;
keep N2BM0407 N2BM0422 N2AH0426 N2DR0047 N2BM0047 N2AH0047 N2BQ0047 N2DR0055
N2DR0056 N2DR0062 N2DR0188
N2DR0259 N2DR0376 N2DR0384 N2DR0392 N2DR0400 N2BQ0433 N2BQ0434 N2BQ0435
N2BQ0437 N2BM0107 PROTEIN FAT CARBS CALORIES BMI
N2BQ0436 N2BQ0438 N2BQ0439 AGEGROUP PERCENTFAT PERCENTPRO PERCENTCARB
BMIGROUP POVERTY GRADE WEIGHT HEIGHT;
if N2DR0047 ge 20 & N2DR0047 le 30 then agegroup=1;
if N2DR0047 ge 31 & N2DR0047 le 40 then agegroup=2;
if N2DR0047 ge 41 & N2DR0047 le 50 then agegroup=3;
if N2DR0047 ge 51 & N2DR0047 le 60 then agegroup=4;
if N2DR0047 ge 61 & N2DR0047 le 70 then agegroup=5;
if N2DR0047 ge 71 & N2DR0047 le 80 then agegroup=6;
if N2DR0047 ge 81 then agegroup=7;
if N2BM0047 ge 20 & N2BM0047 le 30 then agegroup=1;
if N2BM0047 ge 31 & N2BM0047 le 40 then agegroup=2;
if N2BM0047 ge 41 & N2BM0047 le 50 then agegroup=3;
if N2BM0047 ge 51 & N2BM0047 le 60 then agegroup=4;
if N2BM0047 ge 61 & N2BM0047 le 70 then agegroup=5;
if N2BM0047 ge 71 & N2BM0047 le 80 then agegroup=6;
if N2BM0047 ge 81 then agegroup=7;
if N2AH0047 ge 20 & N2AH0047 le 30 then agegroup=1;
if N2AH0047 ge 31 & N2AH0047 le 40 then agegroup=2;
if N2AH0047 ge 41 & N2AH0047 le 50 then agegroup=3;
if N2AH0047 ge 51 & N2AH0047 le 60 then agegroup=4;
if N2AH0047 ge 61 & N2AH0047 le 70 then agegroup=5;
if N2AH0047 ge 71 & N2AH0047 le 80 then agegroup=6;
if N2AH0047 ge 81 then agegroup=7;
if N2BQ0047 ge 20 & N2BQ0047 le 30 then agegroup=1;
```

```

if N2BQ0047 ge 31 & N2BQ0047 le 40 then agegroup=2;
if N2BQ0047 ge 41 & N2BQ0047 le 50 then agegroup=3;
if N2BQ0047 ge 51 & N2BQ0047 le 60 then agegroup=4;
if N2BQ0047 ge 61 & N2BQ0047 le 70 then agegroup=5;
if N2BQ0047 ge 71 & N2BQ0047 le 80 then agegroup=6;
if N2BQ0047 ge 81 then agegroup=7;
if N2DR0062 =88 then N2DR0062 =.;
if N2DR0259 =88 then N2DR0259 =.;
if N2AH0426 =8 then N2AH0426 = .;
if N2DR0210 =999 THEN N2DR0210 = .;
Poverty0 = (N2DR0210/100);
IF Poverty0 le 0.05 THEN POVERTY = 1;
IF Poverty0 gt 0.05 & poverty0 le 1.00 THEN POVERTY = 2;
if poverty0 gt 1.00 & poverty0 le 1.25 then poverty = 3;
if poverty0 gt 1.25 & poverty0 le 2.5 then poverty = 4;
if poverty0 gt 2.5 then poverty = 5;
protein =N2DR0384/100;
fat =N2DR0392/100;
carbs =N2DR0400/100;
calories =N2DR0376/100;
weight =N2BM0407/100;
height =N2BM0422/10;
bmi =(weight/(height**2))*703;
percentfat =((fat*9)/calories)*100;
percentpro =((protein*4)/calories)*100;
percentcarb =((carbs*4)/calories)*100;
if bmi lt 18.5 then bmgroupe=1;
if bmi ge 18.5 & bmi lt 25 then bmgroupe=2;
if bmi ge 25 & bmi lt 30 then bmgroupe=3;
if bmi ge 30 then bmgroupe=4;
if N2DR0062 eq 21 | N2DR0062 eq 22 | N2DR0062 eq 23 | N2DR0062 eq 24 | N2DR0062 eq 25
| N2DR0062 eq 26 | N2DR0062 eq 27 | N2DR0062 eq 28 | N2DR0062 eq 31 | N2DR0062 eq 32 |
N2DR0062 eq 33 then grade = 1;
if N2DR0062 eq 34 then grade = 2;
if N2DR0062 eq 41 | N2DR0062 eq 42 | N2DR0062 eq 43 | N2DR0062 eq 44 | N2DR0062 eq 45 then
grade = 3;
run;

```

```

PROC SORT DATA=NHANESII;
BY AGEGROUP;
RUN;

```

```

ods rtf file="C:\NHANES\Data\NHANESIIMEANS3.15.rtf";
PROC MEANS DATA=NHANESII;
BY AGEGROUP;
VAR N2AH0426 N2DR0047 N2BM0047 N2AH0047 N2BQ0047 N2DR0055 N2DR0056 N2DR0062
N2DR0259 N2BQ0437 PROTEIN FAT CALORIES CARBS BMI HEIGHT WEIGHT
N2BQ0436 N2BQ0438 N2BQ0439 AGEGROUP PERCENTFAT PERCENTPRO PERCENTCARB
GRADE POVERTY;
RUN;
ods rtf close;

```

```

ods rtf file="C:\NHANES\Data\NHANESIIMEANS11.30.15.rtf";
PROC MEANS DATA=NHANESII;
BY AGEGROUP;

```

```
VAR N2BM0407 N2BM0422 N2AH0426 N2DR0047 N2BM0047 N2AH0047 N2BQ0047 N2DR0055  
N2DR0056 N2DR0062 N2DR0188  
N2DR0259 N2DR0376 N2DR0384 N2DR0392 N2DR0400 PROTEIN FAT CALORIES CARBS BMI  
AGEGROUP PERCENTFAT PERCENTPRO PERCENTCARB GRADE POVERTY;
```

```
RUN;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\NHANESIIfreq3.15.rtf";  
proc freq data=NHANESII;  
by AGEGROUP;  
tables N2DR0055 /out=gender;  
tables N2DR0056 /out=ethnicity;  
tables N2DR0259 /out=marital_status;  
tables N2DR0062 /out=grade_level;  
tables N2AH0426 /out=health_status;  
TABLES N2BM0107 /OUT=income;  
TABLES POVERTY /OUT=POVERTY;  
TABLES GRADE /OUT=GRADE;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\NHANESIIbmifreq.rtf";  
proc freq data=NHANESII;  
by agegroup;  
tables bmigroup /out=bmi;  
run;  
ods rtf close;
```

```
ods csv file="C:\NHANES\Data\NHANESIIdemo.csv";  
proc print data=gender;  
run;  
proc print data=ethnicity;  
run;  
proc print data=health_status;  
run;  
proc print data=grade_level;  
run;  
proc print data=marital_status;  
run;  
ods csv close;
```

```
proc means data=NHANESII mean mode stddev;  
by AGEGROUP;  
var CALORIES;  
output out=kcal mean=meankcal mode=modekcal stddev=stdkcal;  
run;  
ods csv file="C:\NHANES\Data\NHANESIIkcalmean.csv";  
proc print data=kcal;  
run;  
ods csv close;
```

```
ods rtf file="C:\NHANES\chisq.age.healthstatus.rtf";  
proc freq data=nhanesii;  
table agegroupc*n2ah0426/ norow nopercent chisq;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\chisq.age.maritalstatus.rtf";
proc freq data=nhanesii;
table agegroup*n2dr0259/ norow nopercnt chisq;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\chisq.age.grade1976.rtf";
proc freq data=nhanesii;
table agegroup*n2dr0062/ norow nopercnt chisq;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\chisq.age.gender1976.rtf";
proc freq data=nhanesii;
table agegroup*n2dr0055/ norow nopercnt chisq;
run;
ods rtf close;
```

```
ods rtf file="C:\nhanes\glm.age1976.kcal.rtf";
proc glm data=nhanesii;
class agegroup n2dr0055 n2dr0056;
model n2dr0376=agegroup n2dr0055 n2dr0056/ss3;
lsmeans agegroup n2dr0055 n2dr0056/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\nhanes\glm.age1976.kcal.3.15rtf";
proc glm data=nhanesii;
class agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259;
model n2dr0376=agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ss3;
lsmeans agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ pdiff stderr;
run;
ods rtf close;
```

```
proc means data=NHANESII mean mode stddev;
by AGEGROUP;
var carbs;
output out=carb mean=meancarb mode=modecarb stddev=stdcarb;
run;
ods csv file="C:\NHANES\Data\NHANESIIcarbmean.csv";
proc print data=carb;
run;
ods csv close;
```

```
PROC SORT DATA=NHANESII;
BY AGEGROUP N2DR0188;
RUN;
```

```
proc means data=NHANESII mean mode stddev;
by AGEGROUP N2DR0188;
var protein;
output out=pro mean=meanpro mode=modepro stddev=stdpro;
run;
ods csv file="C:\NHANES\Data\NHANESIIpromean.csv";
proc print data=pro;
```



```

run;
ods csv close;

proc means data=NHANESII mean mode stddev;
by AGEGROUP N2DR0188;
var carbs;
output out=carb mean=meancarb mode=modecarb stddev=stdcarb;
run;
ods csv file="C:\NHANES\Data\NHANESIIcarbmeanYEAR.csv";
proc print data=carb;
run;
ods csv close;

proc means data=NHANESII mean mode stddev;
by AGEGROUP N2DR0188;
var FAT;
output out=FAT mean=meanFAT mode=modeFAT stddev=stdFAT;
run;
ods csv file="C:\NHANES\Data\NHANESIIFATmean.csv";
proc print data=FAT;
run;
ods csv close;

proc means data=NHANESII mean mode stddev;
by AGEGROUP N2DR0188;
var carbs;
output out=carb mean=meancarb mode=modecarb stddev=stdcarb;
run;
ods csv file="C:\NHANES\Data\NHANESIIcarbmeanYEAR.csv";
proc print data=carb;
run;
ods csv close;

ods rtf file="C:\nhanes\glm.ageNHANESII.kcal.rtf";
proc glm data=nhanesii;
class agegroup n2dr0055 n2dr0056 N2DR0062 N2DR0259;
model CALORIES=agegroup n2dr0055 n2dr0056 N2DR0062 N2DR0259/ss3;
lsmeans agegroup n2dr0055 n2dr0056 N2DR0062 N2DR0259/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\nhanes\glm.ageNHANESII.CARBS2.rtf";
proc glm data=nhanesii;
class agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259;
model CARBS=agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ss3;
lsmeans agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\nhanes\glm.ageNHANESII.PRO2.rtf";
proc glm data=nhanesii;
class agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259;
model PROTEIN=agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ss3;
lsmeans agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ pdiff stderr;
run;
ods rtf close;

```

```
ods rtf file="C:\nhanes\glm.ageNHANESII.FAT2.rtf";
proc glm data=nhanesii;
class agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259;
model FAT=agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ss3;
lsmeans agegroup n2dr0055 n2dr0056 GRADE POVERTY N2DR0259/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="\\Client\C$\nhanes\KCAL.gender.NHANESII.rtf";
proc freq data=NHANESII;
tables N2DR0055*CALORIES/ norow nopercnt chisq;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\NHANESIIfreqYEAR11.30.15.rtf";
proc freq data=NHANESII;
by AGEGROUP N2DR0188;
tables N2DR0055 /out=gender;
tables N2DR0056 /out=ethnicity;
tables N2DR0259 /out=marital_status;
tables N2DR0062 /out=grade_level;
tables N2AH0426 /out=health_status;
TABLES N2BM0107 /OUT=income;
run;
ods rtf close;
```

NHANES III

```
proc sort data=work;
  by seqn;
  run;

  proc sort data=nutrient;
  by seqn;
  run;

  proc sort data=exam;
  by seqn;
  run;
```

```
PROC SORT DATA=EXAM;
  BY SEQN;
RUN;
```

```
PROC SORT DATA=EXAMDR;
  BY SEQN;
RUN;
```

```
DATA EXAM2;
  MERGE EXAM(DROP=DRP:)
  NUTRIENT;
  BY SEQN;
RUN;
```

```
PROC CONTENTS DATA=WORK;
```

```

RUN;

proc contents data=exam2;
run;

data "C:\NHANES\Data\NHANESIII";
merge work EXAM2;
by seqn;
run;

PROC SORT DATA=EXAM2;
BY SEQN;
RUN;

data NHANESIII;
set exam2 work;
keep DMARETHN HSSEX HSAGEIR DRPNKCAL DRPNPROT DRPNTFAT DRPNCARB DRPNFIBE
NCPNKF WTPFqX6
NCPNKP NCPNKC BMPBMI AGEGROUP SEQN HFA8R HFF18 HAB1 HFA12 HFF19R BMIGROUP
DMPPIR GRADE POVERTY;
if HSAGEIR ge 20 & HSAGEIR le 30 then agegroup=1;
if HSAGEIR ge 31 & HSAGEIR le 40 then agegroup=2;
if HSAGEIR ge 41 & HSAGEIR le 50 then agegroup=3;
if HSAGEIR ge 51 & HSAGEIR le 60 then agegroup=4;
if HSAGEIR ge 61 & HSAGEIR le 70 then agegroup=5;
if HSAGEIR ge 71 & HSAGEIR le 80 then agegroup=6;
if HSAGEIR ge 81 then agegroup=7;
/*if want >100 calorie etc then if n1dr0246 =99999999 | n1dr0246 lt 100 then n1dr0246 =.*/
if BMPBMI =8888 then BMPBMI =.;
IF DMPPIR =888888 THEN DMPPIR =.;
if drpnkcal =88888 then drpnkcal =.;
if drpnprot =888888 then drpnprot =.;
if drpntfat =888888 then drpntfat =.;
if drpncarb =888888 then drpncarb =.;
if drpnfibe =88888 then drpnfibe =.;
if ncpnkf =88888 then ncpnkf =.;
if ncpnkp =88888 then ncpnkp =.;
if ncpnkc =88888 then ncpnkc =.;
if HFA8R = 88 | HFA8R = 99 then HFA8R =.;
if HFF18 = 8 | HFF18 = 9 then HFF18 =.;
if HAB1 = 8 | HAB1 = 9 then HAB1 =.;
if BMPBMI lt 18.5 then bmigroup=1;
if BMPBMI ge 18.5 & BMPBMI lt 25 then bmigroup=2;
if BMPBMI ge 25 & BMPBMI lt 30 then bmigroup=3;
if BMPBMI ge 30 then bmigroup=4;
IF DMPPIR le 0.05 THEN POVERTY = 1;
IF DMPPIR gt 0.05 & DMPPIR le 1.00 THEN POVERTY = 2;
if DMPPIR gt 1.00 & DMPPIR le 1.25 then poverty = 3;
if DMPPIR gt 1.25 & DMPPIR le 2.5 then poverty = 4;
if DMPPIR gt 2.5 then poverty = 5;
if HFA8R eq 1 | HFA8R eq 2 | HFA8R eq 3 | HFA8R eq 4 | HFA8R eq 5 | HFA8R EQ 6 | HFA8R EQ 7 |
HFA8R EQ 8
| HFA8R eq 9 | HFA8R eq 10 | HFA8R eq 11 then grade = 1;
if HFA8R eq 12 then grade = 2;
if HFA8R eq 13 | HFA8R eq 14 | HFA8R eq 15 | HFA8R eq 16 | HFA8R eq 17 then grade = 3;
run;

```

```

PROC SORT DATA=NHANESIII;
BY AGEGROUP;
RUN;

```

```

PROC CONTENTS DATA=NHANESIII;
RUN;

```

```

ods rtf file="C:\NHANES\Data\NHANESIII MEANS.3.16.rtf";
PROC MEANS DATA=NHANESIII;
BY AGEGROUP;
VAR DMARETHN HSSEX HSAGEIR DRPNKCAL DRPNPROT DRPNTFAT DRPNCARB
DRPNFIBE NCPNKF
NCPNKP WTPFqX6 NCPNKC BMPBMI HFA8R HFF18 HAB1 HFA12 HFF19R BMIGROUP DMPPIR
POVERTY GRADE;
RUN;
ods rtf close;

```

```

data NHANESIIIb;
set work;
keep DMARETHN HSSEX HSAGEIR HFA8R HFF18 HAB1 AGEGROUP SEQN;
if HSAGEIR ge 20 & HSAGEIR le 30 then agegroup=1;
if HSAGEIR ge 31 & HSAGEIR le 40 then agegroup=2;
if HSAGEIR ge 41 & HSAGEIR le 50 then agegroup=3;
if HSAGEIR ge 51 & HSAGEIR le 60 then agegroup=4;
if HSAGEIR ge 61 & HSAGEIR le 70 then agegroup=5;
if HSAGEIR ge 71 & HSAGEIR le 80 then agegroup=6;
if HSAGEIR ge 81 then agegroup=7;
/*if want >100 calorie etc then if n1dr0246 =99999999 | n1dr0246 lt 100 then n1dr0246 =.;*/
if HFA8R =88 | HFA8R = 99 then NFA8R =.;
if HFF18 =8 | HFF18 = 9 then HFF18 =.;
if HAB1 =8 | HAB1 = 9 then HAB1 = .;
run;

```

```

proc sort data=NHANESIII;
by agegroup seqn;
run;

```

```

ods rtf file="C:\NHANES\Data\NHANESIIIbMEANS.rtf";
PROC MEANS DATA=NHANESIII;
BY AGEGROUP;
VAR DMARETHN HSSEX HSAGEIR HFA8R HFF18 HAB1;
RUN;
ods rtf close;

```

```

ods rtf file="C:\NHANES\Data\NHANESIIIfreqDEMOC.rtf";
proc freq data=NHANESIII;
by AGEGROUP;
tables HSSEX /out=gender;
tables DMARETHN /out=ethnicity;
tables HFA8R /out=grade_level;
tables HAB1 /out=health_status;
TABLES HFF19R /OUT=income;
TABLES HFA12 /OUT=MARITAL;
TABLES POVERTY /OUT=POVERTY;
TABLES GRADE /OUT=GRADE;

```

```

run;
ods rtf close;

ods rtf file="C:\NHANES\Data\NHANESIIIfreqbmi.rtf";
proc freq data=NHANESIII;
by agegroup;
tables bmigroup /out=bmi;
run;
ods rtf close;

ods csv file="C:\NHANES\Data\NHANESIIIdemoB.csv";
proc print data=gender;
run;
proc print data=ethnicity;
run;
proc print data=health_status;
run;
proc print data=grade_level;
run;
ods csv close;

proc means data=NHANESIII mean mode stddev;
by AGEGROUP;
var DRPNKCAL;
output out=kcal mean=meankcal mode=modekcal stddev=stdkcal;
run;
ods csv file="C:\NHANES\Data\NHANESIIIkcalmean.csv";
proc print data=kcal;
run;
ods csv close;

ods rtf file="C:\NHANES\chisq.age.healthstatusIII.rtf";
proc freq data=nhanesIIIb;
table agegroup*HAB1/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.KCAL.III.1.13.16.rtf";
proc glm data=NHANESIII;
class agegroup DMARETHN HSSEX HFA8R HFF19R HFA12 HAB1;
model DRPNKCAL=agegroup DMARETHN HSSEX HFA8R HFF19R HFA12 HAB1/ss3;
lsmeans agegroup DMARETHN HSSEX HFA8R HFF19R HFA12 HAB1/ pdiff stderr;
run;
ods rtf close;
/*Last three variables aren't working. Keeps saying that they have no values*/

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.KCAL.III.3.16.rtf";
proc glm data=NHANESIII;
class agegroup DMARETHN HSSEX POVERTY;
model DRPNKCAL=agegroup DMARETHN HSSEX POVERTY/ss3;
lsmeans agegroup DMARETHN HSSEX POVERTY/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.PRO.III.3.16.rtf";
proc glm data=NHANESIII;

```

```

class agegroup DMARETHN HSSEX POVERTY;
model DRPNPROT=agegroup DMARETHN HSSEX POVERTY/ss3;
lsmeans agegroup DMARETHN HSSEX POVERTY/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.FAT.III.3.16.rtf";
proc glm data=NHANESIII;
class agegroup DMARETHN HSSEX POVERTY;
model DRPNFAT=agegroup DMARETHN HSSEX POVERTY/ss3;
lsmeans agegroup DMARETHN HSSEX POVERTY/ pdiff stderr;
run;
ods rtf close;

ods rtf file="C:\NHANES\Data\GLM.AGE.demo.CARB.III.3.16.rtf";
proc glm data=NHANESIII;
class agegroup DMARETHN HSSEX POVERTY;
model DRPNCARB=agegroup DMARETHN HSSEX POVERTY/ss3;
lsmeans agegroup DMARETHN HSSEX POVERTY/ pdiff stderr;
run;
ods rtf close;

proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var N1DR0254;
output out=PRO mean=MEANPRO mode=MODEPRO stddev=STDPRO;
run;
ods csv file="C:\NHANES\Data\NHANESIpromean11.30.15.csv";
proc print data=PRO;
run;
ods csv close;

ods rtf file="C:\NHANES\chisq.age.healthstatusI.rtf";
proc freq data=nhanesI;
table agegroup*N1GM0340/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.INCOMEI.rtf";
proc freq data=nhanesI;
table agegroup*N1DR0034/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.RACEI.rtf";
proc freq data=nhanesI;
table agegroup*N1DR0103/ norow nopercnt chisq;
run;
ods rtf close;

ods rtf file="C:\NHANES\chisq.age.SEXI.rtf";
proc freq data=nhanesI;
table agegroup*N1DR0104/ norow nopercnt chisq;
run;
ods rtf close;

```

NHANES 2001-2002

```
libname NH "C:\NHANES\Data" ;
libname XPDB xport "C:\nhanes\download\demo_b.xpt" ;
libname XPIB xport "C:\nhanes\download\drxiff_b.xpt" ;
libname XPTB xport "C:\nhanes\download\drxtot_b.xpt" ;
libname XBMB xport "C:\nhanes\download\bm_x_b.xpt" ;
libname XPAB xport "C:\nhanes\download\paqiaf.xpt";
libname XHSB xport "C:\nhanes\download\hsq_b.xpt";
proc copy in =XPDB out =NH;
run ;
proc copy in =XPIB out =NH;
run ;
proc copy in =XPTB out =NH;
run ;
proc copy in =XBMB out =NH;
run ;
proc copy in =XPAB out =NH;
run;
proc copy in =XHSB out =NH;
run;
proc contents data = "C:\nhanes\data\paqiaf";
run;
proc contents data= "C:\nhanes\data\hsq_b";
run;

proc sort data = "C:\nhanes\Data\bm_x_b";
by seqn;
run;
proc sort data="C:\nhanes\Data\demo_b";
by seqn;
run;
proc sort data= "C:\nhanes\Data\drxiff_b";
by seqn;
run;
proc sort data= "C:\nhanes\Data\drxtot_b";
by seqn;
run;
proc sort data= "C:\nhanes\Data\paqiaf";
by seqn;
run;
proc sort data = "C:\nhanes\data\hsq_b";
by seqn;
run;

data "C:\nhanes\Data\NHANES01";
merge "C:\nhanes\Data\bm_x_b" "C:\nhanes\Data\demo_b" "C:\nhanes\Data\drxtot_b"
"C:\nhanes\Data\drxiff_b";
by seqn;
run;

data b_data;
set nhanes01;
year = "2001-2002";
run;
```

```

data NHANES01;
set "C:\nhanes\Data\NHANES01";
keep SEQN BMXWT BMXHT BMXBMI RIDAGEYR RIDRETH1 DMDBORN DMDEDUC2
DMDMARTL DMDHHSIZ INDHHINC DRXTKCAL
DRXTPROT DRXTCARB DRXTFIBE DRXTTFAT DRD030Z DRXIKCAL DRXIPROT DRXICARB
DRXIFIBE DRXITFAT RIAGENDR INDFMPIR
agegroup bmgroupprotein fat carbs BMI POVERTY GRADE;
if ridageyr ge 20 & ridageyr le 30 then agegroup=1;
if ridageyr ge 31 & ridageyr le 40 then agegroup=2;
if ridageyr ge 41 & ridageyr le 50 then agegroup=3;
if ridageyr ge 51 & ridageyr le 60 then agegroup=4;
if ridageyr ge 61 & ridageyr le 70 then agegroup=5;
if ridageyr ge 71 & ridageyr le 80 then agegroup=6;
if ridageyr ge 81 then agegroup=7;
IF DMDEDUC2 =7 | DMDEDUC2 =9 THEN DMDEDUC =.;
IF INDFMPIR le 0.05 THEN POVERTY = 1;
IF INDFMPIR gt 0.05 & INDFMPIR le 1.00 THEN POVERTY = 2;
if INDFMPIR gt 1.00 & INDFMPIR le 1.25 then poverty = 3;
if INDFMPIR gt 1.25 & INDFMPIR le 2.5 then poverty = 4;
if INDFMPIR gt 2.5 then poverty = 5;
if DMDEDUC2 eq 1 | n1dr0112 eq 2 then grade = 1;
if DMDEDUC2 eq 3 then grade = 2;
if DMDEDUC2 eq 4 | DMDEDUC2 eq 5 then grade = 3;
bmi =(BMXWT/(BMXHT**2))*703;
if BMI lt 18.5 then bmgroupp=1;
if bmi ge 18.5 & bmi lt 25 then bmgroupp=2;
if bmi ge 25 & bmi lt 30 then bmgroupp=3;
if bmi ge 30 then bmgroupp=4;
protein =((drxtprot*4)/drxtkcal)*100;
fat =((drxttfat*9)/drxtkcal)*100;
carbs =((drxtcarb*4)/drxtkcal)*100;
run;

PROC SORT DATA=nhanes01;
BY AGEGROUP;
RUN;

proc contents data=nhanes01;
run;

proc sort data=bdata;
by seqn;
run;

ods rtf file="C:\NHANES\Data\NHANES01percentmean.rtf";
PROC MEANS DATA=nhanes01;
BY AGEGROUP;
VAR protein fat carbs;
RUN;
ods rtf close;

data "C:\nhanes\Data\NHANES01b";
merge "C:\nhanes\Data\bm_x_b" "C:\nhanes\Data\demo_b" "C:\nhanes\Data\drxtot_b"
"C:\nhanes\Data\drxiff_b" "C:\nhanes\data\hsq_b";
by seqn;
run;

```



```

proc sort data="C:\nhanes\Data\NHANES01b";
by seqn;
run;

proc sort data=bdata;
by agegroup;
run;

ods rtf file="C:\nhanes\means2001D.rtf";
PROC MEANS DATA=NHANES01;
BY AGEGROUP;
VAR BMXWT BMXHT BMXBMI RIDAGEYR RIDRETH1 DMDBORN DMDEDUC2 DMDMARTL
DMDHHSIZ INDHHINC
DRXTKCAL DRXTPROT DRXTCARB DRXTFIBE DRXTTFAT DRD030Z RIAGENDR BMI GRADE
POVERTY
bmgroupprotein fat carbs;
RUN;
ods rtf close;

ods rtf file="C:\NHANES\Data\NHANES01freq3.16.rtf";
proc freq data=NHANES01;
by AGEGROUP;
tables riagendr /out=gender;
tables ridreth1 /out=ethnicity;
tables dmdmartl /out=marital_status;
tables dmdeduc2 /out=grade_level;
tables indhhinc /out=income_level;
TABLES GRADE /OUT=GRADE;
TABLES POVERTY /OUT=POVERTY;
run;
ods rtf close;

ods rtf file="C:\NHANES\Data\NHANES01freqbmi.rtf";
proc freq data=NHANES01;
by agegroup;
tables bmgroupprotein /out=bmi;
run;
ods rtf close;

ods csv file="C:\NHANES\Data\NHANES01demo.csv";
proc print data=gender;
run;
proc print data=ethnicity;
run;
proc print data=income_level;
run;
proc print data=health_status;
run;
proc print data=grade_level;
run;
proc print data=marital_status;
run;
ods csv close;

proc means data=bdata mean mode stddev;

```

```

by AGEGROUP;
var drxtkcal;
output out=kcal mean=meankcal mode=modekcal stddev=stdkcal;
run;
ods csv file="C:\NHANES\Data\NHANES01kcal12.14.15mean.csv";
proc print data=kcal;
run;
ods csv close;

```

```

proc means data=bdata mean mode stddev;
by AGEGROUP;
var drxtprot;
output out=PROT mean=meanprot mode=modeprot stddev=stdprot;
run;
ods csv file="C:\NHANES\Data\NHANES01prot12.14.15mean.csv";
proc print data=prot;
run;
ods csv close;

```

```

proc means data=bdata mean mode stddev;
by AGEGROUP;
var drxtcarb;
output out=carb mean=meancarb mode=modecarb stddev=stdcarb;
run;
ods csv file="C:\NHANES\Data\NHANES01carb12.14.15mean.csv";
proc print data=carb;
run;
ods csv close;

```

```

proc means data=bdata mean mode stddev;
by AGEGROUP;
var drxtfat;
output out=fat mean=meanfat mode=modefat stddev=stdfat;
run;
ods csv file="C:\NHANES\Data\NHANES01fat12.14.15mean.csv";
proc print data=fat;
run;
ods csv close;

```

```

proc means data=bdata mean mode stddev;
by AGEGROUP;
var drxtfibe;
output out=FIB mean=MEANFIB mode=MODEFIB stddev=STDFIB;
run;
ods csv file="C:\NHANES\Data\NHANES01fibmean.csv";
proc print data=FIB;
run;
ods csv close;

```

```

ods rtf file="C:\NHANES\Data\GLM.nhanes01.KCAL.12.14.15.rtf";
proc glm data=bdata;
class agegroup ridreth1 dmddeduc2 dmdmartl indhhinc riagendr;
model drxtkcal=agegroup ridreth1 dmddeduc2 dmdmartl indhhinc riagendr/ss3;
lsmeans agegroup ridreth1 dmddeduc2 dmdmartl indhhinc riagendr/ pdiff stderr;
run;
ods rtf close;

```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes01.KCAL.3.16.rtf";
proc glm data=NHANES01;
class agegroup ridreth1 GRADE dmdmartl POVERTY riagendr;
model drxtkcal=agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ss3;
lsmeans agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes01.PRO.3.16.rtf";
proc glm data=NHANES01;
class agegroup ridreth1 GRADE dmdmartl POVERTY riagendr;
model DRXTPROT=agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ss3;
lsmeans agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes01.FAT.3.16.rtf";
proc glm data=NHANES01;
class agegroup ridreth1 GRADE dmdmartl POVERTY riagendr;
model DRXTTFAT=agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ss3;
lsmeans agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes01.CARB.3.16.rtf";
proc glm data=NHANES01;
class agegroup ridreth1 GRADE dmdmartl POVERTY riagendr;
model DRXTCARB=agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ss3;
lsmeans agegroup ridreth1 GRADE dmdmartl POVERTY riagendr/ pdiff stderr;
run;
ods rtf close;
```

```
proc corr data=NHANESI;
run;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes01.pro.12.2.15.rtf";
proc glm data=bdata;
class agegroup ridreth1 dmddeduc2 dmdmartl indhhinc riagendr;
model drxtprot=agegroup ridreth1 dmddeduc2 dmdmartl indhhinc riagendr/ss3;
lsmeans agegroup ridreth1 dmddeduc2 dmdmartl indhhinc riagendr/ pdiff stderr;
run;
ods rtf close;
```

```
proc means data=NHANESI mean mode stddev;
by AGEGROUP;
var N1DR0254;
output out=PRO mean=MEANPRO mode=MODEPRO stddev=STDPRO;
run;
ods csv file="C:\NHANES\Data\NHANESIpromean11.30.15.csv";
proc print data=PRO;
run;
ods csv close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes01.fat.12.2.15.rtf";
proc glm data=bdata;
```

```

class agegroup ridreth1 dmdeduc2 dmdmartl indhhinc riagendr;
model drxttfat=agegroup ridreth1 dmdeduc2 dmdmartl indhhinc riagendr/ss3;
lsmeans agegroup ridreth1 dmdeduc2 dmdmartl indhhinc riagendr/ pdiff stderr;
run;
ods rtf close;

```

```

ods rtf file="C:\NHANES\Data\GLM.nhanes01.carb.12.2.15.rtf";
proc glm data=bdata;
class agegroup ridreth1 dmdeduc2 dmdmartl indhhinc riagendr;
model drxtcarb=agegroup ridreth1 dmdeduc2 dmdmartl indhhinc riagendr/ss3;
lsmeans agegroup ridreth1 dmdeduc2 dmdmartl indhhinc riagendr/ pdiff stderr;
run;
ods rtf close;

```

```

ods rtf file="C:\NHANES\chisq.age.healthstatus01.rtf";
proc freq data=bdata;
table agegroup*hsd010/ norow nopercnt chisq;
run;
ods rtf close;

```

```

ods rtf file="C:\NHANES\chisq.age.INCOME01.rtf";
proc freq data=bdata;
table agegroup*indhhinc/ norow nopercnt chisq;
run;
ods rtf close;

```

```

ods rtf file="C:\NHANES\chisq.age.RACE01.rtf";
proc freq data=bdata;
table agegroup*ridreth1/ norow nopercnt chisq;
run;
ods rtf close;

```

```

ods rtf file="C:\NHANES\chisq.age.SEX01.rtf";
proc freq data=bdata;
table agegroup*riagendr/ norow nopercnt chisq;
run;
ods rtf close;

```

NHANES 2011-2012

```

libname NH "C:\NHANES\Data" ;
libname XPDG xport "C:\nhanes\download\demo_g.xpt" ;
libname XPIG xport "C:\nhanes\download\dr1iff_g.xpt" ;
libname XPTG xport "C:\nhanes\download\dr1tot_g.xpt" ;
libname XBMG xport "C:\nhanes\download\bxm_g.xpt" ;
libnameXHSG xport "C:\nhanes\download\hsq_g.xpt";

```

```

proc copy in =XPDG out =NH;
run ;
proc copy in =XPIG out =NH;
run ;
proc copy in =XPTG out =NH;
run ;
proc copy in =XBMG out =NH;
run ;
proc copy in =XHSG out =NH;

```

```

run;

proc sort data = "C:\nhanes\Data\demo_g";
by seqn;
run;
proc sort data = "C:\nhanes\Data\dr1liff_g";
by seqn;
run;
proc sort data = "C:\nhanes\Data\dr1tot_g";
by seqn;
run;
proc sort data = "C:\nhanes\Data\bm_x_g";
by seqn;
run;
proc sort data = "C:\nhanes\data\hsq_g";
by seqn;
run;

data "C:\nhanes\Data\NHANES11";
merge "C:\nhanes\Data\bm_x_g" "C:\nhanes\Data\demo_g" "C:\nhanes\Data\dr1tot_g"
"C:\nhanes\Data\dr1liff_g" "C:\nhanes\data\hsq_g";
by seqn;
run;

data gdata;
set "C:\nhanes\Data\NHANES11";
keep SEQN BMXWT BMXHT BMXBMI RIDAGEYR RIDRETH1 DMDBORN4 DMDEDUC2
DMDMARTL INDDHIN2 DR1TKCAL
DR1TPROT DR1TCARB DR1TFIBE DR1TTFAT DR1IKCAL DR1IPROT DR1ICARB DR1IFIBE
DR1ITFAT RIAGENDR HSD010
agegroup bmggroup protein fat carbs GRADE POVERTY BMI;
if ridageyr ge 20 & ridageyr le 30 then agegroup=1;
if ridageyr ge 31 & ridageyr le 40 then agegroup=2;
if ridageyr ge 41 & ridageyr le 50 then agegroup=3;
if ridageyr ge 51 & ridageyr le 60 then agegroup=4;
if ridageyr ge 61 & ridageyr le 70 then agegroup=5;
if ridageyr ge 71 & ridageyr le 80 then agegroup=6;
if ridageyr ge 81 then agegroup=7;
IF DMDEDUC2 =7 | DMDEDUC2 =9 THEN DMDEDUC =.;
IF INDFMPIR le 0.05 THEN POVERTY = 1;
IF INDFMPIR gt 0.05 & INDFMPIR le 1.00 THEN POVERTY = 2;
if INDFMPIR gt 1.00 & INDFMPIR le 1.25 then poverty = 3;
if INDFMPIR gt 1.25 & INDFMPIR le 2.5 then poverty = 4;
if INDFMPIR gt 2.5 then poverty = 5;
if DMDEDUC2 eq 1 | n1dr0112 eq 2 then grade = 1;
if DMDEDUC2 eq 3 then grade = 2;
if DMDEDUC2 eq 4 | DMDEDUC2 eq 5 then grade = 3;
bmi =(BMXWT/((BMXHT/100)**2));
if bmx bmi lt 18.5 then bmggroup=1;
if bmx bmi ge 18.5 & bmx bmi lt 25 then bmggroup=2;
if bmx bmi ge 25 & bmx bmi lt 30 then bmggroup=3;
if bmx bmi ge 30 then bmggroup=4;
protein =((dr1tprot*4)/dr1tkcal)*100;
fat =((dr1ttfat*9)/dr1tkcal)*100;
carbs =((dr1tcarb*4)/dr1tkcal)*100;
run;

```

```
PROC SORT DATA=gdata;  
BY AGEGROUP;  
RUN;
```

```
ods rtf file ="C:\nhanes\2011percentmeans.rtf";  
proc means data=gdata;  
by agegroup;  
var protein fat carbs;  
run;  
ods rtf close;
```

```
ods rtf file="C:\nhanes\means2011.3.16.rtf";  
PROC MEANS DATA=gdata;  
BY AGEGROUP;  
VAR BMXWT BMXHT BMXBMI RIDAGEYR RIDRETH1 DMDBORN4 DMDEDUC2 DMDMARTL  
INDHHIN2 DR1TKCAL  
DR1TPROT DR1TCARB DR1TFIBE DR1TTFAT DR1IKCAL DR1IPROT DR1ICARB DR1IFIBE  
DR1ITFAT RIAGENDR HSD010  
agegroup bmgroupprotein fat carbs GRADE POVERTY BMI;  
RUN;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\NHANES11freq.3.16.rtf";  
proc freq data=gdata;  
by AGEGROUP;  
tables riagendr /out=gender;  
tables ridreth1 /out=ethnicity;  
tables dmdmartl /out=marital_status;  
tables dmdeduc2 /out=grade_level;  
tables indhhin2 /out=income_level;  
tables hsd010 /out=health_status;  
tables grade /out=grade;  
tables poverty /out=poverty;  
run;  
ods rtf close;
```

```
ods csv file="C:\NHANES\Data\NHANES11demo.csv";  
proc print data=gender;  
run;  
proc print data=ethnicity;  
run;  
proc print data=income_level;  
run;  
proc print data=health_status;  
run;  
proc print data=grade_level;  
run;  
proc print data=marital_status;  
run;  
ods csv close;
```

```
proc means data=gdata mean mode stddev;  
by AGEGROUP;  
var dr1tkcal;  
output out=kcal mean=meankcal mode=modekcal stddev=stdkcal;
```

```

run;
ods csv file="C:\NHANES\Data\NHANES11kcal12.15.15mean.csv";
proc print data=kcal;
run;
ods csv close;

```

```

proc means data=gdata mean mode stddev;
by AGEGROUP;
var dr1tprot;
output out=PROT mean=meanprot mode=modeprot stddev=stdprot;
run;
ods csv file="C:\NHANES\Data\NHANES11prot12.15.15mean.csv";
proc print data=prot;
run;
ods csv close;

```

```

proc means data=gdata mean mode stddev;
by AGEGROUP;
var dr1tcarb;
output out=carb mean=meancarb mode=modecarb stddev=stdcarb;
run;
ods csv file="C:\NHANES\Data\NHANES11carb12.15.15mean.csv";
proc print data=carb;
run;
ods csv close;

```

```

proc means data=gdata mean mode stddev;
by AGEGROUP;
var dr1tffat;
output out=fat mean=meanfat mode=modefat stddev=stdfat;
run;
ods csv file="C:\NHANES\Data\NHANES11fat12.15.15mean.csv";
proc print data=fat;
run;
ods csv close;

```

```

ods rtf file="C:\NHANES\Data\GLM.nhanes11.KCAL.12.14.15.rtf";
proc glm data=gdata;
class agegroup ridreth1 dmddeduc2 dmdmartl indhjin2 riagendr HSD010;
model dr1tkcal=agegroup ridreth1 dmddeduc2 dmdmartl indhjin2 riagendr HSD010/ss3;
lsmeans agegroup ridreth1 dmddeduc2 dmdmartl indhjin2 riagendr HSD010/ pdiff stderr;
run;
ods rtf close;

```

```

proc corr data=fdata;
run;

```

```

ods rtf file="C:\NHANES\Data\GLM.nhanes11.pro.12.2.15.rtf";
proc glm data=gdata;
class agegroup ridreth1 dmddeduc2 dmdmartl indhjin2 riagendr HSD010;
model dr1tprot=agegroup ridreth1 dmddeduc2 dmdmartl indhjin2 riagendr HSD010/ss3;
lsmeans agegroup ridreth1 dmddeduc2 dmdmartl indhjin2 riagendr HSD010/ pdiff stderr;
run;
ods rtf close;

```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes11.fat.12.2.15.rtf";
proc glm data=gdata;
class agegroup ridreth1 dmddeduc2 dmdmartl indhhi2 riagendr HSD010;
model dr1ttfat=agegroup ridreth1 dmddeduc2 dmdmartl indhhi2 riagendr HSD010/ss3;
lsmeans agegroup ridreth1 dmddeduc2 dmdmartl indhhi2 riagendr HSD010/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes11.carb.12.2.15.rtf";
proc glm data=gdata;
class agegroup ridreth1 dmddeduc2 dmdmartl indhhi2 riagendr HSD010;
model dr1tcarb=agegroup ridreth1 dmddeduc2 dmdmartl indhhi2 riagendr HSD010/ss3;
lsmeans agegroup ridreth1 dmddeduc2 dmdmartl indhhi2 riagendr HSD010/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes11.KCAL.3.16.rtf";
proc glm data=gdata;
class agegroup ridreth1 grade dmdmartl poverty riagendr HSD010;
model dr1tkcal=agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ss3;
lsmeans agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ pdiff stderr;
run;
ods rtf close;
```

```
proc corr data=fdata;
run;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes11.pro.3.16.rtf";
proc glm data=gdata;
class agegroup ridreth1 grade dmdmartl poverty riagendr HSD010;
model dr1tprot=agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ss3;
lsmeans agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes11.fat.3.16.rtf";
proc glm data=gdata;
class agegroup ridreth1 grade dmdmartl poverty riagendr HSD010;
model dr1ttfat=agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ss3;
lsmeans agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\Data\GLM.nhanes11.carb.3.16.rtf";
proc glm data=gdata;
class agegroup ridreth1 grade dmdmartl poverty riagendr HSD010;
model dr1tcarb=agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ss3;
lsmeans agegroup ridreth1 grade dmdmartl poverty riagendr HSD010/ pdiff stderr;
run;
ods rtf close;
```

```
ods rtf file="C:\NHANES\chisq.age.healthstatus11.rtf";
proc freq data=gdata;
table agegroup*hsd010/ norow nopercent chisq;
run;
ods rtf close;
```



```
ods rtf file="C:\NHANES\chisq.age.INCOME11.rtf";  
proc freq data=gdata;  
table agegroup*indhhi2/ norow nopercent chisq;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\chisq.age.RACE11.rtf";  
proc freq data=gdata;  
table agegroup*ridreth1/ norow nopercent chisq;  
run;  
ods rtf close;
```

```
ods rtf file="C:\NHANES\chisq.age.SEX11.rtf";  
proc freq data=gdata;  
table agegroup*riagendr/ norow nopercent chisq;  
run;  
ods rtf close;
```

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CURRICULUM VITAE
Karina L. Christopher

PRIMARY RESEARCH INTERESTS

Future research focuses on food intake throughout the life course and changes in food identity as a result of chronic disease. Current research includes the trajectory of food intake patterns and physical activity throughout the life course.

EDUCATION

Dec 2002 B.S. Food & Nutrition: Dietetics, Northwest Missouri State University,
Maryville, MO
Aug 2004 M.S. Community Nutrition, Eastern Kentucky University, Richmond, KY

ACADEMIC APPOINTMENTS

2007-2008 Instructor (Part Time)
Department of Family & Consumer Sciences
Eastern Kentucky University
Richmond, Kentucky

2010 Instructor (Part-Time)
Department of Family & Consumer Sciences
Eastern Kentucky University
Richmond, Kentucky

2012-present Assistant Professor
Department of Family & Consumer Sciences
Eastern Kentucky University
Richmond, Kentucky

OTHER POSITIONS AND EMPLOYMENT

2004 Dietetic Intern
Eastern Kentucky University
Richmond, Kentucky

2004-2005 Supervisor
Saint Joseph Hospital
Lexington, Kentucky

2005-2007 Clinical Dietitian
Saint Joseph Hospital
Lexington, Kentucky

- 2007-2008 Clinical Nutrition Manager
Saint Joseph Health System
Lexington, Kentucky
- 2008-2009 Clinical Dietitian
Saint Joseph East & Saint Joseph Berea
Lexington, Kentucky
- 2009-2012 Senior Clinical Dietitian
University of Kentucky Markey Cancer Center
Lexington, Kentucky

BOARD CERTIFICATION AND LICENSURE

- 2005-present Kentucky Licensed Dietitian #124024

PROFESSIONAL MEMBERSHIPS AND ACTIVITIES

- 2001-present Academy of Nutrition & Dietetics
2010-present Oncology Dietetic Practice Group
2008-present Dietitians in Nutrition Support Dietetic Practice Group
2012 Healthy Aging Dietetic Practice Group
2013-present Sports, Cardiovascular, and Wellness Dietetic Practice Group
2013-2015 Diabetes Care and Education Dietetic Practice Group
2013-present Renal Dietitians Dietetic Practice Group
2016-present Nutrition and Dietetic Educators and Preceptors
- 2012-present Collegiate and Professional Sports Dietitians Association
- 2003-present Kentucky Academy of Nutrition and Dietetics
2012 Annual Food & Nutrition Conference & Exhibition
- Program Chair
2013 Annual Food & Nutrition Conference & Exhibition
- Program Chair
2013-2015 Secretary
2015-present Nominating Committee
- 2003-present Bluegrass District Dietetic Association
2004-2005 Marketing & Public Relations Chair
2005-2007 Awards & Honors Chair
2007-2008 President-Elect
2008-2009 President
2009-2011 Registrar and Continuing Education Chair

2011 September Dinner Meeting Chair
2016 Nominating Committee Chair

2016-Present American Society of Parenteral and Enteral Nutrition

DEPARTMENT COMMITTEES

2014-2015 Co-Sponsor Student Dietetic Association
2013-present Recruitment and Technology Chair

COLLEGE OF HEALTH SCIENCES COMMITTEES

2014-present Interprofessional (IPE) Committee Member
2013-present Recruitment Committee

UNIVERSITY SERVICE

2013-present Department of Athletics Nutrition Consultant

COMMUNITY COMMITTEES

2013-2015 Shannon Johnson Elementary Coordinated School Health Council.
2014-present Madison County Extension Office 2nd Sunday Event
2015-present Madison County Health Alliance, Healthy Lifestyles Committee

HONORS AND AWARDS

2002 Missouri Dietetic Association, Northwest District Scholarship

2007 Kentucky Academy of Nutrition and Dietetics, Recognized Young
Dietitian of the Year Award

2009 Bluegrass District Dietetic Association, Special Contribution Award

2014 Golden Apple Award Nominee

EDUCATIONAL ACTIVITIES

2016 University of Kentucky
 Certificate in Nutrition for Human Performance
 Advisory Board Member

2007-2012 Eastern Kentucky University, Department of Family & Consumer
Sciences
 EKU Nutrition Program Advisory Board

Guest Lecturer for Medical Nutrition Therapy undergraduate and graduate courses

Career Day Panel for junior and senior dietetic students
Dietetic Internship Preceptor

2010-2012 University of Kentucky, Department of Nutrition & Food Science
Dietetic Internship and Coordinated Program Preceptor
Community Based Faculty
Guest Lecturer for graduate and undergraduate courses

2011 Area Health Education Center
Clinical Shadowing Rotation

2011 Murray State University
Dietetic Internship Preceptor

CLINICAL ACTIVITIES

2010-2012 Provide individual Medical Nutrition Therapy (MNT), to patients referred by oncology providers, at the University of Kentucky Markey Cancer Center. Providers include surgical oncologists, radiation oncologists and medical oncologists. MNT is provided approximately 40 hours per week. Participate in Cancer Committee activities. Weekly blog: Markey Menu. Monthly Cooking Demonstrations targeting patients, families and caregivers of oncology patients.

2005-2009 Provide individual Medical Nutrition Therapy (MNT), to patients at Saint Joseph Hospital, Saint Joseph East and Saint Joseph Berea. Specific patient populations included cardiac disease, stroke, diabetes, obesity and nutrition support. Charting implemented the Nutrition Care Process and PES statements.

ABSTRACTS AND PRESENTATIONS

2011 “Vitamin D and other nutritional deficiencies in newly diagnosed cancer patients living in Kentucky”
Poster Abstract
American Institute for Cancer Research Conference

PUBLICATIONS

2013 K. L. Christopher , A. T. Wiggins , E. M. Van Meter , R. T. Means Jr. , J. W. Hayslip & J. P. Roach (2013) Differences in Vitamin D Nutritional Status Between Newly Diagnosed Cancer Patients from Rural or Urban

Settings in Kentucky, Nutrition and Cancer, 65:5, 653-658, DOI:
[10.1080/01635581.2013.789117](https://doi.org/10.1080/01635581.2013.789117)

SCHOLARSHIP

2015 Study collaboration with Dr. Matthew Sabin on Concussion Recovery and Energy Expenditure - Pilot (CREEP) in progress

COMMUNITY EDUCATION PRESENTATIONS

Mar 2008 Diet Basics
WKYT-27 NewsFirst, taped recording
Lexington, Kentucky

Mar 2009 Heart Healthy Cooking
Woodford County Library
Versailles, Kentucky

Mar 2010 Colon Cancer Prevention
Faces of Colon Cancer Event
Lexington, Kentucky

Jan 2011 Healthy Eating for Cancer Prevention
Lexington Herald-Leader
Lexington, Kentucky

May 2011 Losing Even a Little Weight Can Reduce Cancer Risk
Lexington Herald-Leader
Lexington, Kentucky

Aug 2011 Healthy Eating for Cancer Prevention
Morehead State Public Radio
Morehead, Kentucky

Sep 2011 Certain Foods Could Reduce Prostate Cancer Risk
Lexington Herald-Leader
Lexington, Kentucky

Oct 2011 Nutrition and Lung Cancer Prevention
Lung Cancer Symposium
Lexington, Kentucky

Oct 2011 Healthy Eating for Cancer Prevention
WKYT-27 NewsFirst live interview
Lexington, Kentucky

Jan 2012 Your New Year's Resolution: Eat healthfully and lose weight — to help prevent cancer
Kentucky Living Magazine
Kentucky

Apr 2013 “Nutrition, Enzyme, and Vitamin Support”
Neuroendocrine Tumor (NET) Patient Regional Conference
Lexington, KY

Feb 2014 Obesity and Heart Disease in Kentucky
WEKU radio
Richmond, KY

Sep 2014 Healthy Eating on a Budget
Eastern Kentucky University Campus Recreation
Richmond, KY

Feb 2012 The Nutrition & Health Connection
Lexington-Fayette Urban County Government Employees
Lexington, Kentucky

Mar 2012 Cancer and Obesity
Big Men On Campus; Rockcastle Regional Hospital
Mt. Vernon, Kentucky

Mar 2012 The Nutrition & Health Connection
Kentucky Utilities, Information Systems Employees
Lexington, Kentucky

May 2012 Adapt Grilling to Reduce Cancer Risk
Lexington Herald-Leader
Lexington, Kentucky

June 2012 Eat For Your Health
UK Healthcare: Women It’s About You
Lexington, Kentucky

Nov 2013 Healthy Eating
Shannon Johnson Elementary, Kindergarten, 1st, and 2nd graders
Berea, Kentucky

Feb 2014 Obesity and Heart Disease in Kentucky
WEKU Radio Station
Richmond, Kentucky

- Jan 2015 Sports Nutrition and Adolescents
Model Swim Team
Richmond, Kentucky
- Mar 2015 Management of Cancer Cachexia
Kentucky Academy of Nutrition & Dietetics FNCE
Louisville, KY
- Apr 2015 Malnutrition in Older Adults with Chronic Kidney Disease
Kentucky Renal Dietitians
Frankfort, KY
- Aug 2015 Advanced Use of the Nutrition Care Process (co-presenter)
Dietary Consultants, Inc.
Richmond, KY

COURSES TAUGHT

EASTERN KENTUCKY UNIVERSITY

- NFA 121: Introduction to Food Composition and Preparation
 - NFA 201: Essentials of Nutrition
 - NFA 402: Medical Nutrition Therapy I
 - NFA 403: Medical Nutrition Therapy II
 - NFA 509/709: Nutrition and Aging
 - NFA 802: Advanced Applications of the Nutrition Care Process
 - NFA 826: Nutrition for Chronic Disease
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- ATR 221: Sport and Exercise Nutrition