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Original Article

Association between alcohol consumption patterns and metabolic syndrome

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ABSTRACT

Aims: Examine associations between self-reported alcohol consumption patterns and metabolic syndrome.
Materials and methods: Sample ($N = 7432$) included adult (≥20 years) participants in the 1999–2006 National Health and Nutrition Examination Survey.
Results: Above moderate alcohol consumption (AMAC) was negatively associated with waist circumference among those in the 20–29, 40–49, and 70–79 age groups ($\beta = -6.21$, $\beta = -8.34$, and $\beta = -6.60$, respectively) and moderate alcohol consumption (MAC) was negatively associated with waist circumference among those in the 30–39, 40–49, and 70–79 age groups ($\beta = -4.60$, $\beta = -5.69$, and $\beta = -2.88$, respectively). AMAC was negatively associated with triglycerides among those in the 70–79 and 80+ age groups ($\beta = -23.62$ and $\beta = -34.18$, respectively) and positively associated with HDL-C levels in all groups (β range 8.96–18.25). MAC was positively associated with HDL-C in the age groups spanning 20–69 years (β range 3.05–5.34) and those over 80 ($\beta = 5.26$). AMAC and MAC were negatively associated with fasting glucose levels in the 20–29 and 70–79 age groups ($\beta = -3.38$ and -15.61, respectively). MAC was negatively associated with fasting glucose levels among those 70–79 and those over 80 years of age ($\beta = -7.06$ and $\beta = -5.00$, respectively).
Conclusion: MAC and AMAC may favorably impact metabolic health.

1. Introduction

Findings from several studies report an attenuated risk of cardiovascular disease (CVD) associated with various levels of alcohol consumption. Metabolic syndrome (MetS) is a clustering of risk factors that increase the risk of morbidity and mortality due to CVD [1–3]. It is estimated that between 21.2% and 38.9% of the American population have MetS [4]. The general population is aware of the negative effects that long-term and heavy alcohol consumption may have on the body, for example liver and heart disease. Regardless, many individuals on a daily or weekly basis consume alcohol. Some studies have shown a relationship between alcohol consumption and the prevention of risk factors associated with MetS, however, many study findings are conflicting [5–7].

The effect of alcohol on individual criterion for MetS varies. A study by Clerc and colleagues [8] reported lower MetS prevalence estimates in low and medium to high-risk alcohol consumption categories. Additionally, very high-risk alcohol consumption was found to be associated with increased high-density lipoprotein cholesterol (HDL-C), triglycerides, systolic blood pressure, fasting glucose and number of MetS criteria. In a cross-sectional study of Japanese men and women, Wakabayash reported lower prevalence estimates and odds of MetS with both light and heavy alcohol consumption in men and light drinking in women compared to non-drinkers [9]. Findings from a nested case–control study from the Nurse Health Study revealed significantly lower odds of type-2 diabetes (T2D) in women reporting moderate alcohol consumption (MAC) [10]. Gigleux and colleagues reported significant favorable dose–response relationships in men for dyslipidemia, T2D, and MetS in a prospective cohort study [11]. In another cohort study, Yokoyama and colleagues found an association between "average

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drinkers" and a decreased waist circumference (WC) when compared to "excessive drinkers" [12].

There is no consensus as to what volume of alcohol is considered beneficial with regards to MetS. Moreover, there is a paucity of work illustrating MetS prevalence and individual criterion estimates based on alcohol consumption patterns. To address this we analyzed data collected from the National Health and Nutrition Examination Survey (NHANES) between the years 1999 and 2006. The aims of this study were two pronged: (1) to examine the linear relationship between alcohol consumption patterns and MetS criteria; and (2) to illustrate prevalence estimates and potential dose–response relationships for MetS and its individual criterion by self-reported alcohol consumption patterns in a representative sample of the United States (U.S.) adult population.

2. Methods

2.1. Sample and description of NHANES

This study utilized eight years of data from the 1999–2006 NHANES, a continuous survey conducted by the National Center for Health Statistics [13–15]. The NHANES provides national estimates of the health and nutritional status of the non-institutionalized U.S. civilian population over the age of two months. The total number of participants for 1999–2006 NHANES was 41,474. For this study, the final sample consisted of 7432 U.S. adults $\geq$ 20 years of age who met the following conditions (1) adult men and women who gave informed consent; (2) participated in a morning medical examination following an overnight fast; (3) if female, non-pregnant; and (4) had complete data on all the variables of interest. The NHANES utilizes trained staff to conduct in home interview administered questionnaires and standardized medical examinations conducted by physicians and other health care professionals in mobile examination centers. The questionnaires collected demographic data, as well as data specific to physical activity, diet, and current medical conditions. Physician conducted medical examinations and gathered information on anthropometrics, hemodynamics and complete blood profiles. The NHANES questionnaires and laboratory methodology has been described previously [15,16]. The Institutional Review Board of the University of North Florida approved the use of the 1999–2006 NHANES data.

2.2. Alcohol consumption

The primary independent variable in this study was calculated from 'self-reported' alcohol consumption patterns by days per week, per month, or per year. The final sample provided responses to the following items which came from the Alcohol Use Questionnaire (ALQ) file; items ALQ.120Q *In the past 12 months, how often did {you/SP} drink any type of alcoholic beverage? PROBE: How many days per week, per month, or per year did {you/SP} drink; ALQ.120U # days {you/SP} drink alcohol per week, per month, or per year; and ALQ.130 In the past 12 months, on those days that {you/SP} drank alcoholic beverages, on average, how many drinks did {you/he/she} have?* A drinks per day (dkspdy) variable was created with three categories: above moderate alcohol consumption (AMAC), MAC, and none. Self-reported AMAC was coded as >2 dkspdy in men and >1 dkspdy in women and self-reported MAC was coded as <0 to $\leq$2 dkspdy in men and <0 to $\leq$1 dkspdy in women.

2.3. The AHA/NHLBI metabolic syndrome definition

The dependent variable in this study was a positive diagnosis of MetS based on the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) definition [17]. The AHA/NHLBI definition requires that three of the following five CVD risk factors be present for a diagnosis of MetS: (1) impaired fasting glucose (IFG) $\geq$100 milligrams per deciliter (mg/dL) or pharmacological treatment for IFG; (2) low HDL-C (<40 mg/dL in men or <50 mg/dL in women) or pharmacological treatment for an abnormal HDL-C level; (3) triglycerides $\geq$150 mg/dL or pharmacological treatment for hypertriglyceridemia; (4) a WC $\geq$102 cm in men or $\geq$88 cm in women; and (5) blood pressure $\geq$130/85 mm/Hg or pharmacological treatment for elevated blood pressure. The AHA/NHLBI definition is unique in the respect that it precludes specific inclusion criteria of any one condition found in all other medical society definitions of MetS [4].

2.4. Statistical analysis

The data in this study were initially managed using SAS 9.3 [18]. SAS was used to conduct both complex variable recodes and data coding validation. SAS-callable SUDAAN [19] was then used to conduct the analysis, incorporating sampling weights within the context of the correlated multi-stage complex sampling design inherent to NHANES. Linear regression (PROC REGRESS) analysis was used to test the null hypotheses that individual regression coefficients are equal to zero for each MetS criterion. Age-adjusted prevalence estimates were calculated using PROC DESCRIPT. For all prevalence estimates, non-overlapping 95% confidence intervals (CI) indicate significance.

3. Results

Table 1 depicts study participant characteristics and MetS criteria. Table 2 illustrates the associations between reporting MAC and AMAC and MetS criteria, which vary by age group and MetS criteria. Our regression analysis controlled for race/ethnicity, gender, income, smoking status, family history of diabetes, family history of heart disease, and physical activity. Non-drinkers served as the referent group. All reported findings that were significant have a p-value <0.05.

3.1. Waist circumference

When examining alcohol consumption patterns across MetS criteria, both AMAC and MAC were associated with attenuated WC values ($p < 0.05$ for both) compared to non-drinkers (Table 1). Additionally, a significant inverse dose–response relationship was found for alcohol consumption and WC ($p = 0.0020$). Reporting AMAC was negatively associated with WC among those in the 20–29, 40–49, and 70–79 age groups ($\beta = -6.21$, $\beta = -8.34$, and $\beta = -6.60$, respectively) and reporting MAC was found to be negatively associated with WC among those in the 30–39, 40–49, and 70–79 age groups ($\beta = -4.60$, $\beta = -5.69$, and $\beta = -2.88$, respectively) (Table 2).

3.2. Blood pressure

Systolic blood pressure was found to be the highest among participants reporting AMAC, but only significantly greater than those reporting MAC ($p < 0.05$). A consistent inverse dose–response for alcohol consumption and systolic blood pressure was not evident, however, there was a significant trend ($p = 0.0013$) (Table 1). Table 2 illustrates some statistically significant associations between alcohol consumption patterns and blood pressure measures (systolic and diastolic), but these effects do not appear to be clinically relevant.