Serum Insulin Concentrations in Daily Drinkers Compared With Abstainers in the New Mexico Elder Health Survey

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Background. Recent epidemiological studies have shown that individuals who ingest alcohol regularly have a lower prevalence of diabetes mellitus than those who abstain. The purpose of this study was to compare serum glucose and insulin concentrations between daily drinkers and abstainers stratified by diabetic status (participants with diabetes, impaired glucose tolerance, and normal glucose tolerance) to determine if there was a difference in glucose sensitivity (resistance) that might explain the lower prevalence of diabetes in drinkers.

Methods. A cross-sectional community survey was conducted of 883 randomly selected Hispanic and non-Hispanic white men and women, aged ≥65 years, undergoing a home interview and 4-hour interview/examination in a senior health clinic (The New Mexico Elder Health Survey). The interviews included a history of frequency, type, and quantity of alcohol ingested. Serum samples were obtained after an overnight fast and 2 hours after ingestion of 75 grams of glucose for determination of glucose and insulin levels. Height and weight was measured for determination of body mass index.

Results. Participants who consumed alcohol daily had significantly lower fasting and 2-hour postglucose serum insulin concentrations compared with those who abstained from alcohol intake, when adjusted using linear logistic regression models for serum glucose concentration, gender, ethnicity, age, and body mass index.

Conclusions. Abstainers with their relative hyperinsulinemia appear to be more insulin resistant than daily moderate drinkers. This difference in insulin sensitivity may explain the lower prevalence of diabetes in drinkers compared with abstainers observed in various epidemiological studies.

Lower prevalence rates of diabetes mellitus have been reported in individuals who ingest moderate amounts of alcohol when compared with those who are abstainers (1–7). In the Nurse’s Health Study with nearly 85,000 nurses followed prospectively for 16 years, participants who drank less than 5 grams, 5 to 10 grams, and over 10 grams of alcohol per day had relative risks (RR) (95% confidence interval [CI]) for diabetes of 0.78 (0.72–0.84), 0.56 (0.48–0.65), and 0.59 (0.52–0.66), respectively, when compared with those who were nondrinkers (6). These differences persisted after adjustments for differences in body mass indices (BMI). In a 12-year prospective study of nearly 47,000 male health care professionals, those participants who ingested 15–29 grams of alcohol per day had an RR of 0.64 (CI 0.53–0.77) compared with abstainers (7). In this study, consumption of alcohol on at least 5 days per week provided the greatest protection, even when less than 1 drink per day was consumed (RR 0.48; CI 0.27–0.86).

Differences in insulin sensitivity (resistance) could explain the differences in prevalence rates of type 2 diabetes mellitus between drinkers and nondrinkers. Using various measures of insulin sensitivity (fasting insulin, postglucose load insulin, fasting insulin resistance index, and homeostasis models), several studies (8–11) suggest that moderate drinkers are more insulin sensitive than nondrinkers. Kiechl and colleagues (11) reported an inverse linear relationship between alcohol intake and insulin resistance, measuring fasting plasma insulin, postload insulin, and homeostasis models to quantify insulin resistance, adjusting for differences in gender, BMI, exercise, smoking, medications, and diet.

Previous studies have examined the relationships between alcohol intake, the prevalence of diabetes mellitus, and insulin sensitivity (resistance) in younger subjects. The New Mexico Elder Health Survey (NMEHS) was a study of health and health-related issues conducted between 1993 and 1995 on nearly equal numbers of elderly (aged ≥65 years) Hispanic and non-Hispanic white (NHW) men and women randomly selected from the Health Care Financing Administration (HCFA) (Medicare) rolls of Bernalillo County (Albuquerque), New Mexico (12–14). The prevalence rates for diabetes mellitus in our study population were 24.5% in those who never consumed alcohol compared with 11.8% in those who drank daily (RR 2.3; 95% CI 1.4–3.4; p < .001) (12). The purpose of this study is to examine the relationship between alcohol intake and insulin sensitivity (resistance) comparing daily drinkers with abstainers, first by comparing fasting and 2-hour postglucola serum glucose and insulin concentrations for all participants adjusted
for differences in age, gender, ethnicity, and BMIs, then stratifying by diabetic status (diabetes, impaired glucose tolerance, and normal glucose tolerance).

**METHODS**

**Study Design/Subjects**

Twenty-two hundred prospective participants (equal numbers of Hispanic and non-Hispanic white men and women) were randomly selected from the 50,700 HCFA registrants (Medicare recipients), aged 65 years and older, residing in Bernalillo county (Albuquerque), New Mexico. After eliminating those who had died and moved from the county, those who could not be located either because only a post office box address was available or they did not respond to notes left at their homes, and those who were ineligible because they clearly did not meet criteria to qualify as Hispanic or NHW, 1666 eligible participants were contacted. Eleven hundred thirty (67.8%) agreed to participate in home interviews. An additional 29 interviewees were thereafter found not qualified because they did not meet ethnicity standards (self-identification and 3 of 4 grandparents identified as Hispanic or non-Hispanic white) or had died or moved after the home interview and before an examination could be completed. Of the 1101 individuals interviewed at home and found eligible, 883 (80.2%) participated in a 4-hour interview/examination by a nurse practitioner, nurse, and nutritionist. There were no other exclusionary criteria as long as informed consent could be obtained from the participant or legal guardian. A senior health center was used for 89% of the examinations with the remainder performed in the home or in a nursing home. All participants gave a written informed consent, and the research was approved by the Human Research Review Committee of the University of New Mexico Health Sciences Center. Further details on the design and survey instruments used in the study, and demographic characteristics of the recruited participants are published elsewhere (13,14).

**Interview and Examination**

Interviews were obtained directly from 96% of the participants, and from a spouse, relative, or caretaker in 4% of the cases. A history of alcohol intake was obtained by the nurse, who asked the question, “How often do you drink alcoholic beverages?” Possible answers were: (a) never, (b) 1 or fewer days per week, (c) 2 to 5 days per week, (d) daily, less than 4 drinks per day, and (e) daily, 4 or more drinks per day. Comparisons were made between Group 1 (non-drinkers/abstainers) and Groups 4 and 5 combined (daily drinkers). Groups 2 and 3 were combined and examined as a group with intermediate alcohol intake. Height and weight were obtained on each participant by the nurse, and BMI was calculated as weight (kilograms) divided by height (meters) squared.

**Laboratory Determinations**

Blood samples were drawn and immediately placed in ice until separation. Glucose was determined by a hexokinase enzymatic assay using a Cobas Bio instrument (Roche Diagnostics, Indianapolis, IN) and reagents from Beckman Instruments (Carlsbad, CA). Insulin concentration was determined using a radioimmunoassay from Diagnostic Products (Los Angeles, CA).

**Diabetes Evaluation**

Blood samples were collected between 8:00 AM and 8:30 AM after an overnight fast, and assayed for serum glucose and insulin concentrations as part of a larger battery of tests. Unless the participant was on insulin and/or an oral hypoglycemic agent, or had a screening fasting glucose level >150 mg/dl (8.3 mmol/l), the individual was asked to ingest 75 grams of glucose during a 10-minute period, and a blood sample was obtained 2 hours later for serum insulin and glucose determinations.

Participants were placed in one of four categories based on World Health Organization recommendations recently modified by the American Diabetes Association’s Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (15). Participants were considered to have diabetes if they were on insulin, and/or oral hypoglycemic agents. They also were considered to have diabetes if their fasting serum glucose was $\geq 7.0$ mmol/l (126 mg/dl) or their 2-hour postglucola glucose was $\geq 11.1$ mmol/l (200 mg/dl). Participants were considered to have impaired glucose tolerance if their fasting serum glucose was $\geq 6.1$ mmol/l (110 mg/dl) but <7.0 mmol/l or their 2-hour glucose was $\geq 7.8$ mmol/l (140 mg/dl) but <11.1 mmol/l. Participants were considered to have a normal glucose tolerance if their fasting serum glucose was <6.1 mmol/l and the 2-hour glucose was <7.8 mmol/l. The remaining participants were listed as indeterminate, generally because permission was not obtained for blood sampling, or the participant arrived not fasting.

**Statistical Methods**

Descriptive statistics include mean ± standard deviation (SD) and frequency rates (%). In making comparisons between groups on continuous variables, and where normal distribution of the measure held, Student’s $t$ test was used. A logarithmic transformation of skewed variables (glucose, insulin), followed by a $t$ test, was used when approximate normal distribution could be obtained. Linear regression models were constructed to show the associations between serum insulin and glucose concentrations as predictors and age and ethnicity as covariates, and serum insulin and BMI as predictors and serum glucose, ethnicity, and age as covariates for men and women. All analyses were conducted using SAS software (16).

**RESULTS**

Of the 883 participants in the NMEHS, 77 men and 26 women admitted to consuming alcohol on a daily basis (only 11 men admitted to 4 or more drinks daily). There were 180 men and 233 women who stated that they abstained from all alcohol ingestion (Group 1). This left 208 men and 159 women who consumed alcohol on less than a daily basis. They were analyzed as a third group giving results that were intermediate between the 2 groups reported.

Table 1 shows the mean ± SD fasting serum glucose and insulin levels and BMIs comparing daily drinkers with
adjusting for differences in fasting serum glucose concentration, a linear regression model showing the association between the fasting serum insulin level and fat distribution or BMI (17,18), raising the question of whether or not the higher insulin levels in the abstainers compared with the daily drinkers could be explained by the greater total body obesity observed in the former. A linear regression model showing the association between the fasting serum insulin concentrations and the body mass indices, adjusting for differences in fasting serum glucose concentrations, age, gender, and ethnicity for all participants, shows that, at any level of BMI, abstainers still had significantly higher fasting serum insulin levels compared with daily drinkers ($p = 0.003$) (Figure 1).

**DISCUSSION**

Our studies are in agreement with previous reports that the prevalence of diabetes mellitus is higher in those individuals who abstain from alcohol intake compared with those who ingest alcohol on a regular basis (1–7), and the former have higher serum insulin levels, both fasting and postprandial, compared with the latter (8–11). Even when participants were stratified by glucose tolerance status (diabetes, impaired glucose tolerance, normal glucose tolerance) so that blood glucose concentrations were more comparable, abstainers had higher mean serum insulin concentrations than daily drinkers. Furthermore, even though abstainers had higher BMIs than drinkers, adjustments for this difference failed to explain the higher insulin levels seen in nondrinkers.

Besides the implications for diabetes risk, the finding of an inverse correlation between alcohol intake and serum insulin concentration may reflect an additional independent mechanism, other than its effect on raising serum high-density lipoprotein (HDL) cholesterol concentrations (12,19), that would explain how daily alcohol ingestion lowers the risk for coronary heart disease (CHD). Hyperinsulinemia is independently associated with decreased serum HDL cholesterol and increased triglyceride concentrations, obesity, and an increased risk for type 2 diabetes mellitus and CHD (20,21).

Our study population is unique in that all participants were Medicare recipients, therefore aged 65 years or older, with a mean age of 74.1 years. Most previous studies have

| Table 1. Mean ± SD Fasting Serum Glucose and Insulin Concentrations and Body Mass Indices For Men and Women Stratified by Diabetic Status (Diabetes, Impaired Glucose Tolerance, Normal Glucose Tolerance, and All Participants) |
|-----------|-------------|-------------|-------------|
|           | N           | Glucose (mg/dl) | Insulin (pmol/l) | BMI (Kg/m²) |
| **Men (Daily Drinkers)** | | | | |
| Diabetes   | 12          | 137.5 ± 37.1   | 14.5 ± 10.6   | 24.2 ± 3.6** |
| IGT        | 15          | 101.4 ± 11.7   | 8.9 ± 4.3     | 25.6 ± 3.8  |
| NGT        | 50          | 89.0 ± 6.4     | 7.7 ± 2.6     | 24.9 ± 3.2  |
| All participants | 77        | 98.8 ± 23.5*   | 9.0 ± 5.5**   | 25.0 ± 3.4** |

**Men (abstainers)**

| Diabetes   | 55          | 150.6 ± 57.8   | 31.2 ± 45.2   | 27.5 ± 3.3  |
| IGT        | 42          | 101.0 ± 11.7   | 20.4 ± 40.5   | 26.4 ± 3.7  |
| NGT        | 83          | 89.2 ± 10.7    | 9.1 ± 6.5     | 25.8 ± 4.3  |
| All participants | 180    | 110.7 ± 42.6   | 18.5 ± 33.2   | 26.5 ± 3.9  |

**Women (daily drinkers)**

| Diabetes   | 1           | 137.8          | 5.0           | 26.0          |
| IGT        | 6           | 96.1 ± 14.7    | 5.7 ± 1.6*    | 24.5 ± 5.3   |
| NGT        | 19          | 84.9 ± 9.1     | 6.3 ± 1.9     | 25.4 ± 4.9   |
| All participants | 26     | 89.5 ± 14.9    | 6.1 ± 1.8**   | 25.2 ± 4.8   |

**Women (abstainers)**

| Diabetes   | 48          | 135.0 ± 43.2   | 20.0 ± 19.1   | 28.1 ± 5.1   |
| IGT        | 55          | 94.6 ± 13.0    | 13.3 ± 10.4   | 28.4 ± 6.1   |
| NGT        | 130         | 86.7 ± 8.8     | 8.7 ± 7.5     | 25.0 ± 4.2   |
| All participants | 233   | 98.5 ± 28.6    | 12.1 ± 12.2   | 26.4 ± 5.1   |

Notes: * Significant differences at $p < .05$ between daily drinkers and abstainers by gender.

** Significant differences at $p < .01$ between daily drinkers and abstainers by gender.

BMI = body mass index; IGT = impaired glucose tolerance; NGT = normal glucose tolerance.
examined younger subjects. Furthermore, nearly equal numbers of Hispanics and NHWs were studied, the former having a much higher prevalence of diabetes. All volunteers lived in New Mexico with its Southwestern culture and dietary habits. Additional studies in other populations will be necessary before concluding that our findings can be applied to all populations. Nevertheless, our findings appear to confirm previous reports.

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