

Alcohol Consumption in the Severely Obese: Relationship with the Metabolic Syndrome

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Abstract

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Objective: The aim of this study was to examine the association between the clinical and biochemical features of the metabolic syndrome and quantity and type of alcohol intake in the severely obese.

Research Methods and Procedures: A cross-sectional study was performed in 486 consecutive severely obese subjects. Data on alcohol consumption was collected by serial clinical interviews and a questionnaire. The relationship between alcohol intake and the clinical and serum chemistry features of the metabolic syndrome was analyzed by multiple statistical techniques. Laboratory measures included lipid profile, fasting blood glucose, hemoglobin A1c, and fasting serum insulin. An indirect index of insulin resistance was calculated using the log-transformed fasting insulin and glucose product.

Results: There were 486 subjects, 84% women, with a mean age of 40.6 ± 10 years (range, 16 to 71 years) and a body mass index of 45.3 ± 7 kg/m² (range, 34 to 77 kg/m²). Alcohol consumers ($N = 276$) showed a marked reduction in the adjusted odds ratio of type 2 diabetes (odds ratio = 0.29; 95% confidence interval, 0.16 to 0.55) compared with rare or nonconsumers ($N = 210$). There was a U-shaped relationship between the amount and frequency of alcohol consumption and fasting triglyceride, fasting glucose, hemoglobin A1c, and index of insulin resistance measurements. Consumers of <100 g/wk had more favorable measures. The effect was attenuated when diabetics were excluded from the analysis. Timing of alcohol consumption did not influence outcome measures.

Discussion: Light-to-moderate alcohol consumption is associated with a lower prevalence of type 2 diabetes, reduced insulin resistance, and more favorable vascular risk profile in the severely obese. We would propose that light to moderate alcohol consumption should not be discouraged in the severely obese.

Key words: alcohol, vascular risk, insulin resistance, diabetes, metabolic syndrome, wine

Introduction

Moderate alcohol consumption is associated with reduced all-cause mortality, especially cardiovascular mortality, in the middle-aged and elderly (1,2). The reduction in cardiovascular disease has been partly attributed to a more favorable lipid profile and less thrombogenic platelet function. More recently, there has been considerable evidence of favorable changes in glucose metabolism with reduction in the risk of type 2 diabetes (3) and improved insulin sensitivity (4). Beverage-specific benefits to cardiovascular risk may exist with the antioxidant effects of wine, especially red wine (5), and the folate and vitamin B₆ content of beer (6). There is good epidemiological evidence for the "French Paradox," a reduction in cardiovascular morbidity and mortality in areas where wine is commonly consumed, despite a diet high in saturated fat (7,8). However, the benefit of light-to-moderate alcohol consumption is not restricted to wine (9), and factors other than choice of beverage may well influence regional differences.

There is an epidemic of obesity throughout most developed countries and many developing countries (10,11). The prevalence of obesity [body mass index (BMI) > 30 kg/m²] has doubled in most Western countries, including the U.S. and Australia, in the last 15 to 20 years (12,13). Obesity is an independent risk factor for cardiovascular disease and is strongly associated with other independent risk factors such as hypertension, dyslipidemia, and impaired glucose tolerance. These conditions often cluster, producing the high-risk "metabolic syndrome" or "syndrome X." The distribution of excess weight is significant with increased visceral or central obesity

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in association with insulin resistance, constituting important components of this high-risk syndrome (14).

We followed a group of severely obese patients after laparoscopic adjustable gastric-band surgery and found that hyperinsulinemia and increased insulin resistance are important predictors of a reduced rate of weight loss (15). In addition, those consuming alcohol lost weight at a greater rate than those who abstained. In another study, looking at the predictors of steatohepatitis in the severely obese, we have found that light-to-moderate alcohol consumption is associated with less risk of nonalcoholic steatohepatitis, a disease strongly related to impaired glucose metabolism and insulin resistance (16). The effect of alcohol on nonalcoholic steatohepatitis was not significant after controlling for insulin resistance. We hypothesize that these favorable findings are likely to be related to a reduction in insulin resistance associated with alcohol consumption.

The possible benefits of light-to-moderate alcohol consumption to type 2 diabetics has led to considerable interest in identifying appropriate advice concerning alcohol consumption other than a global abstinence policy (4,17). Obese subjects are also at high risk for cardiovascular disease, yet there has been little focus concerning advice, other than abstinence, for this group. The objective of this cross-sectional study was to examine the association between type 2 diabetes, insulin resistance, known cardiovascular risk factors, and alcohol intake in the severely obese.

Research Methods and Procedures

Study Design

This study is of 486 (after 3 exclusions) consecutive patients with severe obesity ($BMI > 35 \text{ kg/m}^2$) who underwent an extensive preoperative assessment before having an adjustable gastric band (Lap-Band System; Bioenterics Corp., Carpentaria, CA) inserted laparoscopically for weight reduction. Subjects were almost all of European origin, with three of Middle Eastern origin. There were no African, Hispanic, or Asian ethnic groups.

Patients with a $BMI > 35 \text{ kg/m}^2$, suffering significant medical, physical, or psychosocial disabilities and who had attempted weight reduction by other means for at least 5 years were considered for entry into the program. After two consultations with the surgeon, when clinical evaluation was made and the procedure discussed extensively, patients who elected to proceed underwent an extensive preoperative assessment. This included clinical assessment by two consultant physicians, anthropometric measurements, and laboratory tests. Laboratory tests included fasting lipid profile, fasting plasma glucose, fasting insulin, and glycosylated hemoglobin A1c (HbA1c). Diagnosis of type 2 diabetes was based on the American Diabetes Association's criteria (fasting venous plasma $\geq 7.0 \text{ mM}$, confirmed on 2 separate days). Hypertension was diagnosed if the patient had a past

history of hypertension and was on antihypertensive medication or if the patient had a resting recumbent blood pressure $\geq 140/90 \text{ mm Hg}$ on at least two occasions. A history of chronic alcoholism or drug dependency is a relative contraindication to surgery. However, two patients with chronic alcoholism and one with binge drinking and recreational drug use were accepted for surgery and therefore were excluded from this study. All subjects gave written informed consent to surgery and preoperative assessments. The information obtained and the questionnaires used were approved by the hospital's ethics committee as part of a larger study.

A careful assessment of the pattern of alcohol consumption was obtained at two separate medical consultations with physicians and separately in a questionnaire completed by the patient. Finally, in a structured interview with a third physician, the responses to the questionnaire and earlier consultations were assessed, and the reason for any discrepancy in the pattern of reported alcohol consumption was sought from the patient or a relative. Any reason for not consuming alcohol was also obtained through questionnaire and interview. The reason for any change in pattern of consumption was also sought. Alcohol consumption was classified into five groups: group 1, nil (no alcohol or very rare consumption); group 2, $<20 \text{ g/wk}$; group 3, $20 \text{ to } 60 \text{ g/wk}$; group 4, $61 \text{ to } 100 \text{ g/wk}$; and group 5, $>100 \text{ g/wk}$. Frequency of consumption was also classified into four groups: nil, most months, most weeks, and most days/every day. Consumers were asked to list the most commonly consumed beverage: beer, wine, or spirits. Consumers were asked if they consumed any wine, and all wine consumers were asked to list the type of wine consumed, either white wine (including champagne-style) or red wine. The time of usual consumption was also recorded, and the two groups were compared; those listing social occasions, parties, or weekend sessions and those consuming with meals or immediately before or after meals.

Insulin Resistance

Insulin levels were measured using an immunoenzymometric assay (MEIA, Abbott Diagnostics, Abbott Park, IL) with inter and intra-assay coefficients of variation $<3\%$.

A quantitative insulin-sensitivity check index (QUICKI) has recently been described and is based on the log-transformed insulin-glucose product (18). This index has been shown to correlate well with the hyperinsulinemic euglycemic clamp technique, and therefore its inverse is a good indirect measure of insulin resistance. We have used the inverse of QUICKI as an insulin resistance index (IRI).

$$IRI = [(\log_e \text{insulin}) + (\log_e \text{fasting plasma glucose})] = 1/\text{QUICKI}$$

Data Analysis

The significance of differences between groups was measured by two-tailed Student's *t* test. As some quantitative

Table 1. Severely obese subjects ($n = 486$) grouped by weekly alcohol consumption

	Nil	<20 g	20 to 60 g (median 30 g)	61 to 100 g (median 80 g)	>100 g (median 130 g, maximum 400 g)	<i>p</i> Value	All groups
Number	210	62	91	70	53		486
Age (years)	41.2 (10.5)	38.9 (10)	39.4 (8.2)	40.3 (8.2)	43.2 (10)	0.12	40.6 (10)
BMI (kg/m ²)	45.5 (7)	45.5 (7)	45.0 (8.2)	44.8 (7.8)	45.4 (7)	0.78	45.3 (7)
Weight (kg)	125 (23)	125 (25)	126 (28)	124 (21)	126 (26)	0.98	125 (26)
Men (%)*	16%	10%	12%	14%	28%	0.06	16%
Diabetic (%)*	19%	2%	5%	4%	6%	<0.001	11%
Hypertension (%)*	45%	34%	34%	31%	36%	0.16	39%
Smokers (%)*	10%	14%	19%	17%	26%	0.03	15%
Wine consumers	—	56%	62%	63%	56%	0.55	60%
Consumption with meals	—	23%	32%	46%	53%	0.002	37%
Glucose metabolism							
F.P. glucose (mM)	6.1 (2.6)†	5.1 (1.0)‡	5.3 (1.0)‡	5.2 (1.0)‡	5.7 (2.1)	0.001	5.6 (2.0)
HbA1c (%)	6.0 (1.3)†	5.4 (0.6)‡	5.5 (0.7)‡	5.5 (0.7)‡	5.8 (1.2)	<0.001	5.7 (1.1)
F.P. insulin (units/mL)§	19.0 (16)	17.0 (14)	15.8 (10)	15.8 (12)	16.6 (12)	0.15	17.4 (13)
IRI	4.68 (0.7)†	4.44 (0.7)	4.39 (0.6)‡	4.42 (0.7)	4.53 (0.7)	0.02	4.54 (0.7)
Lipids							
Cholesterol (mM)	5.6 (1.0)	5.6 (1.0)	5.6 (1.0)	5.6 (0.9)	5.9 (1.1)	0.15	5.6 (0.9)
F triglyceride (mM)	2.07 (0.9)	1.80 (1.0)	1.70 (0.8)	1.87 (1.1)	2.19 (1.3)	0.06	1.95 (1.2)
HDLc (mM)	1.23 (0.3)	1.31 (0.3)	1.30 (0.4)	1.30 (0.3)	1.27 (0.3)	0.46	1.27 (0.3)
LDLc (mM)	3.46 (0.8)	3.60 (0.8)	3.79 (1.0)	3.60 (0.8)	3.84 (1.0)	0.1	3.59 (0.8)
Cholesterol/HDLc ratio	4.79 (1.4)	4.50 (1.1)	4.75 (1.3)	4.51 (1.2)	4.98 (1.4)	0.4	4.73 (1.4)

* *p* value obtained using χ^2 test.

† Results are significantly different from those marked ‡ (ANOVA post hoc Tukey, $p < 0.05$).

§ Geometric mean (interquartile range). For other continuous variables, mean (SD).

BMI, body mass index; F.P., fasting plasma; HbA1c, hemoglobin A1c; IRI, insulin resistance index (\log_e fasting plasma glucose + \log_e fasting insulin; results are unadjusted); F, fasting; HDLc, high-density lipoprotein cholesterol; LDLc, low-density lipoprotein cholesterol.

laboratory variables (e.g., fasting plasma insulin) required log transformation before parametric analysis, these measures are expressed as a geometric mean and interquartile range. Differences between multiple variables were assessed with ANOVA using the Tukey method for post hoc analysis. The χ^2 method with Fisher's exact test was used to test the significance of differences between proportions and categorical variables. The odds ratio (OR) was calculated for some 2×2 tables and expressed with 95% confidence intervals (CI) and adjusted OR using binary logistic regression. Linear regression analysis (forward and backwards) and univariate general linear model analysis were used to adjust for significant demographic or other differences between groups. The SPSS (19) statistical software was used for statistical analysis (SPSS, Inc., Chicago, IL). A *p* value of <0.05 was considered statistically significant.

Results

The characteristics of the group of 486 consecutive severely obese subjects are shown in Table 1. The maximum alcohol consumption in this study was 400 g/wk, and there were eight subjects consuming between 200 and 400 g/wk. Unadjusted measures of cardiovascular risk factors of groups based on the amount of alcohol consumed each week are shown in Table 1. An analysis based on the reported frequency of alcohol consumption (not shown) indicated very similar results, with very high correlation between responses to the questions regarding the amount and frequency of alcohol consumption ($r = 0.92$). The most significant differences between groups were in the measures of impaired glucose metabolism and insulin resistance. Light-to-moderate alcohol consumption is associated with lower

Table 2. Severely obese subjects excluding type 2 diabetic subjects ($n = 433$) grouped by weekly alcohol consumption

	Nil	0 to 100 g (median 40 g)	>100 g (median 130 g, maximum 400 g)	<i>p</i> Value (for comparison of Nil and 0 to 100 g)
Number	169	214	50	
Age (years)	40.2 (11)	39.5 (9)	43.1 (10)	0.49
BMI (kg/m ²)	45.7 (7)	44.9 (8)	44.6 (7)	0.35
Weight (kg)	124 (26)	125 (25)	125 (27)	0.86
Hypertension (%)	43	34	34	0.08*
Smoking (%)	10	17	26	0.04*
Men (%)	12	12	29	1.0*
F.P. glucose (mM)	5.30 (0.62)†	5.10 (0.60)‡	5.36 (0.65)	0.04
HbA1c (%)	5.63 (0.6)†	5.47 (0.5)‡	5.56 (0.5)	0.01
IRI	4.53 (0.6)	4.40 (0.6)	4.53 (0.5)	0.08
F triglyceride (mM)	1.90 (1.1)	1.78 (1.0)	2.04 (1.0)	0.24
HDLC (mM)	1.27 (0.3)	1.31 (0.3)	1.29 (0.3)	0.22

* *p* value obtained using χ^2 test, Fishers exact method.

† Results are significantly different from those marked ‡ (unpaired Student's *t* test and $p < 0.05$).

BMI, body mass index; F.P., fasting plasma; HbA1c, hemoglobin A1c; IRI, insulin resistance index (\log_e fasting plasma glucose + \log_e fasting insulin); F, fasting; HDLC, high-density lipoprotein cholesterol.

Results are unadjusted other than for the exclusion of type 2 diabetics.

levels of fasting plasma glucose, HbA1c, fasting insulin levels, and the calculated insulin resistance index (Table 1). The OR of type 2 diabetes in alcohol consumers is 0.30 (95% CI, 0.16 to 0.55; $p < 0.001$) compared with the nil/rare group. After adjustment for any differences in age, sex, or BMI, the adjusted OR was 0.29 (95% CI, 0.16 to 0.55; $p < 0.001$). For a number of factors with significant differences between groups, there seems to be a U-shaped relationship between the amount and frequency of alcohol consumption and the level of risk factor (Table 1). The group consuming >100 g/wk had higher levels of fasting plasma glucose (5.73 ± 2.1 mM vs. 5.21 ± 0.9 mM; $p = 0.02$), fasting triglycerides (2.2 ± 1.2 mM vs. 1.8 ± 0.9 mM; $p = 0.01$), and fasting total cholesterol (5.96 ± 1.2 mM vs. 5.58 ± 0.9 mM; $p = 0.02$) than groups who consume up to 100 g/wk.

When compared with nonconsumers, consumers of alcohol of <100 g/wk had significantly lower mean fasting levels of plasma glucose ($p < 0.001$), HbA1c ($p < 0.001$), insulin ($p = 0.04$), triglycerides ($p = 0.02$), and insulin resistance index ($p = 0.003$), after controlling for differences in age, sex, or BMI between groups.

In view of the highly significant difference in prevalence of type 2 diabetics between groups, an analysis was performed with all type 2 diabetics excluded. When the 53

subjects with type 2 diabetics were excluded, the U-shaped trends remained, but significance was greatly attenuated (Table 2). Significantly lower fasting plasma glucose and HbA1c were found in those with light-to-moderate alcohol consumption when compared with nonconsumers. The disproportionate number of diabetics within alcohol consumption categories thus drives much of the difference in the biochemical parameters.

In this study there were no significant differences in high-density lipoprotein cholesterol (HDLC) levels, systolic or diastolic blood pressure, or waist-to-hip ratio between groups based on amount or frequency of alcohol consumption.

Wine Consumers

Of the 276 alcohol consumers (rare consumers excluded), 30 chose beer, 165 chose wine, and 81 chose spirits as the alcoholic beverage most frequently consumed. Because there were relatively few beer drinkers, wine consumers were compared with nonwine consumers. Significant differences were found between groups (Table 3, groups I and II). Wine consumers were a significantly older group with a slightly lower mean BMI and weight and were less likely to smoke. Wine consumers had lower fasting insulin levels ($p = 0.04$), and the indirect measure of insulin resistance (IRI) was significantly lower ($p = 0.01$) after correcting for

Table 3. Wine consumers (group I) compared separately with beer and spirit consumers (group II) and nil/rare consumers (group III)

	(I) Wine (median 60 g/wk)	(II) Beer/spirits (median 80 g/wk)	(I) vs. (II), <i>p</i> value	(III) Nil	(I) vs. (III), <i>p</i> value
Number	165	108		210	
Age (years)	42 (9)	38 (9)	<0.001*	41.2 (10.5)	0.5
BMI (kg/m ²)	44 (7)	46 (7)	0.01*	45.5 (7)	0.03*
Weight (kg)	122 (25)	130 (29)	0.01*	125 (23)	0.2
Men (%)†	12%	18%	0.3	16%	0.5
Diabetic (%)†	4%	6%	0.4	19.5%	<0.001*
Hypertension (%)†	40%	38%	0.5	45%	0.1
Smokers (%)†	13%	27%	0.01*	11%	0.3
Glucose metabolism					
F.P. glucose (mM)	5.2 (1.0)	5.3 (1.0)	0.8	6.1 (2.6)	<0.001*
HbA1c (%)	5.5 (0.6)	5.6 (0.7)	0.6	6.0 (1.3)	<0.001*
F.P. insulin (units/mL)‡	14.8 (11)	18.3 (13)	0.02*	19.0 (16)	0.003*
IRI	4.3 (0.7)	4.6 (0.6)	0.02*	4.68 (0.7)	<0.001*
Lipids					
Cholesterol (mM)	5.7 (1.0)	5.6 (1.0)	0.6	5.6 (1.0)	0.35
F triglyceride (mM)	1.8 (1.0)	1.9 (1.0)	0.4	2.07 (0.9)	0.02*
HDLC (mM)	1.33 (0.3)	1.25 (0.3)	0.1	1.23 (0.3)	0.02*
LDLC (mM)	3.6 (0.9)	3.7 (0.9)	0.9	3.46 (0.8)	0.06
Cholesterol/HDLC ratio	4.6 (1.2)	4.8 (1.1)	0.4	4.79 (1.5)	0.2

* Significant difference using Student's *t* test, *p* < 0.05.

† *p* value obtained using χ^2 test.

‡ Variable log-transformed before analysis—geometric mean (interquartile range). For other continuous variables mean (SD).

Results are unadjusted.

BMI, body mass index; F.P., fasting plasma; HbA1c, hemoglobin A1c; IRI, insulin resistance index (\log_e fasting plasma glucose + \log_e fasting insulin); F, fasting; HDLC, high-density lipoprotein cholesterol; LDLC, low-density lipoprotein cholesterol.

differences in age, sex, smoking, and BMI between groups. Significant differences were maintained after controlling for the amount and frequency of alcohol consumption. When compared with the nil group (Table 3, groups I and III), in addition to all measures of glucose metabolism being more favorable, wine consumers had lower fasting triglyceride levels and higher HDLC levels. Because the disproportionately high number of diabetics in the nonalcohol consumers (19.5% vs. 4%) may have driven the difference in biochemical parameters, an analysis without diabetics is shown in Table 4. Favorable trends remain, but the significance is attenuated. Nondiabetic wine consumers have lower fasting plasma insulin and insulin resistance index than nondiabetic nonconsumers.

Time of Consumption

The 276 alcohol consumers were analyzed in two groups based on the usual time of alcohol consumption, with one

group of 103 who drink with meals or just before or after meals and one group of the remaining 173 who drank during social occasions, parties, and weekend sessions. Forty-eight percent of wine and only 20% of beer/spirits consumers chose meals as their usual time of consumption (*p* < 0.001). There are no significant differences between the two groups in any of the measured risk factors.

Reasons for Not Consuming Alcohol

The most common reasons for not consuming alcohol were; "don't like it" or "don't like the taste" (48%), no reason (19%), family history of alcoholism (7%), religious reasons (5%), and allergies (4%). The reason for abstinence was checked at interview. None listed diabetes as a reason for abstinence, and a specific inquiry was made at the interview. However one diabetic patient listed pancreatitis

Table 4. Comparison of wine consumers and nil/rare consumers after exclusion of type 2 diabetic subjects

	Wine (median 60 g/wk)	Nil	<i>p</i> Value
Number	161	169	
Age (years)	42 (9)	40.2 (10)	0.15
BMI (kg/m ²)	44 (7)	45 (7)	0.30
Weight (kg)	122 (22)	124 (26)	0.34
Men (%)*	12%	13%	0.78
Hypertension (%)*	34%	42%	0.11
Smokers (%)*	10%	14%	0.23
Glucose metabolism			
F.P. glucose (mM)	5.14 (0.6)	5.30 (1.0)	0.17
HbA1c (%)	5.50 (0.5)	5.63 (0.6)	0.06
F.P. insulin (units/ mL) ^{†‡}	14.8 (10)	18.0 (12)	0.01 [†]
IRI	4.32 (0.6)	4.52 (0.6)	0.01 [†]
Lipids			
Cholesterol (mM)	5.67 (1.0)	5.54 (1.0)	0.25
F triglyceride (mM)	1.77 (0.9)	1.90 (1.0)	0.28
HDLC (mM)	1.27 (0.3)	1.35 (0.3)	0.06
LDLC (mM)	3.7 (0.9)	3.5 (0.9)	0.09
Cholesterol/HDLC ratio	4.54 (1.2)	4.63 (1.1)	0.56

* *p* value obtained using χ^2 test.

[†] Significant difference using Students *t* test, *p* < 0.05.

[‡] Variable log-transformed before analysis—geometric mean (interquartile range). For other continuous variables mean (SD).

Results are unadjusted other than for the exclusion of type 2 diabetics.

BMI, body mass index; F.P., fasting plasma; HbA1c, hemoglobin A1c; IRI, insulin resistance index (\log_e fasting plasma glucose + \log_e fasting insulin); F, fasting; HDLC, high-density lipoprotein cholesterol; LDLC, low-density lipoprotein cholesterol.

as a reason for abstinence. Only two listed medication as a reason for abstinence and neither were diabetic.

Smoking

Smoking is a cardiovascular risk factor that may confound the effect of alcohol on the risk factors examined. Smokers were younger and more likely to be beer and spirit consumers (Table 3). There was no difference between smokers (*n* = 75) and nonsmokers (*n* = 411) in the prevalence of diabetes and hypertension or any of the measures of glucose metabolism, including insulin resistance. However, severely obese smokers did have an unfavorable lipid

profile, with raised fasting triglycerides, lower HDLC levels, higher low-density lipoprotein cholesterol levels, and a higher total cholesterol to HDLC ratio. After controlling for age, sex, BMI, and alcohol consumption, smokers had significantly unfavorable lipid measures but had no differences in any measures of glucose metabolism (not shown).

Discussion

This cross-sectional study has found favorable vascular risk profiles associated with light-to-moderate alcohol consumption (<100 g/wk) in the severely obese.

The reduced risk of type 2 diabetes, lower fasting glucose levels, lower HbA1c, and lower insulin resistance index, in association with moderate alcohol intake, support recent published data. A number of studies have found a reduced risk of developing diabetes with moderate alcohol consumption; the risk increases at high levels of consumption (3,20–22). Alcohol consumption has been associated with lower insulin levels (23) and increased insulin sensitivity (24,25). However, the marked reduction in the prevalence of type 2 diabetes in the severely obese with light-to-moderate alcohol consumption, in this study, extends our understanding of the benefits of alcohol, particularly in this high-risk group of severely obese subjects. Moderate alcohol consumption has been shown to markedly reduce the risk of coronary heart disease in diabetic women (17), and this may also indicate added benefit for those at greater risk. Based on current evidence, it is recommended that light-to-moderate alcohol consumption in type 2 diabetics should not be discouraged (4,17). The disproportionate number of subjects with type 2 diabetes between groups based on weekly alcohol consumption drives much of the difference in biochemical parameters. An alternative explanation for the marked reduction in type 2 diabetes is bias as a result of reverse causation. Whereas we were careful to assess the reason for not consuming alcohol, it is possible that some diabetics had been advised to abstain from alcohol consumption. Type 2 diabetics are not commonly advised to abstain from alcohol in the Australian community.

This study has found two cardiovascular risk factors that were more favorable in wine consumers when compared with a combined group of beer/spirit consumers. They were less likely to smoke and had lower fasting insulin levels with less insulin resistance. This study confirmed that smoking is not associated with increased insulin resistance or differences in markers of glucose metabolism (26) and also confirmed a more unfavorable lipid profile (27). The reduction in insulin resistance, after adjusting for differences between groups, may help provide explanation for the reduced risk of ischemic heart disease in wine consumers (28). Wine consumption and the lifestyle associated with it has been shown to be associated with a lower waist-to-hip ratio (29), another indicator of the metabolic syndrome. When compared with nonconsumers of alcohol, wine con-

sumers had more favorable measures of glucose and lipid metabolism. The increased prevalence of smoking in beer and spirit consumers may well mask any beneficial effect of light-to-moderate alcohol consumption on lipid measures. There may be other relevant confounding factors that account for differences in insulin sensitivity between wine and nonwine consumers (30), and these may well account for differences that we have found.

We must remain cognizant that heavy and high-risk alcohol consumption is associated with considerable risk of morbidity and death. The problems of acute intoxication, dependence and withdrawal, and deaths associated with stroke, alcoholic cirrhosis, road injury, and suicide are problems with which we, as physicians, are all too familiar (31). The effects of alcohol consumption follow a U- or J-shaped curve, with important benefits for light-to-moderate consumption but with increased risk at high levels of consumption (32,33).

A significant limitation of this study is the cross-sectional design. However, this does not necessarily mean that the effect of "treatment," in this case alcohol consumption, is over- or underestimated (34). The findings of this study are consistent with those of recent epidemiological studies referenced with this paper. Further long-term prospective studies or interventional studies are required to confirm and clarify our findings.

There are a number of possible confounding variables that we have not assessed in our study. These may include differences in socioeconomic status, education, occupation, diet, physical activity, and exercise. These factors may have a considerable effect on the pattern and type of alcohol consumption.

In summary, light-to-moderate alcohol consumption in the severely obese is associated with more favorable vascular risk profile and reduced risk of type 2 diabetes. It reduces insulin resistance and may therefore assist with weight loss after gastric restrictive surgery. In the light of the favorable effect on the risk of type 2 diabetes, we would propose that light-to-moderate alcohol consumption should not be discouraged in the severely obese.

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