



The Food Industry Center
UNIVERSITY OF MINNESOTA

Working Paper 2007-01
The Food Industry Center
University of Minnesota
Printed Copy \$25.50

**Do Eating Patterns Follow a Cohort
or Change Over a Lifetime?
Answers Emerging From the Literature**

A Literature Review by
Minh Wendt and Jean Kinsey

**Department of Applied Economics
University of Minnesota
St. Paul, MN 55108-6040
(612) 625-2744 Phone
(612) 625-2729 Fax**

jkinsey@umn.edu

September 2007

Minh Wendt is a Ph.D. Candidate in Applied Economics at the University of Minnesota and Jean Kinsey is a Professor of Applied Economics and Director, The Food Industry Center at the University of Minnesota. The work was sponsored by The Food Industry Center, University of Minnesota, 317 Classroom Office Building, 1994 Buford Avenue, St. Paul, Minnesota 55108-6040, USA, with support from Agricultural Experiment Station, University of Minnesota Project 1F MN-14-048. The Food Industry Center is an Alfred P. Sloan Foundation Industry Study Center.

Do Eating Patterns Follow a Cohort or Change Over a Lifetime? Answers Emerging from the Literature

A Literature Review by
Jean Kinsey and Minh Wendt

Abstract

With the rapidly increasing American elderly population, food companies, healthcare workers, and policy makers alike are asking whether the dietary habits and food consumption patterns of this growing segment of the U.S. population will follow those of current and past elderly people or whether their cohort will eat like they did when they were younger. The purpose of this report is to review what is known about changes in nutritional intake and food consumption patterns that are associated with cohorts (generational) and with the aging process in the U.S. population. Recent literature on cohort and aging effects related to food consumption indicates that the aging effect is greater than the cohort effect. That is, diets change as people age, due to factors such as food availability, new information, new cumulative experiences, and physiological changes as bodies mature. Cohort effect is more likely due to changes in income, i.e., each succeeding cohort realizing higher real per capita income. Variation in findings is likely due to different data sources and analytic methods. Information on data sources and common databases used in these types of studies are also reviewed.

Keywords: Food consumption, cohort, age effect

Working Paper 2007-01
The Food Industry Center
University of Minnesota

Do Eating Patterns Follow a Cohort or Change Over a Lifetime? Answers Emerging from the Literature

A Literature Review by
Jean Kinsey and Minh Wendt

Copyright © 2007 by Jean Kinsey and Minh Wendt. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

The analyses and views reported in this paper are those of the authors. They are not necessarily endorsed by the Department of Applied Economics, by The Food Industry Center, or by the University of Minnesota.

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

For information on other titles in this series, write The Food Industry Center, University of Minnesota, Department of Applied Economics, 1994 Buford Avenue, 317 Classroom Office Building, St. Paul, MN 55108-6040, USA; phone (612) 625-7019; or E-mail tfic@umn.edu. For more information about the Center and for full text of working papers, visit The Food Industry Center website at <http://foodindustrycenter.umn.edu>.

Do Eating Patterns Follow a Cohort or Change Over a Lifetime? Answers Emerging from the Literature

Table of Contents

1. Introduction.....	1
2. Differences in Food/Nutrient Consumption Patterns within a Cohort Over Time.....	4
3. Differences in Food/Nutrient Consumption Patterns among Different Age Groups Over Time.....	7
3.1 Total Energy Intake and Percent of Total Energy Consumed by Key Food Groups.....	7
3.2 Percentage of Calories Consumed by Location.....	9
3.3 Eating Patterns.....	11
3.4 Macro Nutrients (protein, fat, and carbohydrates) Intake Trend.....	13
3.5 Selected Micro Nutrients Intake Trend.....	15
3.6 Supplement Use.....	16
4. Factors that Affect Different Food Choice Among Cohorts.....	17
4.1 Socio-Economic Factors and Time Constraint.....	17
4.2 Biological and Physiological Factors.....	18
4.3 Other Factors that are Changing Over Time.....	19
4.3.1 Changes in Nutrition Recommendation.....	19
4.3.2 Technology.....	20
4.3.3 Food supply.....	21
5. Issues in Method of Analysis.....	22
5.1 Data Sources.....	22
5.2 Database for Food and Nutrient Conversion.....	27
6. Conclusion.....	28
References.....	30

Figures

1. Age Distribution of U.S. Population, 2000-2050.....	2
2. Ethnic Composition of U.S. Population, 2000-2050.....	2
3. Trends in Mean Daily Energy Intake, U.S. Population, 1971-2000.....	8
4. Percentage of Calories Consumed at Home and Away from Home, 1977-95.....	10
5. U.S. Food and Alcoholic Beverages Expenditure by Locations, 1869-2006.....	11
6. Percentage of Calories from Three Macro-Nutrients: U.S. Population, 1999-2000.....	14
7. Supplement Use by Age Group, NHIS Data 1987, 1992, and 2000.....	16
8. Calories Available from the U.S. Per Capita Food Supply.....	21

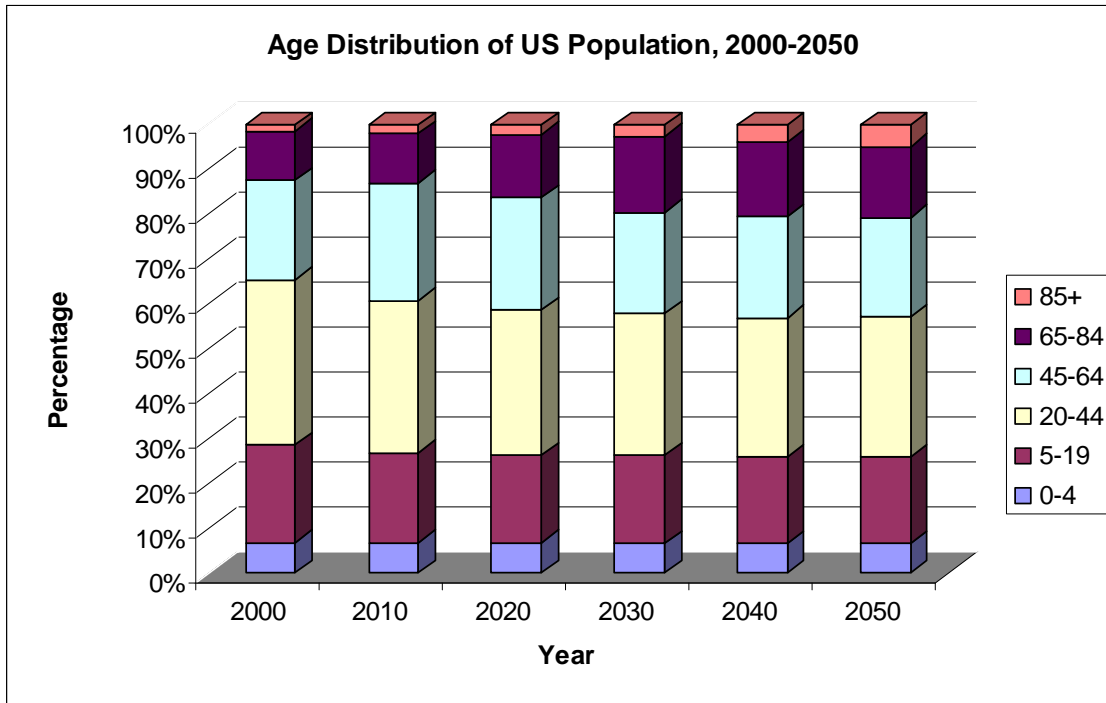
1. Introduction

By 2050, the U.S. population is projected to grow by another 110 million, to 392 million (U.S. Bureau of the Census, 2000). Meanwhile, there is decreasing fertility, increasing life expectancy, and a flow of immigrants producing significant demographic shifts in the U.S. population. Median age increased steadily from 34.0 in 1994 to 35.5 in 2000, and is projected to peak at 39.1 in 2035, then decrease slightly to 39.0 by 2050. This trend is driven by the Baby Boom cohort born between 1946 and 1964. The older population, persons 65 years or older, is projected to increase from 12.4 percent in 2000 to 20.7 percent in 2050. Moreover, the most rapidly growing age group is aged 85 and older. Based on the 2000 U.S. population, this age group will increase fivefold by the year 2050; from 4.2 million to 20.9 million (see Figure 1).

While the sex distribution of the U.S. population is expected to change moderately, the racial/ethnic composition will experience larger changes in the same period. The proportion of persons who are members of racial minority groups (i.e. African American, Indian/Alaska Native, Asian/Pacific Islander) is expected to increase from 19 to 27.9 percent, the proportion of Hispanics will increase from 12.6 to 24.4 percent, and the proportion of Whites will decrease from 69.4 to 50.1 percent (see Figure 2).

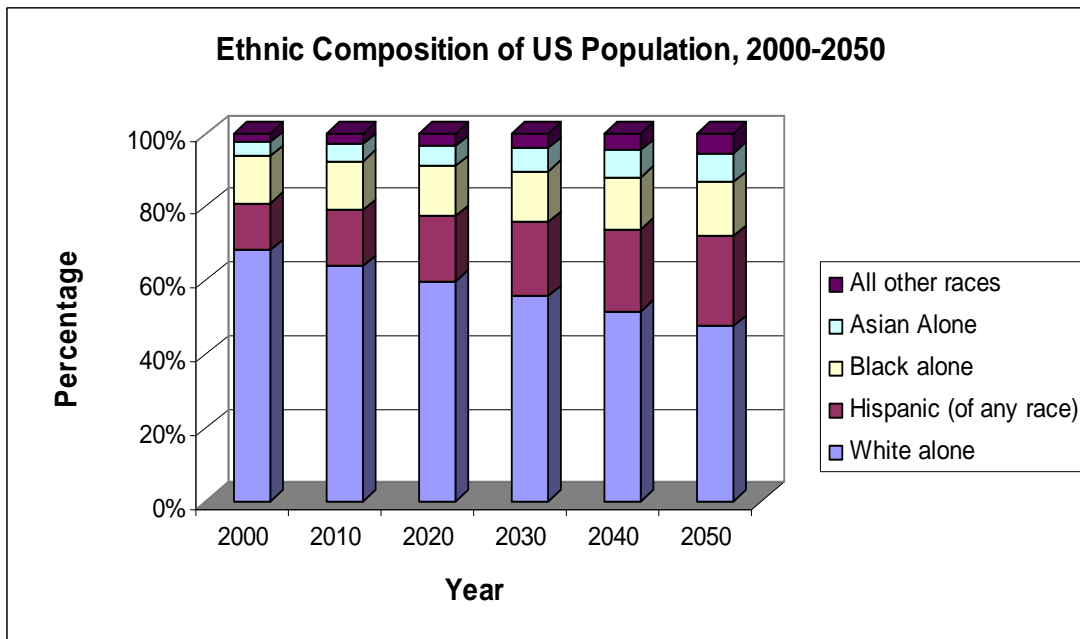
The growing number of older adults in the U.S. population implies that there will be some shifts in consumer demand on the food system. Mature consumers are more likely to be health-conscious than younger generations. They might also have more health problems that require different types of diets.

Figure 1: Age Distribution of U.S. Population, Projection from 2000 to 2050



Source: U.S. Census Bureau, 2000.

Figure 2: Ethnic Composition of U.S. Population, Projection from 2000 to 2050



Source: U.S. Census Bureau, 2000.

According to the World Health Organization (WHO), typical health conditions associated with the ageing process are arthritis, stroke, cancer, heart disease, and diabetes. Many of these problems might be either caused by or at least partly alleviated by diets. Recent studies on the link between nutrition and health problems in older age support this observation (Ahmed, 1992; Chernoff, 2001; Roberts and Barnard, 2005).

Moreover, income for this age group is lower compared to working-age groups. The median income of older persons (65 or older) in 2004 was \$21,102 for males and \$12,080 for females. Comparatively, the median income for males aged 15 years old is \$30,513 and for females it is \$17,629 (U.S. Census Bureau, 2005)¹. Since income is an important determinant of food expenditure (Blisard et al, 2002), the reduction of income could directly affect older adults' demand for food by decreasing the absolute dollar amount and lower the percentage of income spent on food, partly due to other fixed expenses such as housing, utility payments, and healthcare.

With the rapidly increasing population of American elderly, policy makers need to be informed about the dietary and consumption patterns of this growing segment of the U.S. population. The purpose of this report is to review what is known about changes in food consumption and nutrition intake due to shifts in consumer demographics, particularly in terms of age and the aging process in the U.S. population. The analysis includes general trends in food demand and supply in the last three decades.

In particular, this literature review seeks to answer these questions:

- 1) Are there differences in food/nutrient consumption patterns among different cohorts at a given time? Among different cohorts over time? Within a cohort over time? The question often asked is whether people adopt a set of eating habits in

¹ These figures are different from the real median income of *households*, which was \$45,817 in 2004.

their youth and keep them as they age. This is a cohort effect. Alternatively, people may display similar eating patterns at each age, i.e. their 20's to 30's or 30's to 50's or their older years. If so, are they stable over time? For example, do older people eat less beef and has this been true traditionally?

- 2) What are the factors that affect different food choices among cohorts or other demographic criteria at a given time, and over time?
- 3) What are the issues that need to be addressed to conduct this type of study, i.e. data collection, nutrient database, methods of decomposing total effect?

This literature review is selective rather than exhaustive, but it is a systematic exploration of academic, government, and industry information sources related to the topic. Sources include computerized academic literature sources (e.g. JSTOR, Medline), government publications and databases (e.g. government survey data, census data), and market research data.

2. Differences in Food/Nutrient Consumption Patterns within a Cohort over Time

Traditionally, consumption analyses have relied on life-cycle patterns. One often finds that income rises from the early twenties into late fifties and then declines as people retire and live on reduced incomes. Likewise, food/nutrient consumption patterns can be explained based on income and age effect. However, there are others such as generational and time effects that are often ignored. Theoretically, these effects are complementary and should be analyzed together. However, it is rare to have rich enough data to support this type of analysis. So far, there are only a few studies that investigate all issues concurrently. Blisard (2001) utilized a framework of food consumption by

Deaton (1997) to separate food *expenditure*² by age, cohort, and time effects. The findings showed that age effects match the life-cycle profile, cohort effects can be viewed as a secular trend that is associated with generational effects, and time is an aggregate effect that might move cohorts off their trend and age profiles.

Blissard (2001) uses the **Consumer Expenditure Survey (CES)** dataset to estimate a model over 14 years from 1982 to 1995. The analysis follows eight cohorts³ with 35,508 observations on individual households, each with average consumption over a two-week period. A Tobit model is used to account for non-purchasing behavior; therefore it represents the whole sample.

By decomposing the total effect into three components, Blissard finds that there are significant cohort effects for income and food expenditures. Each succeeding cohort realizes higher real per capita income, and since income elasticities for foods are generally positive, food expenditure would continue to increase over time. Furthermore, all other cohorts, except the youngest cohort (age 26-30), have relatively higher spending on food away from home, but this declines for the oldest cohort (61 or older). However, food at-home spending (in absolute dollars) increases steadily from the youngest to the oldest cohort.

By looking at individual food groups, the findings indicated that there are significant cohort effects. Real weekly per capita spending by older cohort is higher for meat, poultry, fish, eggs, dairy products, fruits, beverages, fat and oils, and lower for cereal, bakery goods, and miscellaneous prepared foods. Expenditures for vegetables, sugar and sweets are not significantly different among all cohorts.

² This is to be distinguished from food *consumption* which is the main focus of this report. Nonetheless, the close relationship between food expenditure and consumption makes it relevant in this report.

³ The youngest cohort was 26-30 years of age in 1982, and the oldest cohort was 61-65 years of age.

There are some other interesting points that bear mentioning. First, there is a trend of decreasing dairy consumption with age, and with younger cohorts' decreasing expenditure on dairy, the calcium intake is falling and overall consumption of dairy products will decline in the future. Second, lower expenditures on meat, poultry, fish, and eggs by younger cohorts imply that they might ingest less fat and cholesterol than older cohorts do. Likewise, higher expenditures on cereal and bakery goods by younger consumers mean they consume higher carbohydrates, fiber, and minerals than older cohorts do. However, from this simple framework, one should keep in mind that the underlying assumption of no interaction effects between age, cohort, and time might not always hold true.

There are a few earlier studies that used the **Baltimore Longitudinal Study of Aging (BLSA)** dataset to investigate the cohort effect concurrently with the age and time effects. Common results revealed that as people get older, total calories per day (kcal/day) and calories density (kcal/kg) intake decline. However, while percentage of calories from fat and cholesterol decrease, the percentage of calories from carbohydrates and polyunsaturated or saturated fatty acids ratio increases (Elahi et al, 1983; Hallfrisch et al, 1990). In other words, aging had a negative effect on intake of calories and total fat and a positive impact on carbohydrate intake. On the other hand, cohort effects were not observed for these nutrients. The most noticeable trend was secular changes (time effects) in type and amount of fat consumed. Older people ate less fat and cholesterol, These results, however, were based on a small sample (180 individuals) of predominantly White, highly educated males and it is therefore difficult to generalize these findings to the whole population or the whole market.

Using a longitudinal dataset, the **Bogalusa Heart Study** with a cohort of 246 young adults, a study by Demory-Luce et al (2004) shows that the transition from childhood (age 10 or younger) to young adults (from age 19 to 28) entails decreasing mean consumption of fruits/fruit juice, mixed meat, desserts, candy, and milk while increasing consumption of sweetened beverages, poultry, beef, seafood, cheese, and salty snacks. In addition, there are indicators that children's diet quality decreases when they become young adults. Particularly, there is a 10 percent decrease in the total grams of nutrient-dense foods from childhood to young adulthood even though there is an increase in total grams of food consumption in a 24-hour period. In other words, teenagers and young adults eat more empty calories. Similar findings were found by Lytle et al (2000), Kant (2003), and Kant and Graubard (2003).

3. Differences in Food/Nutrient Consumption Patterns among Different Age Groups over Time

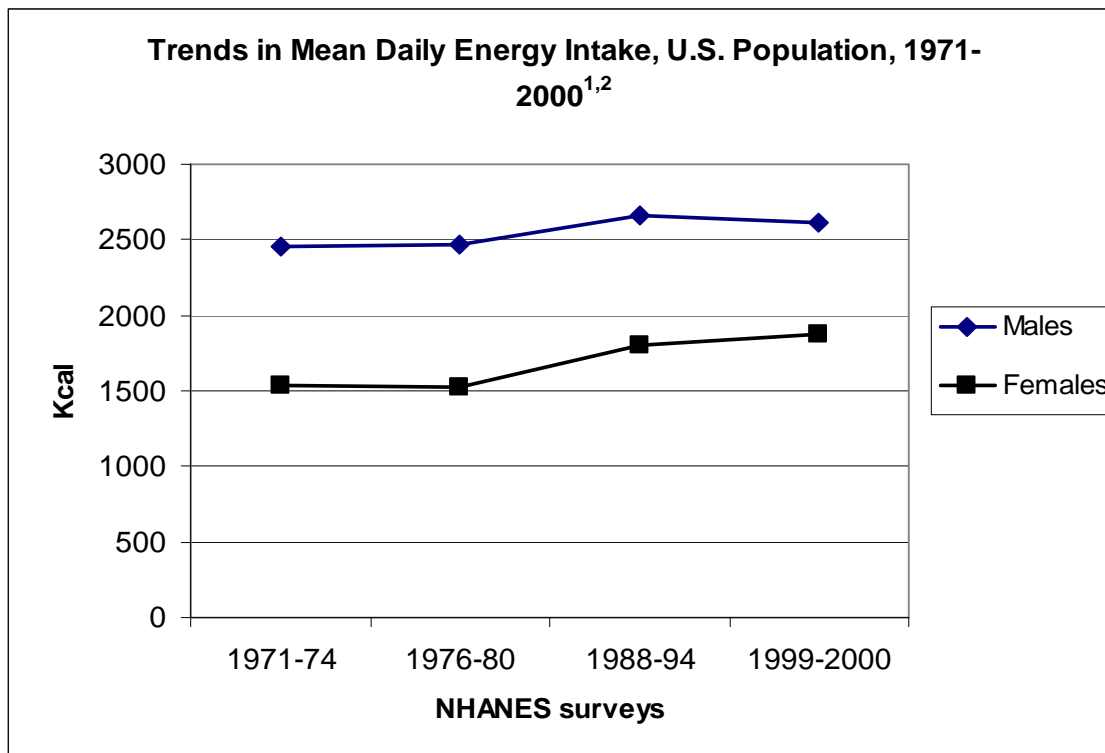
Many studies have utilized this framework of analysis, mainly due to the availability of cross-section datasets such as NHANES and BRFSS which are repeated over time. Although studies have applied different methods of analysis, as well as defined different age-groupings, time frames, and food groups, there is a consensus of findings that is summarized as follows.

3.1) Total Energy Intake and Percent of Total Energy Consumed by Key Food Groups

Total energy intake increased for all age groups except the mature ages (60 or above) from early 1970's to late 1990's, with an average increase of 12 to 18 percent. Overall, there is an average increase of 200 calories for all Americans age 2 and higher.

Of these, about 46 additional calories came from meals and 148 calories from snacks. Specifically, total energy consumed from salty snacks and sweetened beverages (i.e. both fruit drinks and soft drinks) increased from 40 to 141 calories, while consumption of milk decreased from 127 to 82 calories. This trend in total energy consumed and the percentage of energy from snacks instead of meals exists in all age groups. The youngest group, however, between 2 and 18 years of age, has the highest increase while the oldest group, 60 and older, displays the lowest increase (Nielsen et al, 2002; Nielsen and Popkin, 2004; Briefel and Johnson, 2004). Figure 3 illustrates trends of average daily calorie intake over the last three decades.

Figure 3: Trends in Mean Daily Energy Intake, U.S. Population, 1971-2000



Source: National Health and Nutrition Examination Surveys

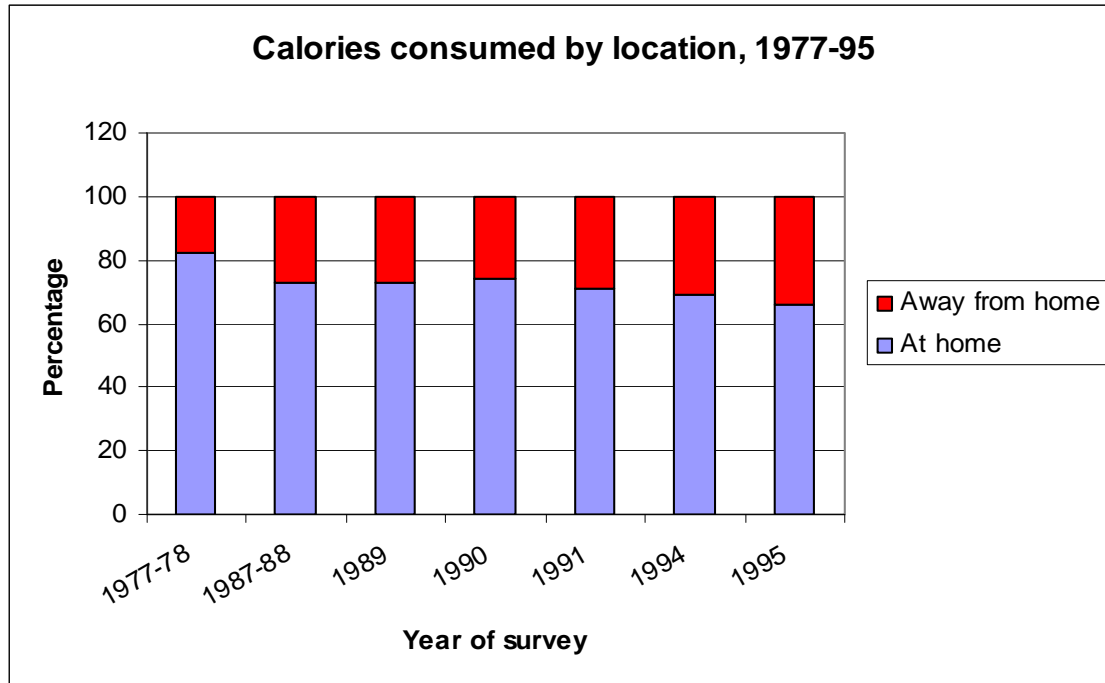
¹ Data are average of one-day intakes; ² Age-adjusted to 2000 population, for adults aged 20-74.

For the oldest age group (65 years or older), there is a shift to healthier food choices such as lower-fat beef, pork, poultry, and fish. Also, consumption of low-fat milk and whole grain bread increased between late 1970's and late 1980's. There are no gender differences, contradicting the idea that women are changing their diets more rapidly than men (Fanelli and Stevehagen, 1985; Popkin et al, 1992). Overall, most studies show a decline in energy intake and it is likely that average intake from food energy are below the USDA recommendations for this older age group (Block et al, 1988; Gerrior 1999).

3.2) Percentage of Calories Consumed by Location

Most studies find that there is a shift of energy intake from food-at-home to food-away-from-home with restaurants and fast food places having the highest increase in high energy food sales. Less than 65 percent of energy is obtained from food-at-home in the mid 1990's compared to 77 percent in the late 1970's (see figure 4). In contrast, there is an increase of about 11 percentage points, from 9.4 to 21.3, of total energy consumed from restaurant/fast food sources for the average American, age 2 and older, during the same period. The group between 20 and 39 displays the largest shift; about 43 percent of total energy is from away-from-home sources in the mid 1990's for young to middle aged adults while the mature group (60 or older) consume about 21 percent away-from-home in the same period (Nielsen et al, 2002).

Figure 4: Percentage of Calories Consumed at Home and Away from Home, 1977-95

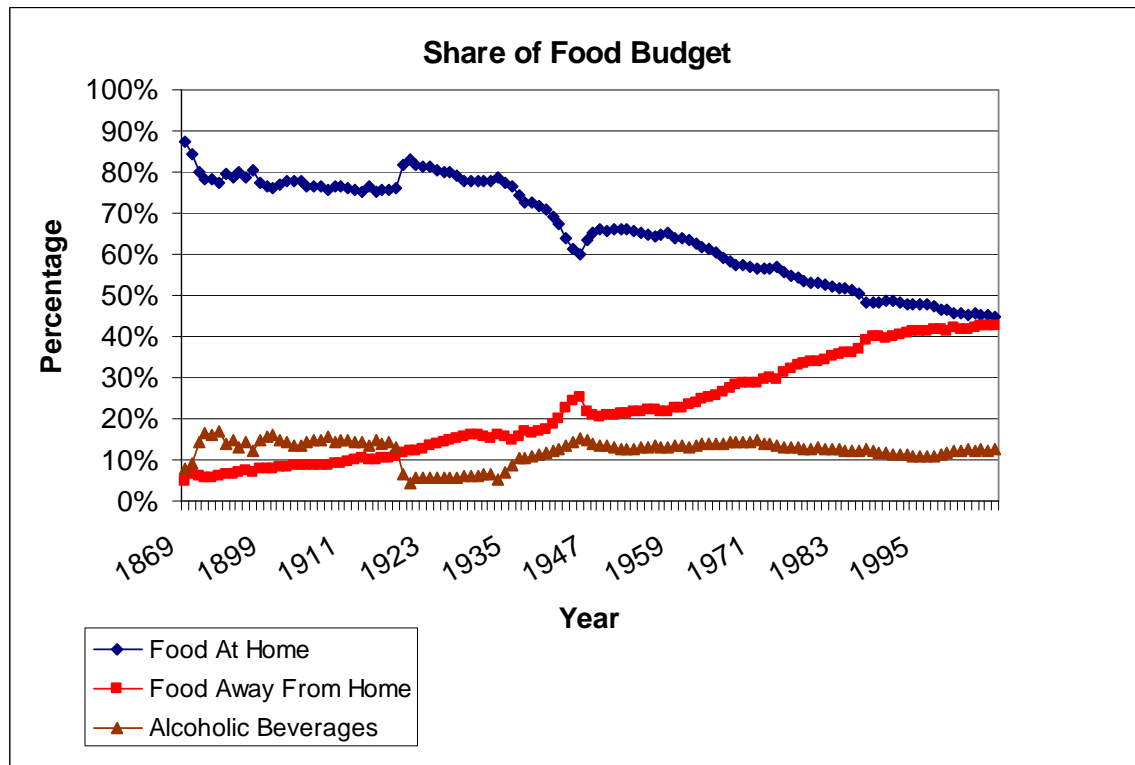


Source: Compiled by ERS, USDA, from NFCS 1977-78, 1987-88, CSFII 1989-90, 1994-95

Another way to put this issue in perspective is looking at the history of food expenditure in terms of budget share. Figure 5 illustrates changes in the share of the U.S. total food and alcoholic beverages expenditure by location, from 1869 to 2006⁴.

⁴ The ERS Food Expenditure Series includes non-household purchases (e.g., food purchased by the U.S. Government for domestic military personnel; the value of school meals; airlines food). See ERS/USDA Briefing Room – Food CPI, Prices, and Expenditures: Measurement Measuring the ERS Food Expenditure Series for definitions and more details.

Figure 5: U.S. Food and Alcoholic Beverages Expenditure by Locations, 1869-2006



Sources: USDA/ERS Series of Food CPI, Prices, and Expenditures, 2007.

3.3) Eating Patterns⁵

Using the 1977-78 **Nationwide Food Consumption Survey** (NFCS) data, several studies documented eating patterns of American elderly, age 55 and older. Core foods (e.g. those routinely consumed by this population group) were whole milk, white bread, coffee, sugar, bananas, orange juice, tomatoes, potatoes, lettuce, and eggs (Fanelli and Stevenhagen, 1985). When examining a subgroup of people age 65 and higher in this dataset, Murphy et al (1992) reported a higher percentage of the oldest age group, 85 and higher, had poorer quality diets where diet quality was defined as one that provides at least two thirds of the RDA for nine nutrients.

⁵ For a thorough review of challenges and opportunities in dietary patterns research, see Moeller et al (2007)

Using the same dataset, 1977-78 NFCS, and its subsequent series, **1989-91 and 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII)**, Cavadini et al (2000) studied cohort diet patterns. They showed a decrease in raw fruits, non-potato sources of vegetables, and dairy sources while there is an increase in high-fat potatoes and mixed dishes (pizza, macaroni cheese) and particularly soft drink consumption from 1965 to 1996 for the U.S. adolescent cohort.

By defining the eating pattern more broadly, whether people's intake meets the federal recommendations for each of five food groups in the food pyramid (grains, vegetables, fruit, dairy products, and meat), Krebs-Smith et al (1997) found that among 32 food-consumption patterns, six patterns representing almost 50 percent of the diets in the population fail to meet the fruit recommendation, four of which also fail to meet the grain and dairy recommendations. *Only one percent of the population meets the recommendation for all five food-groups.* For U.S. children and adolescents, the mean numbers of servings per day were found to be below minimum recommendations for all food groups except the dairy group for ages 2 to 11. Only one percent of youth meet all recommendations while 16 percent of them did not meet any recommendations. However, a diet that meets all recommendations resulted in nutrient intakes above the recommended dietary allowances and was high in fat (Munoz et al, 1997).

Trends in fruit and vegetable consumption were evaluated by Casagrande et al (2007). The authors used two rounds of **NHANES, 1988-94 and 1999-2002**, to assess adult (18 years or older) intake and compare that with the five-a-day recommended level by USDA. Older consumers (aged 40 or older in 1988-1994 and those over 50 in 1999-2002) tended to meet the pyramid guidelines more often than younger people. However,

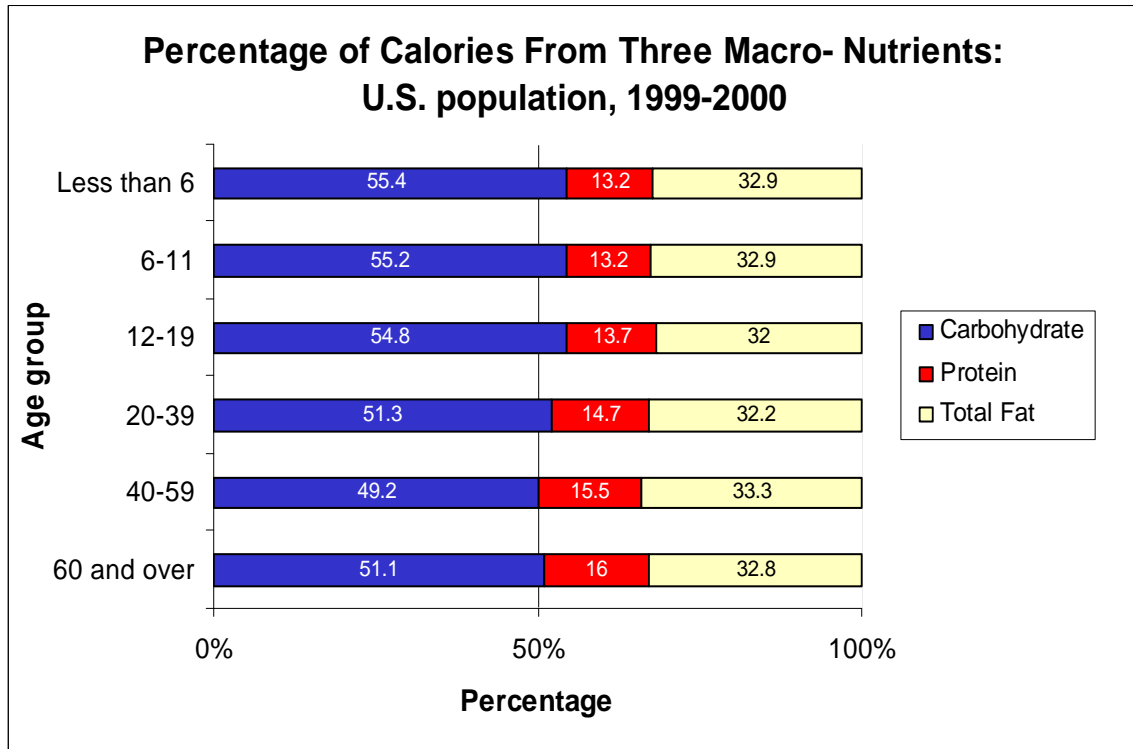
about 89 percent of Americans failed to meet USDA guidelines. About half of the participants consumed no fruit, a quarter consumed no vegetables, and 14 percent consumed neither daily. Furthermore, there is no improvement between the two survey rounds, even after adjusting for age, gender, and ethnicity.

These findings highlight the phenomenon of under-consumption of nutrient-dense foods and over-consumption of energy-dense foods (of modest nutrient), or both, in all age groups and over time. More importantly, there is evidence of a substitution between the two food groups, mostly energy-dense for nutrient dense (Harnack et al, 1999; Kant, 2003).

3.4) Macro Nutrients (Protein, Fat, and Carbohydrate) Intake Trend

Overall, the percentage of total energy consumed from fat declined, but it increased for carbohydrates and is unchanged for protein over the last three decades for U.S. consumers. Using four **NHANES rounds, from 1971-74 to 1999-2000**, Briefel and Johnson (2004) showed there is a decrease in total fat consumption for Americans, from 36 to 33 percent of total calories consumed, between the early 1970's and late 1990's.

Figure 6: Percentage of Calories from 3 Macro-Nutrients: U.S. Population, 1999-2000



Source: Wright et al., 2003, in Advance Data No. 334, CDC

Protein source is relatively stable, but carbohydrate consumption increases from 44 to 50 percent of total energy for all age groups during the same period. While this trend is consistent across ethnic groups and gender, macronutrient intake as well as total calories decreases with age. Comparing among age groups using data from NHANES III (1988-91), Wakimoto and Block (2001) indicates that for those 60 years or older, the percentage of calories from fat and dietary cholesterol consumed is lower, but from protein sources it is higher. For adolescent ages 11-18, USDA surveys from 1977 to 1996 show the percentage of total calories from fats and protein declined steadily while intake of carbohydrates increased (Cavadini et al, 2000).

3.5) Selected Micro Nutrients Intake Trend

Using NFCS and two rounds of CSFII data to compare average intake as a percent of recommended diets by gender for older Americans over age 65 over a course of 20 years, Gerrior (1999) shows that although total energy consumed remains low, some micro-nutrient intake is actually higher than recommended. Since this trend is consistent over a course of 20 years, from the late 1970's to late 1990's, it implies that Americans seem to maintain their micro-nutrient intake levels as they get older. Specifically, the level of vitamin A, C, folate, iron, and sodium have been consistently higher, while dietary fiber, vitamin B6, vitamin E, and calcium are below the daily recommended allowance (RDA) for both genders in their later years.

These results are in line with more current studies which use NHANES data. Wakimoto and Block (2001) report the same decreasing patterns for calcium, iron, and zinc and constant or slightly increasing intake patterns for folate, vitamin A, and vitamin C with age from CSFII (1994-96), and NHANES II and III data. Intake of most B vitamins and vitamin E decline with age in men, but stay fairly constant in women. There are a large percentage of older men and women who consume much less than the RDA for most vitamins and nutrients. For example, only 5 percent of older women and 10 percent of older men consume the RDA for calcium (1200 mg).

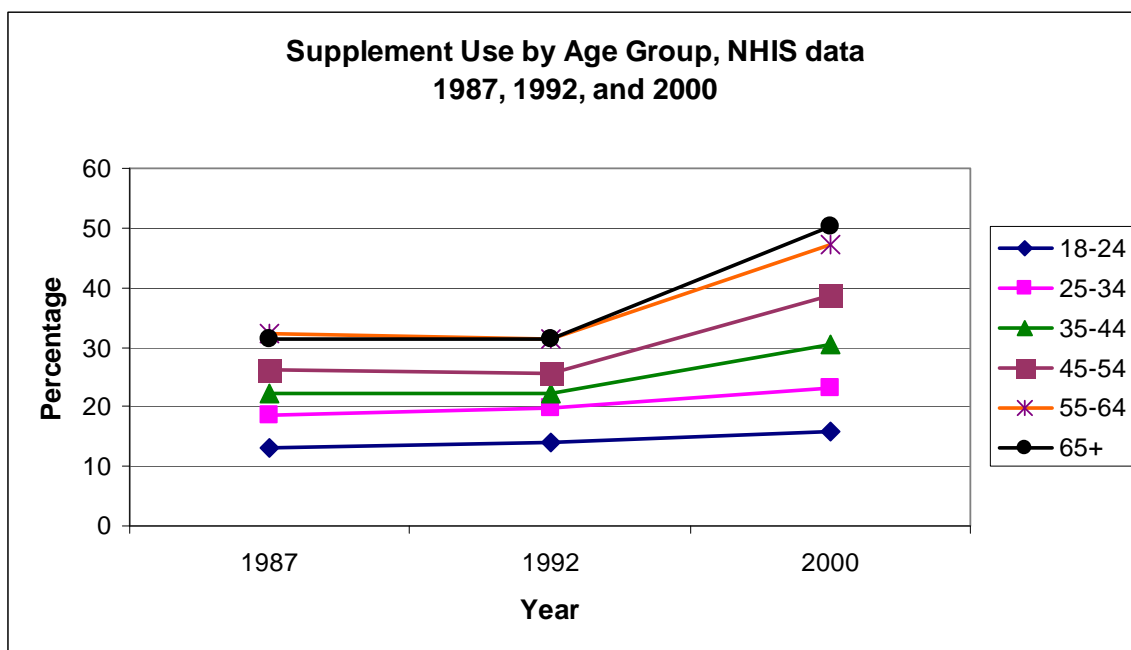
For the adolescent group (age 11-18), data from NFCS between 1965 and 1994-96 show increases in intake of fiber, folate, iron, and vitamin C, but decreases in intake of calcium and vitamin A over the course of 30 years. Intake of iron, folate, and calcium for females were lower than optimal for proper growth and development during adolescence years (Cavadini et al, 2000).

3.6) Supplement Use

Data on supplement use is important in nutrition research since a considerable percentage of micronutrient intake come from supplements. Besides, supplements contribute to the total nutrient consumption and health outcomes. Supplement use in the U.S. is widespread and this trend is increasing with age and over time. **The National Health Interview Survey (NHIS)** data shows that the percentage of the population using vitamin and mineral supplements increased from 23 percent to 34 percent between 1987 and 2000. In the year 2000, about 16 percent of young adults (age 18-24) used some form of a vitamin and mineral supplement, while 35 percent of middle age cohort (35-54) and 50 percent of older cohort (65 or above) had taken supplements (Millen et al, 2004).

Figure 7 shows the trend and differences among age groups in taking supplements from year 1987 to 2000. One can readily see that supplement use has increased over time and with age.

Figure 7: Supplement Use by Age Group, NHIS Data 1987, 1992, and 2000



Source: NHIS data and Millen et al (2004)

NHANES III data indicates there are demographic differences between supplement users. Female, non-Hispanic White, higher level of income, and persons with a high level of education are more likely to take supplements than others (Balluz et al, 2000).

4. Factors that Affect Different Food Choice among Cohorts

4.1) Socio-Economic Factors and Time Constraint

There are several socio-economic factors that affect one's food choice: income, time constraints, education, and nutrition knowledge. Generally, higher levels of income and greater time constraints among working-age cohorts induce people to choose convenient foods and eat out more often compared to the retired cohort. Annual surveys by the Food Marketing Institute (FMI) from the year 2000 to 2007 show that the percentage of older shoppers (Boomers and Matures⁶) having home-cooked meals three or more times per week is much higher than that of younger (generation X and Y⁷) cohorts (e.g. 84-90% compared to 59-70% in January 2007). Conversely, older cohorts eat out less frequently, particularly in the fast-food restaurants category. Older cohorts might not be able to afford the convenience of eating out, and/or might have health problems that prevent them from eating away from home (Henchy, 2001). Also, they are less likely to be in the labor force and eating lunches away from home. Furthermore, Henchy (2001) posits that these differences between younger and older cohorts might be due to their fundamental values. That is, older cohorts grew up during the Great

⁶ Baby Boomer birth cohort is often defined for those who were born between 1946 and 1964; Mature birth cohort is for those born before 1946.

⁷ There are different definitions for Gen X and Gen Y. According to the American Heritage Dictionary, Gen X is "the generation following the post-World War II baby boom, especially people born in the United States and Canada from the early 1960s to the late 1970s"; and generation Y is "The generation following Generation X, especially people born in the United States and Canada from the early 1980s to the late 1990s." However, common definitions are Gen X includes those who were born between 1965 and 1978 to 80; Gen Y includes those who were born between 1981-83 and 1991-94.

Depression and World War II while younger ones grew up in the 1980's and 1990's, a time of relative excess.

Comparing among four generations in the marketplace, the FMI's *Trends* surveys indicate that the Baby Boomer birth cohort is the largest – nearly 40 percent of the retail food market – and the most lucrative market. They make up 50 percent of total spending power in the U.S. Not surprisingly, this cohort is at the height of their income potential and spending power. Moreover, together with the “Mature” cohort, they are more conscious of their health and their diets, particularly about the nutritional content of foods compared to younger cohorts. Also, they are more likely to consume fresh fruits and vegetables. This observation is confirmed by studies that focus on measuring quality of life by Healthy Eating Index⁸ (HEI) scores. Results show that elderly women had the highest scores, reflecting high consumption of whole grains, fruits, and vegetables. Generally, HEI scores increased with age (for adults), education, and income (Variyam et al, 1998; Basiotis et al, 2004).

4.2) Biological and Physiological Factors

Beside the close link between aging and changes in people's income, social status, and lifestyle, there exists strong biological and physiological aspect of aging that affects food consumption. Studies on older adults have noted that the intake of calories and most nutrients fall with increasing age (Elahi et al, 1983; Flynn et al, 1992; Wakimoto and Block, 2001). This reduction in energy intake is explained by reduced muscle mass and declined physical activity (Westerterp and Meijer, 2001), altered sensations of taste (Drewnowski, 2000), and thirst, hunger, and satiety (Morley, 2001). Furthermore, the

⁸ The Healthy Eating Index (HEI) is a measure of diet quality that assesses conformance to federal dietary guidance. The original HEI was created by the U.S. Department of Agriculture in 1995.

age-associated decline in function might be caused by cumulative exposure to risk factors and effects of chronic diseases beyond the aging process (Ory and Cox, 1994; Stewart and King, 1991; Drewnowski and Warren-Mears, 2001; Drewnowski and Evans, 2001).

On the other hand, food preferences are acknowledged to shift from sweet foods during adolescence towards a more diversified diet, particularly to more vegetables and fruits (Drewnowski, 1989; Birch and Sullivan, 1991). A study by Krebs-Smith et al (1995) found that age is a significant explanatory factor in vegetable intake. Similarly, using factor loading to identify consumer's characteristics with three dietary patterns, Park et al (2005) found that age is negatively associated with a "Fat and Meat" pattern while positively correlated with "Vegetable" and "Fruit and Milk" patterns. These age-associated changes emphasize the differences in food consumption and dietary patterns both between cohorts over time and as people age.

4.3) Other Factors that are Changing Over Time

4.3.1 Changes in Nutrition Recommendations

Since 1980, the Department of Health and Human Services (HHS) and the Department of Agriculture (USDA) has issued jointly every five years the *Dietary Guidelines for Americans*⁹. These guidelines provide general advice about good dietary habits and its link with health and the risk of major chronic diseases. Over the course of 25 years, although these guidelines have not changed much fundamentally, the priority has changed to include more details and to emphasize activity and moderation along with a proper mix of food groups in one's diet since the year 2000.

⁹ The USDA first published dietary guidance in 1894 in a Farmers' Bulletin. See Davis and Saltos (1999) for a complete history of dietary recommendations published by the USDA.

Most noticeably is the change from the ubiquitous food guide pyramid to MyPyramid in April 2005. Besides the six food groups that provide details (in cups and ounces instead of number of servings) on whole grains, vegetables, fruits, oils, milk, and meat and beans, MyPyramid also includes recommendations on physical activity and discretionary calorie consumption. Moreover, the USDA also released a set of twelve health and nutrition plans based on gender and age of consumers. These plans can be personalized based on nutritional need and calorie balance between food intake and energy expenditure. These changes in nutrition recommendations highlight the fact that there are differences in recommended food and nutrient intake among different age groups. Therefore, consumers who follow these guidelines will be likely to adjust their food patterns to incorporate new information.

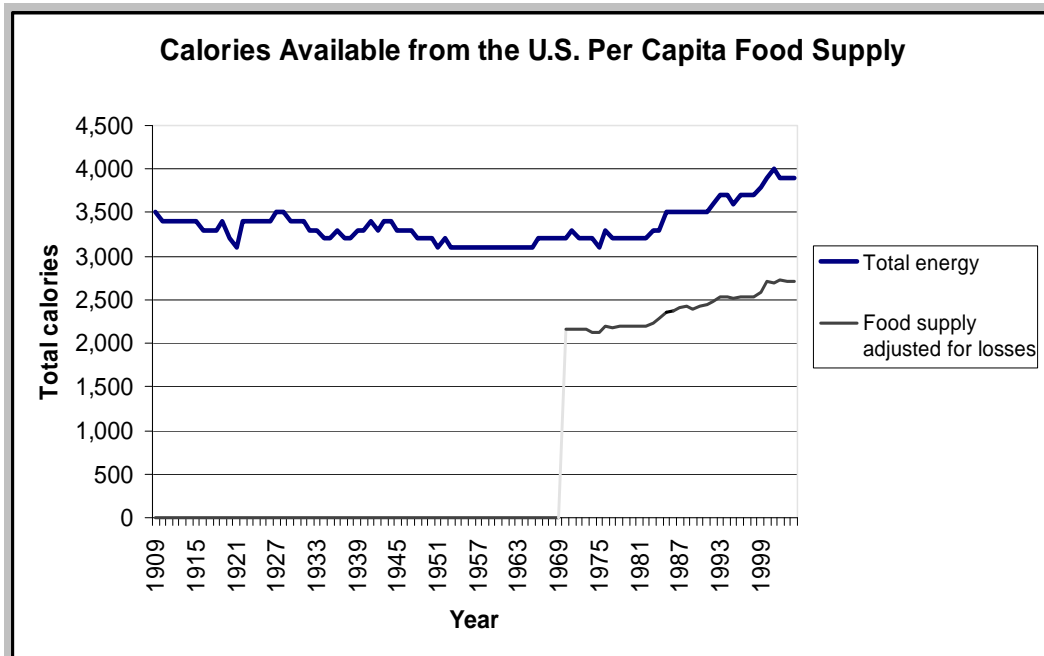
4.3.2 Technology

The link between technology and food choice originated from food production policies and technology advancements that introduce new products such as fat and sugar substitutes, in addition to reduced real food prices. Particularly, technology innovation leading to cheaper ingredients such as high-fructose corn syrup, together with improved processing and packaging over the last three decades have made pre-processed and packaged foods cheaper, more available, and more palatable (Lakdawalla and Phillipson, 2002, Cutler et al, 2003). These factors impact the younger and/or working-age cohorts more than older cohorts due to time constraints and the need for quick and convenient solutions for meal preparation. Indeed, *Trends* (2007) shows that ready-to-eat, takeout solutions is most popular among time-starved groups, i.e., full-time working women, single males, single mothers, and shoppers with older children (aged 7 to 12).

4.3.3 Food Supply

Data from USDA indicates that the variety and types of food in the U.S. food system paralleled changes in consumer preferences such as demand for more healthful foods, increased ethnic diversity, and more elderly consumers in the U.S. population. Together with more effective nutrition policy and dietary guidance from the federal government, the U.S. food supply has evolved dramatically in the last three decades. From the food supply side, USDA's data on both total and loss-adjusted food supply available for consumption indicate an increase of 12 percent in average calories available (about 300 calories,) between 1985 and 2000. Of this 300 calories increase, (refined) grains accounted for 46 percent; added fat, 24 percent; added sugar, 23 percent; fruits and vegetables, 8 percent; and the meat and dairy groups together, declined by 1 percent (Putnam et al, 2002).

Figure 8: Calories Available from the U.S. Per Capita Food Supply, 1909-1999



Note: No data available for food supply adjusted for losses prior to 1969

Source: USDA's Center for Nutrition and Promotion; ERS.

Using the same data source but in a slightly different time frame (1970-1995), Harnack et al (2000) document the annual per capita availability for U.S. consumers as a decrease for red meat (11.9 %) and eggs (21.1%) but an increase for poultry (84.5%), fish and shellfish (23.1%), all types of fats and oils (21.8%), cheese (111.6%), fruits and vegetables, flour and cereal products, and corn sweetener (238.4%). At the same time, availability and sales of reduced-energy and reduced-fat products also grew rapidly. Figure 8 shows the aggregate U.S. per capita food supply trend since 1909 to 2001. The lower line illustrates food available after accounting for losses in spoilage, preparation, shipping, and packaging.

Although the cohort effects are better illustrated by changes in individual food intakes, information on per capita food supply supplements these effects on consumer choice over time by expressing changes in availability and diversity of food sources.

5. Issues in Method of Analysis

5.1) Data Sources

In general, food consumption and dietary information has been available at several levels: food supply data, household, and individual. Food supply data or food balance sheets provide gross estimates of the amount and type of food available for human consumption in a country. Food supply data from around the world is documented by the Food and Agriculture Organization (FAO), a United Nation organization headquartered in Rome. It provides essential information on a country's food system in three sections: domestic supply, domestic utilization, and per capita consumption values for all agricultural commodities. In addition, the U.S. Department of Agriculture (USDA) provides the U.S. Food Supply Series, which contains the measure of per capita

availability of several hundred food commodities and per capita per day nutrient availability estimates (Putnam et al, 2002).

At the household level, food expenditure with prices at retail locations for specific food items purchased is collected by ACNielsen and Information Resources, Inc. (IRI). At the individual level, there are several federal datasets that provide information on food consumption, expenditures, dietary patterns, and knowledge. There are two types of data collected, cross-sectional and longitudinal (panel).

Cross sectional data is useful for studying generational differences at a given time. Repeated cross sectional and longitudinal are useful in studying multiple effects by looking at either the same age group over time or following the same cohort over time. The former type of data can extract information on differences among cohorts over time (e.g. do those age 20-30 eat the same in 2006 as those age 20-30 did in 1986?) while the latter can examine the ageing process since it contains information of the same individuals (e.g. do those who were age 20-30 in 1996 still eat the same foods in 2006 when they are age 30-40?).

Repeated cross-section datasets available are:

- Nationwide Food Consumption Survey (NFCS), collected between 1977-78 and 1987-88 by the U.S. Department of Agriculture.
- Continuing Survey of Food Intakes by Individuals (CSFII), collected in three rounds, 1989-91, 1994-96, and a supplement in 1998, by the U.S. Department of Agriculture. More information for the above datasets is available at

<http://www.ars.usda.gov/Services/docs.htm?docid=14392>

- National Health and Nutrition Examination Survey (NHANES), collected by the U.S. Department of Health and Human Services. There are six rounds in this database, 1971-75, 1976-80, 1988-94, 1999-2000, 2003-04, and 2005-06. In 2002, the CSFII dietary component *What We Eat in America* was integrated into the NHANES. Information is available at <http://www.cdc.gov/nchs/nhanes.htm>
- Behavioral Risk Factor Surveillance System (BRFSS), collected by 50 state health departments as well as District of Columbia, Puerto Rico, Guam, and the U.S. Virgin Islands with support from the Centers for Disease Control and Prevention (CDC). Information is available at <http://www.cdc.gov/brfss/>
- Food Availability (Per Capita) Data System, maintained by the Economic Research Service (ERS) of the U.S Department of Agriculture (USDA). This dataset includes three distinct but related data series on food consumption: Food Availability, Nutrient Availability, and Loss-Adjusted Food Availability (also known as Food Guide Pyramid Servings Data), with some food items information available since 1909. The data serve as popular proxies for actual consumption at the national level. Information is available at <http://www.ers.usda.gov/Data/FoodConsumption>

Longitudinal datasets available are:

- Consumer Expenditure Survey (CES), collected for the Bureau of Labor Statistics by the Census Bureau since 1888. Initially, it was collected every 10-12 years; each round was for a different purpose. Since 1979, it has been collected annually. It consists of two surveys, the quarterly Interview survey and the Diary survey. One of its objectives is to provide information on the spending patterns of

- different types of families, including data on expenditures, income, and consumer characteristics. Each consumer unit is interviewed every three months over five calendar quarters. Information is available at <http://www.bls.gov/cex/home.htm>
- Early Childhood Longitudinal Study, collected by the National Center for Education Statistics (NCES). It is designed to provide detailed information about children's early life experiences. The birth cohort in this database contains information on children's health, development, care, and education during the formative years from birth through kindergarten entry. Information is available at <http://nces.ed.gov/ecls>
 - Health and Retirement Study (HRS) of people over age 50, collected by the University of Michigan every two years since 1992. Part of its objective is to monitor changes in people's consumption and activities as they age. Information is available at <http://hrsonline.isr.umich.edu>
 - Panel Study of Income Dynamics, collected by the Survey Research Center at the University of Michigan since 1968. Information is available at <http://psidonline.isr.umich.edu/Guide/ug/intro.html>

There are also some datasets that are either of smaller scale (focusing on specific subgroups of the population), or collected for specific purposes. Examples include

- Longitudinal Studies of Aging (LSOA), a collaborative project of National Center for Health Statistics (NCHS) and the National Institute on Aging (NIA). It is a multi-cohort study of persons 70 years of age or older. Part of its purpose is to track changes in health, including diet and nutrition intake over time. <http://www.cdc.gov/nchs/about/otheract/aging/lsoa1.htm>

- The Baltimore Longitudinal Study of Aging, collected by the National Institutes of Health (NIH) since 1958. One of its objectives is to trace the relationship between ageing and food/nutrition intake over time. The sample consists of 180 men who are predominantly White, highly educated, and upper-middle class. Their ages ranged from 35 to 74 at entry into the study. Information is available at <http://www.grc.nia.nih.gov/branches/blsa/blsanew.htm>
- The National Eating Trends Survey, conducted by the NPD Group Inc. One of its products is a dataset *National Eating Trends* (NET), which includes up to 10 years of data that ended in 2004. Its NET *Nutrient Intake* database merges frequency from the NET data with portion size and nutrient composition information from the USDA's CSFII and Nutrient database. Information is available at http://www.npd.com/corpServlet?nextpage=food-beverage-national-eating-trends_s.html

On the other hand, trends in consumer demand – mostly consumer food purchasing behavior – is monitored closely by retailers. Typical information collected is consumer preferences such as types of food, packaging, organic versus conventional produce. Furthermore, surveys also collect information on consumers' eating habits, food shopping habits and expenditure, and frequency of eating out. Summary articles about these types of information are available from several sources such as the Food Marketing Institute (FMI) <http://www.fmi.org/> and Progressive Grocer <http://www.progressivegrocer.com> .

Typically, information is grouped by several criteria such as income level, geographic regions, rural/urban, or size of households. However, for the purpose of this

report, we focus on differences among cohorts of consumer. Cohorts are often defined as people in age groups that are characterized and labeled by demographers, market researchers, and the media as “Generation Y” for those who are born in late 1970s to the late 1990s; “Generation X” for those between early 1960s to the late 1970s; “Younger boomer” for those between mid 1950s and mid 1960s; “Older boomer” for those between mid 1940s and mid 1950s, and “Matures” for those who are born in mid 1940s or earlier.

5.2 Database for Food and Nutrient Conversion

To convert food items to nutrient and energy intake, researchers rely on several databases such as

- The Food and Nutrient Database for Dietary Studies (FNDDS), maintained by the Agricultural Research Service (ARS) of the USDA. This database is used for CSFII, NHANES, and WWEIA. It is an extensive database that includes foods in many mixtures, ethnic foods, and brand name items. The nutrient values are based on values in USDA National Nutrient Database form Standard Reference. See <http://arsserv0.tamu.edu/Services/docs.htm?docid=12089> for more information.
- University of North Carolina-Chapel Hill food grouping system. This database aggregates all the foods in the USDA nutrient composition tables into 74 descriptive and nutrient-based subgroups. More information is available at http://www.sph.unc.edu/cnrc/core_b.html
- The Nutrition Data System for Research (NDSR), developed by the Nutrition Coordinating Center at the University of Minnesota <http://www.ncc.umn.edu>

6. Conclusion

The proportion of elderly in the U.S. population is increasing, as many Americans are living to an advanced age. This trend makes analysis of patterns of food demand and consumption increasingly important for those who study nutrition and health, those who design food/feeding programs, and for those who design and sell food to consumers. This report summarizes the main findings of what is known about cohort and aging effects of food patterns and changes over time.

There exist significant cohort (generational) effects related to income and food expenditures. With positive income elasticities on most foods, and with each succeeding cohort realizing higher real per capita income, food expenditures continue to increase over time. However, for the older cohorts (aged 61 and higher), food away-from-home expenditure is lower compared to other cohorts, food-at-home expenditure is the highest. Older cohorts tend to spend more on red meats, poultry, fish, eggs, dairy products, fruits, beverages, fats and oils, while younger cohorts spend more on cereal and bakery products as well as prepared foods. The trend of decreasing diet quality in the transition from childhood to young adults is observed in several studies.

While total energy intake has increased for all age groups in the last three decades, the increase is highest in the youngest age group and smallest in the oldest group. Moreover, there is a shift in the oldest group to healthier food choices such as fruits and vegetables. They are more likely to take supplements, and more likely to meet the USDA recommended dietary guidelines than younger people.

There are several socioeconomic factors and time constraints that differentiate food patterns among age groups. Higher income and greater time constraints among

working-age cohorts induces people to choose convenience foods; they are more likely to eat out compared to the retired-age cohorts. There are also biological and physiological factors such as reduced muscle mass, declined physical activities, and altered sensation of taste and satiety, that affect food and nutrient intake of older age groups. Besides changes in nutritional recommendations, an increase in the food supply supported food consumption patterns of all consumers in the last few decades.

Taken together, the studies reviewed indicate that the aging effect is greater than the cohort effect. Perhaps this reflects the type of data available, since in very few cases are the same people and their eating habits followed over a lifetime. However simulation of cohorts by looking at data for various age groups at different points in time does not strongly indicate that food habits follow one through a lifetime. We are more likely to change food consumption as we age due to a number of factors including food availability, new experiences and information, and physiological and health changes as bodies mature. With an advancing age population, continued study of food habits and nutritional needs of mature people will be a fertile topic for diet and health research and new markets.

References

- Ahmed, F.E. "Effect of nutrition on the health of the elderly." *Journal of the American Dietetic Association* 92 (1992):1102-8.
- Ballenger, N., and J. Blaylock "Consumer-Driven Agriculture." *U.S. Department of Agriculture, Economics Research Service, Amber Waves* April 2003.
- Balluz, L.S., S.M. Kieszak, R.M. Philen, and J. Mulinare "Vitamin and mineral supplement use in the United States. Results from the third National Health and Nutrition Examination Survey." *Archives of Family Medicine* 9 (2000):258-62.
- Basiotis, P.P., A. Carlson, S.A. Gerrior, R. Juan, and M. Lino "The Healthy Eating Index, 1999-2000: Charting Dietary Patterns of Americans." *Family Economics and Nutrition Review* 16 (2004):39-48.
- Birch, L.L., and S.A. Sullivan "Measuring children's food preferences." *The Journal of School Health* 61 (1991):212-4.
- Blisard, N. "Income and Food Expenditures Decomposed by Cohort, Age, and Time Effects." *U.S. Department of Agriculture, Economics Research Service, TB-1896* (2001).
- Blisard, N., B.H. Lin, J. Cromartie, and N. Ballenger "America's Changing Appetite: Food Consumption and Spending to 2020." *Food Review* 25 (2002):2-9.
- Block, G., W.F. Rosenberger, and B.H. Patterson "Calories, fat and cholesterol: intake patterns in the U.S. population by race, sex and age." *American Journal of Public Health* 78 (1988):1150-5.
- Briefel, R.R., and C.L. Johnson "Secular trends in dietary intake in the United States." *Annual Review of Nutrition* 24 (2004):401-31.
- Casagrande, S.S., Y. Wang, C. Anderson, and T.L. Gary "Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002." *American Journal of Preventive Medicine* 32 (2007):257-63.
- Cavadini, C., A.M. Siega-Riz, and B.M. Popkin "U.S. adolescent food intake trends from 1965 to 1996." *Archives of Disease in Childhood* 83 (2000):18-24.

- Chernoff, R. "Nutrition and health promotion in older adults." *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 56 Spec No 2 (2001):47-53.
- Cutler, D.M., E.L. Glaeser, and J.M. Shapiro "Why Have Americans Become More Obese?" *Journal of Economic Perspectives* 17 (2003):93-118.
- Deaton, A. *The Analysis of Household Surveys*, The Johns Hopkins Univ. Press, 1997.
- Demory-Luce, D., M. Morales, T. Nicklas, T. Baranowski, I. Zakeri, and G. Berenson "Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study." *Journal of the American Dietetic Association* 104 (2004):1684-91.
- Drewnowski, A. "Taste responsiveness in eating disorders." *Annals of the New York Academy of Sciences* 575 (1989):399,408; discussion 408-9.
- Drewnowski, A. "Sensory control of energy density at different life stages." *The Proceedings of the Nutrition Society* 59 (2000):239-44.
- Drewnowski, A., and W.J. Evans "Nutrition, physical activity, and quality of life in older adults: summary." *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 56 Spec No 2 (2001):89-94.
- Drewnowski, A., and V.A. Warren-Mears "Does aging change nutrition requirements?" *The Journal of Nutrition, Health & Aging* 5 (2001):70-4.
- Elahi, V.K., D. Elahi, R. Andres, J.D. Tobin, M.G. Butler, and A.H. Norris "A longitudinal study of nutritional intake in men." *Journal of Gerontology* 38 (1983):162-80.
- Fanelli, M.T., and K.J. Stevenhagen "Characterizing consumption patterns by food frequency methods: core foods and variety of foods in diets of older Americans." *Journal of the American Dietetic Association* 85 (1985):1570-6.
- Flynn, M.A., G.B. Nolph, A.S. Baker, and G. Krause "Aging in humans: a continuous 20-year study of physiologic and dietary parameters." *Journal of the American College of Nutrition* 11 (1992):660-72.
- Food Marketing Institute. *Trends in the United States: Consumer Attitudes and the Supermarket*. Food Marketing Institute, Washington, DC. 2000-2007.

- Gerrior, S.A. "Dietary changes in older Americans from 1977 to 1996: implications for dietary quality." *Family Economics and Nutrition Review* 12 (1999):3-14.
- Hallfrisch, J., D. Muller, D. Drinkwater, J. Tobin, and R. Andres "Continuing diet trends in men: the Baltimore Longitudinal Study of Aging (1961-1987)." *Journal of Gerontology* 45 (1990):M186-91.
- Harnack, L.J., R.W. Jeffery, and K.N. Boutelle "Temporal trends in energy intake in the United States: an ecologic perspective." *American Journal of Clinical Nutrition* 71 (2000): 1478-84.
- Harnack, L., J. Stang, and M. Story "Soft drink consumption among U.S. children and adolescents: nutritional consequences." *Journal of the American Dietetic Association* 99 (1999):436-41.
- Henchy, J.A, "The Generation Gap, Based on Trends in the U.S.: Consumer Attitudes and the Supermarket, 2001." *The Food Marketing Institute* (2001): 1-8
- Kant, A.K. "Reported consumption of low-nutrient-density foods by American children and adolescents: nutritional and health correlates, NHANES III, 1988 to 1994." *Archives of Pediatrics & Adolescent Medicine* 157 (2003):789-96.
- Kant, A.K., and B.I. Graubard "Predictors of reported consumption of low-nutrient-density foods in a 24-h recall by 8-16 year old U.S. children and adolescents." *Appetite* 41 (2003):175-80.
- Krebs-Smith, S.M., L.E. Cleveland, R. Ballard-Barbash, D.A. Cook, and L.L. Kahle "Characterizing food intake patterns of American adults." *The American Journal of Clinical Nutrition* 65 (1997):1264S-8S.
- Krebs-Smith, S.M., J. Heimendinger, B.H. Patterson, A.F. Subar, R. Kessler, and E. Pivonka "Psychosocial factors associated with fruit and vegetable consumption." *American Journal of Health Promotion : AJHP* 10 (1995):98-104.
- Lakdawalla, D. and Phillipson, T. "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination." (2002) NBER working paper No. 8946.
- Lytle, L.A., S. Seifert, J. Greenstein, and P. McGovern "How do children's eating patterns and food choices change over time? Results from a cohort study." *American Journal of Health Promotion : AJHP; American Journal of Health Promotion : AJHP* 14 (2000):222-8.

- Millen, A.E., K.W. Dodd, and A.F. Subar "Use of vitamin, mineral, nonvitamin, and nonmineral supplements in the United States: The 1987, 1992, and 2000 National Health Interview Survey results." *Journal of the American Dietetic Association* 104 (2004):942-50.
- Morley, J.E. "Decreased food intake with aging." *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 56 Spec No 2 (2001):81-8.
- Moeller, S., J. Reedy, A. Millen, L. Dixon, P. Newby, K. Tucker, S. Krebs-Smith, and P. Guenther "Dietary Patterns: Challenges and Opportunities in Dietary Patterns Research." *Journal of the American Dietetic Association* 107 (2007):1233-9.
- Munoz, K.A, S.M Krebs-Smith, R. Ballard-Barbash, and L.E Cleveland "Food Intakes of US Children and Adolescents Compared with Recommendations." *Pediatrics* 100 (1997): 323-29.
- Murphy, S.P., D. Rose, M. Hudes, and F.E. Viteri "Demographic and economic factors associated with dietary quality for adults in the 1987-88 Nationwide Food Consumption Survey." *Journal of the American Dietetic Association* 92 (1992): 1352-7.
- Nielsen, S.J., and B.M. Popkin "Changes in beverage intake between 1977 and 2001." *American Journal of Preventive Medicine* 27 (2004):205-10.
- Nielsen, S.J., and B.M. Popkin "Patterns and trends in food portion sizes, 1977-1998." *JAMA : The Journal of the American Medical Association* 289 (2003):450-3.
- Nielsen, S.J., A.M. Siega-Riz, and B.M. Popkin "Trends in energy intake in U.S. between 1977 and 1996: similar shifts seen across age groups." *Obesity research* 10 (2002):370-8.
- Ory, M.G., and D.M. Cox "Forging ahead: Linking health and behavior to improve quality of life in older people." *Social Indicators Research* 33 (1994):89-120.
- Park, S.Y., S.P. Murphy, L.R. Wilkens, J.F. Yamamoto, S. Sharma, J.H. Hankin, B.E. Henderson, and L.N. Kolonel "Dietary patterns using the Food Guide Pyramid groups are associated with socio-demographic and lifestyle factors: the multiethnic cohort study." *The Journal of Nutrition* 135 (2005):843-9.

- Popkin, B.M., P.S. Haines, and R.E. Patterson "Dietary changes in older Americans, 1977-1987." *The American Journal of Clinical Nutrition* 55 (1992):823-30.
- Putnam, J., J. Allshouse, and L.S. Kantor "U.S. per capita food supply trends: more calories, refined carbohydrates, and fats." *Food Review* 25 (2002):2-15.
- Roberts, C.K., and R.J. Barnard "Effects of exercise and diet on chronic disease." *Journal of Applied Physiology* 98 (2005):3-30
- Stewart, A., and A. King "Evaluating the efficacy of physical activity for influencing quality-of-life outcomes in older adults." *Annals of Behavioral Medicine* 13 (1991):108-16.
- U.S. Bureau of the Census, <http://www.census.gov/main/www/cen2000.html>
- U.S. Department of Agriculture, ERS Briefing Room, Series of Food CPI, Prices, and Expenditures (2007)
<http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/data/>
- Variyam, J.N., J. Blaylock, and D. Smallwood "USDA's Healthy Eating Index and Nutrition Information." U.S. Department of Agriculture, Economics Research Service, *TB 1866* (1998).
- Wakimoto, P., and G. Block "Dietary intake, dietary patterns, and changes with age: an epidemiological perspective." *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 56 Spec No 2 (2001):65-80.
- Westerterp, K.R., and E.P. Meijer "Physical activity and parameters of aging: a physiological perspective." *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 56 Spec No 2 (2001):7-12.
- World Health Organization (WHO), <http://www.who.int/mediacentre/factsheets/fs135/en/>