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The relationship among alcohol consumption, dietary intake, and body mass index in young adults

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THE RELATIONSHIP AMONG ALCOHOL CONSUMPTION, DIETARY INTAKE, AND BODY MASS INDEX IN YOUNG ADULTS

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DEDICATION

This manual is dedicated with love to my dearest friend and husband, Robert R. May, who has selflessly supported me through my undergraduate and graduate studies.

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ABSTRACT

This study was designed to assess the relationship of alcohol consumption, dietary intake, and body mass index (BMI) in 1,335 young adult males and females aged 20-38 years (62% female and 27% black) who were part of the Bogalusa Heart Study. Data were collected in 1995-1996 on dietary intake and alcohol consumption patterns.

The prevalence of alcohol consumption was higher in males compared with females and higher in whites than blacks. Among drinkers, whites and blacks did not differ in the amount of alcohol consumed. Energy from alcohol was also greater in males than in females.

Total energy intake did not differ between drinkers and non-drinkers. Across levels of alcohol consumption, total energy intake was not significantly different among non-drinkers, light drinkers, or moderate drinkers; however, heavy drinkers consumed significantly more total energy than did non-drinkers, light, and moderate drinkers.

Drinkers did not differ from non-drinkers in relation to non-alcohol energy intake. Intake of non-alcohol energy remained constant across levels of alcohol consumption.

Carbohydrate intake (g) was significantly lower in drinkers compared with non-drinkers. Carbohydrate intake was significantly lower in moderate and heavy drinkers compared with lower levels of alcohol consumption.

Mean energy intake from protein (g) did not differ between drinkers and non-drinkers. Protein intake was significantly lower in heavy drinkers compared with lower levels of alcohol consumption.

Total fat intake (g) was significantly lower in drinkers compared with non-drinkers. Total fat intake was significantly lower in heavy drinkers compared with lower levels of alcohol consumption.

Adjusted means for BMI and waist circumference were greater drinkers than for non-drinkers. Mean BMI did not differ between males and females; however, waist circumference was greater in males than in females.

Energy from alcohol was added to the diets of drinkers, particularly heavy drinkers. Paradoxically, drinkers had a lower BMI and a smaller waist circumference than did non-drinkers.

CHAPTER 1

INTRODUCTION

Many studies have focused on the role of alcohol in cardiovascular disease (CVD) (1-10), but fewer studies have examined the relation among alcohol consumption, body weight, and total energy and nutrient intake (11, 12), particularly in young adults. Alcohol consumption and obesity are common among Americans (13-20), and both can affect the risk of many chronic diseases, including the risk of CVD (12, 16, 19).

The rate of alcohol consumption in young adults has increased over the past decade (13). Significant increases were observed in the rate of current alcohol use in adults aged 18 years and older over the past three years. Current alcohol use, defined as consuming at least one drink in the previous thirty days, has risen from nearly 57% in 2000 to over 60% in 2002 for persons aged 18 to 25 years. For adults aged 26 years and older, the rate of current alcohol use has risen from 49% in 2000 in approximately 54% in 2002 (13). It has been reported that approximately 4% to 10% of total energy consumed in the American diet is from alcohol (15, 21, 22).

The prevalence of overweight and obesity in the United States population has increased significantly in all age groups in the last twenty years (16, 23). Current national data indicate that over 64% of adults over the age of 20 are either overweight or obese (16). In the last two decades, the prevalence of obesity has risen from approximately 15% to 31%. As weight increases, the rates of morbidity and mortality from chronic diseases increase (24-27).

Atherosclerosis and hypertension begin in childhood and progress throughout a lifetime (28-30). Children who are overweight tend to become overweight or obese adults (31, 32). There is a relationship between overweight and hypertension, type 2 diabetes, and CVD in adults (19, 23, 33-35). Cardiovascular disease, including coronary heart disease and stroke, is the leading cause of death for both males and females in the United States (35). Nearly 40% of all deaths are attributed to CVD. Although more common among people aged 65 years and older, the number of sudden deaths from heart disease among people aged 15 to 34 years has increased (35). Besides overweight, other risk factors for cardiovascular disease in adults include behavior and lifestyle habits involving diet, physical inactivity, excessive alcohol intake, and cigarette smoking (34, 35).

In 1995 to 1996, the Bogalusa Heart Study (BHS), an epidemiologic study of CVD risk factors from birth through young adulthood, surveyed young adults who were BHS participants in childhood to assess dietary intake and alcohol consumption. Participants completed the Youth and Adolescent Questionnaire, a self-administered food frequency questionnaire, and the Health Lifestyle-Behavior Questionnaire, which contained questions concerning alcohol consumption (T. Nicklas, personal communication, September 28, 2002). The data set used for analysis in this thesis contains dietary and alcohol information on 1,345 young adults aged 20 to 38 years (62% female and 27% black).

Justification

The relation among alcohol consumption, body mass index (BMI), and macronutrient intake in a biracial young adult population has not been investigated (T. Nicklas, personal communication, September 28, 2002). Drinking alcohol is a common practice among young adults (13). Alcohol consumption and weight have increased over the last decade (13, 16). Because weight gain has been associated with chronic diseases, including heart disease, in adults (19, 23, 33, 34, 35), it is important to explore the relationship among alcohol consumption, energy and nutrient intakes, and BMI in young adults.

Study Objective

The objective of the proposed study is to examine the relation among alcohol consumption and total energy intake and non-alcohol energy in black and white young adults aged 20 to 38 years who participated in the BHS. The relation among alcohol intake and macronutrients will also be examined in this study.

Hypotheses

The hypotheses of this study are:

1. More white males consume alcohol than black males or females.
2. Total energy increases with increased alcohol consumption in males and females.
3. Non-alcohol energy decreases with increased alcohol consumption in males and females.
4. Body mass index is lower in males and females who consume alcohol compared with males and females who are non-drinkers.
5. As alcohol consumption increases, energy from macronutrients decreases in males and females.

Assumptions

- The sample size is adequate to evaluate the relation among alcohol consumption, total energy and nutrient intake, and BMI.

- The Youth and Adolescent Questionnaire (YAQ) (food frequency questionnaire) used to collect data on energy and nutrient intakes are valid and reliable.
- The Health Habits Questionnaire used to investigate the prevalence of alcohol consumption is valid and reliable.
- Participants gave truthful answers on the self-reported YAQ.

Limitations

- Because the questionnaires were self-administered, participants may have been uncertain of the terms or the meaning of the questions, which could lead to inaccurate answers.
- The YAQ food list is limited to 131 food items.
- The YAQ is a semi-quantitative food frequency questionnaire in which foods are grouped into broad categories. Consequently, the ability to collect information about specific food items is limited.
- The YAQ and the Health Habits Questionnaire rely on memory.
- Power calculations were done on CV risk factors and not on dietary intake, including alcohol consumption, in the BHS.
- Dietary intake and alcohol consumption were reported on separate questionnaires; therefore, more variability may result in non-alcohol energy and total energy intake.

CHAPTER 2

REVIEW OF LITERATURE

Bogalusa Heart Study

The Bogalusa Heart Study (BHS) is a long-term, epidemiologic study of children and young adults in a precisely defined, biracial (black and white) population of Bogalusa, Louisiana (36-38). Originally funded by the National Institutes of Health in 1972, the Specialized Center of Research (SCOR) was established to investigate the major risk factors of cardiovascular disease (CVD) in children (36, 39). In 1973, the BHS was launched to explore the early natural history of coronary artery disease and essential hypertension and to identify the childhood risk factors associated with adult heart diseases (36-39). Cross-sectional and longitudinal studies were designed to answer four specific questions upon which the BHS was originally based: (1) What are the distribution and prevalence of cardiovascular (CV) risk factors in children and how are abnormal levels defined? (2) What are the relationships among CV risk factors (e.g. obesity, high blood pressure, hyperlipidemia) in children? (3) What is the course of time in which CV risk factors develop and change, and can CV risk factors be tracked? (4) How are CV risk factors affected by genetic and environmental interactions? (36, 37, 39)

Bogalusa, Louisiana is located in Washington Parish in the southeastern corner of the state. Bogalusa is a semi-rural community with a population of approximately 22,000 people, including 5,000 children. The study population of children in Bogalusa is approximately 35% black and 65% white (29, 36, 39). Studying a biracial population permits researchers to follow and compare cardiovascular risk factors that may be influenced by race. Cross-sectional and longitudinal observations on more than 14,000 black and white children and young adults in Bogalusa have determined the early natural history of cardiovascular disease risk factors in the biracial population. The community was chosen to represent the population of the southeastern portion of United States (36, 39).

Since 1973, follow-up studies of the original study population who are still available involve annual physical examinations, including blood tests and blood pressure measurements (38). The participants' height, weight, dietary habits, tobacco and alcohol use, oral contraceptive use, and physical activity are recorded (38).

Findings of the BHS show that major etiologies of adult heart disease, atherosclerosis, coronary heart disease, and essential hypertension begin in childhood (28-30, 34, 36). Cardiovascular disease risk factors can be identified in early life but change with an individual's growth phases. Risk factors vary during the first year of life, during puberty and adolescence, and during the transition to young adulthood. Autopsy studies of children in Bogalusa have provided evidence that heart disease can develop in children as early as age three (28-30). Results from the BHS autopsy studies are congruent with autopsy studies of young soldiers killed in the Korean and Vietnam wars, which showed that advanced coronary artery lesions are present in males in the second and third decades of life (40, 41). The BHS has shown that environmental factors, genetic factors, and controllable factors are strongly linked to dyslipidemia, hypertension, and obesity. Lifestyle behaviors that influence CV risk, particularly diet and exercise, are learned and begin early in life (34, 36, 42, 43).

Prevalence of Alcohol Consumption in Young Adults

The National Household Survey on Drug Abuse (NHSDA), a project of the Substance Abuse and Mental Health Services Administration (SAMHSA) of the federal government, was initiated in 1971 and is the primary source of information on the use of illicit drugs, alcohol, and tobacco (13). Annually, the NHSDA collects information from residents of every state over a 12-month period. The NHSDA interviews approximately 70,000 people age 12 years or older. For the 2001 survey, 157,471 household residents throughout the United States were screened. Of those, 68,929 persons age 12 and older were interviewed. For the 2001 survey, interviews were conducted from January to December 2001 (13).

The survey includes a set of questions about the recency and frequency of the consumption of alcoholic beverages, such as beer, wine, whiskey, brandy, and mixed drinks (13). Before the questions were administered, a list of examples of the kinds of beverages is given to the participants. A "drink" is defined as a can or bottle of beer, a glass of wine or a wine cooler, a shot of liquor, or a mixed drink containing liquor. Two levels of use are defined for both males and females and for all ages. Current use is defined as having at least one drink within the thirty days before the interview. Past year alcohol use is described as having had at least one drink in the past year (13).

In 2001, findings of NHSDA show that the rates of both current and past alcohol use increased from the previous year two years. For people aged 18 to 25, the rate for current alcohol use in 2001 was 64.3% and 75.4% for past year alcohol use (Figure 1). The rates of current and past alcohol use for those aged 26 to 34 in 2001 were 59.9% and 76.5%, respectively (13).

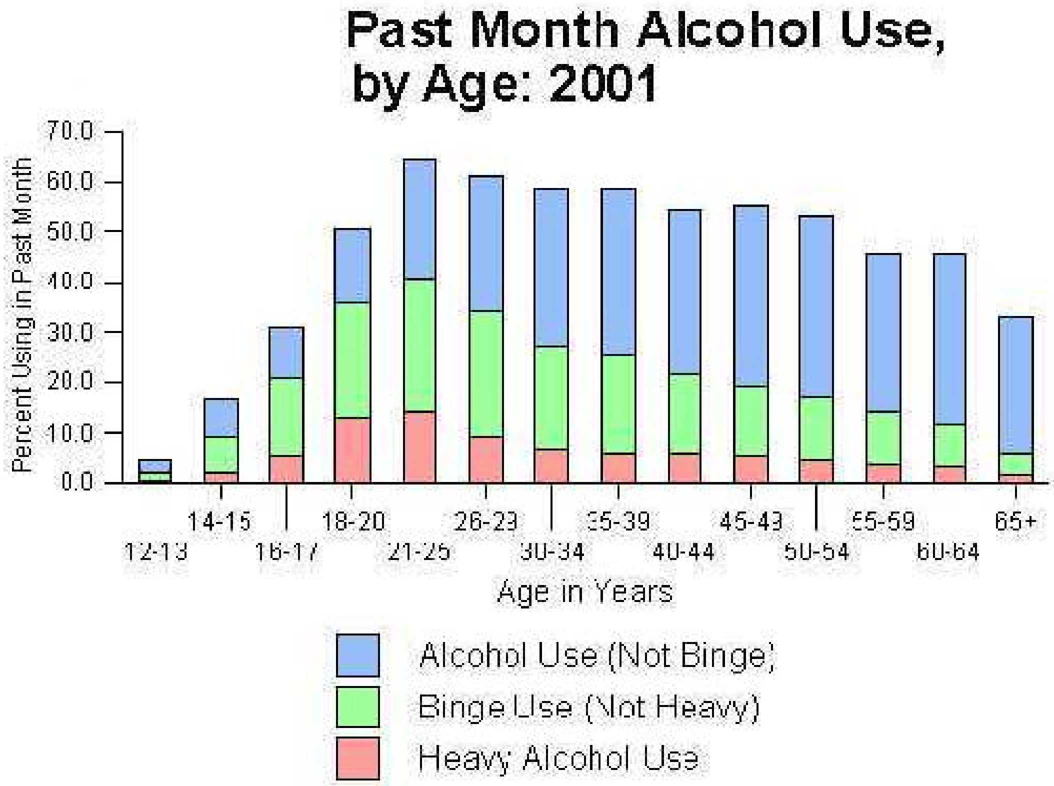

Figure 1. Past alcohol use by age: 2001 (Source: NHSDA).

Gender differences relative to alcohol use were also observed from the NHSDA data (13). Males had a tendency to drink more than females. In 2001, 64.7% of the males aged 18 to 25 reported current alcohol use compared with 53.0% of the females in the same age group. For males aged 18 to 25, 78.3% reported drinking alcohol in the past year, whereas 72.6% of females reported past year alcohol use (13).

The rate of alcohol consumption also differed between races. Over 64% of whites aged 18 to 25 and 54.9% aged 26 or older reported current month alcohol consumption, but only 46.5% and 37.2% of blacks in the respective age groups reported past month alcohol use. An estimated 80.8% of whites and 63.9% of blacks aged 18 to 25 reported using alcohol in the year prior to the survey interviews. Nearly 70% whites and 52% blacks aged 26 or older reported past year alcohol use (13).

Other national data, such as data from the National Health Interview Survey, on trends in adult alcohol use are consistent with the NHSDA results. Both NHSDA and NHIS show an increase in past year alcohol use from 2000 to 2001 (13).

The national trends of alcohol consumption by youths and young adults can be compared to earlier findings of the Bogalusa Heart Study (BHS). Bogalusa data collected from 1981 to 1991 were used to examine the prevalence of alcohol consumption among adolescents and young adults (44). Data were collected in three cross-sectional surveys of school-age children aged 11 to 19 years and three surveys of young adults aged 18 to 32 years. Alcohol consumption was more prevalent among male adolescents than female adolescents and black adolescents (44). White male adolescents were the highest drinking group (approximately 32.5%) and black females were the lowest drinking group (approximately 10%). These trends are consistent with the data reported by the NHSDA for the age group in 2001 (44).

Among young adults, the data are in agreement with national data, such that the prevalence of alcohol consumption was greater for males than females and that more white males than black males use alcohol. Overall, the prevalence of alcohol use between both races was nearly equal (44). A comparison of similar age groups across the three surveys showed that the percentages of white male drinkers declined significantly in the 18 to 23 year age group from approximately 70% to 55.5%, and in the 24 to 27 year age group from 67% to 50% (44).

Weekly alcohol consumption by young adults decreased significantly from 127.8 milliliters (mL) in the first survey to 85.2 mL in the last survey (44). An average of 85% of young adults drank beer either exclusively or in addition to other beverages (44).

Between 60% and 72% of young adults reported drinking alcohol once or twice a week. Daily alcohol intake was reported by 9% to 14% of young adults. In all three surveys, young adults who reported drinking every day had significantly higher alcohol intake than those who drank three to four times a week or once or twice a week (44).

Data collected in 1988-1991 from Bogalusa was used to examine eating patterns, nutrient intakes, and alcohol consumption patterns of 504 young adults aged 19 to 28 years who participated in the BHS (22). Males consumed significantly more alcohol than females. Alcohol accounted for 9% of daily energy intake in males compared with 4% in females. No race differences were seen in alcohol intake (22).

Among alcohol drinkers, approximately 77% of drinkers consumed beer, particularly males; 15% consumed wine, mostly females; and 17% consumed hard liquor, particularly white females. Females consumed hard liquor mostly in the form of mixed drinks, such as daiquiris and eggnog (22).

The Prevalence of Overweight and Obesity in Young Adults

National data indicate that overweight and obesity have increased dramatically over the past two decades for Americans of all ages (16, 20, 23). According to the National Health and Nutrition Examination Survey (NHANES) 1999-2000, over 64% of adults in the United States aged 20 to 74 are either overweight or obese (16, 20, 45). The prevalence of obese adults has more than doubled in the last twenty years from approximately 15% to nearly 31% (16, 45). As weight increases, so does health risks, particularly for CVD and type 2 diabetes (33, 45).

The principal source of national data on healthy weight, overweight, and obesity is obtained from the NHANES surveys (20, 45). Since 1960, the NHANES program of the National Center for Health Statistics, Centers for Disease Control and Prevention (CDC) has conducted cross-sectional health examination surveys from a nationally representative sample of the United States population (20, 45). Data collected from each NHANES survey provide current estimates and secular trends for overweight and obesity for the United States population (20, 45).

Previous NHANES surveys include the first National Health Examination Survey (NHES I, 1960-1962), and the first, second, and third NHANES Surveys (NHANES I, 1971-1974; NHANES II, 1976-1980; NHANES III, 1988-1994) (20, 45). In 1999, NHANES became an ongoing survey without breaks between survey periods (20, 45).

Height and weight measurements obtained from the NHANES surveys were used to assess the overall health and nutritional status of children and adults. Healthy weight, overweight, and obesity can be classified using BMI, which is calculated as weight in kilograms (kg) divided by the square of height in meters (m^2). For adults, a BMI between 18.5 and 24.9 indicates a healthy weight; overweight is defined as a BMI between 25.0 and 29.9; and a BMI of 30.0 or greater indicates obesity (16, 20). These definitions are consistent with those of the National Heart, Lung, and Blood Institute of the National Institutes of Health and the World Health Organization (47, 48). Body mass index is not a measure of body fatness; however, a person with a BMI in the overweight or obese range tends to have excess body fat. Studies have shown that health risk increases as BMI increases. In some cases, a BMI 25.0 or greater may be acceptable for people who are more muscular and have less fat (16).

NHANES reports that the prevalence of overweight and obesity for adults was relatively constant from 1960 to 1980; however, by 1988-1994 NHANES III, overweight and obesity increased significantly for white and black males and females aged 20 to 74 (45). The prevalence of overweight (BMI 25.0-29.9) was higher for males than for females, but the prevalence of obesity was higher for females than for males. From 1976-1980 NHANES II to 1988-1994 NHANES III, overweight among males increased from approximately 53% to 61% and from 42% to over 51% among females. Obesity in males increased from nearly 13% to approximately 21%; obesity in females increased 17% to 26%. Data from NHANES 1999-2000 showed that the prevalence of overweight had increased to 67% among males and to 62% among females. From 1988-1994 NHANES III to NHANES 1999-2000, statistically significant increases occurred in all sex-age groups except for males aged 40 to 59 years, which was not statistically significant but followed the same upward trend as the other sex-age groups. Overall, obesity among males increased from nearly 21% to 28% and from 26% to 34% for females within the ten years between NHANES III and NHANES 1999-2000 (45).

As of NHANES 1999-2000, the prevalence of overweight and obesity among white males and black males was not significantly different (45). Among females, however, black females had significantly higher prevalences of overweight and obesity than white females. Over 68% of black females were overweight and nearly 51% were obese compared with 47% white females who were overweight and nearly 31% who were obese (45).

As with other sex-age groups, the prevalence of overweight and obesity for males and females aged 20-34 remained constant from 1960 to 1980 and then increased significantly from 1976-1980 NHANES II to NHANES 1999-2000 (45). In 1980, 41% of males were overweight and 9% were obese. By 1999, 58% were overweight and 24%

were obese. For females aged 20-34, 37% were overweight in 1980 and 11% were obese. By 1999, over 51% of females were overweight and nearly 26% were obese (45).

The NHANES data on the prevalence of overweight and obesity are similar to data collected from the Coronary Artery Risk Development in Young Adults (CARDIA) (45, 46). CARDIA was a prospective, epidemiologic investigation of the causes and development of cardiovascular risk factors among 5,115 black and white young adults aged 18-30 years beginning in 1985-1986 (46). The cohort was followed over ten years to 1995-1996. Participants were recruited from four geographical areas: Birmingham, Alabama; Chicago, Illinois; Minneapolis, Minnesota; and Oakland, California. The study population was balanced according to age, sex, race, and education. As with NHANES, BMI and BMI ranges were used to assess and classify healthy weight, overweight, and obesity (16, 20, 45, 46).

CARDIA showed significant increases in the prevalence of overweight and obesity over the ten-year period for all race-sex groups (46). The increase was greatest among black females and the least among white females (46). At baseline, approximately 48% of black females were overweight, but by year ten, 72% of black females were overweight. The prevalence of overweight increased from approximately 24% at baseline to 42% at year ten for white females (46).

In all race-sex groups, average weight, BMI, and skinfold measurements increased over the ten year study (46). The average weight increases ranged from 11.9 (kg) in black females to 6.9 kg in white females. The largest weight gains occurred among participants who were already overweight at baseline. Average BMI increased from 4.1 kg/m^2 in black females to 2.3 kg/m^2 in white males. Average skinfold increased from approximately 18 millimeters (mm) in black females to approximately 10 mm in white females. Cumulatively, the marked trends in weight gain, increased BMI, and increased skinfold measurements indicate accumulations of excess body fat (46).

The upward trend in overweight and obesity among adults seen in the NHANES surveys and CARDIA was also observed in the Behavioral Risk Factor Surveillance System (BRFSS) from 1987 to 1993 (23). Data were collected in 33 states by the state health departments in collaboration with the CDC. Self-reported weights and heights were collected via telephone interviews on more than 400,000 persons aged 18 to 70+ who participated in the BRFSS survey over the five year period (23).

The definition of overweight differed in the BRFSS survey from the most current NHANES surveys and CARDIA. Overweight in the BRFSS survey was defined as a BMI of at least 27.8 for males and 27.3 for females (23). Severe overweight, or obesity, was defined as a BMI of at least 31.1 for males and 32.3 for females. The definitions were based on the 85^{th} and 95^{th} percentile values for BMI among US adults aged 20 to 29 years in NHANES II 1976-1980 (23).

From 1987 to 1993, the prevalence of overweight increased from 21.9% to 26.7% among males and from 20.6% to 25.4% among females (23). The prevalence of severe overweight rose from 6.5% to 9.4% for males and from 5.9% to 7.9% for females. By 1993, the greatest prevalence of overweight was seen in black females of whom 43.9% were overweight. The least prevalence of overweight occurred in white females of whom 22.7% were overweight. Nearly 32% of black males were overweight compared with approximately 26% of white males (23).

Results from the BHS are similar to those of CARDIA, NHANES, and BRFSS. All of the studies reported that black females were more obese than white females (23, 45, 46, 48). Data from the BHS indicate that by young adulthood, approximately 40% of black females were obese (33). Young adults in Bogalusa tended to be slightly heavier than in NHANES II 1976-1980. A higher percent of female subjects had BMIs 20% above NHANES II 1976-1980 medians. White males in Bogalusa were more overweight than black males, whereas black females were more overweight than white females (33).

Alcohol Consumption and Cardiovascular Disease

Light-to-moderate alcohol consumption is associated with a reduced risk of CVD (3-6, 8, 10, 49-51), whereas higher rates of morbidity and mortality are seen in abstainers and heavy drinkers (5, 6, 51-53). Evidence suggests a U-shaped relation between the amount of alcohol consumed and CVD with estimates at the bottom of the curve ranging from two to six drinks per day (6, 7, 52). The protective aspects of alcohol may occur primarily through an increase in high-density lipoprotein (HDL) cholesterol (1, 5, 8, 52, 53). Other potential cardioprotective mechanisms include effects on platelet function and antioxidant activity (3, 8, 54). Excessive alcohol consumption, regardless of beverage type, increases morbidity and mortality from hypertension, hemorrhagic stroke, and cardiomyopathy, as well as cancer, cirrhosis, accidents, and homicides (55-58).

The primary mechanism by which alcohol contributes to a reduced risk of CVD is through an increase in HDL cholesterol levels (1, 5, 8, 52, 53). In two prospective cohort studies of 4,860 males aged 45 to 59 in South Wales and Bristol, the relation between alcohol consumption and the primary HDL cholesterol subclasses, HDL_2 and HDL_3, were examined (52). In South Wales, alcohol intake was obtained as part of a self-administered diet questionnaire. In Bristol, the alcohol questionnaire was administered by a nurse. Both questionnaires asked about the frequency of drinking alcohol, and the type and amount of alcohol usually consumed. A fasting blood sample was used for lipid measurements. Although some studies have shown an increase in HDL_3 levels and not HDL_2 levels (59, 60), Miller et al found that both HDL_2 and HDL_3 cholesterol increased significantly with increasing alcohol intake. Total triglyceride levels, however, increased with increasing alcohol consumption (52), which is consistent with findings of studies in which triglyceride levels were measured (6, 10).

Although prospective studies provide information on current dietary habits on a large number of people, limitations of the study by Miller et al must be considered. Dietary intake and alcohol consumption information was assessed using a self-reported questionnaire in South Wales and interviewer-administered questionnaire in Bristol. Varying methods of data collection could impact the results of the study. Self-reported alcohol consumption may tend to underestimate actual consumption (61). It was not clear whether the questionnaires were identical or similar. Another limitation includes comparing data from different geographical regions. Dietary habits, type of alcohol consumed, and amount of alcohol consumed may vary from one geographical area to another. The report did not specify why these two populations were chosen for comparison. This study only included males; therefore, the results cannot be generalized to females. Race of the participants was not reported.

Several review articles have discussed the relation between the types of alcoholic beverage consumed (wine, beer, liquor) and the risk of CVD; they did not find that one type of drink was more cardioprotective than the others (6, 8, 10, 54, 62, 63). A study of three hundred forty cases of patients with myocardial infarction (MI) and an equal number of age-, sex-, and community-matched controls aged 76 years and younger were studied to determine the relationship of alcoholic beverage type and risk of MI (8). Dietary intake and alcohol consumption information was gathered using a semi-quantitative food frequency questionnaire. Total daily intake of alcohol was estimated using information about consumption of wine, beer, and liquor during the year before the MI for the cases and the year before the interview for the controls. A reduction of risk of MI was observed among light-to-moderate drinkers. Among drinkers, HDL cholesterol levels were higher for those who consumed primarily wine, beer, and liquor than among nondrinkers, which suggests that the ethanol in alcoholic beverages, rather than other constituents, is responsible for reduced risks of MI (8).

Participants were asked to recall dietary and alcohol consumption information for the year prior to the MI. Recalling past alcohol consumption may not be as problematic as recalling dietary information (61). An assumption can be made that patients who recently suffered a MI would need prescription drug therapy, which may affect HDL cholesterol levels; however, it was not mentioned whether prescription drug use was considered in the data analysis. This study looked at white males and females; therefore, the results cannot be generalized to other racial groups.

In a cross-sectional survey, HDL cholesterol increased with increased alcohol consumption in a biracial population (53). NHANES II data suggested that HDL cholesterol levels increased with alcohol consumption of any kind in white and black males and females aged 20 to 74 years old. A food frequency questionnaire was used to assess dietary intake and alcohol consumption. More males than females reported consumption of beer, wine, or liquor, which is consistent with findings from two studies of young adults in the Bogalusa Heart Study (22, 44). More white males than black males or females reported daily alcohol use; conversely, fewer white males reported that they had never consumed alcohol. More black females reported never consuming alcohol, and those who did drink, consumed alcohol less often than the other race-sex groups. As seen in the study of young adults in the Bogalusa Heart Study (44), white males had the lowest age-adjusted mean HDL cholesterol levels within all categories of frequency and quantity of alcohol consumption. Age-adjusted levels for white females were consistently and significantly higher than those of white males. Blacks had consistently higher age-adjusted HDL cholesterol levels than white males and females. Overall, age-adjusted HDL cholesterol levels increased with increased alcohol consumption for all race-sex groups (53).

Causal effects of alcohol consumption or abstinence on HDL cholesterol levels cannot be determined from cross-sectional data. Alcohol consumption was self-reported and could have been underestimated; however, it has been reported previously that underreporting occurs mainly for problem drinkers, while those who abstain or seldom drink probably report their alcohol use accurately (61). Data from the study by Linn et al can be compared with data from other studies that used similar methodology.

The U-shaped curve is used to describe the relationship between levels of alcohol consumption and mortality from CVD. People who abstain from alcohol show a higher death rate from CVD than do light drinkers (up to three drinks per day), but heavy drinkers (more than three drinkers per day) die more often of CVD than do light drinkers (2, 64). Excessive alcohol consumption offsets the benefits of alcohol and has been associated with hypertension, hemorrhagic stroke, and cardiomyopathy (2, 58, 64). The risk of hypertension is reduced when excessive drinkers decreased their alcohol intake (64).

The relationship between excessive alcohol consumption and hypertension was examined in random sample of 1,042 males and 1,174 females aged 30 to 70 living in Munich (65). After controlling for gender and age, results suggested that daily consumption of 40 g of ethanol, or the equivalent of one liter of beer, increased diastolic blood pressure of females (65).

Binge drinking over many months appears to increase the risk of cerebral hemorrhage and ischemic stroke (2, 64). Excessive amounts of alcohol may lead to ventricular fibrillation and sudden cardiac arrest by altering the electrical activity of the heart (2, 64). Additionally, long-term excessive alcohol consumption may cause dilated cardiomyopathy by weakening the heart muscle and making it less efficient. Oxidative stress may cause myocardial damage with excessive alcohol intake (2, 64).

Energy and Nutrient Intake of Alcohol Drinkers and Non-drinkers

Studying the relation between alcohol consumption and obesity is important because both are common and both are related to the risk of chronic disease, including coronary heart disease (CHD) (12, 66). Alcohol is a significant component in the diets of many Americans (21, 68). The energy content of alcohol is 7.1 kilocalories per gram (kcal/g) (68). Studies have shown that energy from alcohol accounts for approximately 4% to 10% of the total energy intake of adult drinkers in the United States (21, 22, 68). The increased prevalence of obesity warrants a better understanding of the contribution of alcohol energy to total energy intake (21).

Whether alcohol promotes the development of obesity is controversial (68, 69). Energy from alcohol may be additive to the diet (14, 15, 21, 66, 70-72). It has not been definitely established that the surplus energy contributed by alcohol is associated with increased body weight (69).

Data from a sample of 5,866 adults 19 years of age or older who participated in the 1987-88 Nationwide Food Consumption Survey (NFCS) showed that in drinkers, energy from alcohol was added to non-alcohol energy in the diet (21). Dietary intake data were obtained using a interviewer-administered three day dietary recall. Body mass index was used to determine weight status. Respondents were classified as non-drinkers; light drinkers ($\leq$ 1 drink per day); moderate drinkers (1 to 2 drinks per day); and heavy drinkers (> two drinks per day). Using non-drinkers as a control, non-alcohol energy intake for drinkers was not significantly different from the non-alcohol energy of non-drinkers; however, total energy increased, reflecting the addition of energy from alcohol to the diet (21).

Grams of fat and protein increased for males across alcohol consumption groups (21). Total energy increased with increased alcohol intake; therefore, the percentage of energy from fat, protein, and carbohydrates decreased with increasing alcohol intake for both males and females. Body mass index for males increased slightly, but significantly, across alcohol intake categories, which could be explained partially by the increase in fat and protein intake. For females who drank alcohol, BMI decreased significantly across alcohol intake categories and was significantly lower than non-drinking females (21).

Intake data were self-reported for a 3-day period, which may not have included weekend alcohol or food consumption. It is likely that energy from alcohol and non-alcohol sources was underreported (21).

Data from two longitudinal studies of professional females and males showed similar results for total energy intake and non-alcohol energy to those of Rose et al. Female nurses (n = 89, 538) aged 30-55 years, who participated in the Nurses' Health Study, and a separate study of males (n = 48,493) from six health professions aged 40-75 years who participated in the Health Professionals Follow-up Study showed an increase in total energy intake with higher alcohol consumption (66). A significant inverse relationship between alcohol consumption and BMI was observed for females but not for males (66).

In the Nurses' Health Study and the Health Professionals Follow-up Study, food frequency questionnaires were used to measure total energy consumption; however, the dietary questionnaire used in the Health Professionals Follow-up Study was longer and more detailed (66). Although the food frequency questionnaires were not identical, they were shown to be valid and reproducible in both populations. Results, however, could have differed due to the variation in the questionnaires. Height and weight measurements were self-reported by the health-focused participants but were highly correlated with technician-measured weight (66).

Alcohol intake was recorded as the mean frequency of each beverage over the preceding year (66). Possible responses for frequency of each beverage were on a 9-point scale that ranged from "never" to "greater than six drinks per day." Each drink was converted to grams (g) of alcohol per day: one beer (360 mL = 13.2 g ethanol), one glass of wine (120 mL = 10.8 g ethanol), one drink of liquor (45 mL = 15.1 g ethanol) (66).

There was no relation between age and alcohol intake for females; however, in males, heavier alcohol consumption increased with age to 65 years old then decreased (66). A significant inverse relation between alcohol intake and BMI was observed among females but not among males. The highest level of alcohol intake in females was associated with an increase in BMI, suggesting a U-shaped distribution (66).

Total energy intake increased with higher alcohol consumption in females and especially, in males (Table 1) (66). In females, a slight, but significant, U-shaped distribution between alcohol intake and non-alcohol energy was observed (Table 1). As in the Rose et al study, no relation was seen between alcohol intake and non-alcohol energy for males (66).

Table 1 Adjusted mean energy intake (kcal/d) by level of alcohol intake, in females and males (66)

	Daily Alcohol Intake		
	Abstainers	**25.0 – 49.9 g/d**	**$\geq$ 50.0 g/d**
Females			
Mean total energy (kcal/d)	1,494	1,675	2,002
Mean energy from food (kcal/d)	1,494	1,413	1,514
Males			
Mean total energy (kcal/d)	1,803	2,043	2,338
Mean energy from food (kcal/d)	1,803	1,772	1,831

Variation in nutrient intake in relation to level of alcohol consumption was also examined (66). The strongest relation between alcohol consumption and intake of specific nutrients was observed for carbohydrates. Carbohydrate intake decreased from an average of 152.8 g/d in abstainers to 130.6 g/d in females consuming 25.0 to 49.9 g of alcohol per day. The decrease in carbohydrate consumption was due largely to a lower sucrose intake with increasing alcohol intake. Sucrose intake decreased from 44.6 g/d in abstainers to 24.1 g/d in females consuming 50 g or more of alcohol/d (66).

In males, carbohydrate consumption decreased from 231.3 g/d in abstainers to 213.2 g/d in males consuming 50 g or more of alcohol per day (66). As seen for females, sucrose intake decreased with increasing alcohol intake. Sucrose intake decreased from a mean of 24.2 g/d among abstainers to 16.9 g/d among males consuming 50 g or more of alcohol per day (66).

In relation to other nutrients and the level of alcohol consumed, a trend toward higher total fat, cholesterol, and protein intake was seen with higher alcohol intakes for both males and females (66). Saccharin, dietary fiber, beta carotene, vitamin A, and vitamin E intakes did not show consistent changes in the study population (66).

Associations between alcohol intake and BMI appeared to vary according to gender and are not explained by differences in cigarette smoking or type of alcoholic beverage consumed (66). Data strongly support that a lower intake of carbohydrate is associated with higher levels of alcohol intake, perhaps because of suppression by alcohol of appetite for carbohydrates. This study did not focus on the mechanism by which alcohol suppresses carbohydrate intake (66).

A random sample of 315 males and 376 females aged 30 to 90 years participated in a survey as part of the Lipid Research Clinics Program (14). Respondents were residents of a suburban community in Southern California and were predominately white and upper-middle class. Levels of alcohol consumption were assessed by 24-hour recall, not including Friday evening or Saturday daytime intake. Estimated weekly alcohol intake was collected in a separate interview. Non-drinkers were defined as those who had not drunk alcohol in the preceding 24 hours. Based on their alcohol intake in the preceding 24 hours, drinkers were categorized as low, (1 to 24 g); moderate, (25 to 49 g); and heavy, (50+ g). Weight status was reported as obesity index (14).

The proportion of non-alcohol energy derived from macronutrients was similar in males and females (14). As in previous studies (21, 66), total energy intake was significantly higher among drinkers. Non-alcohol energy tended to be lowest in moderate drinkers; however, the difference was statistically significant only for males. Males who drank moderately consumed significantly less protein; total; saturated and monounsaturated fats; cholesterol; and total carbohydrates, including sucrose, than other males. A similar pattern was observed in females who drank moderately; they consumed significantly less total fat, saturated and monounsaturated fat, and total carbohydrates, including sucrose. Females who drank moderately tended to consume less cholesterol than other drinkers but not less than non-drinkers. Significantly fewer moderate drinking males reported exercising regularly; this was not true for females. The obesity index did not increase as alcohol consumption increased in the study population, suggesting that added energy from alcohol is not associated with increasing obesity as a result of interference with absorption of other nutrients, induced metabolic energy waste, or associated with unexplored behavioral differences that increase energy expenditure. Biases, however, may have occurred due to self-selection of drinkers, errors in alcohol, diet, or exercise history. Although the reported 24-hour recall was highly correlated with reported weekly intake in this population, alcohol intake of irregular and weekend drinkers may have been missed by the 24-hour recall. Caution must be taken in generalizing the results of this study to other populations because the participants were relatively affluent. Food buying power, therefore, was not restricted by alcohol purchases and food choices were not limited by income.

Contrary to the studies reported above, some studies (15, 70, 71) have shown that alcohol replaced other energy sources in the diet. A study of middle-aged Scottish males showed that energy from alcohol tended to replace energy from other nutrients, and increasing intake of alcohol was associated with a decrease in the amount of carbohydrates and fat in the diet (70). The relation between alcohol consumption and dietary intake was examined in 164 middle-aged Scottish males aged 45 to 54 years old who participated in a study of risk factors for coronary heart disease. Each participant provided information on medical history, social background, smoking habits, and physical activity pattern. Height, weight, skinfold thickness, blood pressure, and resting electrocardiograph were recorded, and blood and adipose tissue samples were taken to check the validity of the recorded dietary and alcohol intakes. For seven consecutive days, the participants recorded, in detail, the amount and type of food, beverages, and alcohol they consumed (70).

Alcohol intake was classified as none or low (0.1 to 9.0 g per day); medium (9.1 to 34 g per day); and high (> 34 g per day), which is approximately 0, 1, 2 to 3, and $\geq$ 4 units of alcohol per day, respectively (70). One unit is roughly equivalent to 9 g of absolute alcohol. Participants in the non-drinking category reported no alcohol intake in the week in which they were studied; they were not necessarily abstainers (70).

Total energy intake was higher in nondrinkers and in those with a high alcohol intake than in those with low and medium alcohol intakes (Table 2) (70). The mean daily alcohol intake of all drinkers was 26 g, which is approximately three drinks per day; 6.7% of energy was derived from alcohol. Non-alcohol energy intake decreased as alcohol intake increased (70).

Nondrinkers had the highest intake of protein, fat, carbohydrate, saturated fatty acids (SFA), and monounsaturated fatty acids (MUFA) (70). Those in the low alcohol group had the highest intakes of fiber, cereal fiber, and polyunsaturated fatty acids (PUFA). Those in the high-alcohol group had the lowest intakes of fat, carbohydrate, fiber, and cereal fiber, SFA, MUFA, and PUFA (70).

Table 2 Mean daily intake of energy (kcal/d) and selected dietary components (g/d, mg/d) according to level of alcohol consumption for 164 males (70)

	Nondrinkers	**Low 0.1-9.0 g**	**Medium 9.1 – 34 g**	**High > 34 g**	***p****
Total energy (kcal/d)	2806	2623	2536	2853	< 0.01
Nonalcoholic energy (kcal/d)	2806	2595	2396	2391	< 0.001
Protein (g/d)	96	93	85	91	< 0.05
Carbohydrate (g/d)	342	304	282	280	< 0.01
Fat (g/d)	125	119	109	107	< 0.01
SFA (g/d)	54.8	51.0	46.9	45.8	< 0.01
MUFA (g/d)	45.6	41.4	40.0	40.0	< 0.05
PUFA (g/d)	14.0	16.7	13.2	11.9	< 0.05
Cholesterol (mg/d)	413	404	397	415	NS
Fiber (g/d)	21.6	23.2	18.0	18.0	< 0.001
Fiber from cereal and cereal products (g/d)	11.2	12.9	7.6	7.5	< 0.001
Added sugars (g/d)	40.6	22.8	38.5	33.0	NS

Alcohol intake increased on the weekend; on Saturday it was 2.0 to 2.5 times higher than the intake at the beginning of the week (70). The peak was more pronounced in manual compared to non-manual workers. Non-alcohol energy intake at all levels of alcohol consumption increased during the weekend due to a small increase in protein, fat, especially SFA, and carbohydrate intake (70).

Blood samples were drawn and analyzed for serum gamma-glutamyl transpeptidase and mean cell volume, which are markers of alcohol consumption (70). Higher confidence can be placed in the assessment of nutrient and alcohol consumption because of the use of biochemical markers. A limitation to the study by Thomson et al was that data were only collected on males. It is evident from studies previously discussed dietary intakes and BMI vary widely between genders.

Gruchow et al also showed that energy from alcohol replaces energy from other nutrients. Information on dietary practices and alcohol intakes of a sample of the US population from the NHANES I was analyzed for differences in nutrient intakes based on amounts of alcohol consumed and for the relation among alcohol consumption, energy intake, and BMI (15).

Data from NHANES I included dietary and alcohol intakes of 10,428 eligible respondents aged 18 to 74 years old (15). Nutrient and total non-alcohol energy intakes were estimated from 24-hour recall interviews. Information on the type of alcoholic beverage usually consumed (beer, wine, or liquor) and on quantity and frequency of alcohol consumption was obtained from the medical history interview. Alcohol intakes were converted to equivalent ounces (oz) of ethanol using values of 4% for beer, 12% for wine, and 43% for liquor. Respondents were considered nondrinkers if they reported drinking less than 0.001 oz (0.03 g) of absolute ethanol per day; light drinkers, if less than 0.20 oz (6 g) per day; moderate drinkers, if between 0.30 oz (9 g) and 0.80 oz (24 g) per day; and heavy drinkers if more than 0.80 oz (24 g) per day. Nutrients in beer, independent of ethanol, but including carbohydrate and some minerals and vitamins, were included in the nutrient intakes derived from the 24-hour dietary recall data. Relative body weight was calculated as BMI (15).

There was a significantly greater proportion of nondrinkers among females than among males in every age group (15). Overall, more than 70% of the males were drinkers, compared to 52% of the females. Males consumed more alcohol than females; nearly 17% of the males and 3% of the females consumed more than 0.80 oz of ethanol per day. The highest proportion of drinkers, including males and females in all age categories, was among males aged 30 to 44 years old; over 80% of the males in this age group were drinkers (15).

A significant difference was seen between drinkers and nondrinkers in relation to total energy intake (Table 3) (15). Drinkers had a significantly higher intake of total energy than nondrinkers. For drinkers, alcohol added an average of 129 kilocalories (kcal) to the daily diets of males and 48 kcal to the diet of females. The percentage of total energy obtained from alcohol averaged nearly 6% for males and over 3% for females. Light drinkers tended to have a higher non-alcohol energy intake than nondrinkers, but the non-alcohol energy intakes of moderate and heavy drinkers tended to be lower than those of nondrinkers. Lower non-alcohol energy intakes suggest that energy from alcohol replaced non-alcohol energy among the moderate and heavy drinkers. Using energy intakes of nondrinkers as a baseline, 14% and nearly 16% of non-alcohol energy was replaced by energy from alcohol among males who were moderate and heavy drinkers, respectively. Among females, over 14% and 41% of non-alcohol energy was replaced by alcohol energy among moderate and heavy drinkers, respectively (15).

Despite higher total energy intakes, drinkers did not have higher BMIs than nondrinkers (15). In fact, females who drank had significantly lower BMIs than females who did not drink. For male drinkers, BMI tended to decrease with increased ethanol and total energy intakes. No differences in activity levels were observed, which could account for the lower BMI. A possible explanation for the paradoxical inverse relationship among increased alcohol consumption and energy intake and lower

Table 3 Age-standardized daily energy intakes and BMIs for males and females by alcohol consumption (15)

	Non-drinkers	< 0.20 g	0.20-0.80 g	> 0.80 g	All drinkers
Males					
Total energy	2092	2131	2171	2426*	2212**
Non-alcoholic energy	2092	2114	2079	2029*	2083
BMI	26.2	26.4	26.2	26.0	26.2
Females					
Total energy	1492	1513	1568	1659*	1535**
Non-alcoholic energy	1492	1500	1479	1373*	1487
BMI	26.8	25.9	25.2	25.7	25.7*

*Dose-response trend with ethanol intake statistically significant ($F \geq 4.78$, $p \leq .01$).
**Differences between nondrinkers and all drinkers statistically significant ($t \geq 2.33$, $p \leq .01$)

BMI is that energy from alcohol may be utilized less efficiently than non-alcohol energy or may interfere with utilization of non-alcohol energy (15).

The most pronounced difference in nutrient intake between drinkers and nondrinkers was the substantially lower carbohydrate intake (15). A significant inverse dose-response between carbohydrate and alcohol intake was observed for both males and females. For female heavy drinkers, carbohydrate intake was 16% lower than that of nondrinkers and 13.5% lower than that of light drinkers. For male heavy drinkers, carbohydrate intake was 20% lower than that of nondrinkers and 6% lower than that of light drinkers. Fat and protein intake for females, and protein intake for males, were significantly higher for drinkers compared to nondrinkers. No significant association, however, was observed in fat and protein intake based on levels of ethanol consumption among drinkers. Saturated fat tended to be higher for drinkers than for nondrinkers. The highest intake of saturated fat was among moderate drinkers (15).

Nutrient density, defined as nutrient intake divided by total non-alcohol calories and expressed as units per 1000 kcal, was also reported for micronutrients (15). Comparing all drinkers to nondrinkers, drinkers had higher nutrient densities of niacin, riboflavin, vitamin C, iron, phosphorus, and potassium, but a lower density of calcium. Significant dose-response relationships with ethanol intakes were also observed for these same nutrients except for vitamin C. Among drinkers, however, the nutrient density of calcium was highest in the diets of moderate drinkers. Although there was no difference in cholesterol intake between drinkers and nondrinkers, there was a significant dose-response increase in cholesterol density with higher ethanol intake among males and females drinkers (15).

Energy from alcohol was added to the diets of light drinkers but replaced non-alcohol energy, especially from carbohydrates, in moderate and heavy drinkers (15). Although an increase in total energy in drinkers was observed, relative body weight did not increase; physical activity did not account for the discrepancy. Non-alcohol energy was the highest for moderate drinkers but tended to decrease with increased alcohol intake. Regular consumption of moderate amounts of alcohol appears to be protective against heart disease, and lower intake of fat by moderate drinkers has been proposed as one possible explanation of this effect. The nutrient intakes and densities of saturated fat, however, were higher for drinkers than for nondrinkers. Moreover, moderate drinkers' intake of fat and nutrient densities was the highest for moderate drinkers (15).

Cross-sectional data from the NHANES I provided information on alcohol consumption, nutrient intake, and BMI from a large number of respondents (15). Estimates of nutrient intake, however, were based on information gathered from a 24-hour recall interview and may not be representative of the respondents' typical or weekend dietary intakes. The analysis of the NHANES I data provides only a basis for assessing the impact of alcohol consumption on nutrient intakes (15).

A study of 179 middle-class males was designed to quantify long-term alcohol intake and to investigate the relation of level of alcohol consumption with dietary intake (71). Study participants were chosen from four populations varying in age and in level of alcohol consumption. The study population consisted of undergraduate students who were randomly selected for the study (n = 51); non-faculty university employees whose names were systematically selected from the employee roster (n = 46); males who had been arrested for driving while intoxicated and sentenced to attend Court-Referred Alcohol Schools (n = 35); and males receiving in-patient treatment for alcoholism (n = 47) (71).

Dietary intake, alcohol consumption, and health-related behaviors were assessed using a questionnaire, the Dietary Intake Form, and a 24-hour recall (71). An alcohol score represented the ounces of absolute alcohol consumed in a day. Weight status was quantified by BMI (71).

The participants were grouped into tertiles based on their alcohol score so that dietary differences related to alcohol intake would be maximized (71). The lowest tertile included males whose usual intake was 0.28 or less ounces (oz) of alcohol per day. Usual alcohol intake by the middle tertile ranged from 0.28 to 1.25 oz per day. The upper tertile included males whose alcohol consumption was greater than 1.25 oz per day (71).

No significant differences were seen in energy intakes among the three tertiles; however, sources of energy differed among the tertiles (Table 4) (71). A significant

Table 4 Mean total energy intake and energy sources at three levels of alcohol consumption (71)

	Tertile		
	Lowest	**Middle**	**Highest**
Energy kcal/day	2,667 ± 1,025	2,609 ± 1,446	2,710 ± 1,506
% kcal alcohol	0.5 ± 1.8^{3}	6.1 ± 13.5^{2}	23.8 ± 28.1^{1}
% kcal protein	15.0 ± 4.0^{1}	14.1 ± 5.6^{1,2}	11.6 ± 6.7^{2}
% kcal carbohydrate	43.1 ± 10.4^{1}	43.8 ± 12.4^{1}	34.8 ± 14.2^{2}
% kcal fat	41.4 ± 9.7^{1}	36.0 ± 13.7^{1,2}	29.8 ± 18.7^{2}

*Means with different superscripts are significantly different ($p < 0.05$).

increase in energy from alcohol was observed between the lowest and middle tertiles and the middle and highest tertiles. Percent of energy from protein, carbohydrate, and fat were significantly lower in the highest tertile than in the lowest tertile. A trend was observed in which the percent of energy from protein and fat tended to decrease from the lowest to the middle tertile; percent of energy from carbohydrate was the same in the lowest and middle tertile (71).

There was a significant inverse relationship between meal frequency per week and alcohol score (Table 5) (71). Frequency of meals for the lowest tertile was significantly higher than for the middle and upper tertiles. Although no significant association was observed in the frequency of meals per week in the middle and upper tertiles, a downward trend was observed with an increase in alcohol score. Participants with the highest alcohol intake reported eating less food and skipping meals when they drank. No significant association was observed between alcohol score and frequency of snacks. In contrast to the findings of Colditz et al., a trend was observed toward increased sugar consumption and an increase in alcohol score. BMI was not significantly different among the three tertiles (71).

Table 5 Relation of health-related behaviors at three levels of alcohol intake (71)

	Tertile		
	Lowest	**Middle**	**Upper**
Meal frequency/wk	18.2 ± 3.1[1]	16.3 ± 3.8[2]	14.9 ± 3.9[2]
Snack frequency/wk	8.5 ± 5.4	7.4 ± 3.9	7.6 ± 5.1
Sugar, g/day	100 ± 86	111 ± 91	140 ± 91
BMI	24.1 ± 3.1	23.8 ± 3.8	24.6 ± 3.4

*Means with different superscripts are significantly different ($p < 0.05$).

The quality of the diet varied according to alcohol score (71). Although the high alcohol consumers had significantly lower intakes of vitamin A, vitamin C, thiamin, protein, iron, and calcium, mean nutrient intakes of the upper tertile were above the Recommended Dietary Allowances for all nutrients except vitamin A, vitamin C, and thiamin. No significant association was observed between vitamin/mineral supplement use, and intake of phosphorus, potassium, riboflavin, niacin, and cholesterol. Fiber intake was negatively associated with alcohol score (71).

In conclusion, this study indicated that as alcohol consumption increased, percent of energy from carbohydrates, fat, and protein decreased, the frequency of meals decreased, and the nutritional quality of the diet declined. Alcohol consumption did not affect BMI.

In this study a 24-hour recall was used to assess nutrient intakes. Known limitations of the 24-hour recall are that it may not be representative of the participants' usual intake and may not include weekend dietary intake. In this study, however, the Dietary Intake Form was used to assess each subject's long-term food intake, thereby, reducing the limitations of the 24-hour recall.

As with the study by Thomson et al, this study only includes only males; therefore, results cannot be generalized to females. Another weakness of this study is that some of the participants were receiving in-patient treatment for alcoholism. Studies have shown that chronic alcoholics suffer from nutrient deficiencies (73-75). Data from alcoholics in the study by Hillers et al may skew results pertaining to nutrient intakes.

Although some of the studies found similar results for total and non-alcohol energy intakes, BMI, macro- and micronutrients, findings varied considerably among the variables and between genders. Comparing results across several studies is difficult because methods of assessing alcohol and dietary intake and of categorizing alcohol consumption vary from study to study. Further research is needed to determine the relation among alcohol consumption, total and non-alcohol energy intakes, nutrient intakes, and BMI.

Alcohol Metabolism

The paradoxical inverse relation sometimes seen between alcohol consumption and body weight remains unexplained by nutritionists. Three different types of studies have attempted to explain the role of alcohol energy and body weight: epidemiologic studies (alcohol intake and body weight); psychophysiologic investigations (alcohol intake and appetite regulation); and metabolic studies (effects of alcohol intake on energy expenditure and substrate oxidation) (76). Epidemiologic studies have not shown a clear relation between alcohol consumption and body weight. Most studies show, however, with the exception of alcoholics (76), alcohol energy is added to food energy intake; therefore, moderate alcohol drinkers tend to consume more energy than nondrinkers (14, 15, 66). Energy from alcohol added to the diet does not always result in weight gain even though total energy increases (14, 15, 66, 77).

No clear correlation has been made between alcohol energy intake and body weight, leading to the hypothesis that alcohol energy has a low biological value (78-80). In controlled clinical studies, weight loss was observed when alcohol was substituted for carbohydrates (81, 82), suggesting that energy from alcohol compared with carbohydrate is less effectively deposited as body mass (78, 80, 81). When alcohol energy was added to non-alcohol energy, subjects failed to gain weight (78, 81). Weight loss was seen when participants were given ethanol up to 25% of total energy intake as a substitute for carbohydrate (78). When chocolate was substituted on an equal-energetic basis for ethanol, the subjects gained weight. In contrast, studies using whole-body indirect calorimetry showed that energy from ethanol is used as efficiently by the body as carbohydrate (68, 83, 84). Approximately 85% of ethanol energy is available for metabolizable energy for other metabolic processes. Ethanol-induced thermogenesis, or energy released as heat, accounts for the remaining 15% of ethanol energy. Alcohol was shown to have the same fat-sparing effect as that of carbohydrate and will cause fat gain when consumed in excess of normal energy needs (84).

Rumpler et al (85) found that metabolizable energy was the same as that for carbohydrate in males and females when 5% of total daily energy intake was either ethanol or carbohydrate. The conclusion was made that alcohol has no special thermogenic effect, and that energy can be accounted for in a way similar to that of carbohydrate (85).

The addition of ethanol to a diet has been shown to reduce lipid oxidation measured over a 24-hour period, whereas oxidation of carbohydrate and protein are much less inhibited. In a controlled study using whole-body calorimetry (68), eight young males aged 24 years were each given a total of 96 grams of alcohol in three equal doses per day during two 48-hour test periods. Alcohol was either added to the diet for a total of 125% of energy requirement or substituted for carbohydrate (12.5%) and fat (12.5%), comprising 100% of energy requirement. Consistent with findings of other studies (83, 84), 24-hour energy expenditure increased, and lipid oxidation, which favors fat storage, decreased. Alcohol did not affect carbohydrate oxidation and only slightly increased protein oxidation. No difference was seen in lipid oxidation when alcohol was either added to or substituted for carbohydrate and fat (i.e. when alcohol was found in the blood, and thus, being actively metabolized) (68).

Although the length of the study was not long enough to observe changes in body weight, an assumption can be made that alcohol intake in place of other foods can lead to weight loss due to the increase in 24-hour energy expenditure. Alcohol energy as additional energy above nutritional requirements may be a risk factor for obesity, because lipid oxidation decreases more than 24-hour energy expenditure increases (68). It can be assumed, however, that this effect will be seen in subjects who consume alcohol irregularly (i.e. a few times per week), a behavior pattern that is common in the general population. It is not known whether the suppressive effects of alcohol would be the same in heavier or more regular alcohol consumers (68).

Contrary to carbohydrate and fat, alcohol cannot be stored in the body, so alcohol has absolute priority in metabolism. Further, the body needs to eliminate alcohol as fast as possible to minimize potential toxic effects. Excessive ethanol intake is metabolized predominantly by the microsomal ethanol-oxidizing system (MEOS), which leads to an increased loss of energy from ethanol as heat. In contrast, when intake is light to moderate, ethanol is metabolized primarily by the alcohol dehydrogenase system, with less waste of energy (68). Although the number of study participants was low, the results from study by Suter et al may represent the effect of a large dose of alcohol in occasional alcohol consumers. It was assumed that the ethanol load was metabolized by the alcohol dehydrogenase pathway, since the level of the participants' ethanol consumption would not be expected to lead to metabolism by the more energy-wasting MEOS (68).

A study by Pirola et al showed that the replacement of carbohydrate by ethanol (50% of total energy) resulted in weight loss (78). Ethanol, given as a supplement, resulted in less weight gain than supplementation with an equivalent amount of non-ethanol energy. The weight loss resulting from 50% ethanol substitution was explained by the increased metabolism of ethanol in the MEOS, which resulted in an elevated thermogenic response (78).

Whether energy from alcohol is converted to body mass in humans remains controversial. Answers to the question are partially confounded by differences among individuals. Clevidence et al assessed whether energy from alcohol is efficiently used to maintain body mass in young females who drank alcohol. Alcohol energy may cause no weight gain when added to diets of lean individuals, whereas it may cause weight gain when added to diets of heavy individuals (86).

In epidemiologic studies, the association between alcohol intake and body weight varies according to gender, because of differences in alcohol metabolism between males and females (87). In general, females have a lower proportion of body fat mass and body water than males of similar body weight, so females have higher concentrations of alcohol in the blood after drinking equivalent amounts of alcohol (88). Differences in peak concentrations following equivalent doses of ethanol administered to males and females could be due to differences in first-pass metabolism of ethanol in the gastrointestinal tract, which is significantly correlated with gastric alcohol dehydrogenase activity (89).

The process of alcohol elimination also differs between genders (90). This may be due partly to the differences in blood alcohol concentrations following alcohol consumption. A higher disappearance rate has been seen in females compared to males (90). Differences could be due to differences in daily alcohol intake, influence of sex hormones, such as estrogen and testosterone, or differences in liver size relative to body weight or lean body mass (90).

Confounding factors, such as under- or overreporting of alcohol and nutrient intake, smoking, and physical activity need to be considered in studying the relation between alcohol consumption and body weight.

Alcohol and Appetite Regulation

Psychophysiologic studies on food intake regulation consistently show that in most individuals, the energy of alcohol is added to the energy of carbohydrate, fat, and protein in the daily diet (92-96). Alcohol is a dietary macronutrient, which contributes 7.1 kilocalories per gram of ethanol to energy intake (97). Macronutrients differ in satiation efficiencies with protein consistently found to be the most satiating, followed by carbohydrate and fat (98-100). Alcohol is oxidized first to minimize potential toxic effects (68, 83, 84), but in the satiety hierarchy it is the least satiating (96). A study of 53 males and females examined the effects of energy intake with an alcohol preload ingested minutes before lunch and was compared with an isoenergetic carbohydrate, fat, or protein drink (96). The alcohol preload was followed by a greater energy intake at lunch than the other isoenergetic drinks; there was no compensation for energy intake in the remainder of the day. The alcohol preload also induced a higher eating rate and longer meal duration at lunch than the other preloads. Satiation started to increase later after an alcohol-containing preload compared with macronutrient-containing preloads. When no preload was given, subjects consumed less energy than with isoenergetic preloads. This study illustrates the short-term stimulatory effect of alcohol on appetite and food intake (96).

Other studies using similar methodologies as those used in the Westerterp et al study have observed similar results, such that alcohol intake did not induce any satiating effect (92-95). Buemann et al, however, tested the effect of wine, beer, and a soft drink with a normal meal on food and total energy intake in 22 non-obese young males aged 20 to 33 years. Alcoholic beverages, particularly wine, enhanced total energy intake at a meal compared to the soft drink. Gastric distention caused by carbon dioxide in beer and soft drink may have limited energy intake compared with wine (95).

Alcohol may increase meal size through a combination of direct and indirect effects (95). Direct effects include an increase in the pleasure of eating once eating has been initiated either by association and increasing the pleasantness of the taste of foods (101). Expectancy effects may play a role of appetite stimulation (102). It has been shown that when consumers believe they are drinking alcohol, disinhibition is produced and food intake is increased in restrained eaters (102). Indirect effects include a delay in satiety development by reducing negative feedback activity from the gut or through suppression of substrate oxidation (96).

Alcohol Consumption and Socioeconomic Status

Young adults have the highest prevalence of alcohol consumption than any other age group in the United States (13). Teenagers and young adults consume more alcohol than any other age group (13). In young adults passing from their early to mid-20s, it has been found that the quantity of alcohol consumed per occasion has declined while drinking frequency has increased (103-106). A common trend of drinking among young adults is that a relatively large quantity of alcohol is consumed per occasion (103-106).

Although not consistent among all studies (107, 108), heavier volume of alcohol consumed and heavier quantity per occasion has been found to be more prevalent among the unemployed (109-111). In relation to occupational status among the employed, bluecollar and manual workers report heavier alcohol consumption (112, 113). Consistent findings show a relation between heavier drinking and lower educational achievement (114-116).

In a longitudinal study in New Zealand of young adults aged 18, 21, and 26 years, the relationship between drinking patterns in young adulthood and employment status, educational achievement, occupational status, and income level was examined (117). Frequency of alcohol use and the typical quantity of alcohol consumed per drinking occasion in the prior year was measured. Frequency of drinking increased to age 26; the quantities consumed peaked at age 21 and then decreased at age 26 for both males and females. Frequency of drinking was consistently lower for females than for males. In males and females of all three age groups, frequency of drinking was influenced by income with the higher income respondents drinking more often. Except in males aged 18 years, no significant relation was seen between educational achievement and frequency of alcohol drinking. It was hypothesized that among unemployed males in their late teens, stress or boredom associated with increased leisure time and extended independence from parents may lead to an increase in alcohol consumption (118). No relationship was seen between occupation and frequency of alcohol consumption in males or females. Quantity consumed per occasion was not affected by income. Males and females with more education consumed significantly less than those with less education. Only females showed a significant association for frequency and quantity consumed regarding occupation; unemployed females drank the most at ages 18 and 21 but at age 26 unemployed females were the lowest quantity drinkers. Changing roles of females at age 26 could explain the decline in frequency and quantity of alcohol consumed (119); more females become unemployed after they marry and have children (109).

Marital status, parental status, and employment status cannot be considered as social determinants of drinking behavior (119). Possible effects of changes in marital status, employment status, and having children on alcohol consumption and the frequency of heavy drinking was examined in 1,327 males and females aged 16 to 69 years (119). A shift into social roles was expected to be associated with a decrease in alcohol consumption and heavy drinking, and a shift away from the social roles would increase alcohol consumption and heavy drinking; however, this shift was not observed. The only significant association with regard to gaining or losing marital roles was a decrease in alcohol consumption and heavy drinking in females who married or co-habitated. No association was seen between gaining or losing employment status or between losing the parental role. These findings could be explained by acquisition of a spouse and parental role make it less likely to frequent drinking venues such as bars or clubs. Being employed may leave enough time to drink or even create situations related to work that involve drinking. Being employed possibly creates enough social opportunities to drink or may even create drinking situations related to work. Losing roles did not lead to the expected increase in consumption or heavy drinking. It seems that a reduction of social roles or more leisure time is not necessarily a stimulus to increase drinking (119).

CHAPTER 3

METHODS

Overview

General data collection procedures used in the Bogalusa Heart Study (BHS) are described below; however, a specific data set was used for this thesis. Methods used to collect the data for this thesis will be described later in this section.

From the beginning of the study, quality controls were emphasized for the development and implementation of the Bogalusa Heart Study (39). Specified protocols were developed for all procedures used in the study (i.e., blood pressure measurements, 24-hour recalls, venipuncture) and to coordinate investigators in New Orleans, Louisiana with a field staff in Bogalusa (39).

Specific protocols have been stringently followed throughout the 28 years of the study to ensure consistency in data collection (39). Preliminary studies were conducted over one year in Franklinton, Louisiana, which is located 20 miles east of Bogalusa. A distant preliminary site was chosen to prevent "contamination" of the Bogalusa population. Nurses and observers were trained and feasibility studies were conducted. Afterwards, several pre-pilot studies were conducted on approximately 500 Franklinton school children until the protocols were developed and a trained staff was available to implement the program (39).

After the Franklinton pilot study, initial observations and data were collected from students in fourteen Bogalusa schools (twelve public, one parochial, one private), which included 3,524 children (39). Approximately 93% of the children between the ages of five and fourteen attending school in the political subdivision of Ward 4 participated in the study. Throughout the years of the study, the number of participants and the eligible age of the participants have increased (39).

Collection of Data

The BHS is an epidemiologic investigation of the early natural history of cardiovascular disease in a biracial (two-thirds white and one-third black) pediatric population that began 30 years ago. The study design, participation, and protocols are described in detail elsewhere (39). An existing data set from the BHS was used for this thesis. Data collected to determine dietary intake, the number of drinkers, the amount of alcohol consumed, and the types of alcoholic beverages consumed by young adults in Bogalusa were used for this thesis.

Participants

Participants, n = 1,335, (62% females and 27% black) aged 20-38 years were part of the original study population and completed the food frequency questionnaire and alcohol consumption questionnaire in 1995-1996. Excluded from the study were the 2% of respondents who returned the food frequency questionnaire or the alcohol consumption questionnaire with incomplete responses.

Dietary Intakes and Alcohol Consumption

The Youth and Adolescent Questionnaire (YAQ) and the Health Lifestyle-Behavior Questionnaire (HLBQ) were used to assess dietary intakes, including alcohol consumption, of young adults (T.Nicklas, personal communication, November 25, 2003). The YAQ is a valid and reliable self-administered food frequency questionnaire developed at Harvard School of Public Health that contains categories for frequency of consumption in terms of monthly or weekly consumption of 131 food items. Nutrient intakes were calculated from the questionnaire database, which is based on the U. S. Department of Agriculture Handbook 8 series with additional information from the Composition of Foods, Journals, and Manufacturers (T. Nicklas, personal communication, November 25, 2003).

The Health Lifestyle-Behavior Questionnaire was self-administered in the young adults' survey and consisted of a composite of questions used in the BHS, CARDIA, and the Johns Hopkins Physicians' Survey (T. Nicklas, personal communication, November 25, 2003). The HLBQ is a 24-page questionnaire that assessed demographics (i.e., gender, ethnicity), socioeconomic status (i.e., income, level of education), and lifestyle characteristics (i.e., marital status, physical activity, and household size). The BHS Health Habits Questionnaire was used to assess the frequency and quantity of alcohol consumption and type of alcoholic beverage consumed. Participants were assured that all information being collected was confidential (T. Nicklas, personal communication, November 25, 2003).

In the BHS Health Habits Questionnaire, alcohol use was dichotomized into two categories: "non-drinker", defined as not having consumed any alcoholic beverages during 12 months prior to the survey; or "drinker", one who has had at least one alcoholic beverage in the 12 months before the survey. Usual alcohol intake was based on the frequency of alcoholic beverages consumed per day, week, or month. Quantity of alcohol consumed was based on weekly consumption in terms of glasses, bottles, cans of beer; glasses of wine; mixed drinks or shots of spirits; bottles of wine coolers. Alcohol content for each type of alcoholic beverage was based on the values from the Nutrition Data System. The number of drinks consumed per week was divided by seven days then converted to grams of alcohol per day as follows: one beer (12 ounces [oz]) = 14.1 grams (g) alcohol; one glass of wine (5 oz) = 17.7 g alcohol; 1.5 oz hard liquor = 23.7 g alcohol, and wine cooler (12 oz) = 20.2 g alcohol.

Levels of alcohol consumption were developed to assess dose-response trends in total energy intake, non-alcohol energy intake, macronutrient intake, body mass index (BMI), and waist circumference. A "non-drinker" was defined as having consumed no alcoholic beverages during 12 months prior to the survey; "light drinker", consumption is greater than zero and less than or equal to one drink per day; "moderate drinker", consumption is greater than one and less than or equal to two drinks per day; "heavy drinker", consumption is greater than two drinkers per day.

In the data set, total energy included energy from alcohol and from food sources. Alcohol was recorded in grams; therefore, to determine the energy intake of non-alcohol food sources, alcohol energy at 7 kilocalories (kcal)/g was subtracted from the total energy intake. The macronutrients (carbohydrate, protein, and total fat) were also recorded in grams. To determine the percentage of energy intake for each macronutrient, kilocalories were calculated by multiplying the grams of carbohydrate, protein, or total fat by their approximate kilocalorie equivalents. Carbohydrate and protein were assumed to contain 4 kcal/g and total fat to contain 9 kcal/g. Kilocalories for each macronutrient were divided by total energy intake (kcal) then multiplied by 100 to obtain a percentage of total energy.

Weight and Height

Weight was measured to the nearest 0.1 kg using a balance beam scale, and height was measured to the nearest 0.1 cm with a manual height board. Body mass index, calculated as weight in kg divided by height in m^2, was used as an index of relative weight for height.

Waist Circumference

Waist circumference was measured in cm at the level of the umbilicus with the subject standing and with relaxed breathing. These measurements were obtained in triplicate, and mean values were used in analyses.

Statistical Analyses

All statistical analyses were performed using SPSS Version 11.5. The data were summarized with descriptive statistics, including means and standard errors. Chi-square tests were used to determine overall statistically significant differences in the prevalences of alcohol use by gender, race, and gender*race. Univariate analysis of variance (ANOVA) was used to determine statistical significance in total energy intake, energy from alcohol, non-alcohol energy, and in the macronutrients, as well as in BMI and waist circumference by race, gender, gender*race, drinking status, and level of alcohol consumption. To minimize the risk of a Type I error, the Bonferroni post-hoc test was used when comparing means for statistically significant main effects in the univariate ANOVA. Results are significant if $p \leq 0.05$. Table 6 describes the dependent variables, the independent variables, and the covariates used in the analyses as they relate to the hypotheses.

Table 6 Hypothesis, dependent variables, independent variables, and covariates used in the univariate ANOVA

Hypothesis	Dependent variables	Independent variables	Covariates
Total energy increases with increased alcohol consumption in males and females.	Energy from alcohol (g)	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, BMI
	Percentage of energy from alcohol (%)	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, BMI
	Total energy (kcal)	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, BMI
Non-alcohol energy decreases with increased alcohol consumption in males and females.	Non-alcohol energy (kcal)	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, BMI
As alcohol consumption increases, energy from macronutrients decreases in males and females.	Macronutrient intake - Carbohydrate (g) Protein (g) Total fat (g)	Gender, race, drink; levels of alcohol consumption gender/race	Age, non-work related physical activity, BMI, total energy
	Percentage of energy from macronutrients (%) - % energy from carbohydrate % energy from protein % energy from total fat	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, BMI
BMI is lower in males and females who consume alcohol compared with males and females who are non-drinkers.	BMI	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, total energy
	Waist circumference	Gender, race, drink; levels of alcohol consumption, gender/race	Age, non-work related physical activity, total energy, height, BMI

CHAPTER 4

RESULTS

Prevalence of Alcohol Consumption

Table 7a shows the frequencies and percentages of non-drinkers and drinkers by gender. The prevalence of alcohol consumption was significantly higher ($p = 0.034$) among males compared with females.

Table 7a Frequencies and percentages of non-drinkers and drinkers by gender

Gender	Number of participants	Number of non-drinkers	Number of drinkers	Percentage (%) of drinkers within gender
Males	508	121	387	76.2*
Females	827	241	586	70.9
Total	1335	362	973	-

The asterisk (*) indicates significant differences (see text for the specific value).

The frequencies and percentages of non-drinkers and drinkers by race are presented in Table 7b. The percentage of drinkers was significantly higher ($p = 0.022$) for whites than for blacks.

Table 7b Frequencies and percentages of non-drinkers and drinkers by race

Race	Number of participants	Number of non-drinkers	Number of drinkers	Percentage (%) of drinkers within race
Whites	971	250	721	74.3*
Blacks	364	112	252	69.2
Total	1335	362	973	-

The asterisk (*) indicates significant differences.

Table 7c shows the frequencies and percentages of non-drinkers and drinkers by race and gender. The prevalence of alcohol consumption was not significantly different among the race and gender groups.

Table 7c Frequencies and percentages of non-drinkers and drinkers by race and gender

Race/Gender	Number of participants	Number of non-drinkers	Number of drinkers	Percentage (%) of drinkers within race and gender
White males	377	90	287	76.1
White females	594	160	434	73.1
Black males	131	31	100	76.3
Black females	233	81	152	65.2
Total	1335	362	973	-

Energy Intake

Energy from Alcohol. Adjusted means (± standard error [SE]) for alcohol in grams per day (grams [g] per day [d]) and percentage (%) of total energy intake from alcohol by gender, race, and gender/race are shown in Table 8a. After controlling for total energy, age, and BMI, males consumed significantly more ($p = 0.000$) alcohol (g/d) (15.2 ± 1.7) than did females (7.2 ± 1.0). No differences were seen in alcohol intake (g/d) between whites and blacks.

Table 8a Adjusted means (± SE) for alcohol in grams per day (g/d) and percentages (%) of total energy intake from alcohol by gender, race, and gender/race

	Gender		**Race**		**Gender/Race**			
	Males n=340	**Females n=526**	**Whites n=686**	**Blacks n=180**	**White males n=265**	**White females n=403**	**Black males n=61**	**Black females n=102**
Alcohol (g/d)	15.3^{a} (±1.4)	7.2^{b} (±1.0)	11.6^{a} (±0.8)	10.9^{a} (±1.6)	15.9^{a} (± 1.2)	7.3^{b} (±1.0)	14.6^{a} (± 2.6)	7.2^{b} (± 2.0)
% total energy intake from alcohol	4.7^{a} (±0.3)	2.2^{b} (±0.2)	3.2^{a} (±0.2)	3.7^{a} (±3.7)	4.5^{a} (±0.3)	2.0^{b} (±0.2)	4.9^{a} (±0.6)	2.4^{b} (±0.4)

*Means with different superscripts are significantly different (see text for the specific value).

The percentage of total energy from alcohol was significantly higher (p = 0.000) in males (4.7 $\pm$ 0.3) compared with females (2.2 $\pm$ 0.2). No difference was seen in the percentage of total energy from alcohol between whites and blacks.

Table 8b shows the adjusted means ($\pm$ SE) for alcohol intake (g/d) and the percentages (%) of total energy from alcohol by level of alcohol consumption. Means for total intake of alcohol (g) increased significantly (p = 0.000) among light (4.5 $\pm$ 0.8), moderate (23.7 $\pm$ 1.8), and heavy drinkers (56.6 $\pm$ 2.5). The means for alcohol intake (g/d) between non-drinkers and light drinkers were not significantly different.

Table 8b Adjusted means ($\pm$ SE) for alcohol intake (g/d) and the percentage (%) of total energy from alcohol by level of alcohol consumption

Macronutrient	**Level of Alcohol Consumption**			
	Non-drinkers n=326	**Light drinkers n=774**	**Moderate drinkers n=89**	**Heavy drinkers n=60**
Alcohol (g/d)	0^a ($\pm$ 2.3)	4.5^a ($\pm$0.8)	23.7^b ($\pm$1.8)	56.5^c ($\pm$ 2.5)
% energy from alcohol	0^a ($\pm$0.6)	1.5^a ($\pm$0.2)	8.5^b ($\pm$0.4)	16.1^c ($\pm$0.6)

*Means with different superscripts are significantly different.

The percentage of total energy from alcohol increased as energy from alcohol in grams increased. As seen with the means for alcohol intake in grams, the percentages of total energy from alcohol was significantly different among light (1.5 $\pm$ 0.2) (p = 0.000), moderate (8.5 $\pm$ 0.4) (p = 0.000), and heavy drinkers (16 $\pm$ 0.6) (p = 0.000); non-drinkers and light drinkers were not significantly different.

Total Energy Intake of Drinkers. Adjusted means ($\pm$ SE) for total energy in kilocalories per day (kcal/d) by gender, race, and gender/race for drinkers are shown in Table 9a. Among drinkers, total energy intake was significantly higher (p = 0.000) for males (2567.9 ± 52.0) compared with females (2241.6 ± 42.2) and significantly higher (*p* = 0.000) for blacks (2607.6 ± 58.4) than for whites (2201.8 ± 32.8) after adjusting for age, BMI, and physical activity.

Table 9a Adjusted means (± SE) for total energy intake in kilocalories per day (kcal/d) for drinkers by gender, race, and gender/race

Total energy	**Gender**		**Race**		**Gender/Race**			
	Males	**Females**	**Whites**	**Blacks**	**White males**	**White females**	**Black males**	**Black females**
(kcal/d)	2567.9[a] (±52.0)	2241.6[b] (±42.2)	2201.8[a] (±32.8)	2607.6[b] (±58.4)	2378.5[a] (±51.4)	2025.2[b] (±42.0)	2757.3[c] (±89.8)	2458.0[a,c] (±74.2)

*Means with different superscripts are significantly different

White females (2025.2 ± 42.0) consumed significantly less total energy than did white males (2378.5 ± 51.4) (*p* = 0.000), black males (2757.3 ± 89.8) (*p* = 0.000), and black females (2458.0 ± 74.2) (*p* = 0.000). Total energy intake did not differ in white males and black females; however, white males consumed significantly less (*p* = 0.001) energy than did black males. Black males and black females did not differ in mean total energy intake.

Table 9b shows the adjusted means (± SE) for total energy intake (kcal/d) for non-drinkers and drinkers. Mean total energy intake tended to be greater in drinkers compared with non-drinkers; however, the difference was not significant.

Table 9b Adjusted means (± SE) for total energy intake (kcal/d) for non-drinkers and drinkers

	Non-drinkers n=326	**Drinkers n=923**
Total energy (kcal/d)	2310.6[a] (±50.5)	2404.6[a] (±32.6)

*Means with different superscripts are significantly different.

The adjusted mean intake (+ SE) for total energy (kcal/d) by level of alcohol consumption is presented in Table 9c. Total energy intake tended to increase in a

Table 9c Adjusted mean intake (+ SE) for total energy (kcal/d) by level of alcohol consumption

Total energy	**Level of Alcohol Consumption**			
	Non-drinkers	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
(kcal/d)	2282.3[a] (+55.8)	2365.3[a] (+37.2)	2408.4[a] (+111.7)	3062.8[b] (+158.0)

*Means with different superscripts are significantly different.

stepwise manner as alcohol consumption increased. The only significant relationship, however, was among heavy drinkers compared with lower levels of alcohol consumption. Heavy drinkers (3062.8 + 158.0) consumed significantly more (p = 0.000) total energy than did non-drinkers (2282.3 + 55.8), light drinkers (2365.3 + 37.2), and moderate drinkers (2408.4 + 111.7).

Non-alcohol Energy. The adjusted means (+ SE) for non-alcohol energy (kcal/d) for drinkers by gender, race, and gender/race are shown in Table 10a. After adjusting for

Table 10a Adjusted means (+ SE) for non-alcohol energy (kcal/d) for drinkers by gender, race, and gender/race

Non-alcohol energy	**Gender**		**Race**		**Gender/Race**			
	Males	**Females**	**Whites**	**Blacks**	**White males**	**White females**	**Black males**	**Black females**
(kcal/d)	2467.7[a] (+50.3)	2200.8[b] (+40.8)	2125.7[a] (+31.7)	2542.7[b] (+56.5)	2263.2[a] (+50.0)	1988.2[b] (+40.6)	2672.2[c] (+86.8)	2413.3[a,c] (+71.7)

*Means with different superscripts are significantly different.

age, BMI, and physical activity, males (2467.7 + 50.3) who drank alcohol consumed significantly more (p = 0.000) non-alcohol energy than did female drinkers (2200.8 +

40.8). Non-alcohol energy was significantly higher (p = 0.000) for blacks (2542.7 ± 56.5) compared with whites (2125.7 ± 31.7).

White females (1988.2 ± 40.6) consumed significantly less (p = 0.000) non-alcohol energy than did white males (2263.2 ± 50.0), black males (2672.2 ± 86.8), and black females (2413.3 ± 71.7). The adjusted mean energy intake for black females did not differ significantly from white males or black males. Black males consumed significantly more non-alcohol energy than did white males (p = 0.000) and white females (p = 0.000).

Table 10b shows the adjusted means (± SE) for non-alcohol energy (kcal/d) for non-drinkers and drinkers. No significant difference was seen between drinkers and non-drinkers in relation to non-alcohol energy.

Table 10b Adjusted means (± SE) for non-alcohol energy (kcal/d) for non-drinkers and drinkers

Non-alcohol energy	**Non-drinkers**	**Drinkers**
(kcal/d)	2303.2[a] (±49.3)	2335.5[a] (±31.8)

*Means with different superscripts are significantly different.

Table 10c shows the adjusted means (± SE) for non alcohol energy intake (kcal/d) by level of alcohol consumption. Adjusted means for non-alcohol energy intake did not differ significantly across levels of alcohol consumption.

Table 10c Adjusted means (± SE) for non-alcohol energy (kcal/d) by level of alcohol consumption

	Level of Alcohol Consumption			
	Non-drinkers	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
Non-alcohol (kcal/d)	2280.1[a] (±55.1)	2340.7[a] (±36.7)	2240.8[a] (±110.3)	2660.9[a] (±156.1)

*Means with different superscripts are significantly different.

Body Mass Index

The adjusted means (+ SE) for BMI (kg/m^2) of drinkers by gender, race, and race/gender are shown in Table 11a. After adjusting for total energy intake, age, and physical activity, no significant differences were seen in BMI between males and females who consumed alcohol. Blacks (29.2 + 0.4) had a significantly higher (p = 0.000) BMI than did whites (26.5 + 0.2).

Table 11a Adjusted means (+ SE) for BMI (kg/m^2) of drinkers by gender, race, and race/gender

	Gender		**Race**		**Race/Gender**			
	Males	**Females**	**Whites**	**Blacks**	**White males**	**White females**	**Black males**	**Black females**
BMI (kg/m^2)	28.1^a (+0.4)	27.6^a (+0.3)	26.5^a (+0.2)	29.2^b (+0.4)	27.7^a (+0.4)	25.4^b (+0.3)	28.5^{a,c} (+0.7)	29.8^c (+0.5)

*Means with different superscripts are significantly different.

Among drinkers, mean BMI was significantly lower (p = 0.000) for white females (25.4 + 0.3) compared with white males (27.7 + 0.4), black males (28.5 + 0.7), and black females (29.8 + 0.5). Black females had the highest mean BMI, but it was significantly higher only than white males (p = 0.000) and females (p = 0.000); no difference was seen between black females and males. The adjusted mean BMI for black males was not significantly different from that of white males or black females.

Table 11b shows the adjusted means (+ SE) for BMI (kg/m^2) for non-drinkers and drinkers. Non-drinkers (29.0 + 0.4) had a significantly higher (p = 0.006) BMI than did drinkers (27.9 + 0.3). No difference was observed in the level of physical activity between drinkers and non-drinkers.

Table 11b Adjusted means (+ SE) for BMI (kg/m^2) for non-drinkers and drinkers

	Non-drinkers	Drinkers
BMI (kg/m^2)	29.0^a (+0.4)	27.9^b (+0.3)

*Means with different superscripts are significantly different.

The adjusted means (+ SE) for BMI (kg/m^2) by level of alcohol consumption is presented in table 11c. The adjusted means for body mass index were significantly lower

Table 11c Adjusted means (+ SE) for BMI (kg/m^2) by level of alcohol consumption

	Level of Alcohol Consumption			
	Non-drinkers	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
BMI (kg/m^2)	28.9^a (+0.4)	28.0^{a,b} (+0.3)	29.0^a (+0.9)	24.9^b (+1.2)

*Means with different superscripts are significantly different.

for heavy drinkers (24.9 + 1.2) compared with non-drinkers (28.9 + 0.4) and moderate drinkers (29.0 + 0.9) (p = 0.012) but not light drinkers (28.0 + 0.3). No other significant differences were seen among levels of alcohol consumption.

Waist Circumference

Table 12a shows the adjusted means (+ SE) for waist circumference (cm) of drinkers by gender, race, and race/gender. Among drinkers, mean waist circumference

Table 12a Adjusted means (+ SE) for waist circumference (cm) of drinkers by gender, race and race/gender

Waist circumference	Gender		Race		Race/Gender			
	Males	**Females**	**Whites**	**Blacks**	**White males**	**White females**	**Black males**	**Black females**
(cm)	90.4^a (+0.4)	84.8^b (+0.3)	85.9^a (+0.6)	89.2^b (+1.0)	91.7^a (+1.1)	80.1^b (+0.8)	89.0^a (+1.6)	89.4^a (+1.3)

*Means with different superscripts are significantly different.

(cm) for females (83.9 ± 0.3) was significantly lower ($p = 0.000$) compared with males (87.5 ± 0.4) after adjusting for physical activity, height, age, and total energy. The adjusted mean waist circumference for whites (85.9 ± 0.6) was significantly lower ($p = 0.000$) than for blacks (89.2 ± 1.0).

White females (80.1 ± 0.8) had a significantly lower ($p = 0.000$) waist circumference compared with white males (91.7 ± 1.1), black males (89.3 ± 1.6), and black females (89.4 ± 1.3). No other significant differences were seen in drinkers by race and gender.

Adjusted means (± SE) for waist circumference (cm) for non-drinkers and drinkers are shown in Table 12b. The adjusted means for waist circumference were

Table 12b Adjusted means (± SE) for waist circumference (cm) for non-drinkers and drinkers

	Non-drinkers	**Drinkers**
Waist circumference (cm)	90.5[a] (±0.9)	87.6[b] (±0.6)

*Means with different superscripts are significantly different.

significantly different between drinkers and non-drinkers. Drinkers (87.6 ± 0.6) had a significantly lower ($p = 0.002$) waist circumference than did non-drinkers (90.5 ± 0.9).

Table 12c shows the adjusted means (± SE) for waist circumference (cm) by level of alcohol consumption. The adjusted means for waist circumference were significantly

Table 12c Adjusted means (± SE) for waist circumference (cm) by level of alcohol consumption

	Level of Alcohol Consumption			
Waist circumference	**Non-drinkers**	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
(cm)	90.4[a] (±1.0)	87.8[a] (±0.7)	90.5[a] (±1.9)	82.7[b] (±2.8)

*Means with different superscripts are significantly different.

different for heavy drinkers compared with lower levels of alcohol consumption. Heavy drinkers (82.7 ± 2.8) had a significantly lower (*p* = 0.017) waist circumference than did non-drinkers (90.4 ± 1.0), light (87.8 ± 0.7), and moderate drinkers (90.5 ± 1.9).

Macronutrient Intake

Carbohydrate. The adjusted means (± SE) for carbohydrate (g/d) and percentages (%) of total energy from carbohydrate for drinkers by gender, race, and race/gender are shown in Table 13a. Among drinkers, mean carbohydrate intake in

Table 13a Adjusted means (± SE) for carbohydrate (g/d) and percentages (%) of total energy from carbohydrate for drinkers by gender, race, and race/gender

Macronutrient	**Gender**		**Race**		**Race/Gender**			
	Males	**Females**	**Whites**	**Blacks**	**White males**	**White females**	**Black males**	**Black females**
Carbohydrate (g/d)	279.6[a] (±2.2)	293.4[b] (±1.8)	283.6[a] (±1.4)	289.4[b] (±2.5)	276.2[a] (±2.2)	291.0[b] (±1.8)	283.0[a,b] (±3.9)	295.8[b] (±3.1)
% kcal carbohydrate	49.3[a] (±0.4)	51.5[b] (±0.3)	50.3[a] (±0.2)	50.6[a] (±0.4)	49.1[a] (±0.4)	51.5[b] (±0.3)	49.5[a,c] (±0.6)	51.6[b,c] (±0.5)

*Means with different superscripts are significantly different.

grams was significantly higher (*p* = 0.000) for females (293.4 ± 1.8) compared with males (279.6 ± 2.2) and higher (*p* = 0.045) for blacks (289.4 ± 2.5) compared with whites (283.6 ± 1.4) after adjusting for total energy intake, BMI, and age.

White males (276.2 ± 2.2) consumed significantly fewer (*p* = 0.000) grams of carbohydrate compared with white females (291.0 ± 1.8) and black females (295.8 ± 3.1). The adjusted mean intake for carbohydrate was highest in black females, but was only significantly higher (*p* = 0.000) than that seen in white males (276.2 ± 2.2).

The percentage of energy from carbohydrate was significantly higher (*p* = 0.000) for females (51.5 ± 0.3) who consumed alcohol compared with males who drank (49.3 ±

0.4). No significant difference was seen in the percentage of total energy from carbohydrate between whites and blacks.

White females (51.5 + 0.3) consumed a significantly higher percentage of energy from carbohydrate than did white (49.1 + 0.4) (p = 0.000) and black males (49.5 + 0.6) (p = 0.000). The percentage of energy from carbohydrate was significantly higher (p = 0.001) for black females (51.6 + 0.5) compared with white males, but not white females or black males.

Table 13b shows the adjusted means (+ SE) for carbohydrate intake (g/d) and the percentages (%) of total energy from carbohydrate for non-drinkers and drinkers. Non-drinkers (292.4 + 2.0) consumed significantly more energy from carbohydrate than did drinkers (283.7 + 1.3) (p = 0.000). The percentage of energy from carbohydrate was also significantly higher for non-drinkers (52.2 + 0.3) compared with drinkers (50.5 + 0.2) (p = 0.000).

Table 13b Adjusted means (+ SE) for carbohydrate intake (g/d) and percentage (%) of total energy from carbohydrate for non-drinkers and drinkers

Macronutrient	**Non-drinkers**	**Drinkers**
Carbohydrate (g/d)	292.4[a] (+2.0)	283.7[b] (+1.3)
% kcal carbohydrate	52.2[a] (+0.3)	50.5[b] (+0.2)

*Means with different superscripts are significantly different

Table 13c shows the adjusted means (+ SE) for carbohydrate intake (g/d) and the percentage of total energy intake from carbohydrate by level of alcohol consumption.

Table 13c Adjusted means (± SE) for carbohydrate intake (g/d) and percentages (%) of total energy intake from carbohydrate by level of alcohol consumption

Macronutrient	Level of Alcohol Consumption			
	Non-drinkers	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
Carbohydrate (g/d)	294.2[a] (±2.0)	289.9[a] (±1.4)	265.1[b] (±4.1)	238.9[c] (±5.8)
% energy from carbohydrate	52.7[a] (±0.4)	51.4[b] (±0.2)	47.5[c] (±0.7)	44.7[c] (±1.0)

*Means with different superscripts are significantly different

Adjusted means for carbohydrate (g) tended to decrease as alcohol consumption increased. Non-drinkers (294.2 ± 2.0) and light drinkers (289.9 ± 1.4) consumed significantly more energy from carbohydrate than did moderate drinkers (265.0 ± 4.1) (p = 0.000, p = 0.000, respectively) and heavy drinkers (238.9 ± 5.8) (p = 0.000, p = 0.000, respectively). Moderate drinkers consumed significantly less carbohydrate than non-drinkers (p = 0.000) and light drinkers (p = 0.000), but significantly more than did heavy drinkers (p = 0.001). Heavy drinkers consumed the least amount of energy from carbohydrate compared with non-drinkers (p = 0.000), light drinkers (p = 0.000), and moderate drinkers (p = 0.001).

As alcohol consumption increased, the percentage of energy from carbohydrate decreased significantly (p = 0.000) across levels of alcohol consumption, with the exception of moderate and heavy drinkers. Heavy drinkers (44.7 ± 1.0) consumed a lower percentage of energy from carbohydrate than did moderate drinkers (47.5 ± 0.7); however, the difference was not significant.

Protein. Adjusted means (± SE) for protein (g) and the percentages (%) of total energy from protein for drinkers by gender, race, and race/gender are shown in Table 14a. After adjusting for age, energy intake, physical activity, and BMI, no significant

Table 14a Adjusted means (+ SE) for protein (g) and percentages (%) of total energy from protein for drinkers by gender, race, and race/gender

Macronutrient	Gender		Race		Race/Gender			
	Males	Females	Whites	Blacks	White males	White females	Black males	Black females
Protein (g)	79.6[a] (+0.8)	79.6[a] (+0.6)	81.7[a] (+0.5)	77.59[b] (+0.9)	80.3[a,b] (+0.7)	83.0[b] (+0.6)	78.8[a,c] (+1.3)	76.2[c] (+1.1)
% energy from protein	14.1[a] (+0.1)	14.3[a] (+0.1)	14.7[a] (+0.1)	13.7[b] (+0.2)	14.3[a] (+0.1)	15.1[b] (+0.1)	13.9[a,c] (+0.2)	13.6[c] (+0.2)

*Means with different superscripts are significantly different.

difference in protein intake was seen between male and female drinkers. Whites (81.7 + 0.5) consumed significant more (p = 0.000) protein than did blacks (77.4 + 0.9). White males (80.3 + 0.7) consumed significantly more (p = 0.015) energy from protein compared with black females (76.2 + 1.1). White females (83.2 + 0.6) consumed significantly more energy from protein compared with black males (78.8 + 1.3) (p = 0.045) and black females (p = 0.000). Black females consumed the least amount of energy from protein; they consumed significantly less than white males (p = 0.015) and white females (p = 0.000), but not black males.

The adjusted means for the percentage of energy from protein were not significantly different between males and females. Whites (14.7 + 0.1) consumed a significantly higher (p = 0.000) percentage of total energy from protein than did blacks (13.7 + 0.2). A significantly higher percentage of energy from protein was seen in white females (15.1 + 0.1) compared with white males (14.3 + 0.1) (p = 0.000), black males (13.9 + 0.2) (p = 0.000) and black females (13.5 + 0.2) (p = 0.000). Black females consumed the least amount of energy from protein; they consumed a significantly lower percentage of energy from protein compared with white males (p = 0.017) and white females (p = 0.000).

Table 14b shows the adjusted means (± SE) for protein intake (g/d) and the percentages (%) of total energy from protein for non-drinkers and drinkers. No significant difference was seen between drinkers and non-drinkers for energy from protein in grams or for percentage of total energy from protein.

Table 14b Adjusted means (± SE) for protein intake (g/d) and percentages (%) of total energy from protein for non-drinkers and drinkers

Macronutrient	**Non-drinkers**	**Drinkers**
Protein (g/d)	80.0[a] (±0.7)	78.9[a] (±0.5)
% energy from protein	14.4[a] (±0.1)	14.3[a] (±0.1)

*Means with different superscripts are significantly different.

Table 14c shows the adjusted means (± SE) for protein intake (g/d) and the percentages (%) of total energy intake from protein by level of alcohol consumption.

Table 14c Adjusted means (± SE) for protein intake (g/d) and percentage (%) of total energy intake from protein by level of alcohol consumption

Macronutrient	**Level of Alcohol Consumption**			
	Non-drinkers	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
Protein (g)	80.5[a] (±0.8)	79.8[a] (±0.6)	77.7[a,b] (±1.6)	70.3[b] (±2.4)
% energy from protein	14.5[a] (±0.2)	14.4[a] (±0.1)	14.0[a,b] (±0.3)	12.8[b] (±0.4)

*Means with different superscripts are significantly different.

Protein intake tended to decrease as the level of alcohol consumption increased. Significance, however, was seen only in heavy drinkers (70.3 ± 2.4) compared with non-drinkers (80.5 ± 0.8) light drinkers (79.8 ± 0.6) ($p = 0.002$). No significant difference was seen in protein intake between moderate and heavy drinkers.

Consistent with energy from protein, the percentage of total energy from protein decreased as alcohol consumption increased. Heavy drinkers (12.8 ± 0.4) consumed a significantly lower ($p = 0.002$) percentage of energy from protein than did non-drinkers (14.5 ± 0.2) and light drinkers (14.4 ± 0.1). Moderate drinkers consumed a slightly higher percentage of energy from protein than did heavy drinkers, but the difference was not significant.

Total Fat. The adjusted means (± SE) for total fat (g) and the percentages (%) of energy from total fat for drinkers by gender, race, and race/gender are shown in Table 15a. After adjusting for total energy intake, BMI, age, and physical activity, no significant differences were observed in total fat intake (g) between male and female drinkers. Blacks (83.2 ± 0.8) consumed significant more ($p = 0.007$) energy from total fat than did whites (80.6 ± 0.5). No differences were seen in the race/gender categories in total fat intake.

Table 15a Adjusted means (± SE) for total fat (g) and percentages (%) of energy from total fat for drinkers by gender, race, and race and gender

Macronutrient	Gender		Race		Race/Gender			
	Males	Females	Whites	Blacks	White males	White females	Black males	Black females
Total fat (g)	82.5[a] (±0.8)	81.3[a] (±0.6)	80.6[a] (±0.5)	83.2[b] (±0.8)	81.0[a] (±0.7)	80.1[a] (±0.6)	84.0[a] (±1.3)	82.4[a] (±1.1)
% energy from total fat	32.8[a] (±0.3)	32.3[a] (±0.2)	31.9[a] (±0.2)	33.2[b] (±0.3)	32.2[a] (±0.3)	31.6[b] (±0.2)	33.3[a] (±0.5)	33.0[a] (±0.4)

*Means with different superscripts are significantly different

Among drinkers, the percentage of total energy from total fat did not differ between males and females. As with total fat in grams, blacks (33.2 ± 0.3) consumed a significantly higher ($p = 0.001$) percentage of energy from total fat than did whites (31.9 ± 0.2). White females (31.6 ± 0.2) consumed a lower percentage of energy from total fat than did black males (33.3 $\pm$ 0.5) (p = 0.015) and black females (33.0 $\pm$ 0.4) (p = 0.033) but significantly less than white males (32.2 $\pm$ 0.3).

Table 15b shows the adjusted means ($\pm$ SE) for total fat (g) and the percentages (%) of energy from total fat for non-drinkers and drinkers. Non-drinkers (82.8 $\pm$ 0.7) consumed significantly more (p = 0.007) energy from total fat (g) than did drinkers (80.8 $\pm$ 0.5). The percentage of energy from total fat was also significantly higher (p = 0.034) for non-drinkers (33.1 $\pm$ 0.3) compared with drinkers (32.4 $\pm$ 0.2).

Table 15b Adjusted means ($\pm$ SE) for total fat (g) and percentage (%) of energy from total fat for non-drinkers and drinkers

Macronutrient	**Non-drinkers**	**Drinkers**
Total fat (g/d)	82.8^{a} ($\pm$0.7)	80.8^{b} ($\pm$0.5)
% energy from total fat	33.1^{a} ($\pm$0.3)	32.4^{b} ($\pm$0.2)

*Means with different superscripts are significantly different.

The adjusted means ($\pm$ SE) for total fat intake (g) and the percentages of total energy from fat (%) by level of alcohol consumption are presented in Table 15c. As alcohol consumption increased, total fat intake tended to decrease. The only significant

Table 15c Adjusted means ($\pm$ SE) for total fat intake (g) and percentages (%) of total energy from fat (%) by level of alcohol consumption

Macronutrient	**Level of Alcohol Consumption**			
	Non-drinkers	**Light drinkers**	**Moderate drinkers**	**Heavy drinkers**
Total fat (g)	82.3^{a} ($\pm$0.8)	82.2^{a} ($\pm$0.5)	78.3^{a} ($\pm$1.6)	68.4^{b} ($\pm$2.2)
% energy from total fat	$32.7^{a,b}$ ($\pm$0.3)	33.0^{a} ($\pm$0.2)	$30.8^{b,c}$ ($\pm$0.6)	29.0^{c} ($\pm$0.9)

*Means with different superscripts are significantly different.

difference was seen, however, among heavy drinkers and lower levels of alcohol consumption. Total fat intake was significantly lower (p = 0.000) in heavy drinkers (68.4 $\pm$ 2.2) compared with non-drinkers (82.3 $\pm$ 0.8), light drinkers (82.2 $\pm$ 0.5), and moderate drinkers (78.3 $\pm$ 1.6).

With respect to the percentage of total energy from fat, light drinkers consumed a higher percentage than did any other level of alcohol consumption. Light drinkers (33.0 $\pm$ 0.2) consumed a significantly higher percentage of total energy from fat than did moderate (30.8 $\pm$ 0.6) (p = 0.006) and heavy drinkers (29.0 $\pm$ 0.9) (p = 0.000) but not significantly more than non-drinkers (32.7 $\pm$ 0.3). No significant differences were seen among non-drinkers, light drinkers, and moderate drinkers. Heavy drinkers consumed a lower percentage of total energy from fat than did non-drinkers and light drinkers but not moderate drinkers.

CHAPTER 5

DISCUSSION

Results of this study showed that total energy intake was not significantly different among non-drinkers, light drinkers, or moderate drinkers; however, heavy drinkers consumed significantly more total energy than did non-drinkers, light, and moderate drinkers. Intake of non-alcohol energy remained constant across levels of alcohol consumption. Carbohydrate intake tended to decrease across levels of alcohol consumption but only significantly in moderate and heavy drinkers. Protein and total fat intake were significantly lower in heavy drinkers compared with lower levels of alcohol consumption. Energy from alcohol was added to the diets of drinkers, particularly heavy drinkers. Paradoxically, drinkers had a lower BMI and waist circumference than did non-drinkers.

Prevalence of Alcohol Consumption

The results of our study support the hypothesis that more white males consume alcohol than do black males or females. The prevalence of alcohol consumption among young adults in the BHS was similar to other surveys of young adults (13, 44) and of adults in general (11, 12, 15, 21), in that fewer females drank alcohol than did males. Similar to the findings of an earlier cross-sectional study of the BHS (44), no difference was seen in the prevalence of alcohol consumption between races. National surveys (13, 120), however, have shown that the prevalence of alcohol consumption is highest among whites, particularly white males, compared with blacks both nationwide and within Louisiana. The BHS data used in this study and data from the national surveys reported herein were collected during different periods of time, and possibly reflect secular trends in changes of alcohol consumption. The sample sizes of the national surveys tend to be large compared with the sample size of the study population in the BHS. A larger sample size may better represent the general population. Definitions of alcohol intake vary among studies and surveys; therefore, parallel comparisons among studies are difficult.

Energy from Alcohol

This study found that males consumed nearly two times more alcohol than did females. These findings are different from those reported by Nicklas and associates (22), which showed that males consumed nearly three times more alcohol (g) than did females. In our study, alcohol accounted for nearly 5% of total daily energy intake in males compared with 2% in females. Nicklas and associates showed the percentage of total daily energy intake to be 9% for males and 4% in females. Other studies have reported that up to 10% of total energy consumed in the American diet is from alcohol (15, 21, 22). Data collection methods and data analyses methods differ among studies, which could explain the variances in the percentages of total energy consumed from alcohol. Compared with our study, other studies include adults of all ages; our study included only young adults. In comparison to the study by Nicklas and associates (22), a smaller sample size was used in that study and the participants were younger than those in our study. Alcohol consumption tends to peak in young adulthood and decrease as adults age (13).

Total Energy Intake

Results of this study supported the hypothesis that total energy intake increases with increased energy intake from alcohol in males and females. These results are consistent with the findings of previous studies in relation to alcohol consumption and total energy, including alcohol. Rose and associates (21) assessed the association between alcohol consumption and dietary variables from a sample of respondents who participated in the NFCS. Consistent with the findings of our study, total energy intake increased as alcohol consumption increased, while non-alcohol energy remained constant as alcohol consumption increased. These authors concluded that drinkers tended not to substitute alcohol energy for food energy, but rather added alcohol energy to the diet (21). Compared with our study, Rose used similar definitions of alcohol consumption; therefore, similar results could be expected.

Gruchow and associates (15) used data from the first NHANES to assess differences in nutrient intakes based on the amount of alcohol consumed. Comparing drinkers with non-drinkers, drinkers had a significantly higher total energy intake than non-drinkers because of their intake of energy from alcohol. In our study, total energy intake was not significantly different between drinkers and non-drinkers. Data collection methods for alcohol usage and standards for alcohol content for beer, wine, and liquor differed between our study and the study by Gruchow; this may account for the different results. Gruchow (15) also reported a significant dose-response trend among levels of alcohol consumption; total energy intake increased as alcohol consumption increased in males and females. Our study did not show a significant increase in total energy intake as alcohol consumption increased. Total energy intake was significantly higher for heavy drinkers compared with lower levels of alcohol consumption. Gruchow reported only a dose-response trend rather than significant differences within levels of alcohol consumption (15).

Colditz and associates (66) studied the relationship between alcohol intake, BMI, and diet in males and females in two cohort studies, the Health Professionals Follow-up Study and the Nurses' Health Study, respectively. In females, total energy intake increased with alcohol consumption. An even more pronounced increase in mean energy intake was seen in males (66). In those studies, data were analyzed in a different manner than our study. That study used a regression model to determine a dose-response trend over drinking categories; therefore, differences among levels of alcohol consumption were not compared. Colditz and associates (66) defined drinking categories by grams of ethanol per day. Our study categorized levels of alcohol consumption by number of drinks per day.

Non-alcohol Energy

Results from our study do not support the hypothesis that non-alcohol energy decreases with increased alcohol consumption in males and females. In our study, non-alcohol energy remained constant as alcohol consumption increased in males and females. Rose and associates (21) showed similar findings in relation to total energy from alcohol, as well as non-alcohol energy. They showed that non-alcohol energy remained constant across alcohol consumption categories. Comparing our study to that one, similar definitions of levels of alcohol consumption and data collection methods produced similar results. Our study and the study by Rose and associates were based on observational data. Levels of alcohol consumption were similarly defined in both studies.

Gruchow and associates (15) found results similar to those of our study in relation to drinkers and non-drinkers. Non-alcohol energy intakes were not significantly different between drinkers and non-drinkers. In contrast to our study, light drinkers had a higher non-alcohol energy intake than non-drinkers, while the non-alcohol energy intakes of moderate and heavy drinkers were below those of nondrinkers. Gruchow (15) concluded that the lower non-alcohol energy intakes suggest that energy from alcohol replaced non-alcohol energy among moderate and heavy drinkers. Drinking categories were defined differently in the study by Gruchow compared with our study.

Body Mass Index

Results of our study supported the hypothesis that BMI is lower in males and in females who drink alcohol compared with non-drinkers. No differences in levels of physical activity outside of work were seen which could account for the lack of association between total energy intake and BMI in males and females.

Several studies have found similar results. In the analysis of data from the first NHANES by Gruchow and associates (15), alcohol intake was inversely associated with BMI in females but less strongly so in males. Despite higher alcohol intake, drinkers were no more overweight than were non-drinkers. It was concluded that energy from alcohol may be less efficiently used than energy from macronutrients (15).

Jones and associates conducted a survey of a community in California and collected information on alcohol intake from 24-hour recalls (14). An inverse relationship was observed between alcohol intake and BMI; however, the relationship was statistically significant only in females (14). A cross-sectional study, FINRISK, showed that males and females with low alcohol consumption tended to weigh less than non-drinkers or subjects with higher alcohol consumption (121).

Several clinical studies have attempted to explain the inverse relation between alcohol consumption and BMI (64, 72, 122). Results, however, have been inconsistent

(72). Alcohol is the second most dense energy source. Many epidemiologic studies support the hypothesis that high alcohol intake may be associated with lower BMI. These paradoxical findings could be explained by the energy-wasting microsomal ethanol-oxidizing system. Suter and associates (122) showed that 24-hour energy expenditure was increased when ethanol was either added to the base diet or substituted for an equal amount of energy in the whole diet. An in vitro study has shown that alcohol is metabolized by the liver and in the large bowel by bacteria in the colon; therefore, all energy from alcohol may not be available (123).

In contrast, Sonko and associates (84) reported values for heat dissipation of alcohol similar to carbohydrate. Alcohol has been shown to have the same fat-sparing effect as carbohydrate and will cause fat gain when consumed in excess of normal energy needs (84). Rumpler and associates (85) found that metabolizable energy for ethanol was the same as that for carbohydrate in males and females. The authors concluded that ethanol has no special thermogenic effect and that energy can be accounted for in a way similar to that of carbohydrate (85).

Waist Circumference

Since BMI and waist circumference are indicators of relative body weight, we analyzed our data for differences in waist circumference between drinkers and non-drinkers to further support our findings that drinkers have a lower BMI than non-drinkers. In our study, waist circumference was significantly lower in drinkers compared with non-drinkers. In heavy drinkers, the adjusted mean for waist circumference was lower compared with non-drinkers, light, and moderate drinkers.

Few studies have assessed the relationship between waist circumference and alcohol consumption. Most studies with the objective of assessing the association of alcohol consumption and abdominal fat deposition focus on BMI and waist-hip ratio. In our study, however, we chose to use only waist circumference.

We found one study that examined the long-term association between the amount and type of alcohol consumed and waist circumference in male and female drinkers who participated in the Copenhagen City Heart Study in Denmark (124). Males and females were assessed at baseline then re-assessed after 10 years for changes in waist circumference. Contrary to our study, waist circumference increased in males and females who, by our definition, were heavy drinkers. Waist circumference increased in males and females who drank more than 28 alcoholic beverages per week compared to those who consumed one to six beverages per week. Males who drank more than 21 beers per week and females who consumed more than 14 beers per week had a larger waist circumference than males and females who drank no beer. An increase in waist circumference was also seen in males and females who drank liquor. Interestingly, no trend was seen in males or females who consumed wine (124).

In contrast to our study, Dallongeville and associates (125) found that waist circumference increased independently of BMI in a sample of French males and females. Wine was the most commonly consumed alcoholic beverage in that population. In males, there was no association between alcohol intake and BMI or body weight, whereas in females, alcohol consumption was inversely correlated with BMI and body weight (125).

In the Copenhagen City Heart Study, the age range of the study participants was 20 to 83 years. The study of French males and females included participants aged 35 to

64 years. In our study, participants were younger (20 to 38 years). It is common knowledge that physical activity level decreases and body weight increases with age; therefore, an assumption can be made that waist circumference, as well as BMI will be lower in the younger population, regardless of drinking habit. In our study population, however, both drinkers and non-drinkers were overweight.

Macronutrients

Results from this study supported the hypothesis that energy from macronutrients decreases as alcohol consumption increases in males and females. The most prominent difference in macronutrient intake was seen in carbohydrate.

Carbohydrate. Several studies (15, 66, 126) have shown that those who consume alcohol have a lower carbohydrate intake than non-drinkers. The study by Colditz (66) found that the consumption of candy and sugar is inversely related to alcohol intake. The authors suggested the possibility that sweet foods and alcohol may be competitors in the diet. Similar to our study, Gruchow (15) found that carbohydrate intake was significantly lower in drinkers compared with non-drinkers. For both males and females who were heavy drinkers, carbohydrate intake was significantly lower than that of non-drinkers and light drinkers (15).

Le Marchand and associates (126) examined the relationship of alcohol use and dietary variables in a population-based study of males and females in Hawaii. Consistent with our study, drinkers of both genders reported a significantly lower intake of carbohydrate compared with non-drinkers. A significant dose-response relationship was also seen in that study. The authors concluded that alcohol is primarily a substitute for carbohydrate intake (126).

Protein. In our study, protein intake tended to decrease as alcohol consumption increased; however, this relationship was only significant in heavy drinkers compared with non-drinkers and light drinkers. Protein intake in moderate drinkers did not differ from non-drinkers, light, or heavy drinkers. The percentage of energy from protein followed the same trend as the mean protein intake in grams.

Similar results were seen in male drinkers in the study by Le Marchand and associates (126). In that study, protein intake decreased significantly only in males who were heavy drinkers (126). Contrary to our findings, Gruchow (15) found that protein intake for females and males were significantly higher for drinkers compared to non-drinkers. In that study, no significant trends in protein intake were seen based on levels of alcohol consumption.

Total Fat. Total fat was significantly lower in heavy drinkers compared with non-drinkers, light, and moderate drinkers. Comparing drinkers to non-drinkers, drinkers consumed significantly less energy from total fat than did drinkers. Our findings are consistent with the findings of Thomson and associates (70), who found that increasing alcohol intake was associated with a decrease in energy from total fat in middle-aged Scottish males.

Contrary to the findings of our study, Le Marchand (126) found that fat intake was higher among drinkers. In females, Gruchow (15) found fat intake was significantly higher for drinkers compared with non-drinkers.

Conclusions

Our study showed that energy from alcohol was added to the diets of drinkers, and did not replace energy derived from other nutrients. The results suggest that a relationship among alcohol consumption, BMI, and waist circumference exist. Alcohol may interfere with the absorption of other nutrients, induce metabolic energy wastage, or be associated with some unknown biological mechanism that increases energy expenditure. Self-reporting of alcohol use, errors in reporting alcohol consumption, dietary intake, or exercise history, or other unknown influential factors may influence the paradoxical findings of added energy from alcohol and lower BMI and smaller waist circumference in drinkers.

The purpose of the BHS was to determine the early natural history of CAD and essential hypertension and to identify the childhood risk factors associated with adult heart diseases (36-39). Power calculations were done on CV risk factors and not on dietary intake. Nevertheless, this study provides valuable information on the relationship among alcohol consumption, dietary intake, and relative body weight in young adults.

Future Directions

It is important to determine whether alcohol consumption influences dietary intake and relative body weight. Overweight and obesity have increased in the last two decades, leading to many chronic diseases. Alcohol is a significant energy source in the American diet; therefore, the influence of alcohol on dietary intake and body weight should be explored. Studies could be conducted to assess the relationship between smoking, physical activity in the workplace, and lifestyle factors in drinkers compared to non-drinkers.

It might also be important to assess the relation between the type of alcohol consumed, macro- and micronutrient intake, food choices, and level of work-related physical activity. Foods linked to levels of alcohol consumption could be explored.

Perhaps light and moderate drinkers tend to consume more fruits and vegetables and tend to lead a healthier lifestyle than do heavy drinkers. The complex relation among alcohol consumption, dietary intake, and body weight regulation needs to be studied further.

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