ELSEVIER

Nutrition 26 (2010) 100–105

NUTRITION

www.nutritionjrnl.com

Applied nutritional investigation

Moderate alcohol intake is associated with decreased risk of insulin resistance among individuals with vitamin D insufficiency

Marty S. Player, M.D., M.S.*, Arch G. Mainous III, Ph.D., Dana E. King, M.D., Vanessa A. Diaz, M.D., and Charles J. Everett, Ph.D.

Department of Family Medicine, Medical University of South Carolina, Charleston, South Carolina, USA

Manuscript received October 21, 2008; accepted March 26, 2009.

Abstract

Objective: To determine whether moderate alcohol intake modifies the association between low vitamin D levels and insulin resistance (IR), we hypothesized that moderate alcohol intake would have a modifying effect on IR in people with low vitamin D levels.

Methods: This was a cross-sectional analysis of subjects ≥20 y old without a history of diabetes, coronary heart disease, or stroke in the National Health and Nutrition Examination Survey 2001–2004. Main outcome was IR status measured by homeostasis model assessment for IR (HOMA-IR; ≥ 2.6) and fasting insulin (>12.2 μU/mL) in moderate drinkers compared with non-drinkers by vitamin D levels (deficient ≤20 ng/mL, insufficient 21–32 ng/mL, normal >32 ng/mL).

Results: Two thousand seven hundred twenty-one subjects met the inclusion criteria, representing a weighted total of >138 million people. Of these, 34% were vitamin D deficient and 47% insufficient. In adjusted analysis, compared with moderate drinkers with normal vitamin D levels, non-drinkers had no increased risk of IR by HOMA-IR levels (odds ratio [OR] 1.18, 95% confidence interval [CI] 0.61–2.30). Vitamin D–deficient individuals had a higher risk of IR regardless of alcohol consumption (moderate drinkers OR 2.12, 95% CI 1.41–3.19; non-drinkers OR 2.22, 95% CI 1.29–3.83). However, in those with insufficient vitamin D levels, moderate alcohol intake had a modifying effect on the odds of IR, with no difference seen in moderate drinkers (OR 1.29, 95% CI 0.92–1.80) and an increased risk found in non-drinkers (OR 1.82, 95% CI 1.07–3.11). Similar results were seen with fasting insulin.

Conclusion: Moderate alcohol consumption appears to have a modifying effect on the risk of IR in individuals with insufficient levels of vitamin D.

Keywords: Alcohol intake; Insulin resistance; Vitamin D; Diabetes; National Health and Nutrition Examination Survey

Introduction

Insulin resistance (IR) is a marker of early cardiovascular disease (CVD) and relates to impairment of physiologic response of tissues to insulin, leading to disruption of various metabolic processes. Patients with IR are more likely to progress to various CVDs including hypertension and type 2 diabetes [1,2].

Cardiovascular disease and glucose metabolism are also related to vitamin D insufficiency. Fasting serum glucose has been found to be significantly higher in subjects with 25-hydroxyvitamin D levels <80 nmol/L compared with subjects with levels >80 nmol/L [3]. A similar result was found in a study of elderly patients with insufficient vitamin D status [4]. Subjects in the lowest tertile of 25-hydroxyvitamin D had a significantly higher blood glucose increase and a higher blood insulin increase after an oral glucose load compared with subjects in the highest tertile [4]. Analyzing the Third National Health and Nutrition Examination Survey (NHANES III), Scragg et al. [5] found an inverse association of 25-hydroxyvitamin D with fasting glucose in non-Hispanic whites and Mexican Americans, but not in non-Hispanic blacks. The homeostasis model assessment of IR (HOMA-IR) was inversely associated with 25-hydroxyvitamin D in Mexican Americans, but not in non-Hispanic whites ($P = 0.058$) or non-Hispanic blacks ($P = 0.93$).

In terms of alcohol consumption, many epidemiologic studies have found that moderate alcohol intake decreases

This study supported in part by grant 5 D55HP05150 from the Health Resources and Services Administration.

* Corresponding author. Tel.: +843-792-0163; fax: +843-792-3598.
E-mail address: playerm@musc.edu (M.S. Player).

0899-9007/10/$ – see front matter
doi:10.1016/j.nut.2009.03.006

coronary heart disease risk and cardiovascular mortality [6–9]. This has been observed in those at high risk for coronary heart disease and those at lowest risk [10,11]. In the Physicians Health Study, there was a decrease in total and cardiovascular mortality risk in hypertensive men who drank alcohol compared with rare or non-drinkers [12]. King et al. [13] recently showed that middle-aged people free of CVD who started drinking in midlife had lower rates of CVD morbidity in just 4 y.

Research for more than a decade has shown that moderate alcohol consumption has a favorable affect on insulin sensitivity and is protective against IR in various populations. The Bruneck study of 820 healthy men and women 40–79 y of age in Italy showed that low to moderate amounts of alcohol were associated with improved insulin sensitivity as measured by fasting insulin and HOMA [14]. Further, favorable effects have been demonstrated in postmenopausal women [15], overweight women in the Nurses' Health Study II [16], in young adults [17], and in the nationally representative NHANES III [18].

It is unknown whether alcohol intake can offset the detrimental effects of low serum vitamin D levels on IR. The purpose of this study is to determine whether moderate alcohol intake is associated with lower IR in individuals with low vitamin D levels.

Materials and methods

Survey description

We analyzed data from the 2001–2004 NHANES. The NHANES 2001–2004 is a product of the National Center for Health Statistics that consists of detailed household interviews and physical and laboratory examinations. It is a continuous annual survey consisting of participants from a nationally representative sample of non-institutionalized residents of the United States. Certain groups such as African Americans, Mexican Americans, and older people are oversampled to ensure adequate numbers for subgroup analyses. Samples are weighted so they are representative of the U.S. population. Sampling weights were calculated by taking into account unequal probabilities of selection due to sample design and oversampling and then matched to known population control totals to be representative of the U.S. population. Descriptions of the NHANES design and sampling methods are available from the National Center for Health Statistics [19,20].

Subsample population

The subpopulation analyzed included adult men and women $\geq$20 y of age in NHANES 2001–2004. Participants with fasting insulin and fasting glucose levels were selected. Because we were interested in looking at IR as a prediabetic state and as a risk factor for later disease, we excluded any patients with a history of diabetes because they are known to already have IR. Diabetes was operationalized by patients' self-report of having ever been told by a doctor they have diabetes or are currently taking medications for diabetes. We also excluded participants with a history of heart attack, a history of stroke, and excessive alcohol drinkers. Excessive alcohol drinking was defined as more than two drinks per day for men and more than one drink per day for women. A drink was defined as 12 oz of beer, a 4-oz glass of wine, or 1 oz of liquor.

Insulin resistance was defined by the established marker of a fasting insulin level $>$12.2 mU/L, which was established by correlation with the glycemic/euglycemic clamp method [21], considered the gold standard for determining IR. We also used the HOMA-IR. HOMA-IR is calculated by multiplying fasting serum insulin (milliunits per liter) and fasting plasma glucose (milligrams per deciliter) divided by 405 [22]. Standardized cutoff values for HOMA-IR have been determined at the 75th percentile in only one study [23]. However, this level of $\geq$2.6 corresponds to a fasting insulin level representative of IR established by the glycemic/euglycemic clamp method. We also used ''score 2B'' by McAuley et al. [21] to characterize the insulin sensitivity index as a categorical variable using fasting insulin and fasting triacylglycerol levels. A score 2B $>$1 corresponded to a 73% chance of IR.

Vitamin D

The Diasorin (Stillwater, MN, USA) 25-hydroxyvitamin D assay consists of a two-step procedure. The first step involves extraction of 25-hydroxyvitamin D and other hydroxylated metabolites from serum with acetonitrile. After extraction, the treated sample is assayed by using an equilibrium radioimmunoassay procedure. The radioimmunoassay method is based on an antibody with specificity to 25-hydroxyvitamin D. Vitamin D deficiency was characterized as $<$20 ng/mL [24], insufficiency as 20–32 ng/mL [25], and normal as $>$32 ng/mL.

Alcohol consumption

Participants were also classified as non-drinkers or moderate drinkers within vitamin D categories. Moderate drinking was defined as no more than two drinks per day for men and no more than one drink per day for women. A drink was defined as 355 mL of beer, a 118-mL glass of wine, or 30 mL of liquor.

Covariates

Several potential confounding variables were assessed. The covariates included were age, gender, race/ethnicity, smoking status, body mass index (BMI), and physical activity. For race/ethnicity, participants were categorized into non-Hispanic white, non-Hispanic black, and Hispanic plus other race including multiracial based on patient self-report. Smoking status was categorized as current smoker or not.