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Effects of Alcohol Abstinence on Spontaneous Feeding Patterns in Moderate Alcohol Consuming Humans

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OROZCO, S. AND J. M. DE CASTRO. *Effects of alcohol abstinence on spontaneous feeding patterns in moderate alcohol consuming humans.* PHARMACOL BIOCHEM BEHAV **40**(4) 867–873, 1991.—It has previously been found through observational techniques that moderate alcohol consumers tend to add alcohol calories to their diets without displacing macronutrient calories. The present investigation was an active manipulation of alcohol consumption to test for causation by instructing subjects to refrain from alcohol for five days. Twenty-five moderate alcohol consumers, identified with the Michigan Alcoholism Screening Test, were asked to complete a food intake diary for ten consecutive days during which they refrained from drinking any alcoholic beverages for either the first five days or the last five days. The subjects recorded in a diary everything they either ate or drank, the time at which the meal began and ended, their subjective state before and after the meal, and the number of other people present. Subjects' overall intake of food energy during the alcohol week was significantly higher than during the no alcohol week (2205 vs. 1829 kcal) and meals eaten during the alcohol week contained significantly more food energy than did meals eaten during the no alcohol week (649 vs. 541 kcal). Alcohol added additional calories to the diets without altering any other macronutrient intake. These results could have both health and weight loss implications.

Alcohol Eating Feeding pattern Hunger Meals Thirst

FOR a large number of people, alcohol constitutes an important portion of the diet. However, little is known about how it is accommodated into the diet and how it influences the ingestion of other nutrients. Since alcohol has virtually no nutritional value, many complications due to alcohol in the digestive system are due more to nutritional and vitamin deficiencies than the actual toxic effects of alcohol, especially if alcohol replaces an ordinarily balanced diet. Unfortunately, differing conclusions have been reached regarding the effect of alcohol ingestion on nutrient intake.

Many studies have found that for heavy alcohol users total energy increased as alcohol consumption increased, and as alcohol intake increased, energy derived from macronutrients decreased (15,31). On the other hand, there is evidence that moderate alcohol consumers tend to add alcohol to their caloric intake rather than replacing food with alcohol, thus consuming more total energy than those individuals that do not drink (2, 14, 22). De Castro and Orozco (10) investigated the effects of moderate alcohol consumption on the food intake and meal patterns of 92 adult humans. They found that alcohol supplemented rather than displaced food energy, and that the consumption of alcohol had little effect on the ingestion of other nutrients. The differences between the results of these studies would appear to be due to the subjects selected in these studies. Those studies indicating that energy derived from alcohol is added onto normal caloric intake used subjects that were healthy and considered low to moderate alcohol consumers. In contrast, the studies indicating that alcohol replaces food intake used subjects that were either alcoholics or patients in an alcohol treatment center.

These prior studies of the effects of alcohol on nutrient intakes did not manipulate alcohol intake. Rather they used observational techniques and documented the differences between consumers and nonconsumers. They, thus, cannot distinguish whether the difference in food intake is due to alcohol or due to the differences between alcohol consuming and nonconsuming individuals. The present investigation differs from these previous studies in that alcohol consumption was manipulated in subjects who acted as their own controls. The manipulation allows for a test for causation, while the within subjects design controls for individual differences in eating patterns.

In the present study, subjects recorded their intakes in diaries during a five day period when they were told to refrain from drinking alcohol and to also record for a five day normal drinking period. If the previously observed differences between consumer and nonconsumers resulted from a direct effect of alcohol, then the same individuals should show marked differences in their diets when accompanied by alcohol intake in comparison to periods without alcohol. If, on the other hand, the observed differences were due to individual differences, then the dietary intakes should not differ between conditions.

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METHOD

The details of the procedure are available in prior publications (5,8). Therefore, they will only be briefly summarized here. The study was conducted under the ethical guidelines of the National Institutes of Health and the American Psychological Association.

Subjects

Thirteen males and twelve female subjects were recruited from the Georgia State University student population. They received participation credit towards satisfaction of an introductory psychology course requirement and a detailed nutritional analysis of their reported diets. The subjects ranged in age from 19 to 30 years with the females averaging 24 years of age and the males averaging 23 years of age. The female subjects averaged 56.75 kg at 1.65 meters and the males averaged 72.64 kg at 1.76 meters.

The subjects completed the Michigan Alcoholism Screening Test (MAST). Moderate alcohol consumers drink approximately three to five drinks at a sitting.

Procedure

Subjects completed a one day trial diary of their food/alcohol intake. Data collected in the pocket sized diary for each meal/snack included seven point Likert-scale measures, before and after each entry of the attractiveness of the food: 1) Bad-Good, their state of hunger: 2) Full-Hungry, and thirst: 3) Sated-Thirsty, and their moods: 4) Depressed-Elated and 5) Calm-Anxious. The subjects also recorded the time the meal began and ended, whether it was a snack or a meal, and the number of other people present. Finally, the subjects gave a detailed description of the meal including exactly what foods they ate, the amount and how it was prepared.

After the completion of the one day trial diary, the subject and experimenter reviewed the diary for proper recording and clarified any difficulties. Before starting the ten day diary, the subjects were randomly assigned to either abstain from drinking any alcoholic beverages for the first five days of the recording period, or the last five days of the recording period. In addition, the subjects began on a day that would assure that both periods would contain a weekend day.

After completion of the ten day diaries, the experimenter met with each subject individually to go over any questions or problems with the diaries. The subjects also identified two people with whom they ate most of their meals. The experimenter then contacted the indicated family member, spouse, roommate, etc., in order to verify the entries in the diaries. The people contacted were given the date and location of the meal and were asked to name everything the subject ate. This procedure was done twice for every subject. There were no instances of disagreement between the meal reported in the diary and the recall of the verifier.

Data Analysis

After the diaries were checked and verified, the food and alcohol items were coded by the experimenter using a file of over 3500 food items created from the *U.S. Department of Agriculture Handbooks* numbers 6 and 456 of the *Nutritive Value of American Foods*. All complex food items and liquid items were broken down into single components. For example, a Rum Runner was broken down into the amount of 151 Rum, Blackberry Brandy, Banana Liquor, Grenadine and lime juice necessary to make the mixed drink. Once the diaries had been coded by the experimenter, the codes were entered into a computer for analysis.

The computer summed together the food items recorded for each meal. Meals were identified using various definitions based on two criteria, the amount of total food energy consumed in the meal and the interval of time, in minutes, since the last meal. In order for a reported intake to be classified as a meal it had to contain at least 50 kcal and had to be separated in time from the previous intake by at least 15 min. Four other definitions of 50 kcal and 45 min, 100 kcal and 45 min, 200 kcal and 45 min and 50 kcal and 90 min were also employed. Next, the computer program took the entire set of codes defined as a meal and evaluated the nutritional composition of each meal. These meals were characterized by their caloric content and composition of each meal. These meals were characterized by their caloric content and composition of carbohydrates, fat, protein, vitamins, minerals and alcohol. Deprivation ratios, meal size in kcal divided by the duration of the prior interval in minutes, and the satiety ratios, the duration of the following interval in minutes divided by the meal size in kcal were also calculated. The caloric content of the stomach for each subject was also calculated. Food energy was estimated to empty from the stomach at a rate proportional to the square root of the caloric content of the stomach in little calories per minute $s_{n+1} = s_n - 5\sqrt{s_n}$ where s equals the stomach content in little calories and n equals a particular minute of the day (9, 19–21). The total caloric content of the stomach and the estimated proportion of each macronutrient present at the beginning and end of each meal was included in the analysis.

For each subject, the number of people present, the meal characteristics, the premeal intervals, the postmeal interval, the stomach content, hunger self-ratings, depression and self-ratings and anxiety self-ratings were intercorrelated using Pearson Product Moment Correlations. Preprandial correlations were calculated by correlating meal sizes with premeal intervals, self-rated hunger, mood states and number of people present. Postprandial correlations were calculated for meal size, post meal self-rated hunger and post meal stomach content correlated with the duration of the postmeal interval. All between meal intervals were used to compare the means between the alcohol week and the no alcohol week. For the alcohol week, those days on which drinking occurred were separated from those days without any alcohol intake and the above analysis were performed separately for meals occurring on alcohol days and no alcohol days. The correlated *t*-test was also used to compare the means of the alcohol days versus the no alcohol days during the alcohol week.

RESULTS

Overall Intakes

There were no significant qualitative differences in the results obtained with the different meal definitions, and therefore, the data presented and discussed in the text are for the minimum 50 kcal, 45 min definition, which is representative of all the data. There were no significant differences found between female and male consumption of alcohol or daily food intake and therefore gender differences will not be discussed in the text. Table 1 gives the mean amounts and the minimum and maximum values of the macronutrient composition of the overall intakes for the normal alcohol consumption week and the no alcohol week. Subjects' overall intake of food energy during the alcohol week was significantly higher than during the no alcohol week [2205 vs. 1829 kcal, $t(24) = 3.23$, $p < 0.01$]. During the alcohol week,

TABLE 1

MEAN AMOUNTS OF OVERALL INTAKES FOR THE TWO CONDITIONS

	Alcohol Week			No Alcohol Week	
Nutrients	Mean	SEM	*t*	Mean	SEM
kcal	2205	129	3.228*	1829	119
Carbohydrates (g)	226	14	—	202	16
Fat (g)	83	6	—	77	5
Proteins (g)	82	5	—	77	4
Cholesterol (mg)	339	33	—	288	25
Phosphorus (mg)	1392	79	2.190*	1223	72
Niacin (mg)	55	9	3.120†	34	5
Vitamin A (IU)	4888	482	—	4857	628
Vitamin B12 (mg)	3	.310	—	3	.338
Vitamin C (mg)	120	18	—	114	16
Vitamin E (TE)	13	1.71	—	11	1.37
Magnesium (mg)	271	17	2.866†	215	12
Folic Acid (mg)	191	20	—	185	21
Calcium (mg)	969	74	—	944	83
Iron (mg)	15	1	—	17	3
Riboflavin (mg)	1773	105	—	1702	185
Sodium (mg)	3187	174	—	2852	231
Thiamin (mg)	1490	142	—	1583	322

$^*p<0.01$; $^\dagger p<0.05$.

218 kcal a day were attributable to alcohol, while 1988 kcal of other nutrients were ingested. The amounts of the macronutrients, carbohydrates, proteins or fats, did not significantly differ between conditions. There were significantly larger amounts of phosphorus, $t(24)=2.19$, $p<0.05$, niacin, $t(24)=3.12$, $p<0.01$, and magnesium, $t(24)=2.86$, $p<0.01$, consumed during the alcohol week than during the no alcohol week. There were no significant differences in the amount of zinc, thiamin, Vitamin A and the other miconutrients consumed between the alcohol week and the no alcohol week.

Meal Characteristics

Figure 1 gives the mean amounts (+SEM) and macronutrient composition of the reported meals consumed during the alcohol week and the abstinence week, as well as the mean amounts (+SEM) and macronutrient content of the reported meals consumed during the alcohol days and no alcohol days of the alcohol week. Each stacked column in the figure shows the total amount of carbohydrates, fats, proteins, alcohol, if any, and the food energy estimated to be remaining in the stomach at the time of meal initiation.

There was a significant difference in the reported meals eaten during the normal alcohol consumption week and the abstinence week. Meals eaten during the alcohol period contained significantly more food energy [649 vs. 541 kcal, $t(24)=2.89$, $p<0.01$] than did meals eaten during the abstinence period. During the alcohol period the average meal contained 67 kcals of alcohol and 584 kcals of macronutrients. The meals did not significantly differ in their average amount of carbohydrates, proteins or fats. The subjects ate an average of 3.46 meals a day during the alcohol week and 3.36 meals a day during the abstinence week. Also apparent in Fig. 1, there was a tiny amount of alcohol consumed during the no alcohol days. Figure 2 gives the mean (+SEM) in minutes for the durations of the reported meals con-

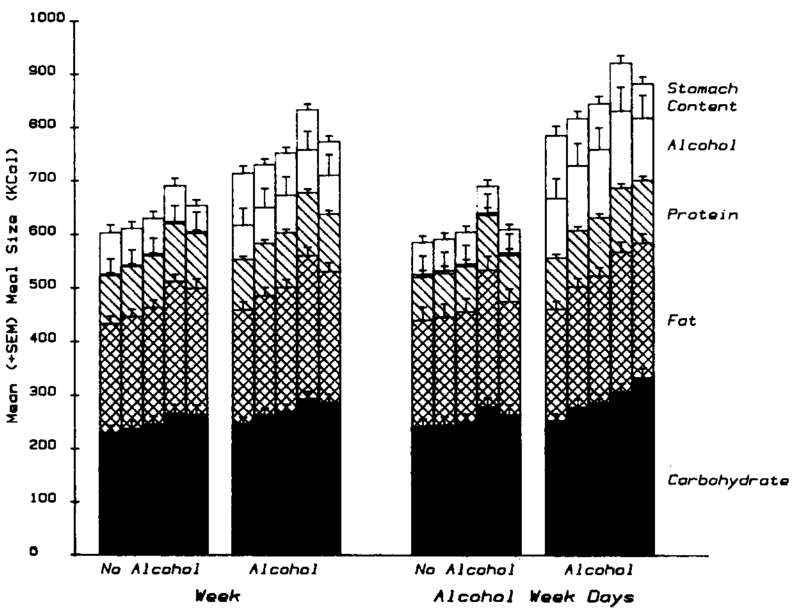

FIG. 1. Mean (+S.E.M.) amount ingested in the reported meals of carbohydrates (solid lines), fat (cross hatched), protein (hatched), alcohol (open) if any, and the food energy estimated to be remaining in the stomach at the time of meal initiation (open) for all meals ingested during the no alcohol week (left five bars) and alcohol week (left middle five bars) as well as the no-alcohol days (right middle five bars) and alcohol days (right five bars) of the alcohol week. The first bar of each set of five represents the meal definition of minimum 15 minutes IMI and 50 kcalories size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal.

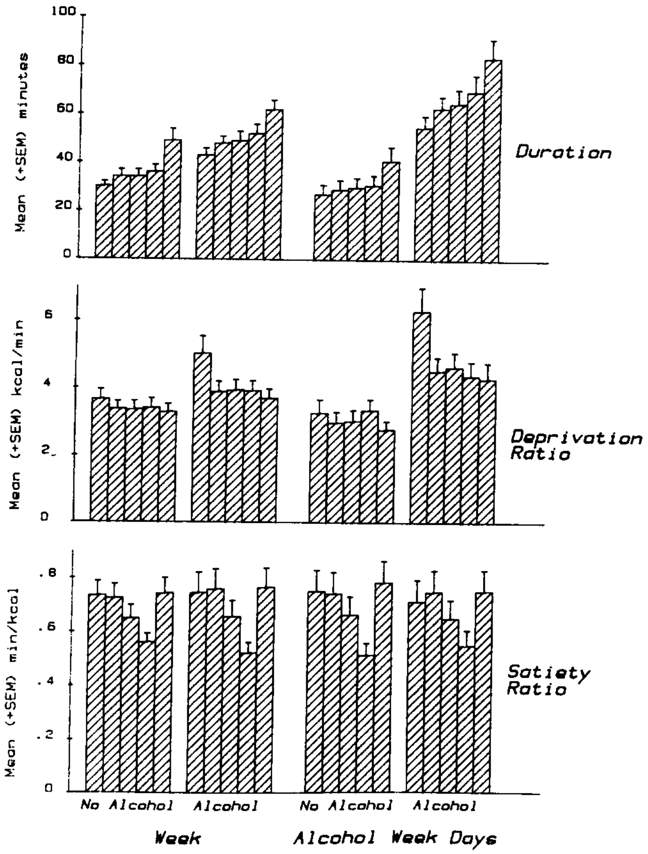

FIG. 2. Mean (+S.E.M.) meal duration (top), deprivation ratio, meal size divided by the duration of the premeal interval (middle) and satiety ratio, the duration of the postmeal interval divided by the meal size (bottom) for all meals ingested during the no alcohol week (left five bars) and alcohol week (left middle five bars) as well as the no-alcohol days (right middle five bars) and alcohol days (right five bars) of the alcohol week. The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcalories size; the second, 45 min/50 kcal; the third, 45 min/100; the fourth, 45 min/200 kcal; and fifth, 90 min/50 kcal.

sumed during the alcohol week and the abstinence week as well as the mean amounts (+SEM) in minutes for the durations of the reported meals consumed during the alcohol days and no alcohol days of the alcohol week. During the alcohol week, meal durations were significantly longer than the duration of meals during the abstinence week [48 minutes vs. 33 minutes, $t(24)=3.78$, $p<0.001$].

The deprivation ratio, meal size in kcal divided by the duration of the prior interval in minutes (see Fig. 2), significantly differed between the alcohol week and the abstinence week (3.88 vs. 3.36 calories per minute respectively), $t(24)=2.33$, $p<0.05$. Thus the subjects are not only consuming more calories per meal during the alcohol week than the abstinence week, they are eating more calories per minute of prior interval as well. The satiety ratio (see Fig. 2), the duration of the following interval in minutes divided by the meal size in kcal, did not significantly differ between the two conditions. The premeal interval, that is the amount of time since the last meal, and the postmeal interval, that is the amount of time before the initiation of the next meal, did not significantly differ between the two conditions.

The subjects premeal subjective state of hunger differed significantly between the alcohol week and the abstinence week, with the subjects reporting less hunger during the alcohol week (4.98 vs. 5.20 respectively), $t(24)=-2.632$, $p<0.01$. The subjects' premeal rating on thirst, depression, anxiety or fullness and all of the postmeal ratings did not differ significantly between the two conditions. The number of people present at each meal did not significantly differ between the two conditions.

Univariate Analyses

The correlations between the postmeal interval and the meal size differed significantly between the alcohol week (r=.023) and the abstinence week (r=.203), $t(24)=2.78$, $p<0.01$, while the correlations between the premeal interval and the meal size did not significantly differ between the two conditions. Figure 3 presents the mean (+SEM) correlations between the number of people present at each meal and the amount of kcal, carbohydrates, fats and proteins consumed in the meal between the alcohol week and the no alcohol week. The magnitude of the correlations between the number of people present at each meal and the amount consumed in the meal between the alcohol week (r=.383) and the abstinence week were significantly different (r=.181), $t(24)=2.64$, $p<0.01$. There was a significant difference in the magnitude of the correlations between the number of people present at each meal and the amount of carbohydrates consumed during the alcohol week (r=.266) and the abstinence week (r=.121), $t=2.25$, $p<0.05$. There were no significant differences in the correlations between the number of people present at each meal and the consumption of fat or protein between the two conditions.

Figure 4 shows the mean (+SEM) correlations between the estimated stomach contents prior to each meal and the amounts of kcal, carbohydrates, fats and proteins consumed in the meal between the alcohol week and the abstinence week. The correlations did not differ significantly between the two conditions. The subjects' subjective state of hunger correlated with the meal size did not differ significantly between the two conditions.

Nutritional Analysis of Alcohol Week

The macronutrient composition of meals consumed during the alcohol week were further broken down into those meals eaten on days that alcohol was ingested and those meals eaten on days when no alcohol was ingested. The average meal sizes and compositions are presented in Fig. 1. Meals eaten during the alcohol days were significantly larger than during the no alcohol days [728 vs. 527 kcal, $t(24)=3.14$, $p<0.005$]. During the alcohol days, the average meal contained 122 kcal of alcohol and 606 kcal of the other macronutrients. The meals did not significantly differ in their average amounts or proportions of carbohydrates, proteins or fats.

During the alcohol days, meal durations were significantly longer than the duration of meals during the no alcohol days [62 minutes vs. 29 minutes, $t(24)=4.40$, $p<0.001$]. The deprivation ratios were also significantly different between the alcohol and no alcohol days [4.52 vs. 2.98, $t(24)=3.09$, $p<0.01$]. The premeal interval and the postmeal interval did not significantly differ from one condition to the next. There were no significant differences between the subjects' premeal or postmeal self-rated subjective states during the alcohol days versus the no alcohol days. The average number of people present at each meal during the alcohol days was significantly larger than during the no alcohol days [1.04 vs. 0.215, $t(24)=6.92$, $p<0.001$].

DISCUSSION

The present study indicated that the most significant impact of alcohol consumption on human eating patterns is its high ca-

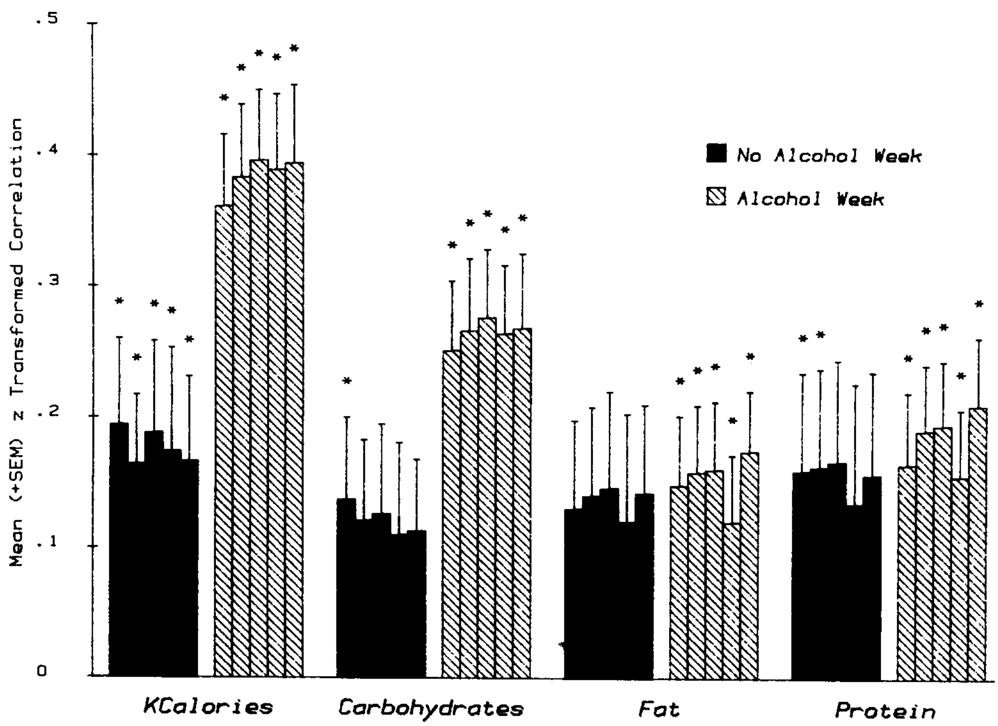

FIG. 3. Mean (+S.E.M.) correlations between the number of people present at each meal and the amount of kcalories (first set of bars), carbohydrates (second set of bars), fat (third set of bars) and proteins (fourth set of bars) consumed in the meal between the no-alcohol week (solid bars) and the alcohol week (slashed bars). The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcalories; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal.

loric contribution. During the alcohol week the subjects consumed an additional 218 kcal a day to their diets over and above all other calories consumed without altering any other macronutrient intake. This could have both health and weight loss implications.

The present findings are a result of evidence obtained from self-reports. There are several problems with this kind of procedure, such as relying on the accuracy of the reports and the reliability of the information the subjects provide. The diary technique used in this study differs only slightly from ones demonstrated to be both reliable and valid (1, 16, 25). This diary technique used moderate alcohol consumers. Consequently, this type of procedure also relies on the integrity and accuracy of alcohol consuming individuals. Studies looking at the accuracy with which alcoholics report their alcohol intake found that information derived from alcoholic reported dietary histories compared satisfactory with those reported by the patients' family members (13,30). In this study, the subjects' diary entries were verified twice by people who ate with the subjects. Thus there is every reason to believe that the subjects' diary entries were accurate.

The durations of the meals were significantly longer during the alcohol week, which suggests that the subjects were, in fact, staying longer at the meals during both the alcohol week versus the no alcohol week as well as the alcohol days versus the no alcohol days. Previous studies have shown alcohol intake to be associated with enlarged meals of long durations (10). This may be considered indirect evidence of the validity of the diaries. If the subjects were still drinking alcohol but lying and not reporting it, then the meal durations during the no alcohol week would be expected to be comparable to those days of the alcohol week. The fact that they are not suggests compliance with the established protocol.

Although it has been previously thought that normal individuals use alcohol to relieve depression, the present study agrees with other studies in that it shows no indication of a decrease in depression (6). Moderate alcohol consumers' self-ratings on the depression-elation scale remained relatively neutral (4.5) at the time of alcohol ingestion. Therefore, it seems that subjects are not particularly depressed at the onset of drinking. There is no evidence of a significant decrease in anxiety, as was found in other studies (6). In fact, moderate alcohol consumers' self-ratings on the calm-anxious scale remained relatively below neutral (3.6) at the time of alcohol ingestion. Subjects were not particularly anxious at the onset of drinking and the level of anxiety did not correlate with alcohol consumption. It appears that spontaneous alcohol intake by moderate alcohol consumers is not related to depression nor anxiety. Thus neither mood state is a determinant of alcohol consumption. This is not to suggest that alcohol may not be used under severe conditions or by extreme depressed or anxious people, but only that it is not under relatively normal conditions by otherwise normal people.

Moderate alcohol consumers tend to drink in groups. The presence of other people influences alcohol consumption (4, 27, 28) with individuals tending to drink more in the presence of others. Moreover, DeRicco (11) found that it was not just the presence of other people that influenced the rate of consumption, but the presence of other alcohol consuming individuals. Hence the literature suggests that alcohol intake is facilitated by social factors. Indeed, the present study not only showed a significant positive correlation between the number of people present

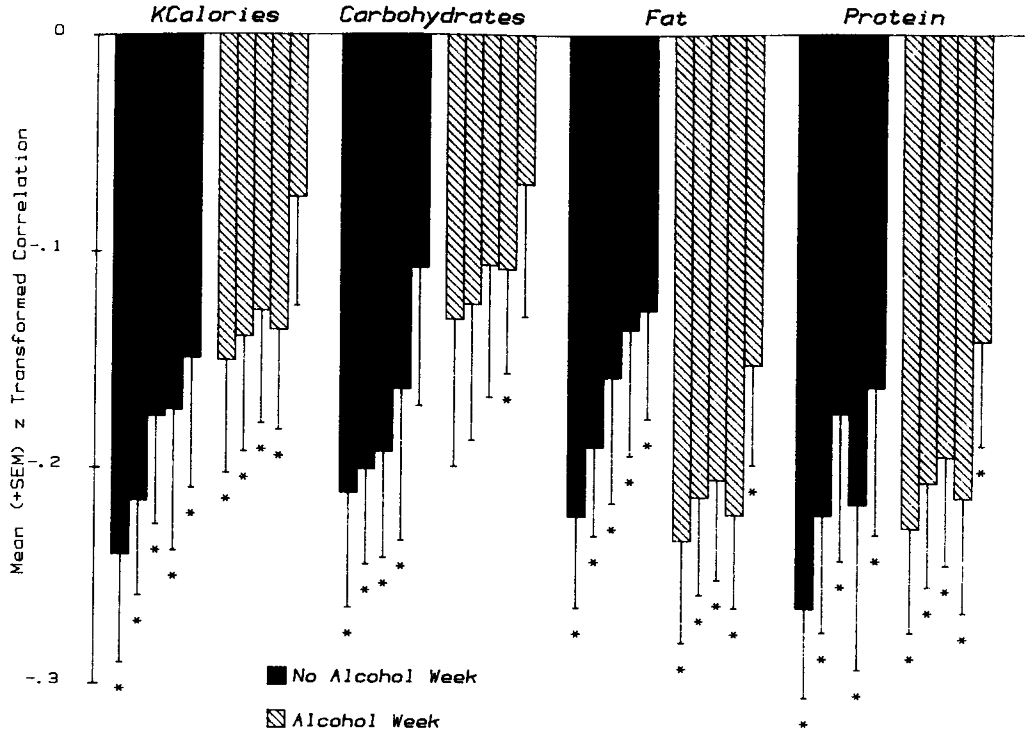

FIG. 4. Mean (+S.E.M.) correlations between the estimated premeal stomach contents of the meal size at each meal and the amounts of kcalories (first set of bars), carbohydrates (second set of bars), fats (third set of bars) and proteins (fourth set of bars) consumed in the meal between the no-alcohol week (solid bars) and the alcohol week (slashed bars). The first bar of each set of five represents the meal definition of minimum 15 minute IMI and 50 kcalories size; the second, 45 min/50 kcal; the third, 45 min/100 kcal; the fourth, 45 min/200 kcal; and the fifth, 90 min/50 kcal.

at each meal and the amount consumed in the meal for both alcohol and no alcohol conditions, but also the correlations were significantly larger during the alcohol week and alcohol days of the alcohol week. There were significantly more people present in the meals that contained alcohol. It has been found that the presence of other people during a meal extends the duration of the meal, and therefore, people tend to eat more in the presence of other people (7). In the present study, the meals were approximately 15 minutes longer during the alcohol week than during the no alcohol week. These results suggest that social facilitation of eating behavior is even stronger when alcohol is involved than when eating occurs without alcohol.

The most notable feature of this experiment is the fact that calories attributed to alcohol ingestion appear to be nothing more than excess caloric energy. This idea that moderate alcohol consumers tend to add alcohol to their caloric intake is not new (2, 10, 14, 22, 23). Studies that indicate that alcohol replaces other energy sources are usually studies that are looking at high alcohol consumers (15, 18, 26, 31).

In this study, the subjects' overall intake of food energy was significantly higher during the alcohol week than the abstinence week while the amounts of the macronutrients, carbohydrates, proteins or fats, did not significantly differ. In fact, when the alcohol calories were subtracted from the total energy intake, the intake for the two conditions were almost identical. This was also true for the reported meals eaten during the two conditions. When the alcohol week was divided into alcohol days and no alcohol days, the results were identical to those reported for the overall intakes and the overall reported meals during the alcohol week versus the abstinence week. These results indicate that calories added by alcohol are not playing a major role in the overall caloric regulation.

The present study was an attempt to manipulate alcohol intake in order to investigate its impact on human eating patterns. During the week when alcohol was consumed, the subjects added an extra 218 kcal a day to their diets over and above all other calories consumed. The manipulation of asking the subjects to abstain from drinking alcohol caused a substantial caloric reduction without an alteration in any of the macronutrients. Since the same subjects were used in both conditions, it can be concluded that the previously reported differences in the intake are not due to differences between alcohol consuming individuals and abstainers, but rather that intake is added to the diet over and above other intake and not compensated for by a reduction in other essential nutrients. This has both health and weight loss implications, especially for moderate alcohol consumers who have a weight problem. One possible way to eliminate the excess weight without altering food intake is to eliminate alcohol from the diet.

The results of this study suggest that eliminating alcohol consumption from one's diet may be an effective way to eliminate excess weight. Blair (3) found a positive correlation between successful weight loss techniques and avoidance of alcohol. These data may also suggest that moderate alcohol consumers may have a weight problem due to the fact that on the average they consume an excess of 218 kcal a day just of alcohol. However, studies have found that alcohol consumers are less obese than nondrinkers (2, 17, 22). Le Marchand et al. (23) looked at individuals that were 45 years or older, and also found that drinkers were less obese than abstainers. As suggested before, this may just be an indication that alcohol calories are not being fully utilized in the overall regulation of energy intake (10).

In the last several decades, there have appeared in the literature numerous articles on the various views of energy metabolism (12). It seems that many nutritional factors such as the type of food consumed or the amount of nutrients consumed may effect energy intake and expenditure. Nonnutrient constituents of food such as alcohol can influence energy input and output as well. The metabolic rate and thermic energy of rats has shown to increase 14–15% when orally given alcohol, but no changes have been noted in the composition of the food intake (29). Perman (24) used moderate alcohol consumers and found that in man, a small dose of alcohol (0.3 g/kg) increases the metabolic rate by 6% 20 to 50 minutes after alcohol ingestion. Perhaps the findings in the present experiment are an indication of diet induced thermogenesis (DIT). Future studies are needed to find out more about the increases of oxygen consumption of nonnutrient food constituents such as alcohol.

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