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METHODS FOR ESTIMATING EXPECTED BLOOD ALCOHOL CONCENTRATION

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They have items in abstract which weren't discussed in the report, i.e., body fat, female/male differences.
Where is Section II (p. 44)

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16. Abstract

Estimates of blood alcohol concentration (BAC) typically are based on the amount of alcohol consumed per pound bodyweight. This method fails to consider either food intake or body composition, factors which significantly affect BAC. A laboratory experiment was conducted to examine amount and type of food and time of food intake in relation to alcohol intake and BAC. Protein and carbohydrates were more effective than fatty foods in reducing the BAC, expected in a fasted state. A moderate to large amount of food, such as a typical full meal, was more effective than lesser amounts, but even a small amount of food had some effect. Time intervals of ½ to 4 hours between eating and drinking were investigated; the ½ hour interval was most effective in an inverse relationship. At 4 hours there was no food effect. In a study of body composition and BAC, 20 men and 20 women were subjects. Estimates of percent body fat were calculated using body circumferences or skinfold measurements. Subjects were dosed with .68 g alcohol/kg bodyweight, and the relationship of BAC to body fat estimate was analyzed. Use of body fat estimates did not increase the accuracy of BAC estimates sufficiently to recommend the method. It may be useful for scientific purposes but appears not to be feasible for widespread use. The data suggest that compared to men, women will achieve the same BAC with 15% less alcohol, based on ounces of alcohol per pound bodyweight. Similarly, the overweight person will achieve the same BAC as the average weight person with 10% less alcohol. These recommendation reflect the male-female differences in body composition, and the higher percent body fat in the obese body.

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METRIC CONVERSION FACTORS

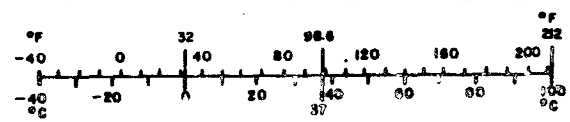
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This research was supported by the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation, under Contract No. DOT-HS-8-01999. The opinions, findings and recommendations contained herein are those of the authors, and do not necessarily represent those of the NHTSA.

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THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION, EXPERIMENTAL DATA

I. Food Effects and Alcohol: A Brief Overview of the Literature

As early as the late 19th century, the relationship of food and alcohol effects was specifically noted in the literature (Weissenfeld, 1898). During the subsequent decades of the early 1900's, a number of investigators reported that alcohol levels in blood or urine had been found to be lower when subjects drank after eating, compared to drinking on an empty stomach (Voltz, Baudrexel and Dietrich, 1912; Mellanby, 1919, 1920; Southgate, 1925).

In 1943 Goldberg reported a series of alcohol experiments with light vs. substantial meals. He found that in all cases the "food" alcohol curve was lower than the fasting curve.

Serianni et al. (1953) investigated the question of the time of eating in relation to drinking and reported only a slight effect when the food was eaten four hours before drinking. There was no effect when the interval was six hours. When the alcohol was consumed during or after a meal, the subjects reached a lower peak blood alcohol concentration (BAC). In 1966 Miller et al. reported that milk alone reduced the average BAC by almost 50%. Sharma and Moskowitz (1978) reported almost 50% BAC reduction attributable to food.

A review of the physiology of alcohol metabolism by Bode (1978) notes that absorption can occur throughout the gastrointestinal tract but occurs most rapidly in the duodenum and jejunum. The reduced absorption of alcohol after a meal is attributed to the delay in emptying the stomach.

Although there is general agreement that food reduces alcohol effects, and that it is most effective when eaten shortly before the intake of alcohol, the literature provides relatively little information or agreement about the type and amount of food which is most effective. Some indirect evidence can be derived from a review of the literature on gastric emptying (Hunt and Stubbs, 1975). They concluded that the slowing of gastric emptying is a function of the nutritive density of food, not the volume of the meal. The greater the nutritive density, the less volume transferred to the duodenum per unit time.

There is little evidence that the metabolism of alcohol can be changed to an extent which has any practical significance. Alcohol is oxidized predominantly in the liver in a two-step process. Alcohol dehydrogenase produces acetaldehyde which then is broken down to acetate by aldehyde dehydrogenase. Alcohol dehydrogenase is the most important enzyme for alcohol oxidation, and it has been assumed that its activity is the rate limiting factor in the process. Recent studies suggest that it is the capacity of the liver to reoxidize NADH that limits ethanol oxidation (Lieber, 1970; Krebs and Stubbs, 1975).

In summary, the limited literature on alcohol and food effects provides considerable evidence that food delays gastric emptying, and that it is the delay which slows the rate of alcohol absorption. In turn, it is the slower absorption process which underlies the lower BACs associated with food intake.

II. Introduction

The blood alcohol concentration (BAC) reached by an individual depends on the amount of alcohol consumed and on other important variables. Among these are the individual's bodyweight and body composition (in terms of lean body mass and adipose tissue) and the contents of the gastrointestinal system. The presence of food in the stomach is known to decrease peak and subsequent BACs.

Information about the relationship of food and alcohol levels in the body has the potential for serving as a countermeasure for alcohol-related traffic safety problems. If individuals who drink and drive can be sufficiently motivated about safety, they can use food as a means of reducing BACs. To obtain maximum benefit, drivers require information about the quantity and kinds of food which work best in reducing BAC. They also need to know the time relationship between food consumption and drinking.

To obtain information on these issues a series of pilot studies and a laboratory experiment were carried out. The initial effort consisted of a series of small pilot studies to examine the three major variables: 1) time of eating, 2) amount of food, and 3) type of food. It was essential to establish the levels of these prior to undertaking the experiment.

Peak BAC can occur from 15 to 60 minutes after drink completion.

III. Pilot Studies

METHOD

Seven subjects participated in preliminary examinations of the effects of food on BAC. The time of food intake and the amount and type of food were investigated (Table 1).

Participants were seven men, ages 21 - 32 years (mean age 24 years 8 months). Their weights ranged from 58.18 to 77.27 Kg (mean weight 69.55 Kg). These men were recruited through state and college employment offices. They were screened by standard procedures which evaluate health status, drinking practices and drug use. All were in good physical health, were moderate drinkers in terms of quantity and frequency of alcohol use, as measured by the Q-F-V Index (Cahalan, Cisin and Crossley, 1969), and were neither heavy nor chronic users of drugs.

Procedures and Findings for all pilot sessions are described in the following section. Only the three independent variables, food conditions, were varied.

The alcohol treatment was .85 g alcohol/Kg bodyweight. In males this dose produces a mean expected peak BAC of 0.10% approximately 30 minutes after completion of the drink if it is consumed on an empty stomach over a half-hour drinking period. The alcohol was given as a mixture of orange juice and 80-proof vodka, and BACs were measured with gas chromatograph analysis of breath samples.

Baseline BAC data were obtained for all subjects by administering the alcohol dose at a session where they received no food. Subjects were instructed to take no food or stimulants after midnight preceding a pilot session. They came to the laboratory at 8:00 a.m. The alcohol treatment was given at noon and drinking was completed at 12:30 p.m. BACs were monitored at 5-minute intervals for the initial 45 minutes following drinking, then at 15-minute intervals for 1-1/4 hour, and finally in the latter stages of the BAC curve the readings were taken at 30-minute intervals. Subjects were kept in the laboratory until the BAC decreased below 0.03%.

All pilot sessions were scheduled at least three days apart. Most occurred at one-week intervals.

The data to be reported will focus on three measures: 1) the peak BAC, 2) the BAC as measured 60 minutes after drink completion, and 3) a mean of the BAC readings for the period 60 - 180 minutes post-drinking. It should be kept in mind that the peak BAC occurs at different times after the drinking period; some individuals reach a peak as early as 15 minutes after drink completion and others as late as 60 minutes. Because the peak is confounded with the time variable, the BAC at a fixed time interval after drinking was examined. The 60-minute time was chosen for the additional analysis since it is the point on the alcohol curve which is at the end of or beyond the alcohol absorption phase for most subjects.

The Time of Food Intake was examined with three pilot subjects. Meals were given at four different times: 4 hours, 2 hours, 1 hour, and 1/2 hour before drinking. The meal consisted of standard food items from a McDonald's restaurant and provided 1116 calories (Table 1).

Table 2 and Figures 1 - 2 present the data for Time effects. The results indicate that food more effectively moderates the BAC when it is eaten shortly before drinking. With an increasing time interval, the food effect is lessened.

The Amount variable was examined with three pilot subjects who were initially given a McDonald's meal of 1327 calories (Table 1). At subsequent sessions they received exactly one-half and then one- quarter of the same food items. Table 3 and Figures 3 - 4 display the results of these sessions.

The larger meal reduced the peak BAC and the 60-minute BAC by approximately 50% in comparison to the no-food condition. Note that amount of food was defined in terms of weight. For the half (or one-quarter) meal, the hamburger, french fries, and milkshake were measured to provide the desired portions in grams. It is assumed that this also produced portions with one-half and one-quarter the total calories.

Smaller amounts of food had correspondingly smaller effects on the BAC ($\approx$ 30% for one-half the amount of the full meal, $\approx$ 10% for the one-quarter meal). Although the smaller food portions were less effective than the full meal, it is worth noting that even very small amounts do have some efficacy.

The third variable was Type of Food. In terms of effects on BAC, this is an important but difficult issue. It is particularly difficult because the characteristics of interest are not readily isolated for laboratory study. Because nutritive density (calories), weight, volume, and the protein-carbohydrate-fat composition of foods are not independent variables, they cannot be manipulated orthogonally as they need to be for the purposes of systematic study. Menus of palatable food which vary protein, carbohydrate and fat content also inevitably vary calories, weight and volume of the food. Given these limitations it was necessary to carry out three separate pilot studies on food type. Table 3a describes these studies in detail.

In the "A" Series the three menus were designed to provide one meal which was predominantly protein, another carbohydrates, and another fat with the percentage of the dominant type being as nearly equivalent for all meals as possible. As can be seen in all of the pilot conditions, it is difficult to create an acceptable meal which is largely fat.

"B" Series were designed to provide meals of equivalent calories, holding the protein-carbohydrate-fat content as nearly equivalent as possible. Again, the greatest deviation occurred with the fat meal which was only 65% fat, compared to approximately 75% each for the other food types.

Finally, "C" Series meals were designed to compare meals of equivalent weight with widely varying caloric content.

It should be pointed out that food portions were measured by weight with a scale accurate to 0.1 gram. It was not possible, however, to directly measure calories or the protein, carbohydrate and fat content of the food. The values for these were derived from tables in Nutrition and Diet Therapy (Williams, 1977). The composition of meats and commercially prepared breads, pasta, and other products may have varied slightly, but care was taken to minimize deviations from the tabled values. Although we believe the variations to be insignificant, the measures other than weight must be considered approximate.

TABLE 1

Pilot Sessions: Food Conditions

Variable	Food	Number of Subjects
Time of food intake. 4 hours) 2 hours) 1 hour) prior to drinking 1/2 hour) alcohol.	McDonald's food. Big Mac Small French Fries Chocolate Milk Shake 1116 Calories	3
Amount of food. Full meal - 1327 calories 1/2 meal - 664 calories 1/4 meal - 332 calories	McDonald's food. Big Mac Large French Fries Chocolate Milk Shake	3
Equivalent weight, varying cals.	Menu 3, B Series	2
Type of food. High protein High carbohydrate High fat	Menu 1, A Series Menu 2, C Series Menus appear in Appendix A	3 2

TABLE 2

Effects of Time of Food Intake

Data for Three Pilot Subjects

Subject No.	Baseline (No Food)	Time Between Food and Alcohol Intake 4 hrs.	2 hrs.	1 hr.	½ hr.
Peak BAC (%)					
1	.107	.096	.080	.056	.061
2	.094	.090	.088	.088	.066
5	.105	*	.055	.056	.044
$\bar{X}$	.102	.093	.074	.066	.057
Percent change from baseline		-8.8	-27.5	-35.3	-44.1
60-Minute BAC (%)[1]					
1	.096	.096	.077	.047	.060
2	.084	.087	.080	.088	.054
5	.080	*	.055	.053	.042
$\bar{X}$	.087	.092	.071	.063	.052
Percent change from baseline		+5.7	-18.4	-27.6	-40.2
Mean BAC: 60-180 minutes[2]					
1	.078	.076	.069	.050	.054
2	.072	.076	.066	.069	.054
5	.068	*	.045	.045	.037
$\bar{X}$	.073	.076	.060	.055	.048
Percent change from baseline		+4.1	-17.8	-24.7	-34.2

*Subject No. 5 discontinued. No 4-hour data obtained.

[1]BAC measured 60 minutes after completion of drinking.

[2]Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

Figure 1. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Time" of Food Ingestion - $\overline{X}$ BACs Over Time
for Three Pilot Subjects

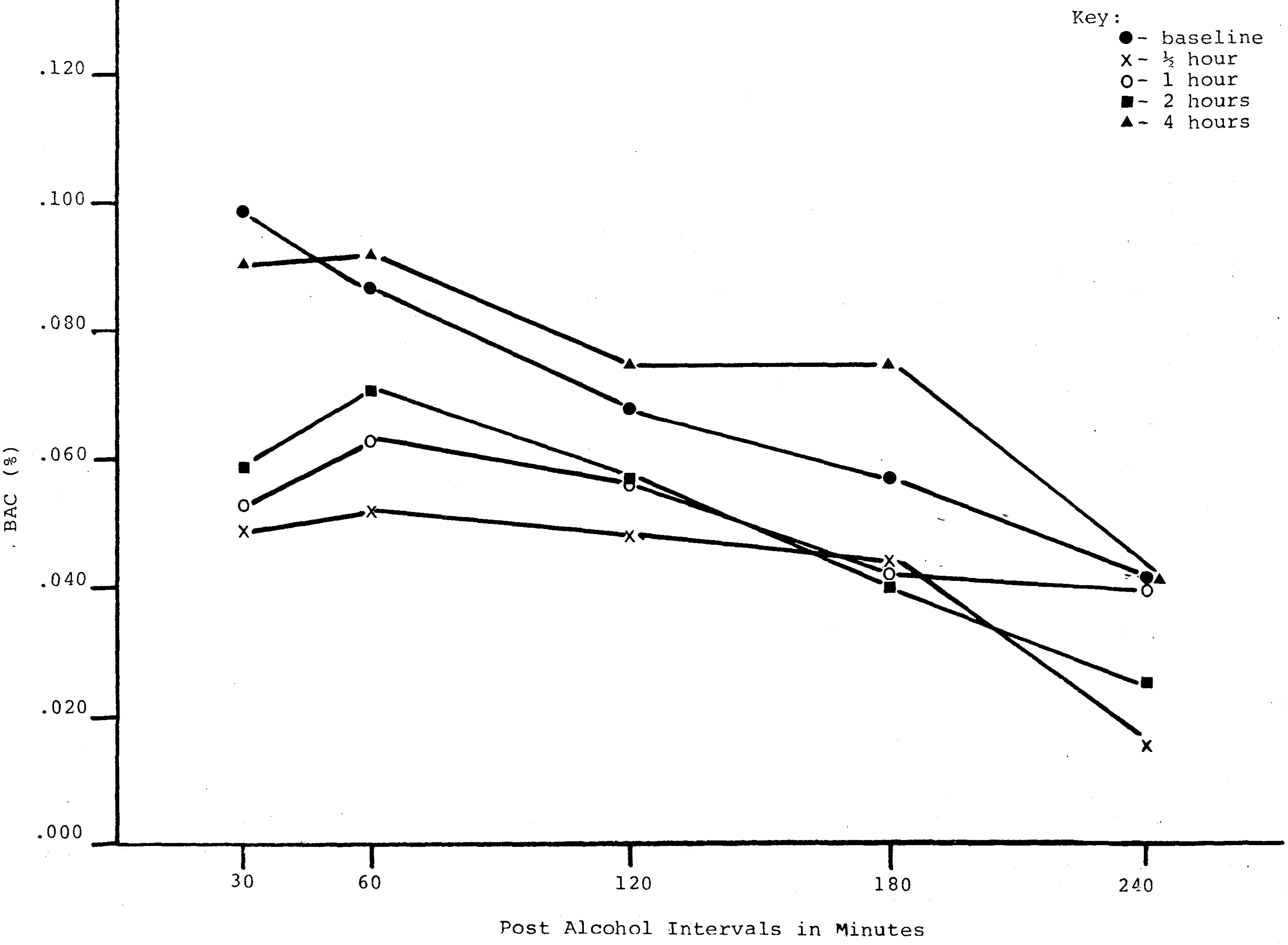


Figure 2. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Time" of Food Intake - $\bar{X}$ BACs 60-180 Minutes Post Dose for Three Pilot Subjects

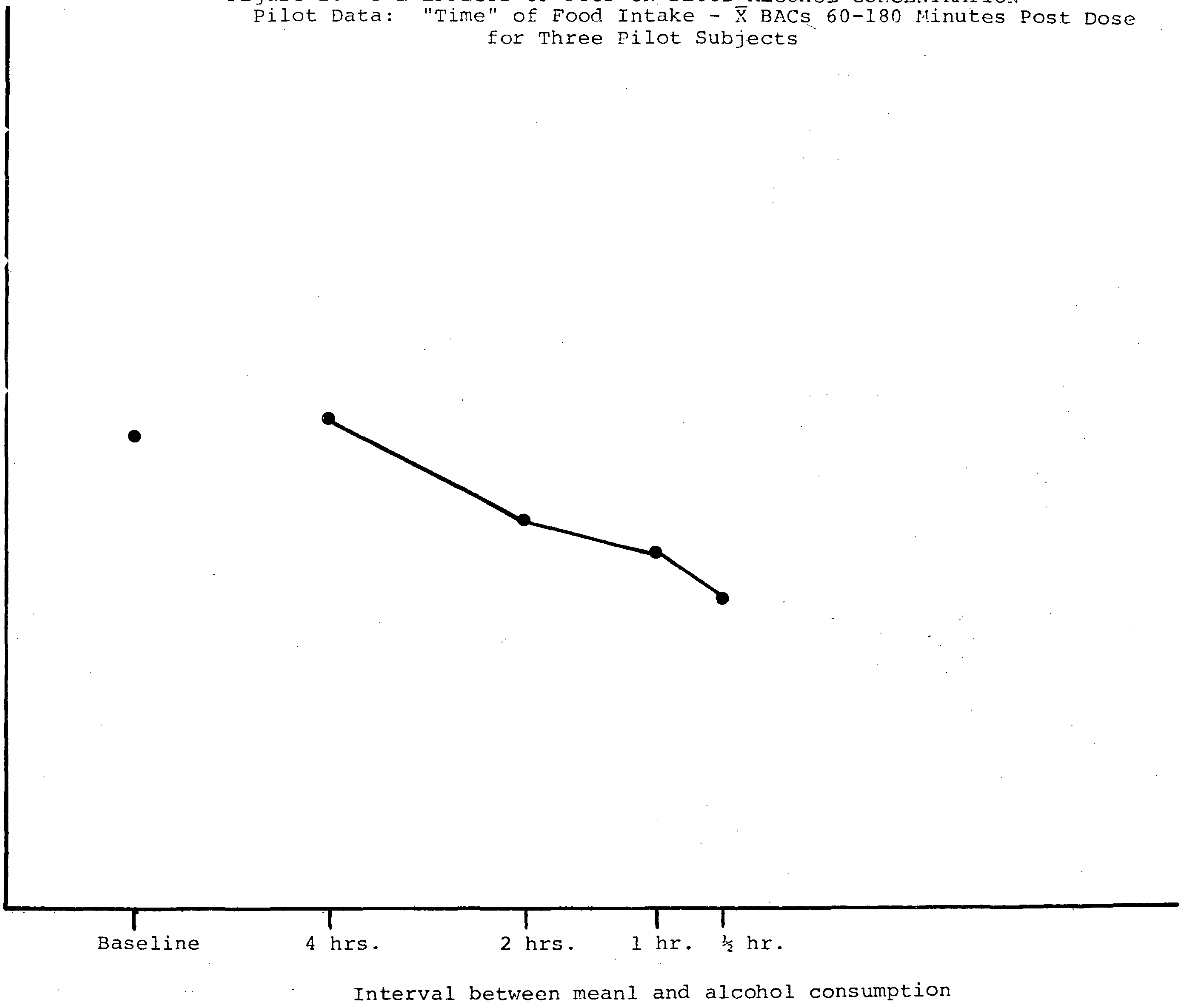


TABLE 3

Effects of Amount of Food

Data for Three Pilot Subjects

Subject No.	Baseline (No food)	Weight of Food (grams) 154 gms	309 gms	616 gms
Peak BAC (%)				
1	.107	.087	.073	.052
2	.094	.096	.081	.059
4	.091	.080	.057	.035
$\bar{X}$	.097	.088	.070	.049
Percent change from baseline		9.2	27.8	49.5
60-Minute BAC (%)[1]				
1	.096	.087	.070	.035
2	.084	.088	.068	.056
4	.091	.080	.048	.034
$\bar{X}$	.090	.085	.062	.042
Percent change from baseline		5.6	31.1	53.3
Mean BAC: 60-180 minutes[2]				
1	.078	.071	.069	.041
2	.072	.066	.055	.048
4	.075	.063	.051	.028
$\bar{X}$	.075	.067	.058	.039
Percent change from baseline		10.7	22.7	48.0

[1] BAC measured 60 minutes after completion of drinking

[2] Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

Figure 3. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Amount" of Food - $\overline{X}$ BACs Over Time: Three Subjects

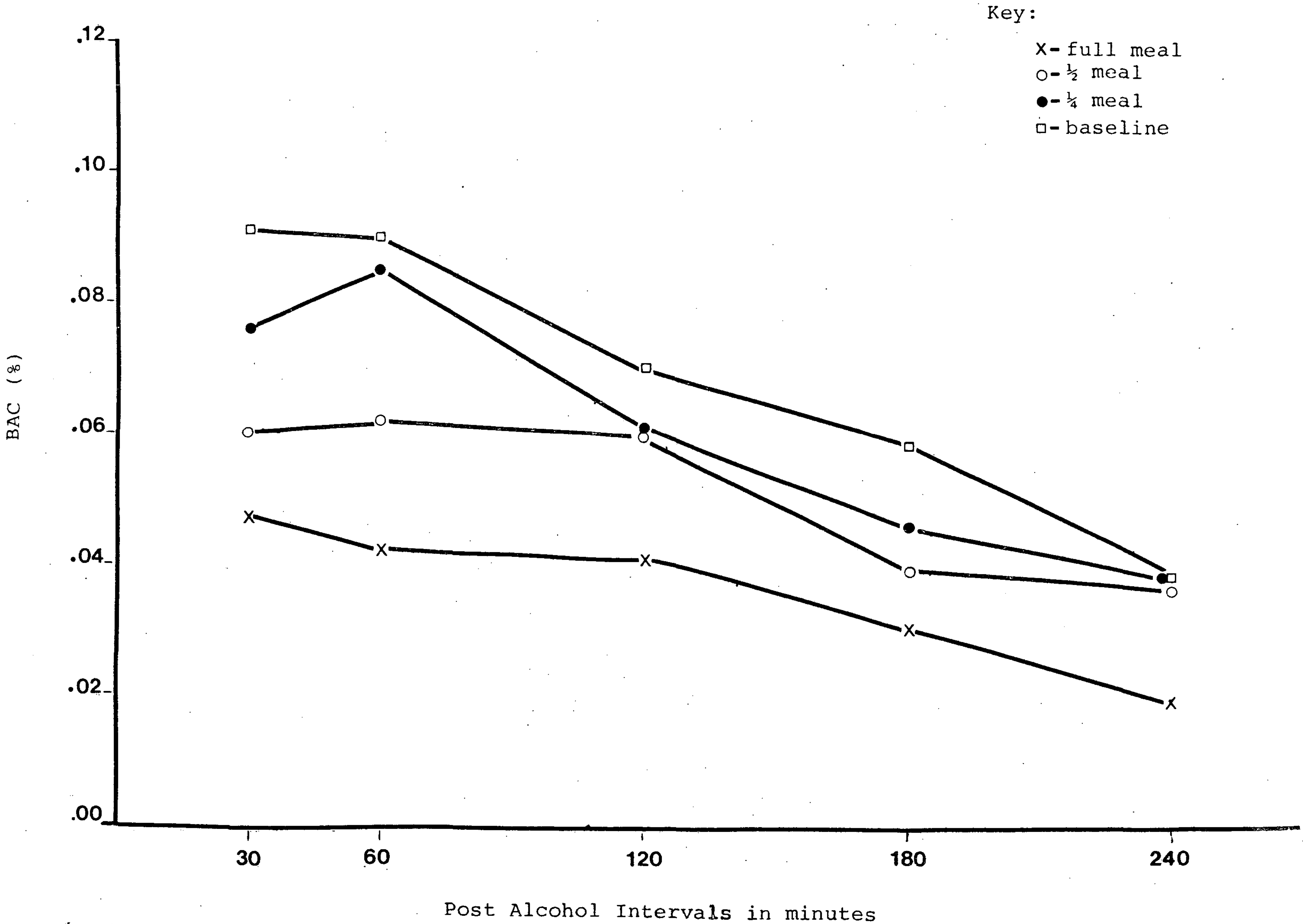


Figure 4. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Amount" of Food - $\bar{X}$ BAC 60-180 Minutes Post Dose
for Three Pilot Subjects

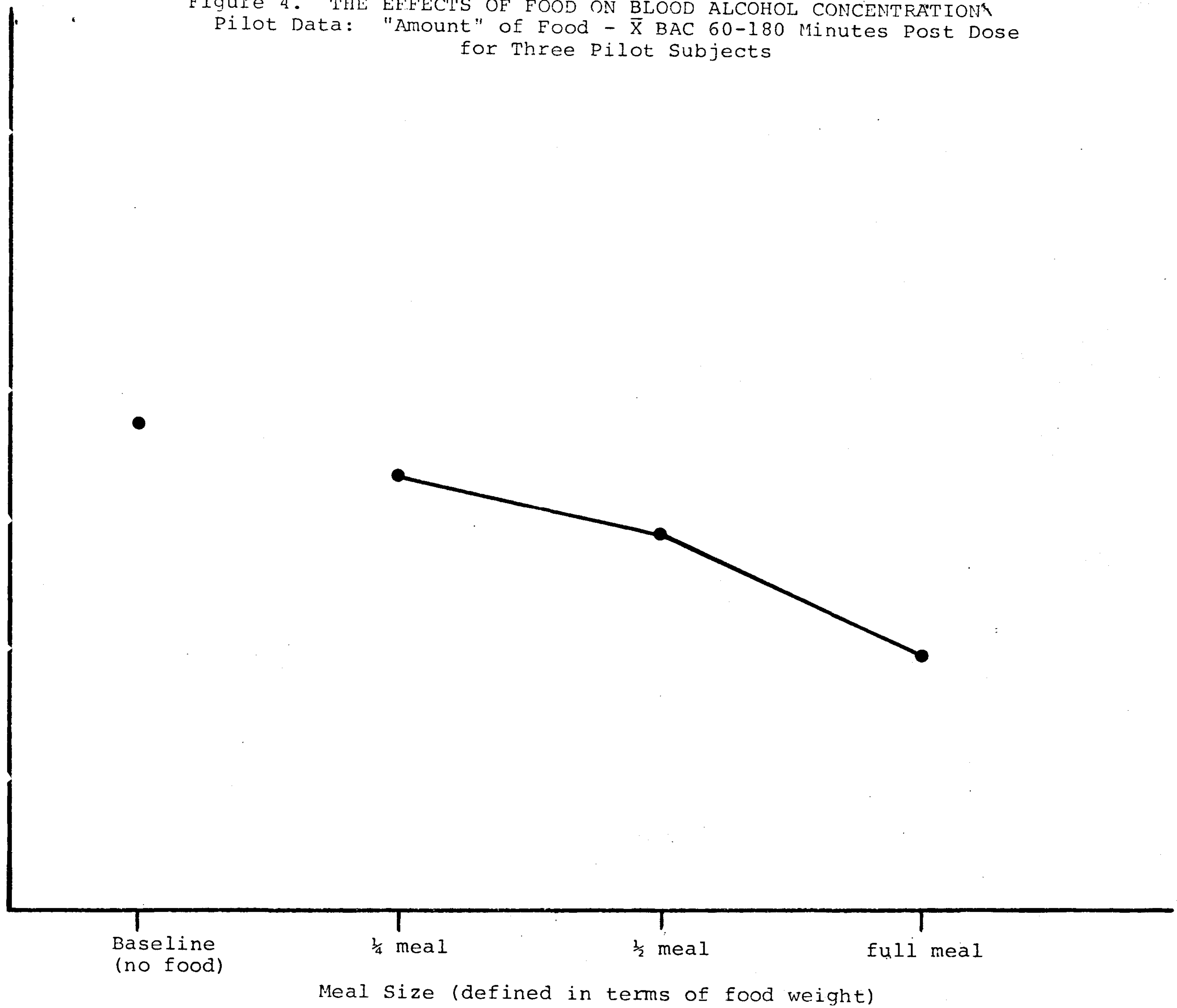


TABLE 3a

Food Type Pilot Studies

Description of Meals

Pilot Studies	Food Characteristics which were Varied	Food Characteristics which were held constant (approx.)
"A" Series:		
Protein Meal	840 calories 730 grams	72% Protein (9% Carbohydrates, 19% Fat)
Carbohydrate Meal	835 calories 963 grams	79% Carbohydrates (11% Protein, 10% Fat)
Fat Meal	770 calories 219 grams	70% Fat (10% Protein, 19% Carbohydrates)
"B" Series:		
Protein Meal	76% Protein (16% Fat, 8% Carbohydrates) 927 grams	1088 calories
Carbohydrate Meal	74% Carbohydrates (14% Fat, 12% Protein) 1092 grams	1060 calories
Fat Meal	65% Fat (23% Protein, 13% Carbohydrates) 522 grams	1080 calories
"C" Series:		
Low Calorie Meal	505 calories (29% Protein, 15% Fat, 56% Carbohydrates)	833 grams
High Calorie Meal	970 calories (31% Protein, 31% Fat, 37% Carbohydrates)	836 grams

The first examination of Type of Food ("A" Series) used Menu No. 1. Menus appear in Appendix A. For this series the high protein meal provided 72% of its 730 grams as protein. The high carbohydrate meal provided 79% of its 963 grams as carbohydrates, and the high fat meal provided 70% of 219 grams as fat. Note that the characteristics of fatty foods are such that it was found to be impossible to assemble a meal of acceptable foods providing a higher percentage of fat and to simultaneously maintain calories, weight and volume equivalent to the other two meals.

The BAC measures following meals of the three food types appear in Table 4 and Figures 5 - 6. At 60 minutes after drinking, the greatest BAC reduction ($\approx$ 39%) occurred with the high protein meal. Carbohydrates also were effective, producing a mean BAC 34% lower than the no-food condition. The high carbohydrate meal appears also to have delayed the occurrence of the peak for some subjects, as can be seen in the individual graphs (Appendix D, Figures 7d - 9d). In comparison to protein and carbohydrates, the high fat meal was less effective with a mean BAC reduction of less than 20%.

To further explore the issue of food type, "B" Series meals were planned for comparing equivalent caloric value. It is possible that the composition of food is not the critical factor and that large nutritive quantities of any food will work well. Menu No. 3 provided meals of approximately 1000 calories, one of which was 76% protein and another 74% carbohydrates. Again, due to the characteristics of fatty foods, the high fat meal (65% fat) was considerably smaller by gram weight; 522 grams compared to 927 and 1092 for protein and carbohydrates, respectively.

The results of these sessions with equal-calorie meals appear in Table 5 and Figures 7 - 8. There are two findings which are of particular interest. First, fatty foods are relatively ineffective even when compared with other foods at equivalent calorie levels. This is interesting in view of the rather widespread notion among drinkers that oils, heavy creams, and similar food substances are the best protection against intoxication and hangover. Second, there can be seen in the individual graphs (Appendix D, Figures 10d - 11d) some suggestion again that carbohydrates may delay the occurrence of the peak, compared to other food types.

The "A" Series and "B" Series examined the effects of moderately large amounts of food in terms of calories. Food quantity can also be defined as weight, and it was essential to determine whether weight (or density) of food is a critical characteristic. The meals for "C" Series provided equivalent total grams with the high calorie meal providing 970 calories, the low calorie meal providing 505 calories (Menu No. 2).

Table 6 and Figures 9 - 10 display the BACs for these sessions. With the high calorie meal, the BACs for two subjects were approximately 30% below the baseline BACs. With the low calorie meal, the change was less than half that magnitude. Note, however, that with meals of equal grams, differing in calories, the carbohydrate-protein-fat composition could not be held equivalent. The carbohydrate and fat content of the low and high calorie meals differ markedly. Thus, although fat has been demonstrated to have relatively little effect on BAC, it is not clear whether the observed difference for the high calorie-low calorie comparison can be attributed solely to calorie differences. It is possible that the difference in fat content also was important.

TABLE 4

Effect of Type of Food: "A" Series

Data for Three Pilot Subjects

Subject No.	Baseline (No food)	Protein 840 cal 730 gm	Carbohydrate 835 cal 963 gm	Fat 770 cal 219 gm
Peak BAC (%)				
1	.107	.075	.068	.090
2	.094	.074	.067	.068
4	.091	.040	.044	.085
$\bar{X}$	.097	.063	.060	.081
Percent change from baseline		35.1	38.1	16.5
60-Minute BAC (%)[1]				
1	.096	.068	.068	.076
2	.084	.065	.065	.061
4	.091	.032	.044	.083
$\bar{X}$	.090	.055	.059	.073
Percent change from baseline		38.9	34.4	18.9
Mean BAC: 60-180 minutes[2]				
1	.078	.056	.061	.071
2	.072	.047	.048	.057
4	.075	.031	.040	.068
$\bar{X}$	.075	.045	.050	.065
Percent change from baseline		40.0	33.3	13.3

[1] BAC measured 1 hour after completion of drinking.

[2] Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

Figure 5. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Type" of Food - "A" Series - $\overline{X}$ BACs Over Time
for Three Pilot Subjects

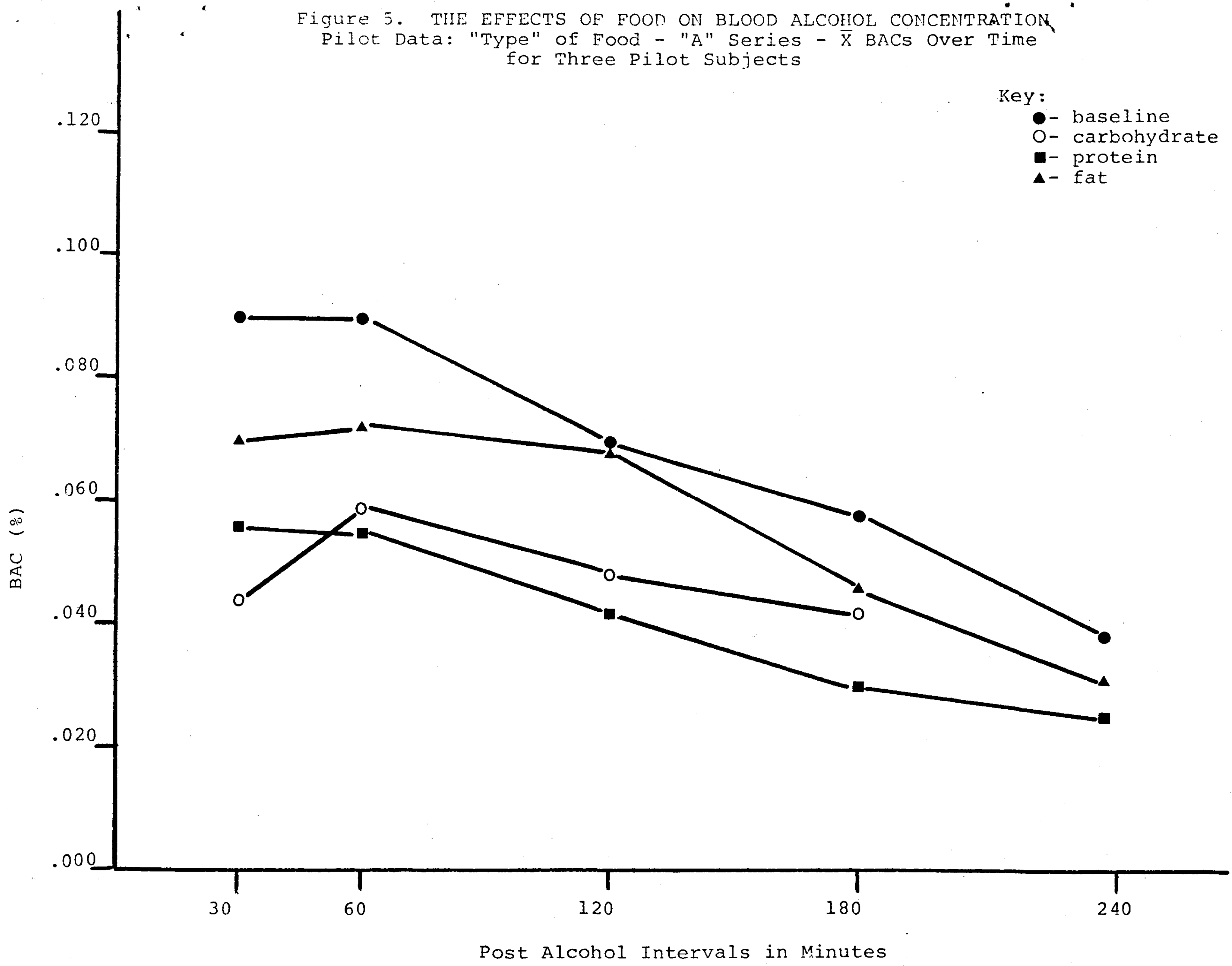


Figure 6. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Type" of Food - "A" Series - $\overline{X}$ BACs 60-180 Minutes Post Dose for Three Pilot Subjects

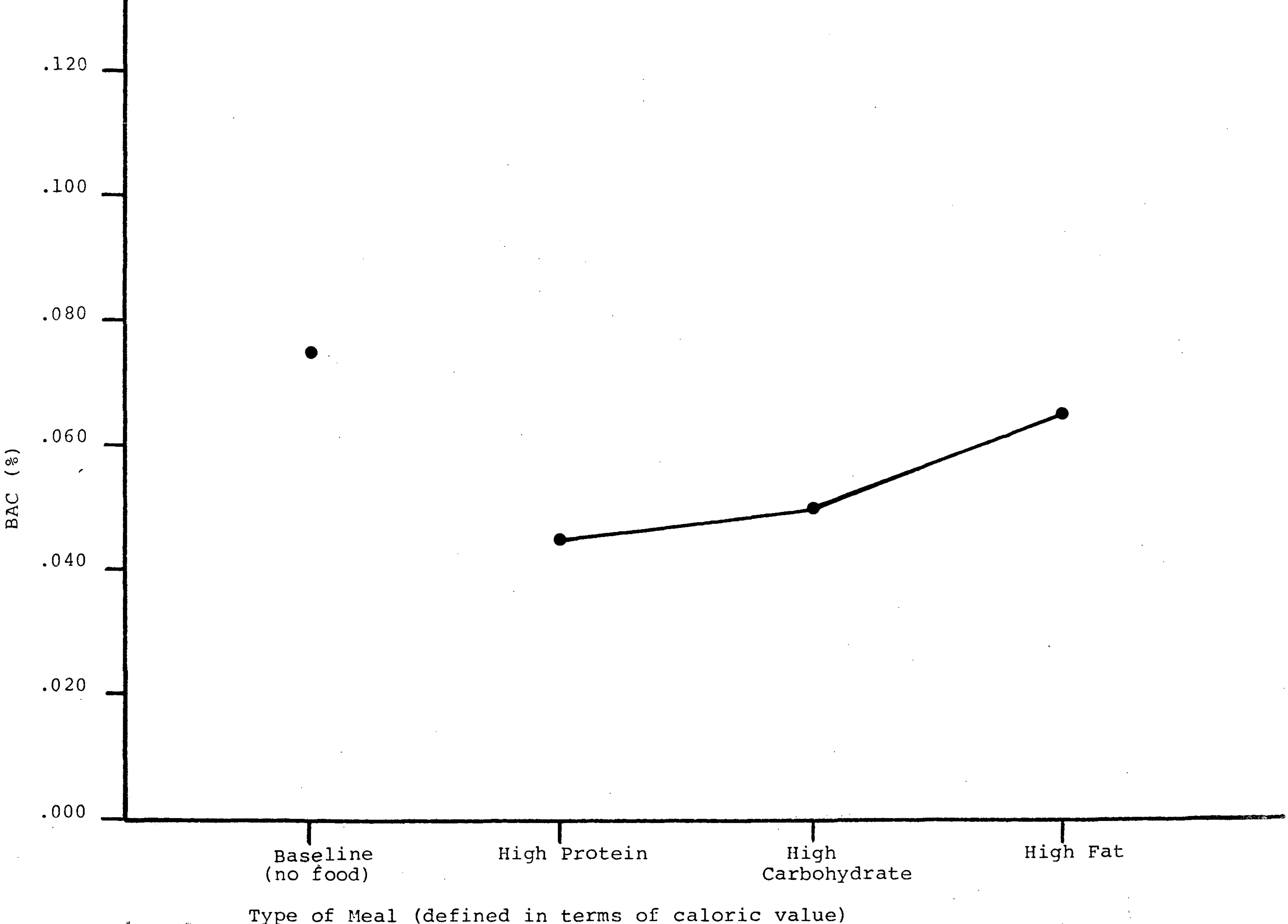


TABLE 5

Effects of Type of Food, Equal Calories: "B" Series

Data for Two Pilot Subjects

Subject No.	Baseline (No food)	Protein 1088 cal 927 gm	Carbohydrate 1060 cal 1092 gms	Fat 1080 cal 522 gms
Peak BAC (%)				
6	.111	.071	.064	.107
7	.104	.087	.061	.106
$\bar{X}$	.108	.079	.063	.107
Percent change from baseline		26.9	41.7	0.90
60-Minute BAC (%)[1]				
6	.115	.061	.061	.101
7	.098	.075	.059	.093
$\bar{X}$	.107	.068	.060	.097
Percent change from baseline		36.4	43.9	9.3
Mean BAC: 60-180 minutes[2]				
6	.094	.049	.056	.079
7	.082	.056	.052	.080
$\bar{X}$	.088	.053	.054	.080
Percent change from baseline		39.8	38.6	9.1

[1]BAC measure 1 hour after completion of drinking.

[2]Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

Figure 7. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Type" of Food - Series B
$\overline{X}$ BACs Over Time: Two Subjects

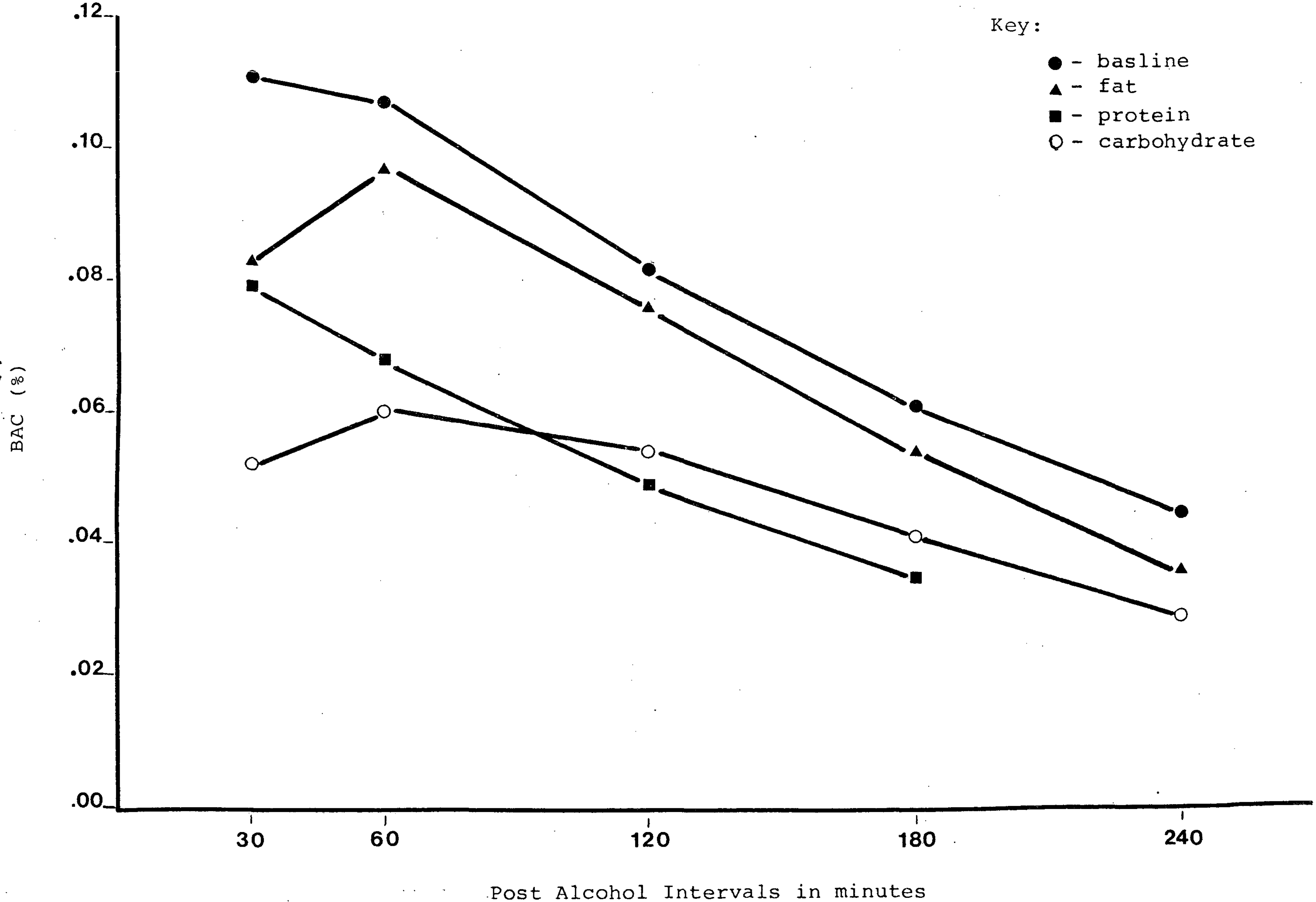
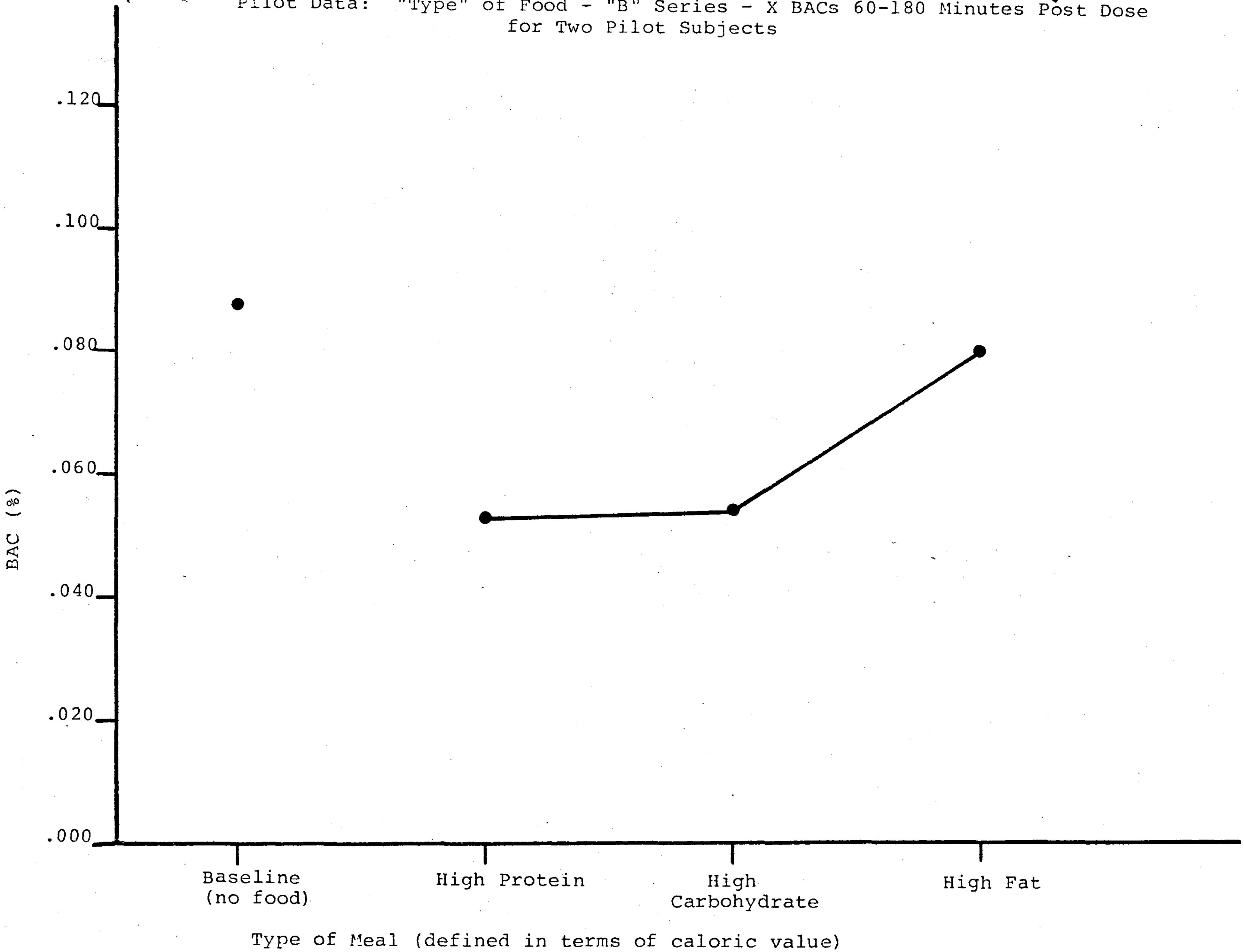


Figure 8. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Type" of Food - "B" Series - $\bar{X}$ BACs 60-180 Minutes Post Dose for Two Pilot Subjects



SUMMARY: PILOT SESSIONS

Three variables were investigated in preliminary sessions with pilot subjects: the time of food consumption relative to alcohol intake, the amount of food, and the type of food. The data indicate that for maximum effect on BAC, food should be eaten in close proximity to drinking. Effectiveness decreases with an increase in the interval between eating and drinking, and no effect was apparent at four hours. An interval of one-half hour between eating and drinking, which produced more than 40% reduction below the mean target BAC of 0.10%, was selected as the time to be used in further laboratory investigation of food effects.

The pilot data demonstrate that a meal of 1000 or more calories consumed one-half hour before drinking causes a lower BAC than would occur without food. Less food has less effect. However, it is important to note that even small amounts of protein and carbohydrates will have some effect on the BAC.

Considerable effort was given to the pilot examination of food type. Although important information was obtained, difficult questions remained. The pilot data indicate that both protein and carbohydrates are excellent substances for causing a lower BAC. Fatty foods are markedly less effective.

In all of the pilot sessions the alcohol beverage was consumed over a half-hour period. There was no examination of the effects of food on BAC when alcohol is consumed over a longer time period.

The scope of this study does not include an analysis of the mechanism or action by which food acts on BAC. Much of the relevant literature hypothesizes that food delays the emptying of stomach contents into the small intestine where the absorption of alcohol largely takes place. There are, however, a number of papers which take the position that the delay of stomach emptying and slowed absorption are insufficient explanation of the reduced BAC found when food has been eaten (Broitman et al., 1976; Southgate, 1925; Serianni et al., 1953).

In summary, the pilot studies were carried out to establish appropriate variable levels for a laboratory experiment. Based on the pilot data, a time of one-half hour between eating and drinking was chosen as an optimal time interval. Meals of 1000 and 500 calories were specified as the amounts of food for further testing. Note that although it was recognized that the weight of food may also be an important variable, the project budget did not permit testing the amount of food in both units, i.e., calories and grams. Since calories are most widely known and used in calculating food intake, a decision was made to define amount as the number of calories. Finally, to more fully examine the effects of type of food, it was decided to continue testing all of the three major types, protein, carbohydrates, and fats.

TABLE 6

Effects of Type of Food, Equal Grams: "C" Series

Data for Two Pilot Subjects

	Peak BAC (%)		
		Food Type	
Subject No.	Baseline (No Food)	Low calorie meal* 505 cal/833 gms	High calorie meal** 970 cal/836 gms
6	.111	.095	.074
8	.105	.086	.069
X̄	.108	.091	.072
Percent change from baseline		15.7	33.3
	60-Minute BAC (%)[1]		
6	.115	.095	.074
8	.094	.086	.068
X̄	.105	.091	.071
Percent change from baseline		13.3	32.4
	Mean BAC: 60-180 minutes[2]		
6	.094	.078	.065
8	.075	.075	.059
X̄	.085	.077	.062
Percent change from baseline		9.4	27.1

[1] BAC measured 1 hour after completion of drinking.

[2] Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

* 29% Protein, 56% Carbohydrates, 15% Fat

** 31% Protein, 37% Carbohydrates, 31% Fat

Figure 9. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data: "Type" of Food - Series C
$\overline{X}$ BACs Over Time: Two Subjects

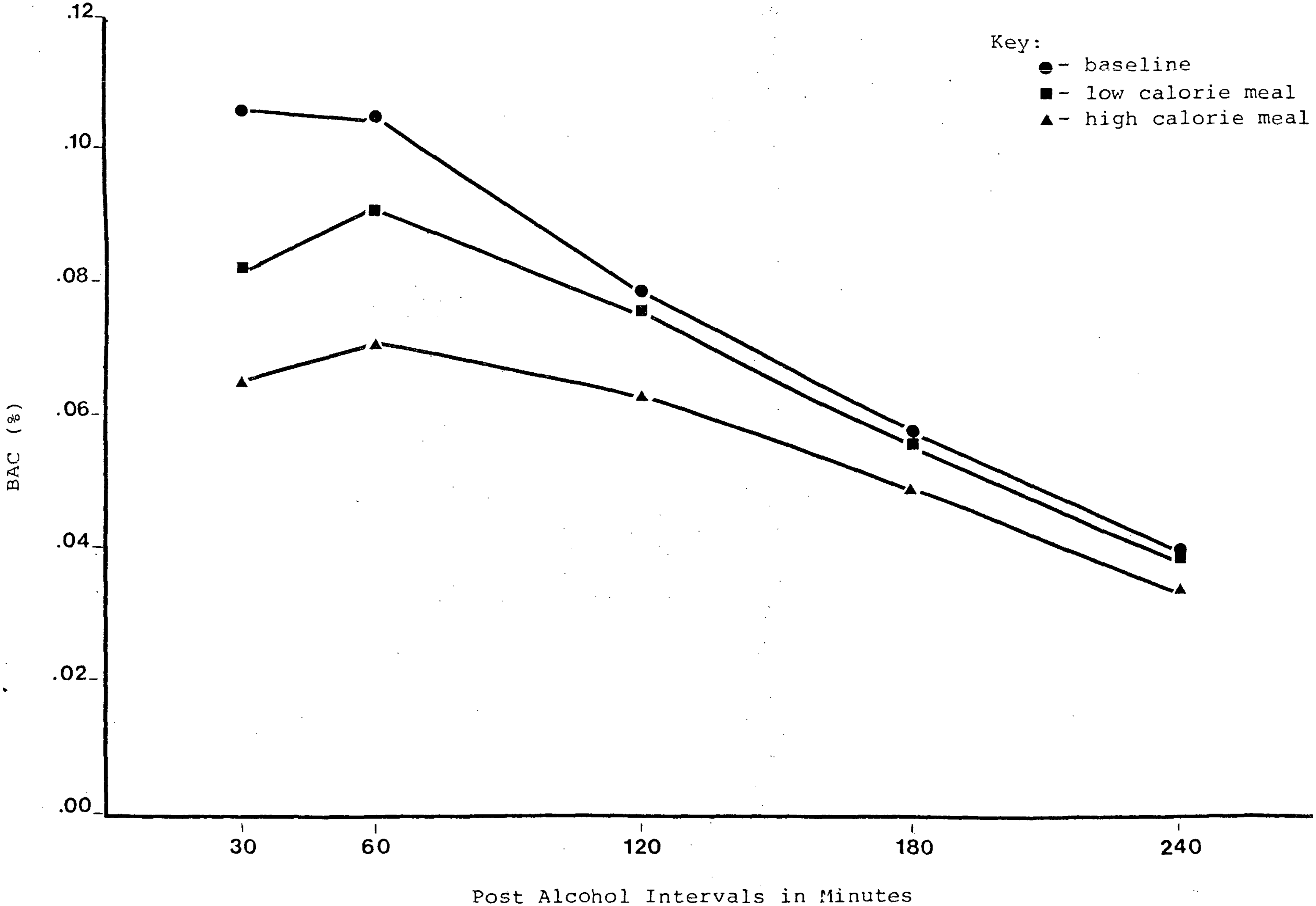
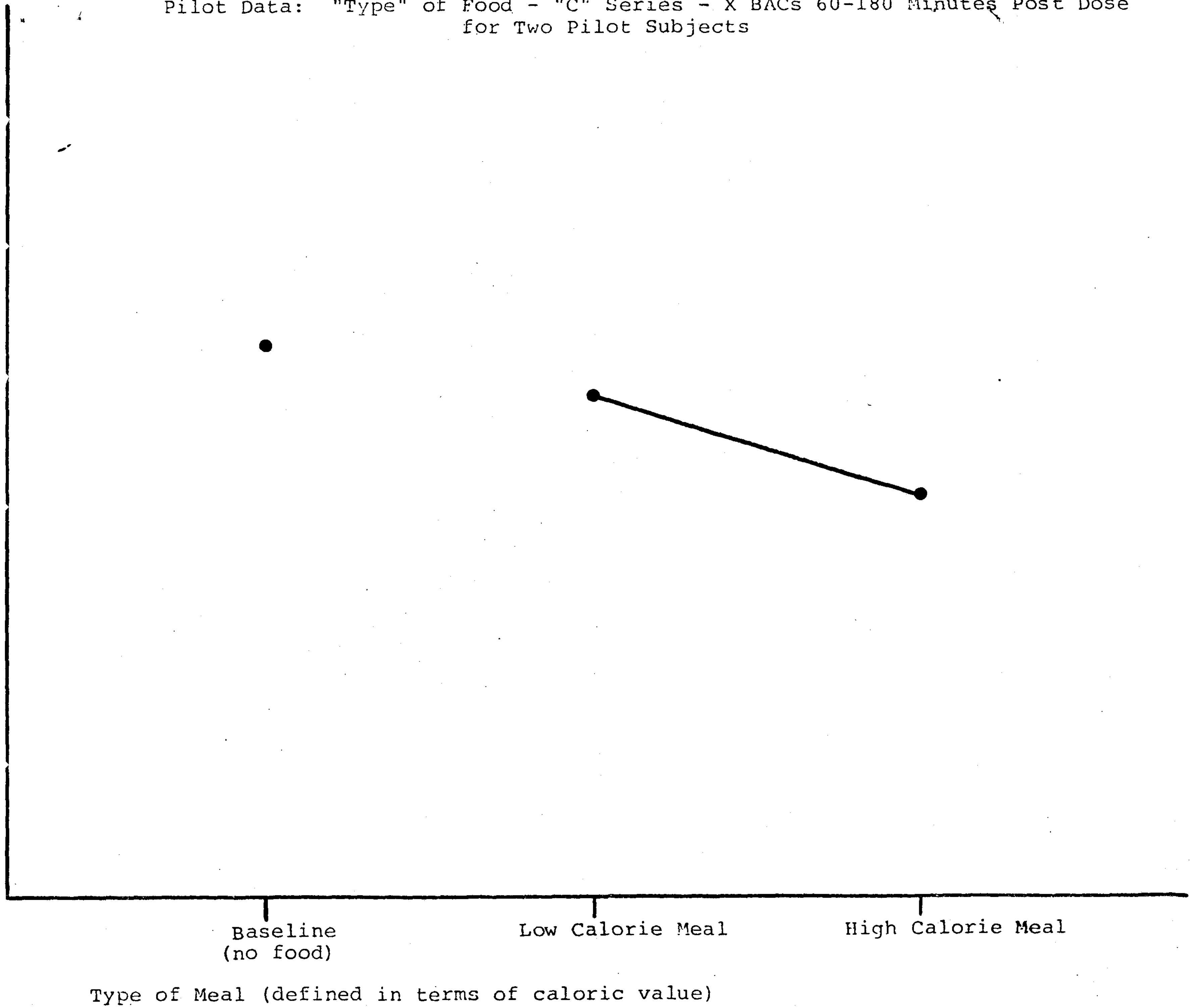


Figure 10. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION. Pilot Data: "Type" of Food - "C" Series - $\bar{X}$ BACs 60-180 Minutes Post Dose for Two Pilot Subjects



IV. Laboratory Experiment

A larger experiment was designed to further examine the effect of food on BAC. The factorial design of the experiment is displayed in the following figure:

FOOD TYPE

		High Protein Meal	High Carbo. Meal	High Fat Meal	
Calories	1000 Calories n = 8				24 Food Sessions
	500 Calories n = 8				24 Food Sessions
					48 Sessions Total*

*All Subjects also attended a baseline session where the alcohol treatment was given but no food was given.

Food type and number of calories were varied. The time of eating was held constant at 30 minutes prior to drinking, the time interval which was found to be most effective during the pilot testing.

Nine men participated in the experiment. The original intent was to maintain the same set of subjects throughout all sessions, but Subject No. 16 unexpectedly left the city after completing only the 500 calorie sessions. He was replaced with Subject No. 19. Given this change in subjects, a conservative approach was taken, avoiding the expense of re-running sessions by treating only <u>Food Type</u> as a repeated measures variable. <u>Calories</u>, the unit of measurement for amount of food, is treated as a separate groups variable.

METHOD

Participants

Nine men, ages 21 - 30 years (mean age 23 years), were paid for participating in the experiment. In order to keep the small sample as homogeneous as possible, only young men were accepted as subject, thus avoiding aging effects and male-female differences in BAC at a given dose. Subjects were recruited through state and college employment offices and were screened by standard SCRI procedures, which evaluate health status, drinking practices, and drug use.

There was no evidence of health problems for any subject. Their drinking practices were assessed with the Q-F-V Index which reflects both the quantity and frequency of alcohol consumption (Cahalan, Cisin and Crossley, 1969). All subjects were categorized by this scale as moderate drinkers. The mean weight was 71.16 Kg (range 68.18 Kg to 72.23 Kg) and the mean height was 178.65 cm (range 172.72 cm to 182.88 cm). At an average weight of approximately 156 pounds and an average height of 5 feet 10 inches, they can be described as being of average body build with only a small range of individual variability. 7

V.t.C.

Treatment

The alcohol dose at all sessions was .85 g alcohol/Kg bodyweight. It was given as a "screwdriver" made with 80-proof vodka and orange juice in a 1:1.5 ratio. Subjects were instructed to pace their consumption of the drink evenly over a half hour, and they were monitored to ensure compliance. A gas chromatograph (Intoximeter Mark IV) was used to measure BAC by analysis of breath samples at 30-minute intervals after drink completion.

Food treatments were meals of 1000 or 500 calories, each of which provided a specified high proportion of its total food value as either protein, carbohydrate, or fat. The details of these meals appear in Appendix B. The food treatments were designed to examine the effects of moderately large and small meals with each of the three major food types.

The meals were prepared at SCRI by the Research Assistant for the project. All measurements were made with an Ohaus Harvard Trip Balance Scale with magnetic damping. This scale is accurate to ± 0.1 g. Food was purchased at only one market, using the same product or brand throughout the study to maximize consistency of content and quality.

Procedures

Subjects came to the laboratory at 8:00 a.m., having been instructed to fast from the preceding midnight. The early morning arrival was required as a control on food, stimulant, or alcohol intake during the hours immediately preceding the experiment. A breath sample was obtained upon arrival to confirm that the individual was at zero BAC. Subjects were permitted only water throughout the morning, and they remained under supervision in the laboratory watching television, reading, and socializing with other participants.

The first session, where no food was given, established a baseline BAC curve for each individual. The alcohol beverage was given at 12:00 noon and finished at 12:30 p.m. BAC readings then were obtained at 30-minute intervals, beginning at 1:00 p.m.

Most of the men had eaten no food since dinner of the previous day, and they were acutely hungry by early to mid-afternoon. In order to permit them to eat as early as possible, the BACs were graphed as the readings were taken. When it was clearly established that an individual had passed the alcohol absorption phase, he was given lunch (sandwich, potato salad, beverage). These meals were eaten 2 1/2 to 4 hours after drinking.

At food-treatment sessions a subject received the meal at 11:30 a.m., finished eating the food no later than 11:45 a.m., and began drinking at 12:00 noon. The monitoring of BAC and subsequent food intake followed the same schedule as at the baseline session. In all cases, subjects remained in the laboratory until a BAC reading below 0.03% was obtained. There were no adverse reactions among the subjects to any treatment.

Food effects in relation to BAC may appear in at least three important ways: 1) the BAC is at lower levels throughout the course of the BAC curve, 2) the peak BAC is lower, and 3) the peak BAC is delayed in relation to alcohol intake.

The following measures were analyzed for statistical significance:

1. Peak BAC
   - changes in comparison to the no-food, baseline BAC
   - absolute changes
   - percent changes

2. BAC at 60 minutes following drinking
   - changes in comparison to the no-food, baseline BAC
   - absolute changes
   - percent changes

3. Minutes to peak BAC (elapsed time from completion of drink to the highest BAC)

4. Mean BAC for period 60 - 180 minutes after completion of drinking

5. BAC change over time, by 30-minute intervals

Statistics include _F_ tests, regression analyses, Newman-Keuls test on means, and Dunnett's _t_ for individual comparisons. The complete data set appears in Appendix C.

Analysis of the peak BAC and the BAC at 60 minutes

Tables 7 and 7a summarize the data which are graphed in Figures 11 - 15. The effect of Food Type is statistically significant ($p < 0.001$) as is the effect of Calories (Amount) ($p < 0.001$). The 1000 calories, high protein meal had the greatest effect on the peak BAC and the 60-minute BAC with a mean change of 40% in comparison to the condition of no food. The 1000 calorie high carbohydrate meal also was effective with changes of approximately 39%.

With only 500 calories the reduction with a protein meal was approximately 28%. The carbohydrate meal effected a 22% reduction of the peak and also delayed the occurrence of the peak with the result that the mean peak BAC and 60-minute BAC are identical. As can be seen in Table 7, the fat meal was considerably less effective. The peak BAC measure shows an 11% reduction for both 500 and 1000 calories. With the BAC measurement at 60 minutes, the 500 calories fat meal led to a reduction of 4%, the 1000 calorie fat meal to almost 12%. Graphs of the BAC curves for individual subjects can be seen in Appendix E. ANOVAs appear in Table 8.

The measure "Change in BAC" produces findings which substantiate those reported above. The changes both in peak BAC and the 60-minute BAC were examined as absolute change and as percent change, comparing the various food conditions to the no-food condition. The _F_ ratios are significant for both Type and Calories.

As can be seen in the Table of ANOVAs (Table 8), the interaction term Type X Calories reaches statistical significance for a number of the measures. This significant interaction reflects the fact that the high fat meal was relatively

TABLE 7

Effects of Food by Amount and Type

Mean BACs

Number of Calories	Baseline (no food)	Food Type: Protein	Carbohydrates	Fat
	Peak BAC (%)			
500 calories	.108	.077	.084	.096
1000 calories	.105	.058	.064	.093
	60-Minute BAC[1]			
500 calories	.096	.069	.084	.092
1000 calories	.093	.054	.057	.082
	Mean BAC: 60-180 Minutes[2]			
500 calories	.080	.060	.071	.076
1000 calories	.078	.044	.053	.071

[1]BAC measured 60 minutes after completion of drinking.

[2]Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

TABLE 7a

Effects of Food by Amount and Type

Percent Change in BAC, Compared to Baseline

Number of Calories	Protein	Carbohydrates	Fat
	Peak BAC (%)		
500 calories	28.7	22.2	11.1
1000 calories	44.8	39.0	11.4
	60-Minute BAC[1]		
500 calories	28.1	12.5	4.2
1000 calories	41.9	38.7	11.8
	Mean BAC: 60-180 Minutes[2]		
500 calories	25.0	11.3	5.0
1000 calories	43.6	32.1	9.0

Food Type spans Protein, Carbohydrates and Fat.

[1]BAC measured 60 minutes after completion of drinking.

[2]Mean of BAC readings taken from 60 minutes to 3 hours after completion of drinking.

Figure 11. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
$\overline{X}$ BACs Over Time for All Food Categories and Baseline
for Eight Subjects

-500 Calorie Meals-

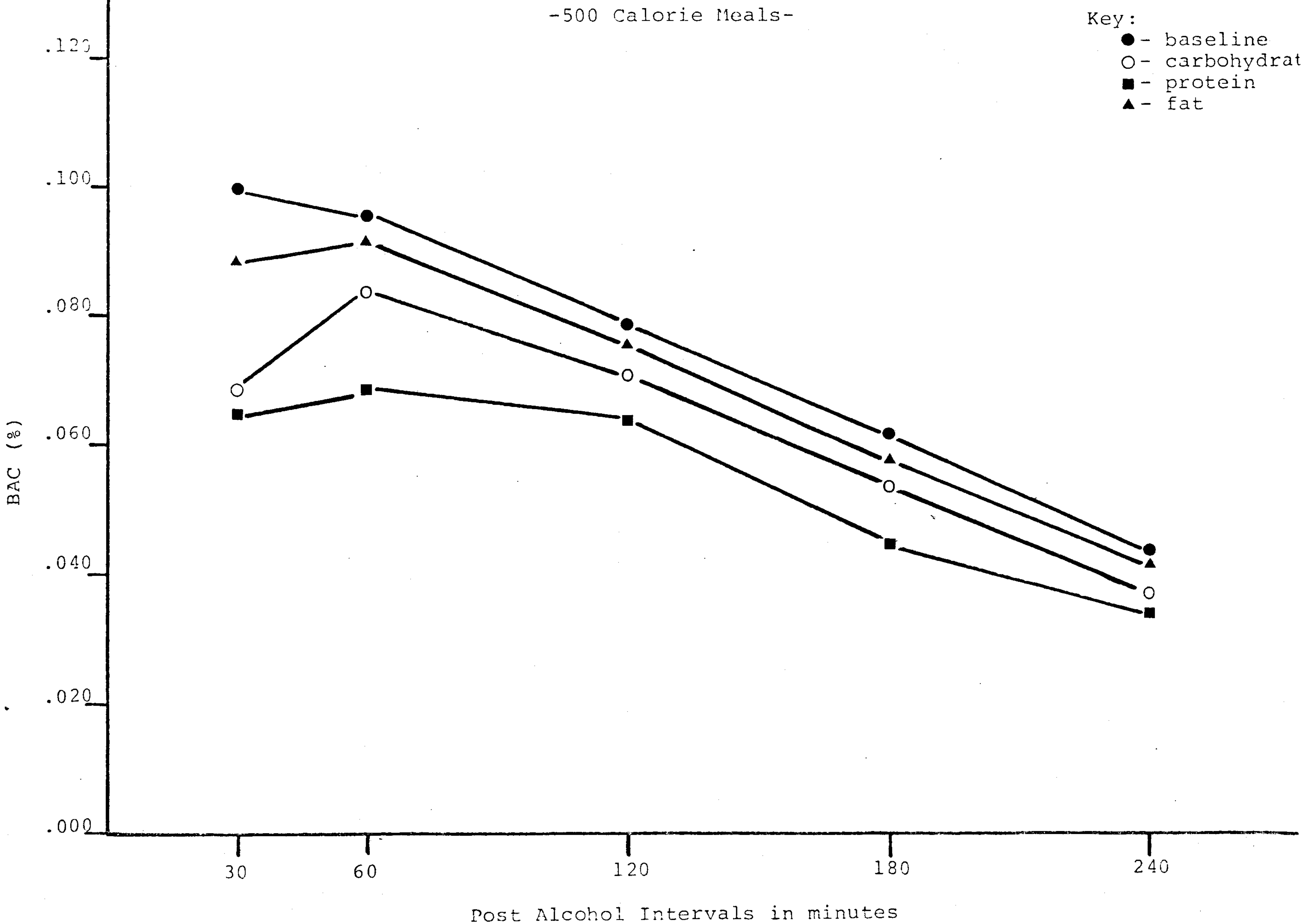


Figure 12. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
$\overline{X}$ BACs Over Time for All Food Categories and Baseline
for Eight Subjects
-1000 Calorie Meals-

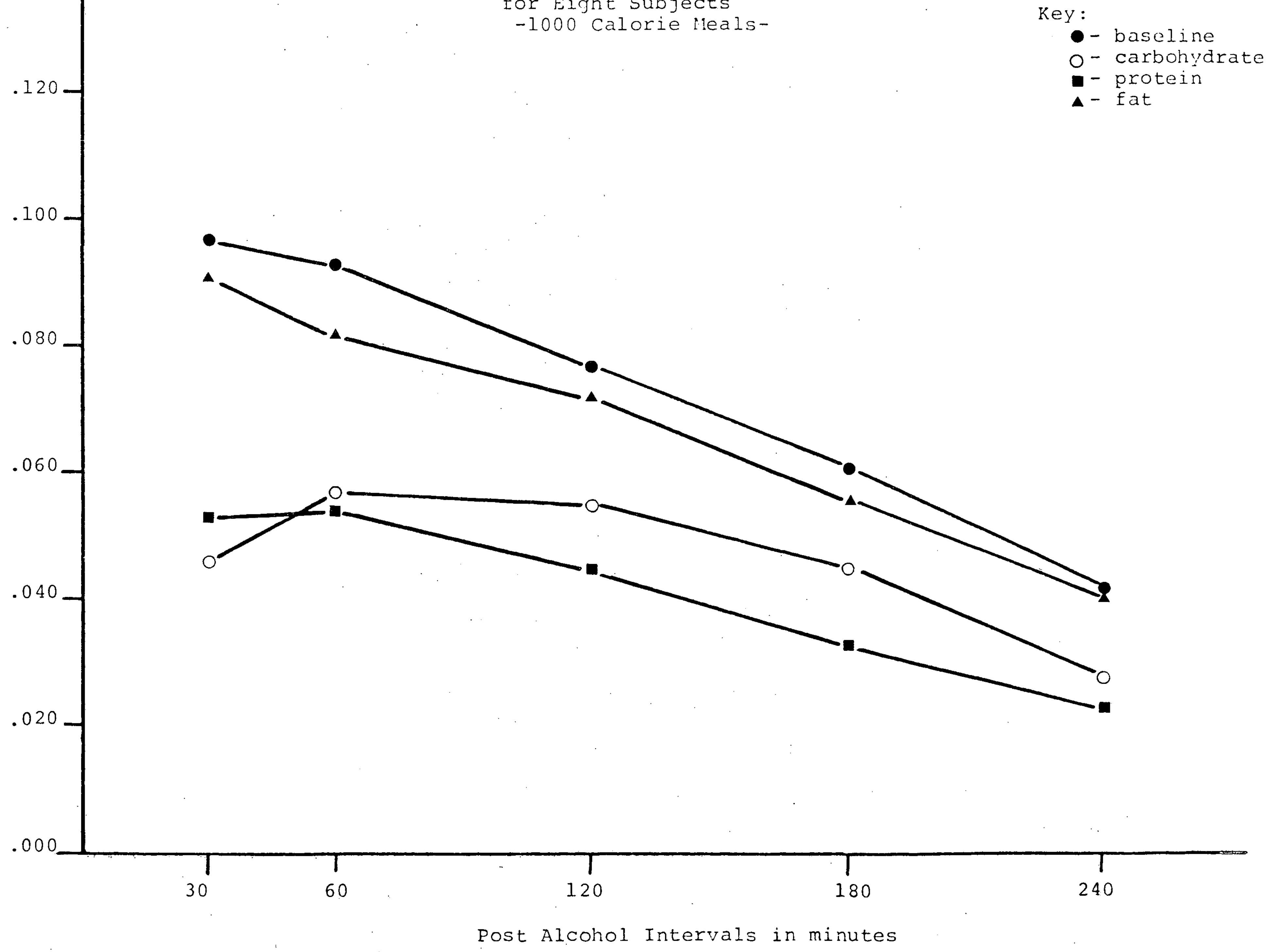


Figure 13. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
$\overline{X}$ BACs 60-180 Minutes Post Dose for Nine Subjects

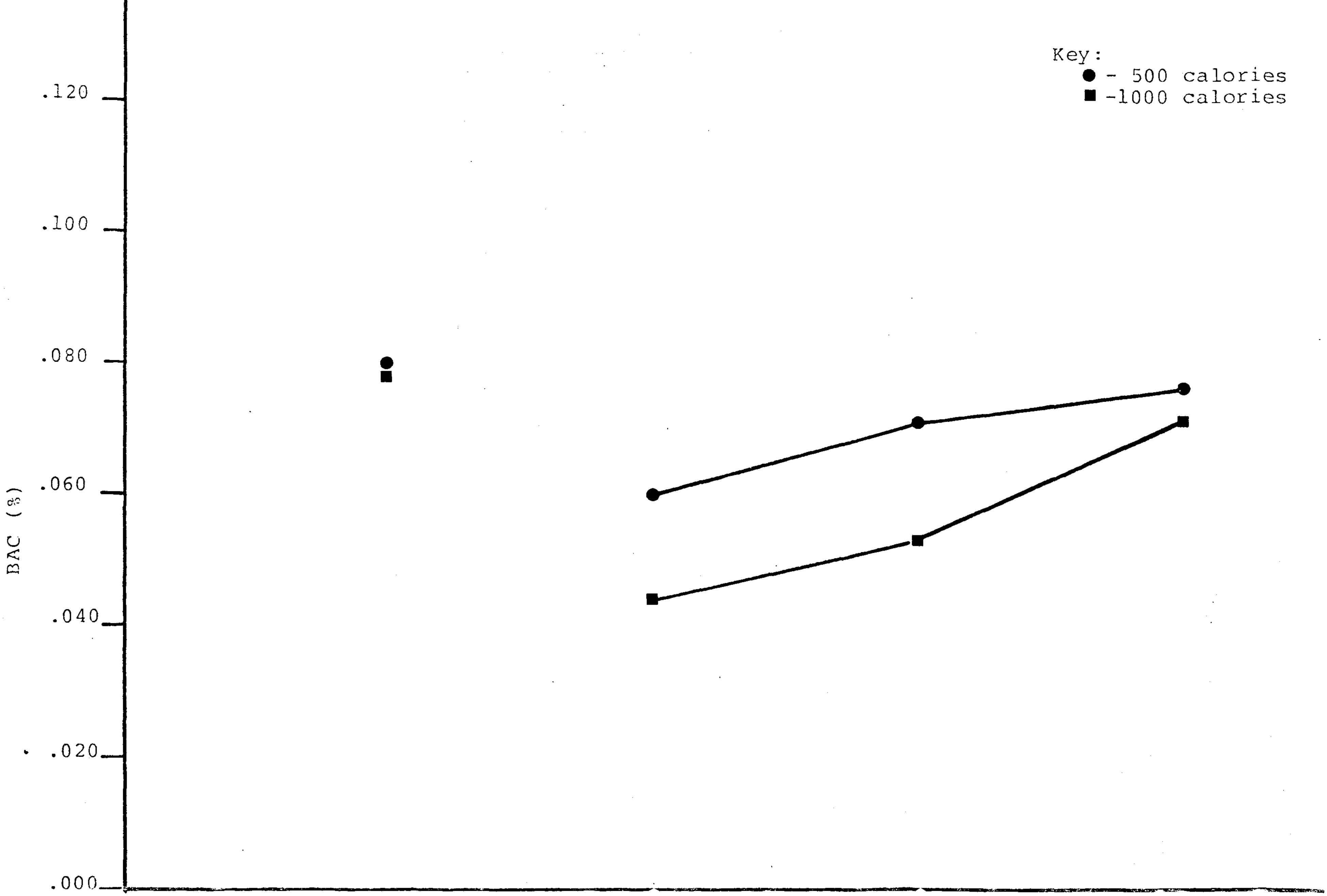


Figure 14. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
X Peak BAC for All Food Categories and Baseline for Nine Subjects

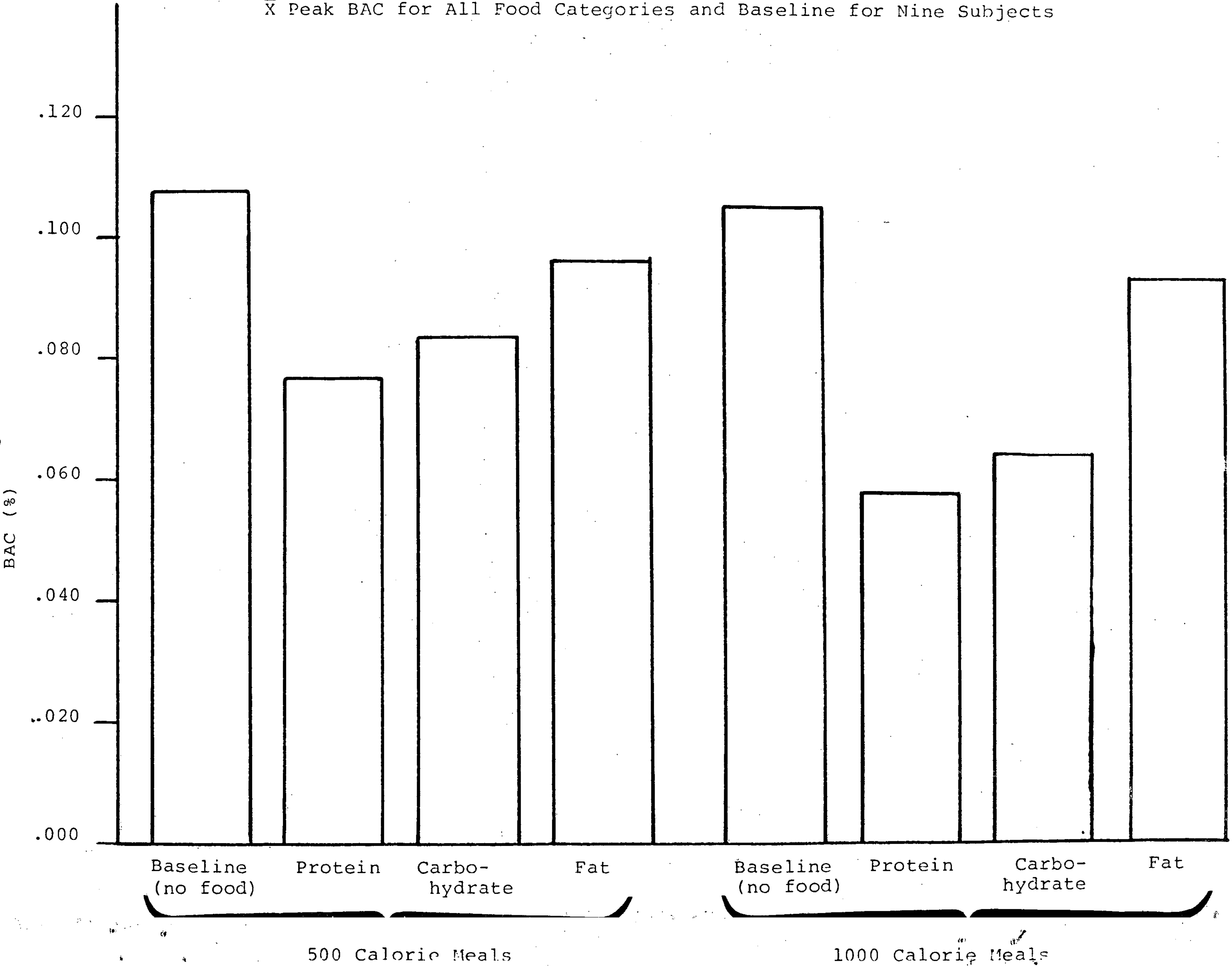


Figure 15. THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
$\bar{X}$ 60 Minute BACs for All Food Categories and Baseline for Nine Subjects

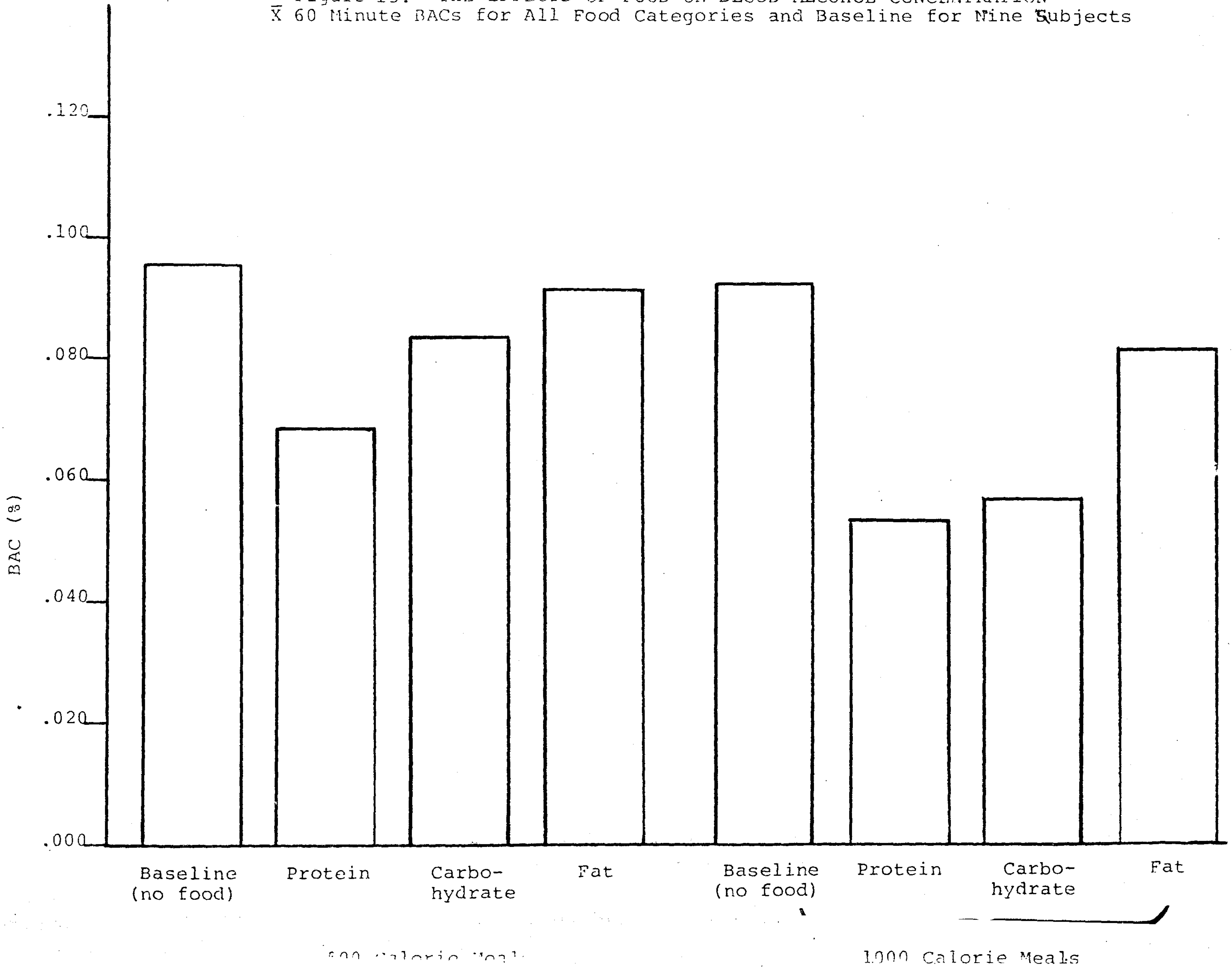


TABLE 8

Analyses of Variance[1,2]

Laboratory Experiment Data

(A)

Measure	Source	df	F	Prob.
Peak BAC	Calories	1,14	11.94	0.004
	Type	2,28	43.01	<0.001
	T X C	2,28	4.68	0.018
60-Minute BAC	Calories	1,14	22,03	<0.001
	Type	2,28	17.98	<0.001
	T X C	2,28	2.27	0.018
Peak BAC: Change from Baseline	Calories	1,14	3.21	0.095
	Type	2,28	43.28	<0.001
	T X C	2,28	4.16	0.026
Percent change from baseline	Calories	1,14	6.33	0.025
	Type	2,28	35.43	<0.001
	T X C	2,28	4.96	0.014
60 Minute BAC: Change from Baseline	Calories	1,14	15.72	0.001
	Type	2,28	14.88	<0.001
	T X C	2,28	3.24	0.054
Percent change from baseline	Calories	1,14	18.85	0.001
	Type	2,28	17.33	<0.001
	T X C	2,28	2.29	0.120
Mean BAC, 60-180 minutes post dose	Calories	1,14	23.45	<0.001
	Type	2,28	33.62	<0.001
	T X C	2,28	2.02	0.151
Elapsed time to peak	Calories	1,14	0.000	1.000
	Type	2,28	5.66	0.009
	T X C	2,28	1.74	0.194

1 See following page for definition of terms.
2 ANOVAs computed with BMD P2V, Biomedical Computing Programs (Dixon, 1977).

Table 8 (Cont'd)

Measure	Source	df	F	Prob
BAC over time (Readings at peak and 30, 60, 90, 120 and 150 min post peak)	Calories	1,14	7.650	0.015
	Type (1)	1,14	2.409	0.143
	T(1)xC	1,14	0.0006	0.981
	Type 2	1,14	127.283	<0.001
	T(2)xC	1,14	11.124	0.005
	Type 3	1,14	7.826	0.014
	T(3)xC	1,14	0.5599	0.467
	Type	3,42	49.127	<0.001
	TxC	3,42	4.195	0.011
	Time 1	1,14	524.724	<0.001
	Time (1)xC	1,14	1.789	0.202
	Time 2	1,14	2.540	0.133
	Time (2)xC	1,14	1.407	0.255
	Time 3	1,14	4.149	0.061
	Time (3)xC	1,14	0.003	0.959
	Time	5,70	391.758	<0.001
	Time xC	5,70	1.559	0.183
	Type x Time (1,2)	1,14	3.865	0.069
	Type x Time (2,1)	1,14	20.637	<0.001
	Type x Time (2,2)	1,14	9.201	0.009
	Type x Time	15,210	6.184	<0.001

"Measure" Definitions"

60-minute BAC	Intoximeter reading from breath sample taken 60 minutes after the completion of drinking.
Peak BAC	BAC at highest level. Time of occurrence varied between subjects and between sessions.
Minutes to Peak	Elapsed time from completion of drinking to the peak BAC.
Mean BAC for 3-hr. post-dose period	Intoximeter readings from breath samples taken 60 minutes through 180 minutes after completion of drinking.
"Λ"	Food Treatment data only; i.e., BACs from protein, carbohydrate and fat meal sessions.

"Source" Definitions"

Calories	Number of calories in food treatment, 500 calories and 1000 calories.
Type	Type of food given as a meal, (no food or meals high in protein, carbohydrates, or fats).

ineffective with both a small and a large caloric amount whereas the other two food types were significantly more effective with 1000 calories than with 500 calories. However, it was not possible to fully define the nature of the function relating change in BAC to number of calories with only two levels of the calories variable.

Analysis of the Mean BAC for the Period 60-180 minutes post-dose

The statistics reported in the preceding discussion have been used to examine the differences in the BAC measurements at the highest point on the alcohol curve and at 60 minutes after drinking completion. It is also of interest to make comparisons of the BAC over a longer time period under the various conditions.

Table 7 and Figure 12 present mean BACs for the 5 breath tests which were made at 60, 90, 120, 150 and 180 minutes post-dose. The mean BACs are lower than those discussed in the preceding section since they include a longer segment of the declining curve. Nonetheless, the findings essentially parallel those previously reported with significant F's for Type and Calories.

Analysis of the Elapsed Time to Peak BAC

The individual graphs of BAC curves suggest that carbohydrates delay the occurrence of the peak BAC. The F ratio for Type of food in the analysis of elapsed time is significant at the 0.01 level.

Individual comparisons of the elapsed time to the peak BAC were made with Dunnett's t, with the baseline (no food) condition as the control. Only the carbohydrate meal-no food comparison was statistically significant ($p < 0.001$).

These analyses demonstrate that the carbohydrate meal significantly delayed the occurrence of the peak BAC, in comparison to the other food conditions. This finding should be kept in mind in interpreting the various statistics which are based on the mean peak BAC.

Comparisons of Means

In addition to ANOVAs, individual comparisons of the food Types were made, summing across the Amount (Calories) variable. The means for each food type are as follows:

60-minute BACs:	Baseline (no food)	0.095%
	Protein meals	0.061%
	Carbohydrate meals	0.070%
	Fat meals	0.087%

Testing each food-type BAC against the baseline BAC as a control, both the protein-baseline and the carbohydrate-baseline comparisons were found to be significant at the 0.001 level. The fat-baseline comparison was not statistically significant. The Dunnett's t statistic was used for these tests.

Differences between all possible pairs of means also were tested using the Newman-Keuls method, as tabled below, for both the peak BACs and BACs at 60 minutes. Peak BACs following protein and carbohydrate meals were significantly different from BACs following the fat meal or the no-food (baseline) condition;

this finding applies to both 500 and 1000 calorie meals. For the 1000 calorie meal only, the peak BACs following the fat meal were significantly lower than when no food was eaten. It should be noted that the peak BAC occurs at different times following dosing for different subjects.

At 60 minutes the comparisons are somewhat changed from those for the peak BACs. For the smaller meal only the comparisons of BACs following the protein meal with the other conditions is significant. At 1000 calories the protein-carbohydrate comparison is not significant, but the BAC comparisons for protein and carbohydrate meals with both the fat meal and baseline condition are significant. Note that at 60 minutes the fat meal-baseline comparison does not reach statistical significance for either meal size.

NEWMAN-KEULS
Tests on All Ordered Pairs of Means

500 Calorie Meals: Peak BAC (%)		1 Protein	2 Carbohydrate	3 Fat	4 Baseline
Ordered BACs		.077	.084	.096	.108
Difference between pairs	1		.007	.019	.031
	2			.012	.024
	3				.012
s = .0025	r =		2	3	4
$q_{.99}(r,21)$			4.02	4.64	5.02
$s \cdot q_{.99}(r,21)$			.010	.012	.013
	1		-	**	**
	2			**	**
	3				-

1000 Calorie Meals: Peak BAC (%)					
Ordered BACs		.058	.064	.093	.105
Difference between pairs	1		.006	.035	.047
	2			.029	.041
	3				.012
s = .0022	r =		2	3	4
$q_{.99}(r,21)$			4.02	4.64	5.02
$s \cdot q_{.99}(r,21)$			.009	.010	.011
	1		-	**	**
	2			**	**
	3				**

** $p < .01$

NEWMAN-KEULS
Tests on All Ordered Pairs of Means

500 Calorie Meals: 60 minute BACs (%)		1 Protein	2 Carbohydrate	3 Fat	4 Baseline
Ordered Means		.068	.084	.092	.096
Difference between pairs	1		.016	.024	.028
	2			.008	.012
	3				.004
$s = .0027$	$r =$		2	3	4
$q_{.99}(r,21)$			4.02	4.64	5.02
$s \cdot q_{.99}(r,21)$			.011	.013	.014
	1		**	**	**
	2			-	-
	3				-

1000 Calorie Meals: 60 minute BACs (%)					
Ordered Means		.054	.057	.082	.093
Difference between pairs	1		.003	.028	.039
	2			.025	.036
	3				.022
$s = .0025$ $s \cdot q_{.99}(r,21)$			.010	.012	.013
	1		-	**	**
	2			**	**
	3				-

** $p < .01$

ANOVA and Linear Regression Analysis of BAC Curves Over Time

In addition to the analyses of the peak and 60-minute BACs, and the mean of five BAC readings, it is of interest to examine food effects in terms of the entire alcohol curve. To do this, an ANOVA (Table 8) and linear regression analyses (Table 9) were carried out with the following design:

Time*	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Food Type	No Food	Protein	Carbohydrate	Fat
500 Calories:				
S No. 10				
11				
12				
13				
14				
15				
16				
17				
18				
1000 Calories:				
S No. 10				
11				
12				
13				
14				
15				
16				
17				
18				
19				

* 1 = Peak BAC
2 = 30 minutes post-peak
3 = 60 minutes post-peak
4 = 90 minutes post-peak
5 = 120 minutes post-peak
6 = 150 minutes post-peak

The ANOVA included an orthogonal polynomial decomposition for the factors, Food Type and Time of BAC. As can be seen in the above design, Time of BAC is defined in this analysis in minutes, beginning with the peak BAC at time 0 and continuing with readings at 30-minute intervals.

The ANOVA of the BACs over time shows the same pattern of significance; i.e., Type and Amount are statistically significant ($p < 0.001$ and < 0.015, respectively). Of course, the time variable is highly significant as the alcohol levels decreased from the peak and approached zero. Also, the Type X Amount interaction term is significant, as previously reported for other analyses. The BAC decrease over time is a linear function, as confirmed by the significant (p 0.001) linear term.

Linear regression analyses, calculated separately for 500 and 1000 calorie meals, relate the dependent variable, BAC, to the independent variable, time. As can be seen in Table 9, the intercepts of the regressions curves are significantly different under the various food conditions; that is, when the alcohol curve is extended back to time zero, there is a significant effect by type of food. Finally, the BAC-Time correlation closely approached -1.0 (or, conversely, the multiple R statistic approached 1.0) as would be expected in view of the linearity of the BAC decline over time.

CONCLUSIONS

If a drinker wishes to hold his or her BAC at a low to moderate level, what are the guidelines for food consumption? What is the best time to eat in relation to alcohol intake? What type of food is best? How much food is it necessary to eat to insure the desired effect? The data from this study indicate that the following are appropriate responses to these questions.

In brief summary of the study findings, when food is eaten in close proximity to drinking alcohol, it can substantially reduce the BAC from the level that would be reached if the alcohol were consumed on an empty stomach. Protein has the largest effect, and carbohydrates also are very effective.

Fatty foods are relatively ineffective in any quantity, and for the purposes of limiting BAC, it would be best to restrict the fat content of meals to a minimum, choosing instead foods which are largely protein and carbohydrates. Finally, a large amount of these latter types of food will be more effective than a small amount.

The findings regarding Time of food intake show an inverse relationship; the greatest reduction in BAC was found at one-half hour, the shortest interval between eating and drinking which was examined. At an interval as long as two hours, the laboratory data show that the food exerted an effect. At four hours there was no effect of the food (as would be expected inasmuch as that period of time allows the food to pass through the stomach). Note that the findings regarding Time of food intake are from pilot data only. This variable was not examined in the larger experiment in which the single interval of one-half hour between food intake and alcohol consumption was used.

The findings concerning the Amount of Food are fairly straightforward. A full meal will offer more protection than a snack, but even small amounts of food will have some effects on the BAC. In the laboratory 1000 calorie meals, which were either high in protein content or high in carbohydrate content, were followed by $\approx 40\%$ reductions in BAC. Certainly a change of that magnitude has practical singificance to the individual. 40% reduction

Type of Food is a more complex issue than the other variables of interest, but the data provide the basis for some recommendations. The person who expects to be drinking and would prefer to offset the alcohol to some extent by eating can be advised to consume a typical, full meal. For example, a meal which contains

TABLE 9

Linear Regression Analyses

Laboratory Experiment Data

Independent variable - time
Dependent variable - BAC

500 Calories

ANOVA		df	F	P
Regression -	all data	1,26	80.89	0.000
	no food	1,5	1077.89	0.000
	protein	1,5	438.595	0.000
	carbohydrate	1,5	665.397	0.000
	fat	1,5	1978.533	0.000
Regression Coefficients		6,20	174.087	0.000

	Mean BAC	Std Dev	Intercept	Std Err of Est	Multiple R
All data	.065	.019	.090	.0097	.870
No food	.077	.020	.105	.0015	.998
Protein	.053	.016	.074	.0018	.994
Carbohydrate	.062	.017	.086	.0016	.996
Fat	.070	.019	.096	.0010	.999

1000 Calories

ANOVA		df	F	P
Regression -	all data	1,26	24.074	0.000
	no food	1,5	1041.66	0.000
	protein	1,5	3131.530	0.000
	carbohydrate	1,5	702.428	0.000
	fat	1,5	3240.132	0.000
Regression Coefficients		6,20	918.479	0.000

	Mean BAC	Std Dev	Intercept	Std Err of Est	Multiple R
All data	.058	.021	.079	.0156	.693
No food	.075	.019	.102	.0015	.998
Protein	.041	.013	.058	.0006	.999
Carbohydrate	.046	.014	.065	.0013	.997
Fat	.0699	.017	.093	.0007	.999

bread, meat, potatoes, and vegetables would be ideal. Such foods are largely protein and carbohydrates with a smaller proportion of the food being fats, and that kind of basic menu can be recommended. There is no evidence in these data to suggest that any specific, special foods should be eaten.

The pilot study and experiment findings have defined the food conditions which will make the maximum difference in BAC. It is important to emphasize, however, that these are not all-or-nothing variables. Rather, almost any food, eaten during the time interval of two hours or less prior to drinking, can be expected to produce some reduction in BAC compared to drinking in a fasted state. Although a small amount of food may have relatively minor effects, it would be unfortunate if the public believed that only a full meal would suffice. Snack foods, light meals, and typical party foods which accompany drinking all can be eaten with some benefit expected for the individual who wishes to minimize BAC.

There are some significant limits to these findings which should be noted. The alcohol beverage (80-proof vodka and orange juice mixed in a 1:1.5 ratio) was consumed over a half-hour period. No examination was made of other types of alcohol or of other alcohol concentrations, nor was it possible within the scope of this study to examine the condition in which alcohol is consumed as multiple drinks over a longer time period. The individual who may use the findings from this study as a basis for estimating BAC is likely not to duplicate the laboratory conditions and will need to be advised of the limits of the data.

Clearly, a high calorie meal is more effective than a low calorie meal of equal weight. However, to determine whether weight of food is a critical variable, an additional test is needed. Specifically, the question requires comparisons of meals with equal calories but varying weight. The tests did not include this condition, and thus the issue is not resolved by these data.

Also, the findings are based on study of male subjects only. It is expected that the effects of food on BAC will be closely similar for women, but no data have been obtained with female subjects.

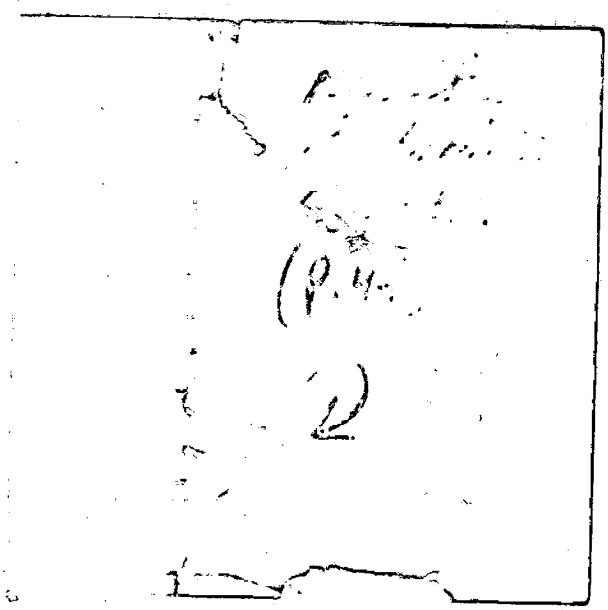
Finally, the subjects were young men, ages 21 - 30 years, and 'age' as a variable was not included in the study. It is possible that findings for older individuals will differ from those reported. Physiological changes, including changes in body composition, metabolic processes, and organ function which may occur with aging, presumably may affect the reported food-alcohol relationship.

It can reasonably be assumed that food will have some effect under these various conditions, but the extent of that effect has not been established. It is recommended that further study include a wider age range and include women as subjects. Additionally, if food is to find optimal use as an alcohol countermeasure, it will be necessary to examine the effects in circumstances more typical of social drinking. For example, it will be important to the alcohol user to know what may be expected if he/she has consumed an average-size, typical evening meal at 6 or 7 p.m. and then goes to a party or bar and drinks steadily for the rest of the evening without further food intake. Further study also will be needed to determine food effects on BAC when alcohol is consumed simultaneously with a meal.

Alcohol Nomographs

Tables which relate number of drinks and bodyweight to BAC are available for drivers, commonly made available to the public by law enforcement agencies and other groups with a responsibility or concern for traffic safety. Although these nomographs vary in detail, they all are similar in that the expected BAC is tabled as a linear function of bodyweight and number of drinks. (A drink is defined in terms of ounces of liquor, beer, or wine.) In addition, some rule-of-thumb usually is given by which to allow for elapsed time.

As will be discussed in Section II of this report, there are some problems with the linear model in this application. Further, the accuracy of the BAC estimate varies as a function of the user's age, weight, body composition, and alcohol-use history. The tables are likely to significantly underestimate BAC for women. However, it is believed that improved tables can be developed, which will reduce the error in tabled estimates.



V. Recommendations

It is recommended that the following findings be incorporated into a pamphlet for drivers:

1. Eat a meal in close proximity to the time of drinking.

2. Eat a full meal, if possible, with a variety of foods which are largely protein and/or carbohydrates.

3. When it is not possible to have a meal before drinking, take advantage of whatever food is available. Almost any food will be better than no food at all.

4. Avoid drinking when no food has been eaten for more than two hours.

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Appendix A

"Type of Food" Pilot Sessions

Menu 1 - A Series

High Carbo Meal	gms	cal	protein (GMS)	fat (GMS)	carbo (GMS)	
1 c spaghetti	250	260	9	9	37	
1 c canned corn	256	170	5	2	40	
1 hard roll	52	160	5	2	31	
1 pat butter	7	50	0	6	0	
1 c orange juice	248	110	2	0	27	
1 banana	150	85	1	0	23	
	963	835	22	19	158	= 199gms
			(11%)	(10%)	(79%)	

High Protein Meal	gms	cal	protein	fat	carbo	
2 boiled eggs	100	160	13	12	1	
1 c uncreamed cottage cheese	225	195	38	1	6	
3 oz tuna	85	170	24	7	0	
3 oz lean roast beef	85	165	25	7	0	
3 oz broiled skinned chicken	85	115	20	3	0	
1 raw medium tomato	150	35	2	0	7	
	730	840	112	30	14	= 156gms
			(72%)	(19%)	(9%)	

High Fat Meal	gms	cal	protein	fat	carbo	
½ California avocado	108	185	2	18	6	
2 Tb mayonnaise	30	220	0	24	0	
1 oz cream cheese	28	105	2	11	1	
2 slices fried bacon	16	100	5	8	1	
2 pats butter	14	100	0	12	0	
2 slices cracked wheat bread	23	60	2	1	12	
	219	770	11	74	20	= 105gms
			(10%)	(70%)	(19%)	

Appendix A

Menu 2 - C Series

High Calorie Meal	gms	cal	protein	GMS fat	carbo	
3 oz lean roast beef	85	165	25	7	0	
2 slices wheat bread	46	120	4	2	24	
1 Tb mayonnaise	15	110	0	12	0	
1 c cream/mushroom soup	240	135	2	10	10	
2 oz swiss cheese	56	210	16	16	2	
1 medium raw apple	150	70	0	0	18	
1 c whole milk	244	160	9	9	12	
	836	970	56	56	66	= 178gms
			(31%)	(31%)	(37%)	

Low Calorie Meal	gms	cal	protein	GMS fat	carbo	
1½ oz lean roast beef	42½	82½	12½	3½	0	
1 slice wheat bread	23	60	2	1	12	
½Tb mayonnaise	7½	55	0	6	0	
1 c vegetable soup	250	80	3	2	14	
½ oz swiss cheese	14	52½	4	4	½	
1 medium raw apple	150	70	0	0	18	
1 c diced celery	100	15	1	0	4	
1 c nonfat milk	246	90	9	0	13	
	833	505	31½	16½	61½	= 109½gms
			(29%)	(15%)	(56%)	

Appendix A

Menu 3 - B Series

High Carbo Meal	gms	cal	protein	fat	carbo	
				GMS		
2 c spaghetti/sauce	500	520	18	18	74	
½ c uncreamed corn	128	85	25	1	20	
1 hard roll	52	160	5	2	31	
2 pats butter	14	100	0	12	0	
1 c orange juice	248	110	1	0	27	
1 medium banana	150	85	1	0	23	
	1092	1060	28½	33	175	= 236½gms
			(12%)	(14%)	(74%)	

High Protein Meal	gms	cal	protein	fat	carbo	
2 boiled eggs	100	160	13	12	1	
1½c cottage cheese	337½	292½	57	1½	9	
4 oz tuna	113	227	32	9	0	
4 oz roast beef	113	220	33	9	0	
4 oz chicken	113	153	27	4	0	
1 medium raw tomato	150	35	2	0	7	
	926½	1087½	164	35½	17	= 216½gms
			(76%)	(16%)	(8%)	

High Fat Meal	gms	cal	protein	fat	carbo	
½ California avocado	108	185	2	18	6	
1 Tb mayonnaise	15	110	0	12	0	
1 oz cream cheese	28	105	2	11	1	
4 slices fried bacon	32	200	10	16	2	
2 pats butter	14	100	0	12	0	
1 c cream/mushroom soup	240	135	2	10	10	
3 oz cubed ham	85	245	18	19	0	
	522	1080	34	98	19	= 151gms
			(23%)	(65%)	(13%)	

Appendix B

Menus for Laboratory Experiment

"Protein" Meals (≥ 70% Protein)

1000 Calorie Meal	Total gms	Total cal	gms protein	gms fat	gms carbo	
1 c broiled chicken	226	306	54	8	0	
3½ oz Sunkist Tuna*	94	100	22½	1	0	
1½ c Knudsen cottage cheese**	340	300	48	6	12	
5 oz lean roast beef	142	275	42	12	0	
1 medium raw tomato	150	35	2	0	7	
	952	1016	168½	27	19	=214½gms
			(79%)	(13%)	(9%)	

500 Calorie Meal	Total gms	Total cal	gms protein	gms fat	gms carbo	
½ c broiled chicken	113	153	27	4	0	
1 3/4 oz tuna	47	50	11¼	½	0	
3/4 c cottage cheese	170	150	24	3	6	
2½ oz lean roast beef	70	137½	21	6	0	
½ medium raw tomato	75	17½	1	0	3½	
	475	508	84¼	13½	9½	=107¼gms
			(79%)	(13%)	(8%)	

*water-packed tuna

**low-fat cottage cheese

Appendix B

Menus for Laboratory Experiment
"Carbohydrate" Meals (≥ 70% Carbo)

1000 Calorie Meal	Total gms	Total cal	gms protein	gms fat	gms carbo
3 oz spaghetti	85	300	12	2	60
4 oz Hunt's tomato/onion sauce	113	45	2	0	10
7 oz Green Giant Corn	198	150	4	1	30
1 sourdough roll	28	90	3	1	18
2 pats butter	14	100	0	12	0
8 oz Vita-Pakt Orange Juice	227	110	1	0	24
1 5½ oz banana	150	85	1	0	23
1 c lime Jello Gelatin	227	160	4	0	38
	1042	1040	27	16	203 =246gms
			(11%)	(7%)	(83%)

500 Calorie Meal	Total gms	Total cal	gms protein	gms fat	gms carbo
1½ oz spaghetti	42½	150	6	1	30
2 oz tomato/onion sauce	56½	22½	1	0	5
3½ oz corn	99	75	2	½	15
1 sourdough roll	28	90	3	1	18
1 pat butter	7	50	0	6	0
4 oz orange juice	113½	55	½	0	12
1 5½ oz banana	150	85	1	0	23
	496½	527½	13½	8½	103 =125gms
			(11%)	(7%)	(83%)

Appendix B

Menus for Laboratory Experiment
"Fat" Meals ($\geq$ 70% Fat)

1000 Calorie Meal	Total gms	Total cal	protein (gms)	fat (gms)	carbo (gms)
1 c cubed avocado	152	260	3	26	9
2 Tb Best's mayonnaise	28	200	0	22	0
2 oz Knudsen's cream cheese	56	220	6	20	2
2 slices fried bacon	16	100	5	8	1
2 pats butter	14	100	0	12	0
5 oz Campbell's cream/mushroom soup	142	75	1	5½	5½
6 extra large green olives	32	30	0	4	0
1 large dill pickle	135	15	1	0	3
	575	1000	16 (12%)	97½ (73%)	20½ (15%) =134gms

500 Calorie Meal	Total gms	Total cal	protein (gms)	fat (gms)	carbo (gms)
½ c cubed avocado	76	130	1½	13	4½
1 Tb mayonnaise	14	100	0	11	0
1 oz cream cheese	28	110	3	10	1
1 slice fried bacon	8	50	2½	4	½
1 pat butter	7	50	0	6	0
2½ oz cream/mushroom soup	71	37½	½	2.75	2.75
3 extra large green olives	16	15	0	2	0
½ large dill pickle	67½	7½	½	0	1½
	287½	500	8 (12%)	48.75 (73%)	10¼ (15%) =67gms

Appendix C

Summary of Laboratory Experiment Data

Data Summary
BACs at 30-minute Intervals

Baseline (No Food)	BAC (%)							
	minutes after drinking							
Subject #	30	60	90	120	150	180	210	240
10	.102	.095	.085	.073	.069	.060	.053	.044
11	.057	.086	.096	.087	.077	.067	.061	.051
12	.088	.091	.079	.077	.065	.056	.046	.036
14	.105	.101	.096	.080	.080	.063	.052	.042
15	.105	.100	.093	.081	.073	.066	.057	.042
16*	.134	.114	.096	.083	.075	.065	.058	.052
17	.099	.086	.076	.068	.067	.061	.049	.040
18	.112	.095	.089	.082	.076	.061	.051	.044
19**	.110	.092	.073	.069	.059	.050	.042	.034
500 Calorie/High Protein Meal								
10	.073	.072	.070	.066	.056	.052	.047	.042
11	.075	.075	.076	.070	.061	.049	.044	.037
12	.061	.092	.084	.075	.066	.053	.049	.041
14	.056	.061	.067	.059	.047	.039	.028	-
15	.042	.047	.049	-	.045	.035	.035	.025
16	.097	.092	.084	.076	.065	.049	.040	.030
17	.071	.066	.068	.062	.057	.049	.038	.030
18	.045	.047	.045	.043	.039	.032	.021	-
500 Calorie/High Carbo Meal								
10	.067	.079	.070	.066	.060	.052	.045	.036
11	.059	.083	.080	.078	.076	.059	.050	.045
12	.057	.078	.073	.062	.050	.044	.032	.027
14	.082	.089	.085	.081	.073	.059	.050	.040
15	.074	.090	.080	.072	.070	.061	.055	.048
16	.098	.097	.091	.072	.071	.057	.047	.036
17	.056	.081	.077	.074	.067	.056	.051	.047
18	.061	.075	.076	.060	.054	.044	.034	.020

*Participated in 500 calorie sessions only.
**Participated in 1000 calorie sessions only.

Summary of Laboratory Experiment Data

500 Calorie/High Fat Meal	BAC (%)							
Subject #	minutes after drinking							
	30	60	90	120	150	180	210	240
10	.087	.095	.078	.071	.063	.058	.043	.046
11	.110	.101	.089	.079	.069	.060	.058	.052
12	.082	.073	.081	.070	.062	.053	.044	.035
14	.099	.100	.091	.081	.071	.062	.054	.043
15	.073	.088	.082	.073	.069	.061	.052	.045
16	.120	.099	.089	.080	.068	.054	.043	.035
17	.085	.087	.081	.077	.066	.063	.054	.042
18	.053	.089	.084	.075	.073	.054	.042	.030
1000 Calorie/High Protein Meal								
10	.076	.072	.064	.057	.050	.042	.032	.022
11	.055	.050	.047	.041	.033	.029	.025	.021
12	.032	.040	.043	.038	.039	.035	.031	.026
14	.058	.059	.053	.048	.040	.037	.034	.025
15	.027	.048	.044	.041	.037	.033	.029	.022
17	.068	.065	.057	.056	.051	.041	.038	.034
18	.043	.048	.050	.045	.039	.030	.023	.016
19	.064	.048	.037	.032	.022	.014	.006	-
1000 Calorie/High Carbo Meal								
10	.068	.065	.065	.063	.058	.045	.036	.027
11	.050	.071	.069	.047	.056	.056	.048	.037
12	.041	.053	.058	.053	.044	.042	.036	.028
14	.051	.065	.066	.061	.052	.052	.038	.028
15	.020	.043	.046	.063	.059	.054	.045	.034
17	.029	.041	.048	.059	.053	.048	.039	.027
18	.044	.063	.059	.054	.048	.036	.028	.020
19	.063	.051	.045	.038	.031	.028	.025	.022
1000 Calorie/High Fat Meal								
10	.095	.092	.075	.071	.062	.051	.045	.037
11	.102	.053	.086	.080	.081	.069	.055	.050
12	.086	.076	.075	.060	.058	.046	.042	.036
14	.094	.087	.080	.074	.066	.060	.055	.047
15	.098	.102	.092	.087	.074	.068	.064	.054
17	.089	.085	.081	.070	.061	.057	.051	.040
18	.063	.077	.072	.068	.061	.054	.043	.034
19	.100	.083	.071	.062	.052	.046	.035	.029

Effects of Food by Amount and Type

Summary of Laboratory Experiment Data

Subject Number	Baseline (no food)	Protein	Carbohydrates	Fat
			Peak BAC (%)[1]	
			Food Type	
			500 Calories	
10	.102	.073	.079	.095
11	.096	.076	.083	.110
12	.091	.092	.078	.082
14	.123	.067	.089	.100
15	.105	.090	.090	.088
16	.134	.097	.098	.120
17	.099	.071	.081	.087
18	.112	.047	.076	.089
$\bar{X}$	.108	.077	.084	.096
	.015	.016	.007	.013
Percent decrease from baseline		28.7	22.2	11.1
			1000 Calories	
10	.102	.076	.068	.095
11	.096	.055	.071	.102
12	.091	.043	.058	.086
14	.123	.059	.066	.094
15	.105	.048	.063	.102
17	.099	.068	.059	.089
18	.112	.050	.063	.077
19	.110	.064	.063	.100
$\bar{X}$	.105	.058	.064	.093
	.010	.011	.004	.009
Percent decrease from baseline		44.8	39.0	11.4

[1]Time of occurrence of peak BAC varied between subjects and between sessions.

Effects of Food by Amount and Type

Summary of Laboratory Experiment Data

Subject Number	60-Minute BAC (%) [1]: Baseline (no food)	Food Type: Protein	Food Type: Carbohydrates	Food Type: Fat
			500 Calories	
10	.095	.072	.079	.095
11	.086	.075	.083	.101
12	.091	.092	.078	.073
14	.101	.061	.089	.100
15	.100	.047	.090	.088
16	.114	.092	.097	.099
17	.086	.066	.081	.087
18	.095	.047	.075	.089
$\overline{X}$	.096	.069	.084	.092
	.009	.018	.007	.009
Percent decrease from baseline		28.1	12.5	4.2
			1000 Calories	
10	.095	.072	.065	.092
11	.086	.050	.071	.053
12	.091	.040	.053	.076
14	.101	.059	.065	.087
15	.100	.048	.043	.102
17	.086	.065	.041	.085
18	.095	.048	.063	.077
19	.092	.048	.051	.083
$\overline{X}$	.093	.054	.057	.082
	.006	.011	.011	.014
Percent decrease from baseline		41.9	38.7	11.8

[1] BAC measured 60 minutes after completion of drinking.

Effects of Food by Amount and Type

Summary of Laboratory Experiment Data

Subject Number	Baseline (no food)	Protein	Carbohydrates	Fat
	Mean BAC, 60 - 180 minutes post-dose			
		Food Type		
			500 Calories	
10	.076	.063	.065	.073
11	.083	.066	.075	.083
12	.074	.074	.061	.072
14	.084	.055	.077	.086
15	.083	.048	.075	.075
16	.087	.073	.078	.078
17	.072	.060	.071	.075
18	.081	.039	.062	.075
$\overline{X}$	.080	.060	.071	.077
	.005	.012	.007	.005
Percent decrease from baseline		25.0	11.3	3.8
			1000 Calories	
10	.076	.059	.059	.070
11	.083	.040	.060	.074
12	.074	.039	.050	.063
14	.084	.050	.059	.073
15	.083	.041	.053	.085
17	.072	.054	.050	.071
18	.081	.042	.052	.066
19	.056	.035	.039	.063
$\overline{X}$	.076	.045	.053	.071
	.009	.008	.007	.007
Percent decrease from baseline		40.8	30.3	6.6

Effects of Food by Amount and Type

Summary of Laboratory Experiment Data

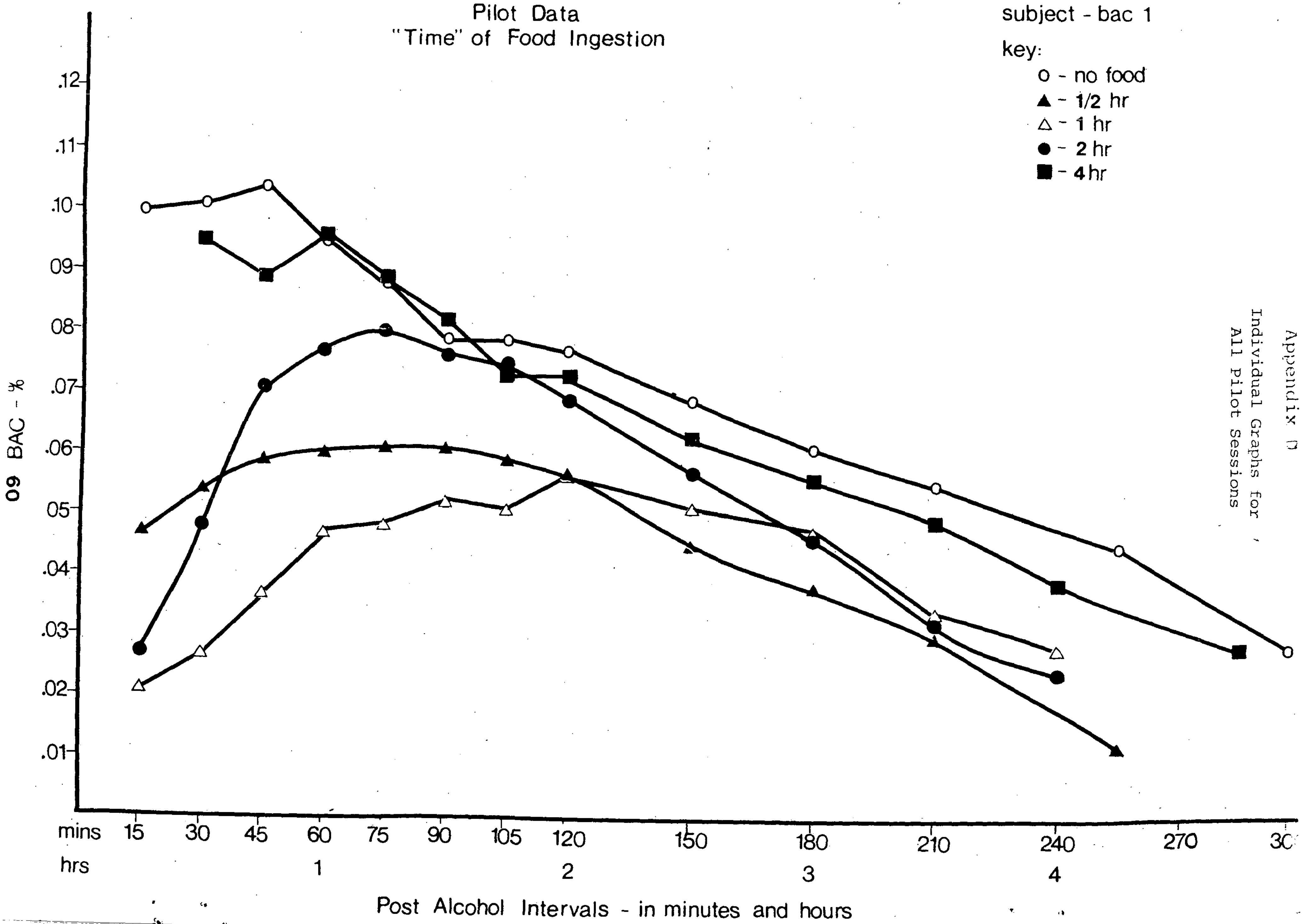
Subject Number	Elapsed Time (minutes) to Peak BAC			
	Baseline (no food)	Food Type		
		Protein	Carbohydrates	Fat
			500 Calories	
10	30	30	60	60
11	90	90	60	30
12	60	60	60	30
14	30	90	60	60
15	30	60	60	60
16	30	30	30	30
17	30	30	60	60
18	30	60	90	60
$\overline{X}$	41.3	56.3	60	48.8
	22.3	25	16	15.5
			1000 Calories	
10	30	30	30	30
11	90	30	60	30
12	60	90	90	30
14	30	60	90	30
15	30	60	120	60
17	30	30	120	30
18	30	90	60	60
19	30	30	30	30
$\overline{X}$	41.3	52.5	75	37.5
	22.3	26.6	35.9	13.9

Figure 1d

THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

Pilot Data

"Time" of Food Ingestion



Appendix D
Individual Graphs for
All Pilot Sessions

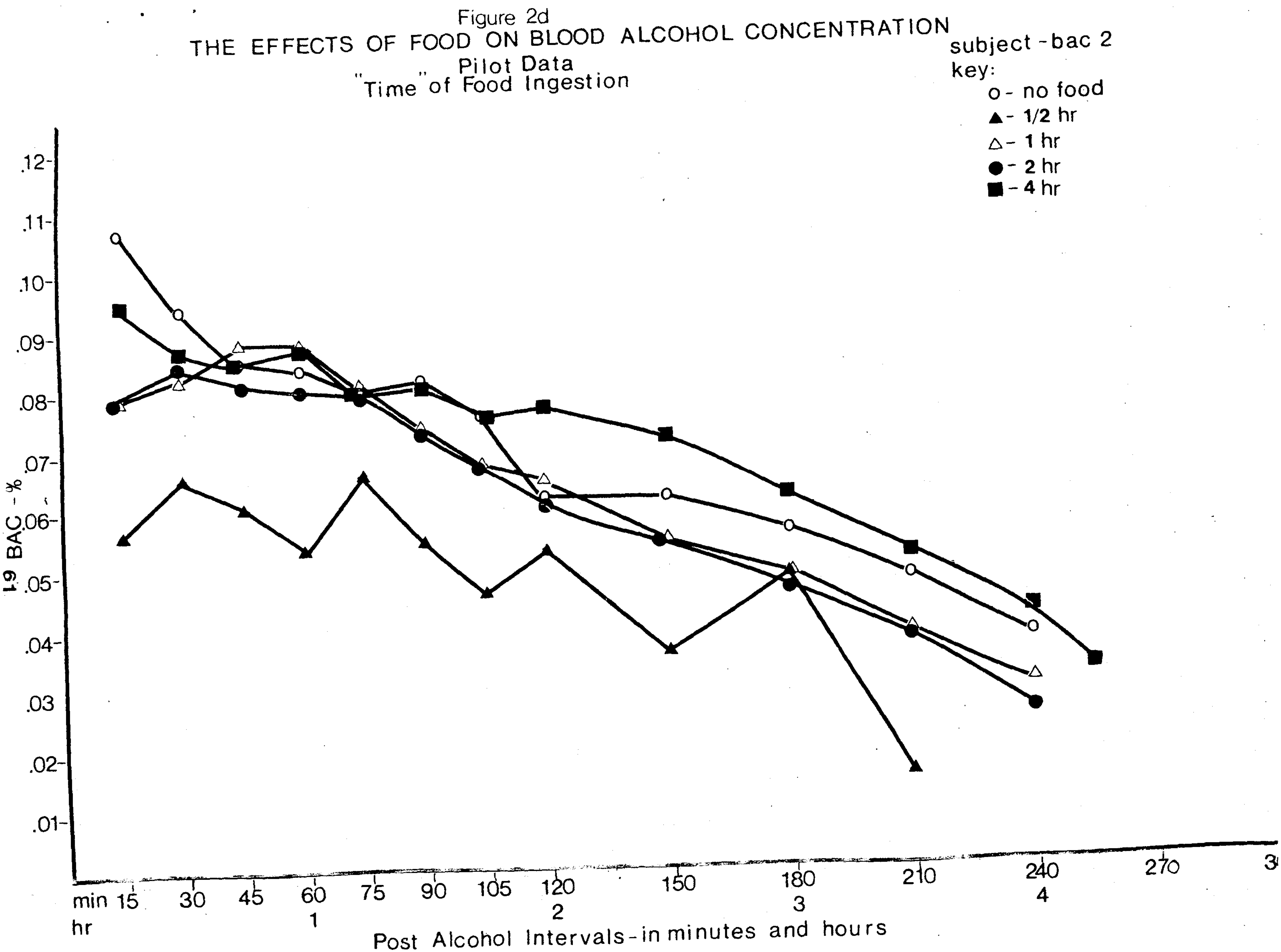


Figure 2d
THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
Pilot Data
"Time" of Food Ingestion
subject - bac 2
key:
o - no food
▲ - 1/2 hr
△ - 1 hr
● - 2 hr
■ - 4 hr
BAC - %
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
min 15 30 45 60 75 90 105 120 150 180 210 240 270
hr 1 2 3 4
Post Alcohol Intervals - in minutes and hours
67

Figure 3d - THE EFFECTS OF FOOD OF BLOOD ALCOHOL CONCENTRATION - Pilot Data: "Time" of Food Ingestion

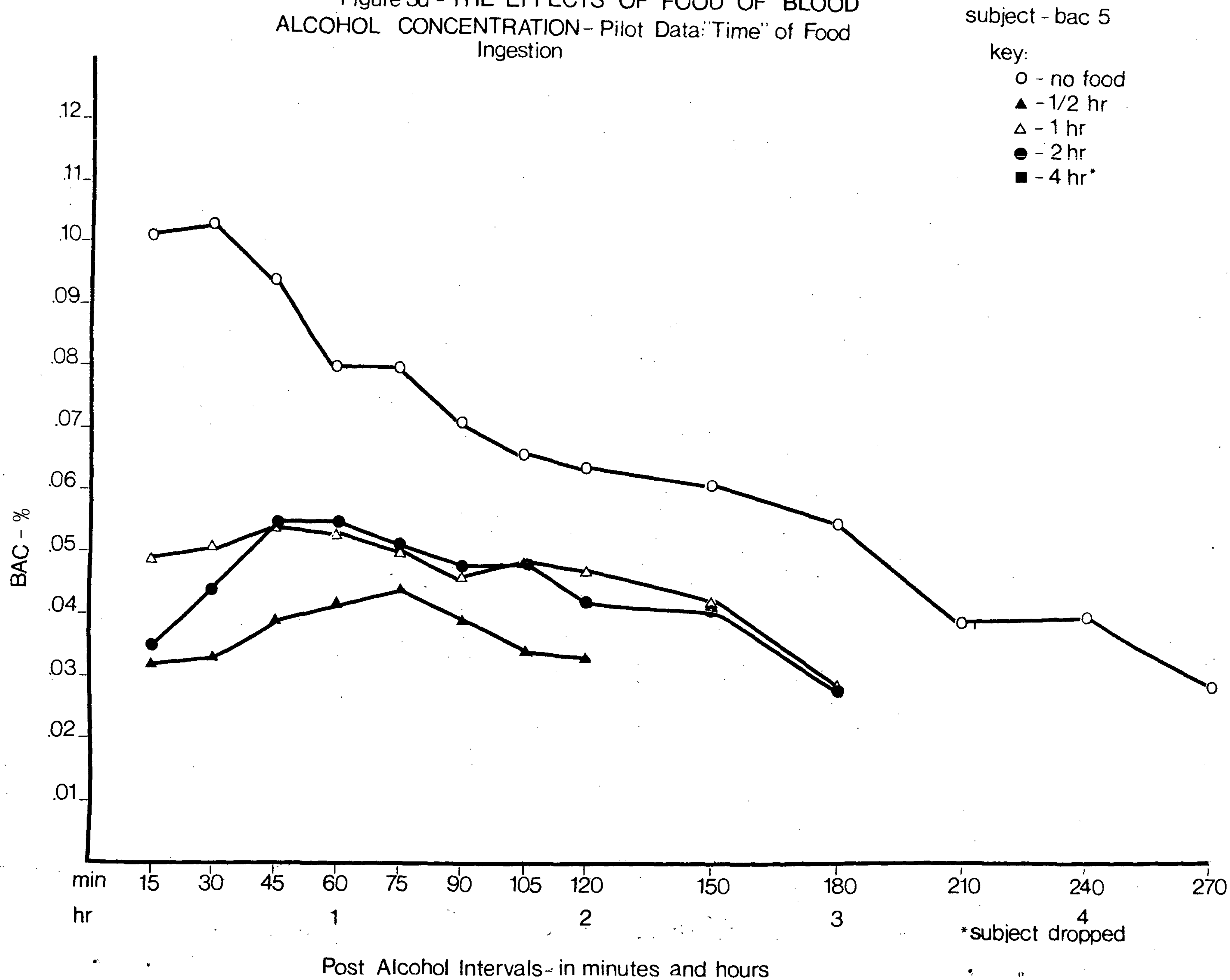


Figure 4d- THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION - Pilot Data - "Amount" of Food

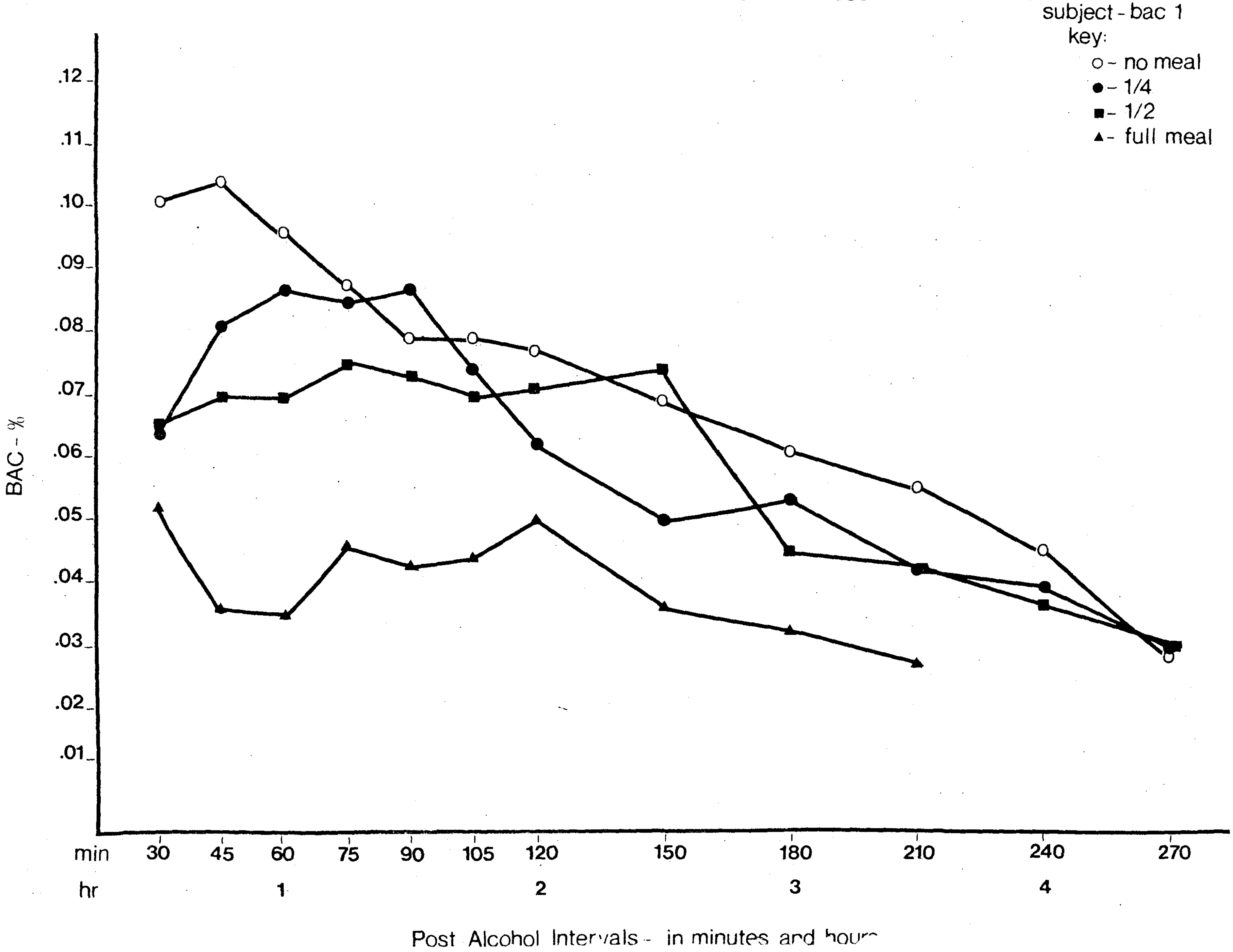


Figure 5d-THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION - Pilot Data-"Amount" of Food

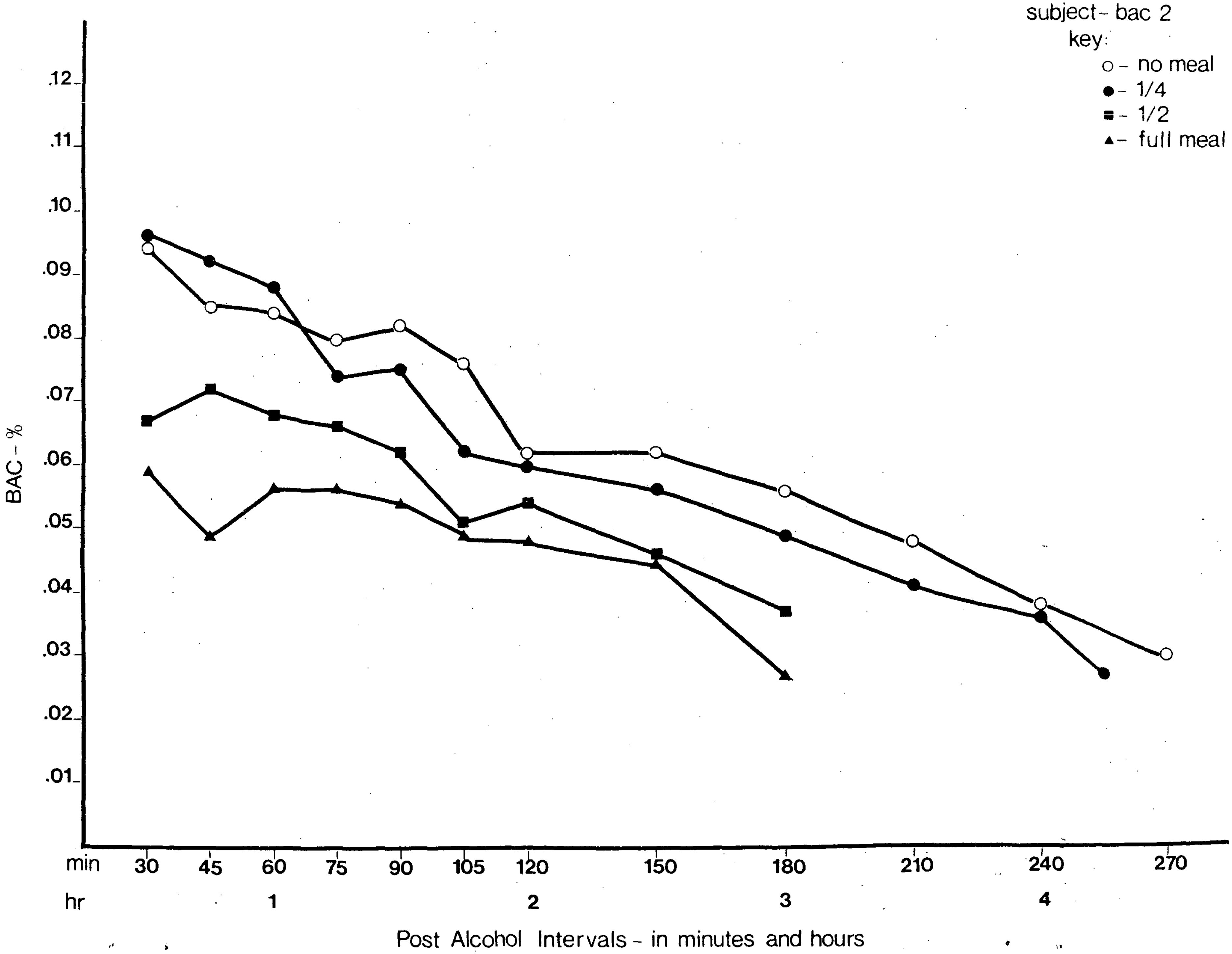
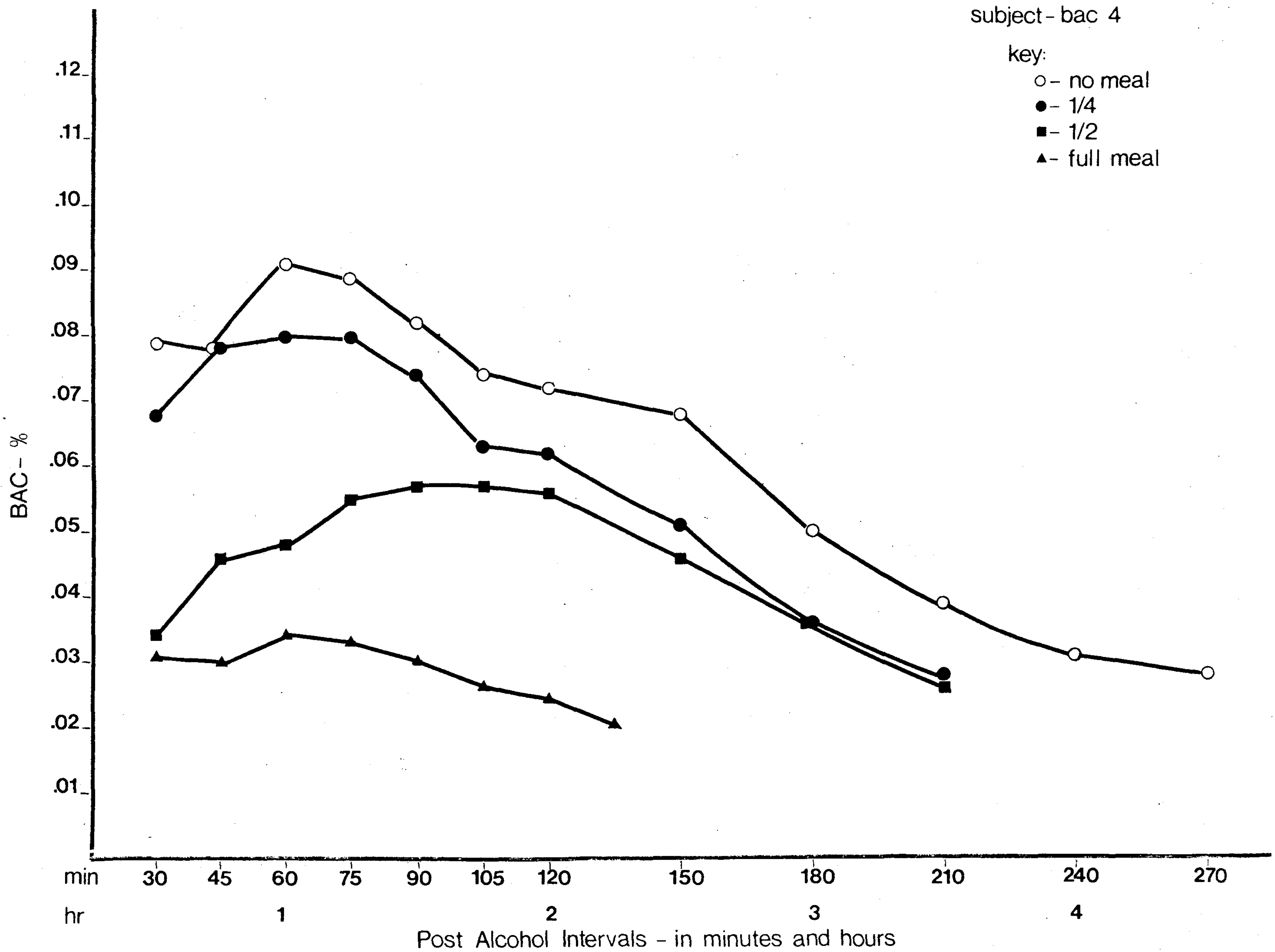


Figure 6d -THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION - Pilot Data - "Amount" of Food



65

Figure 7d - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION - Pilot Data: "Type" of Food
Series A

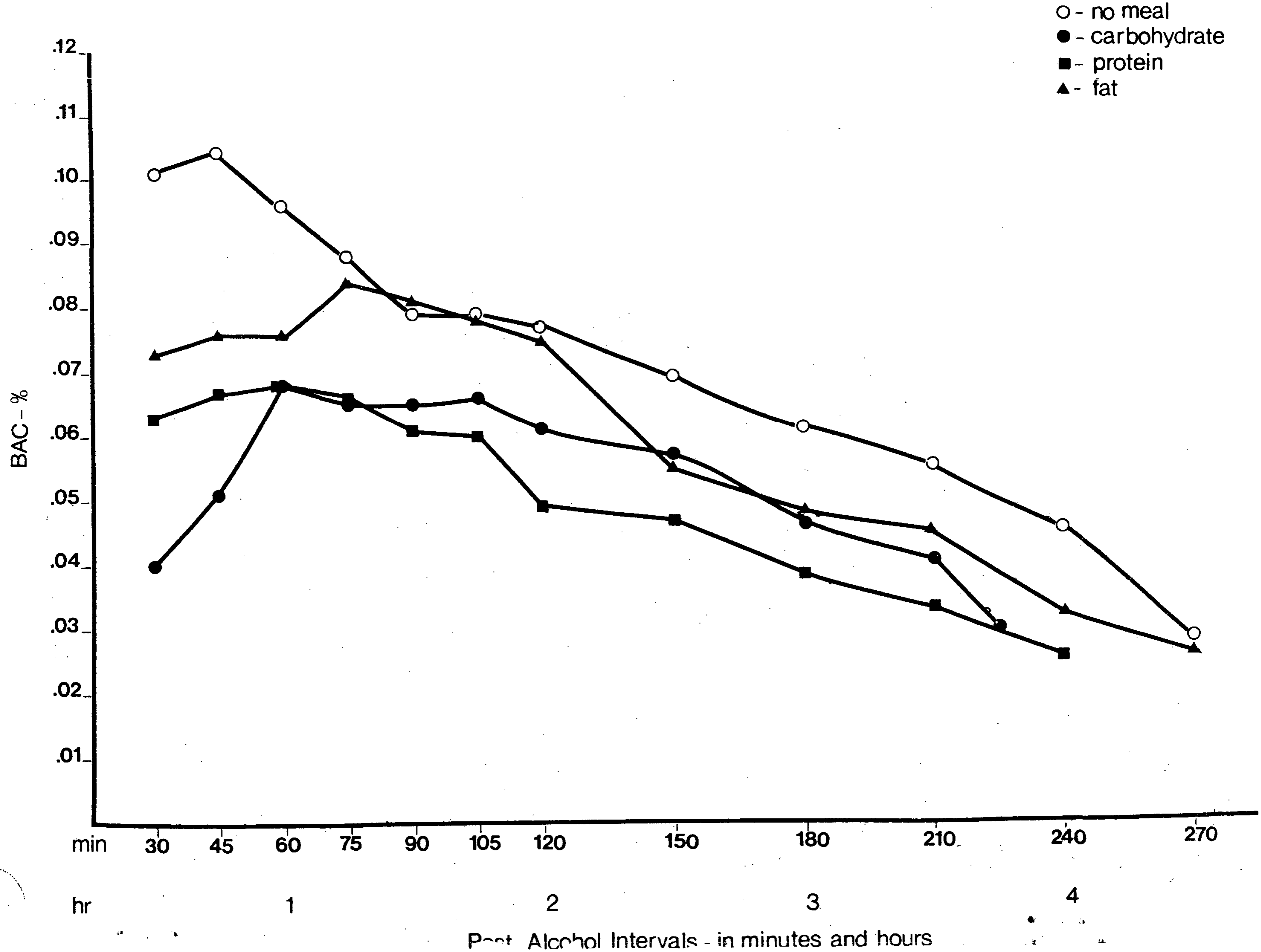


Figure 8d- THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION - Pilot Data: "Type" of Food
Series A

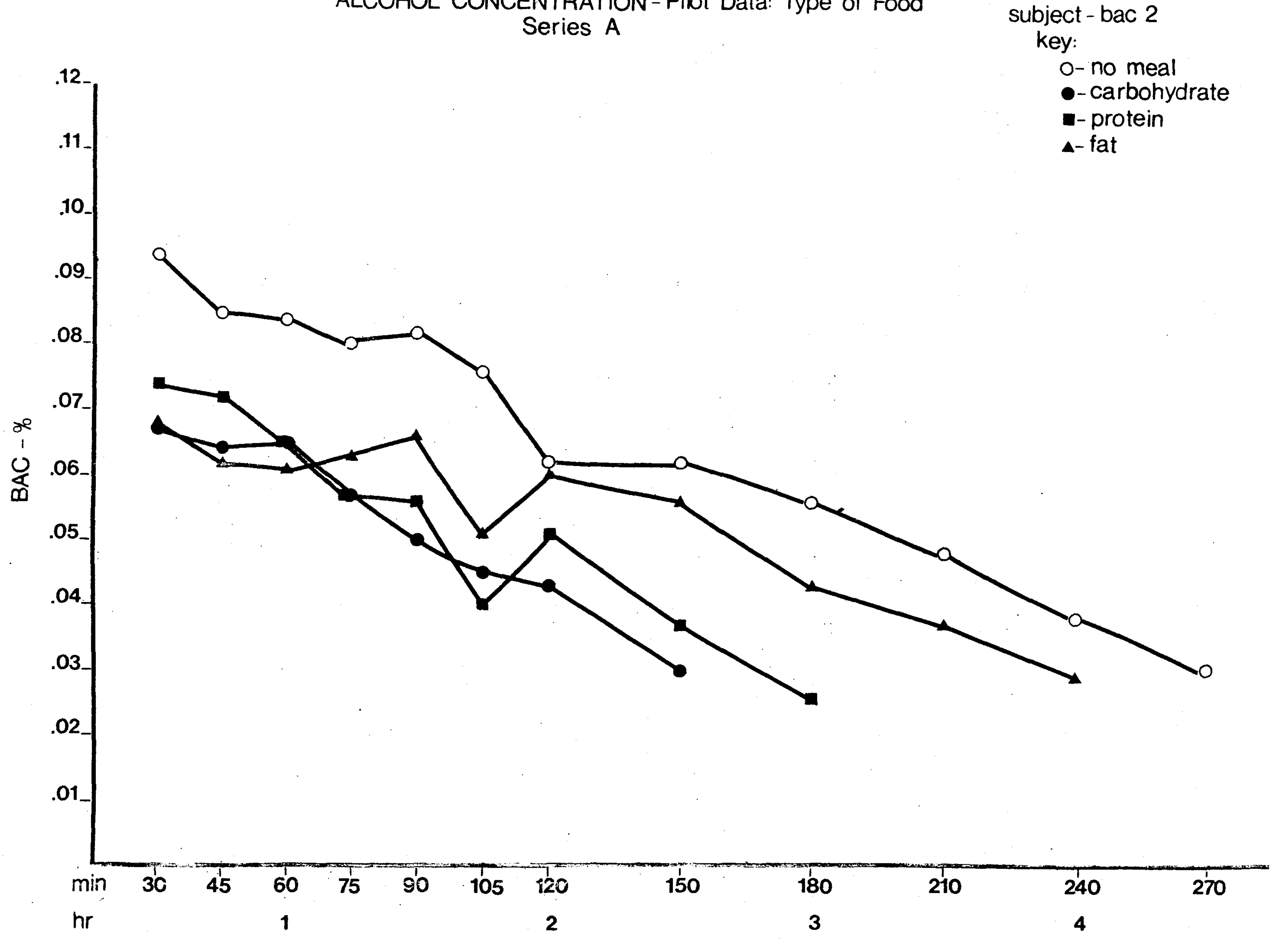


Figure 9d - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION - Pilot Data: "Type" of Food
Series A

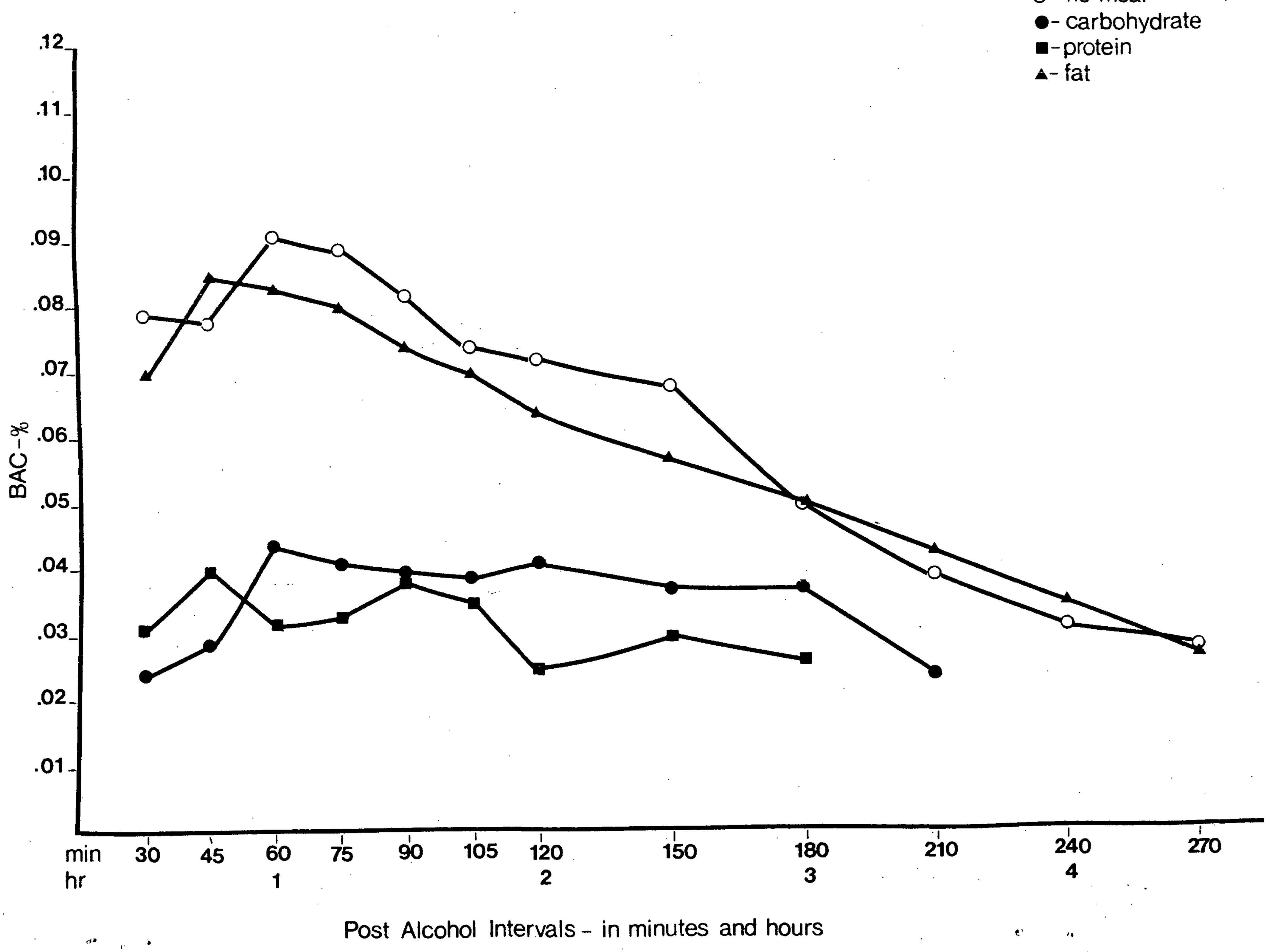


Figure 10d
FOOD EFFECTS ON BLOOD ALCOHOL CONCENTRATION

Pilot Data -"Type" of Food
Series B

subject - bac 6

key:
o - fasting
*● - 74% carbo (1092 gm)
**▲ - 76% protein (926.5 gm)
***■ - 65% fat (522 gm)

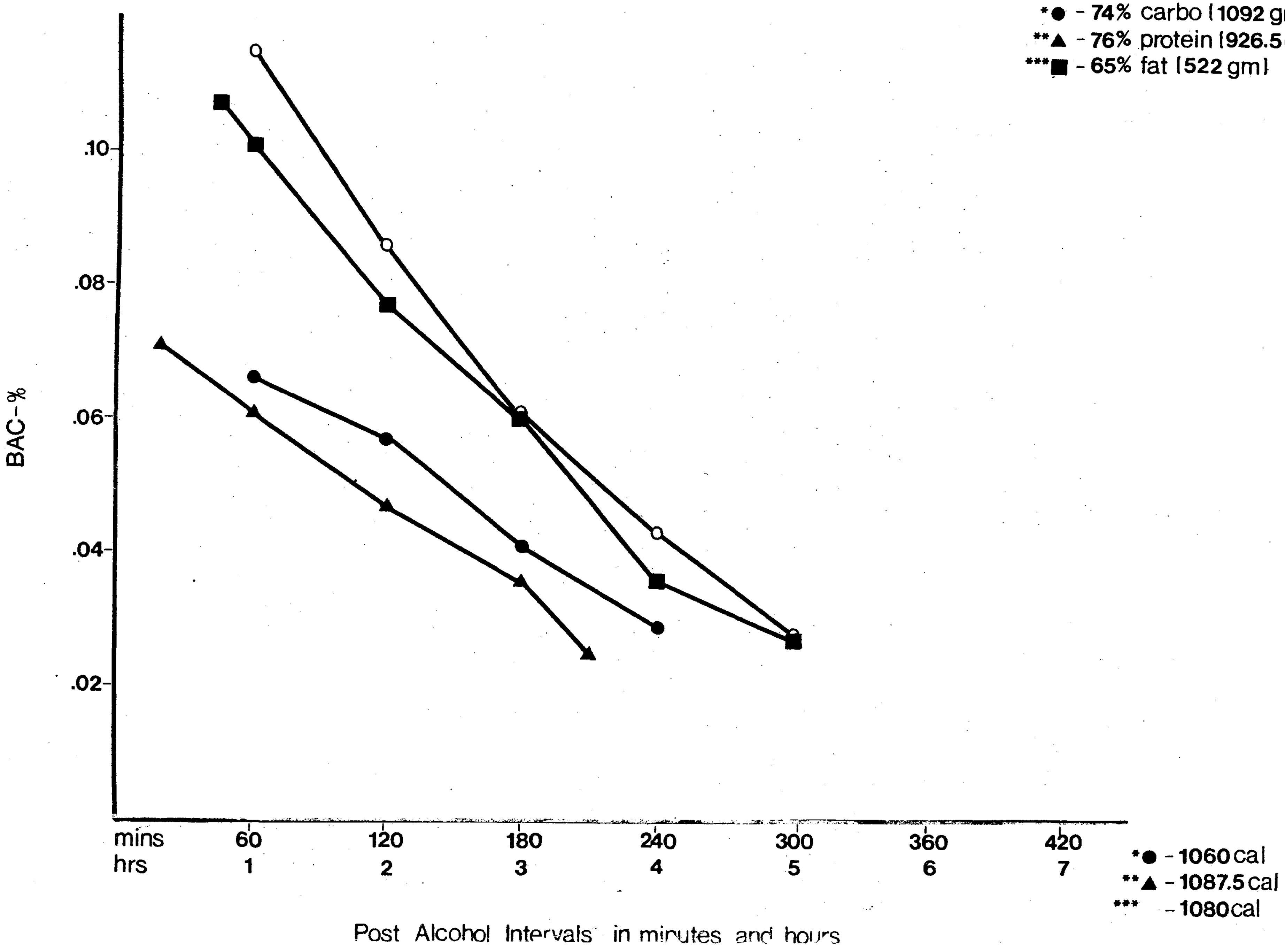


Figure 11d
FOOD EFFECTS ON BLOOD ALCOHOL CONCENTRATION
Pilot Data - "Type" of Food
Series B

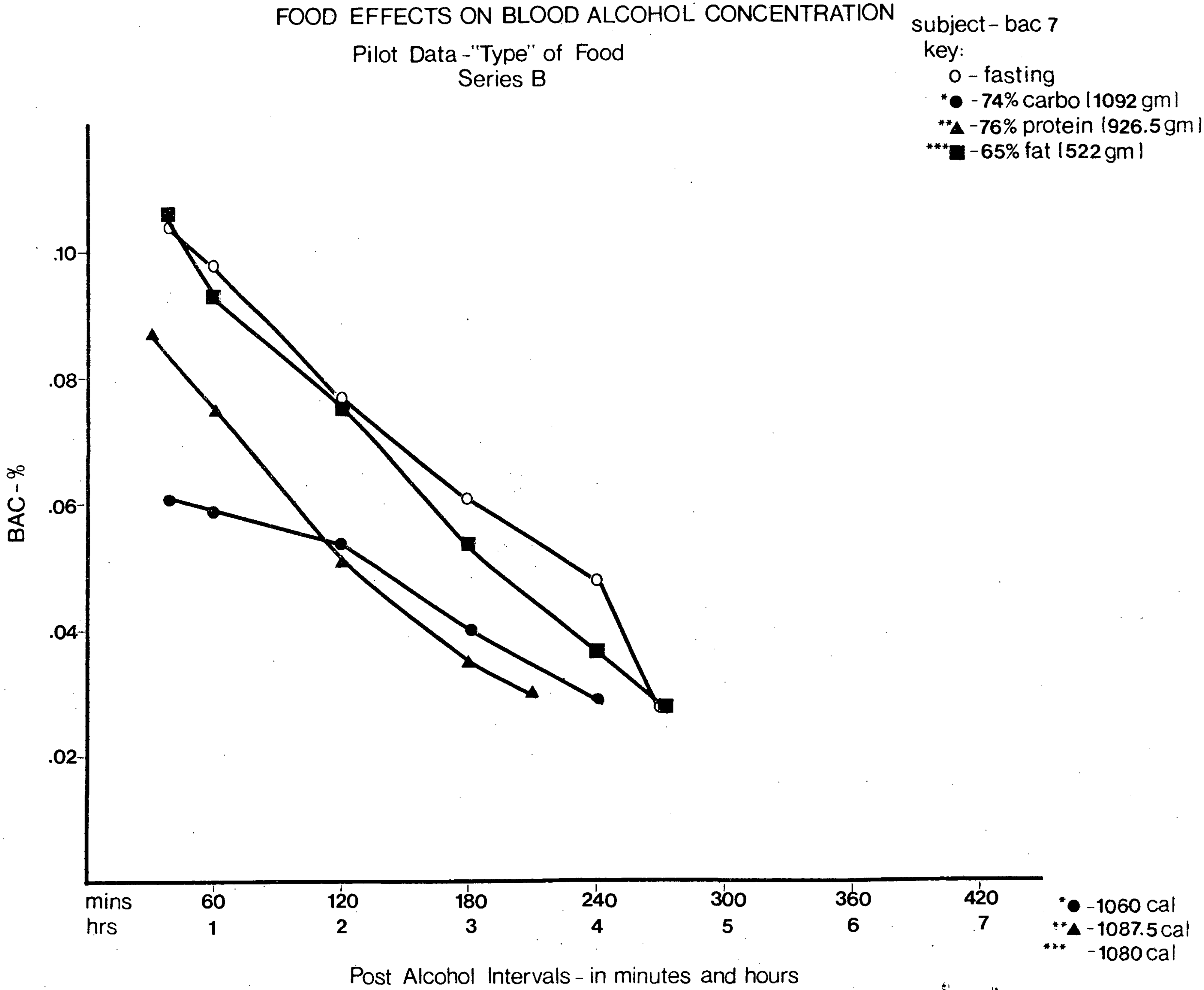


Figure 12d

FOOD EFFECTS ON BLOOD ALCOHOL CONCENTRATION

Pilot Data: "Type" of Food - Series C

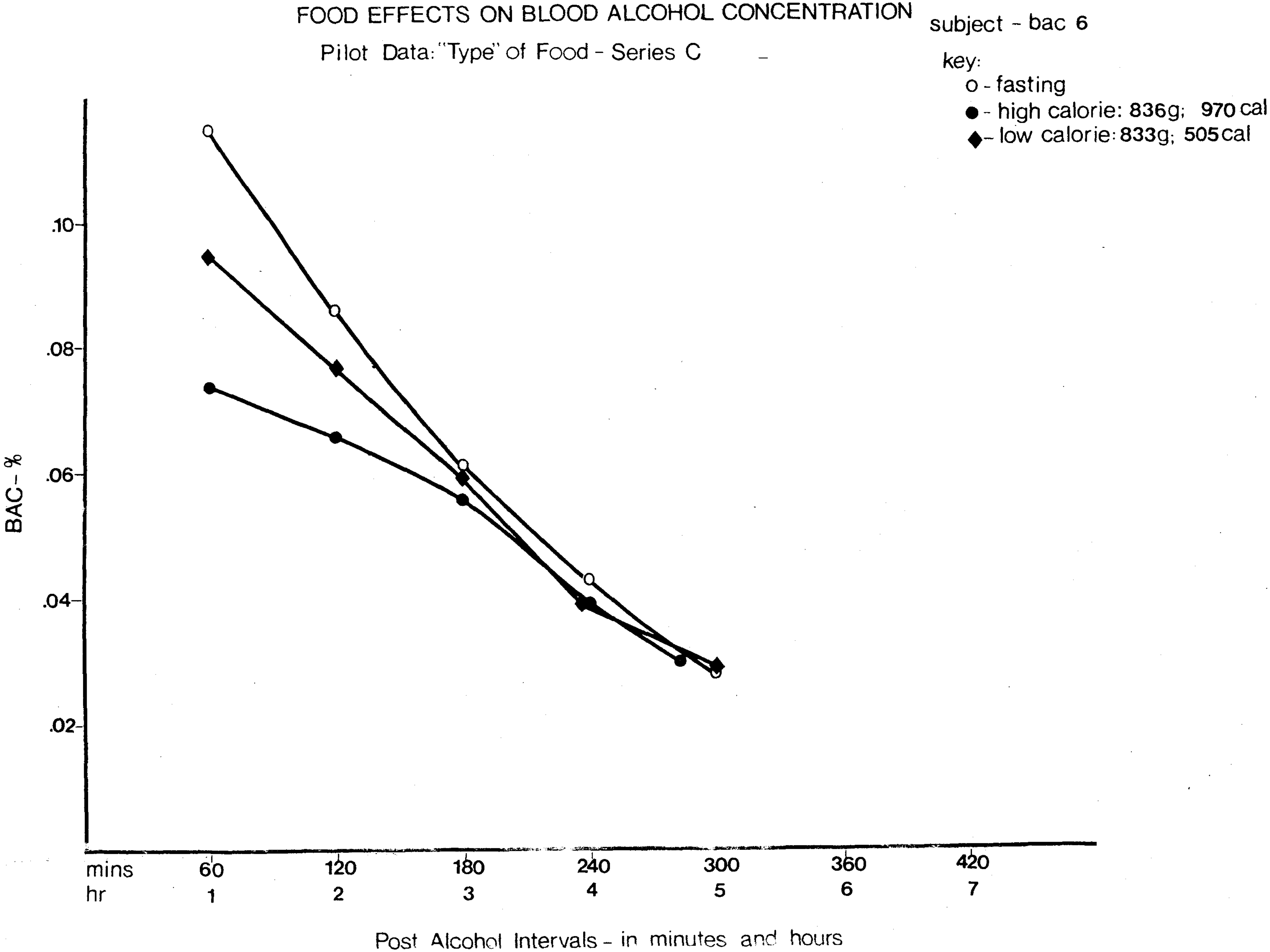


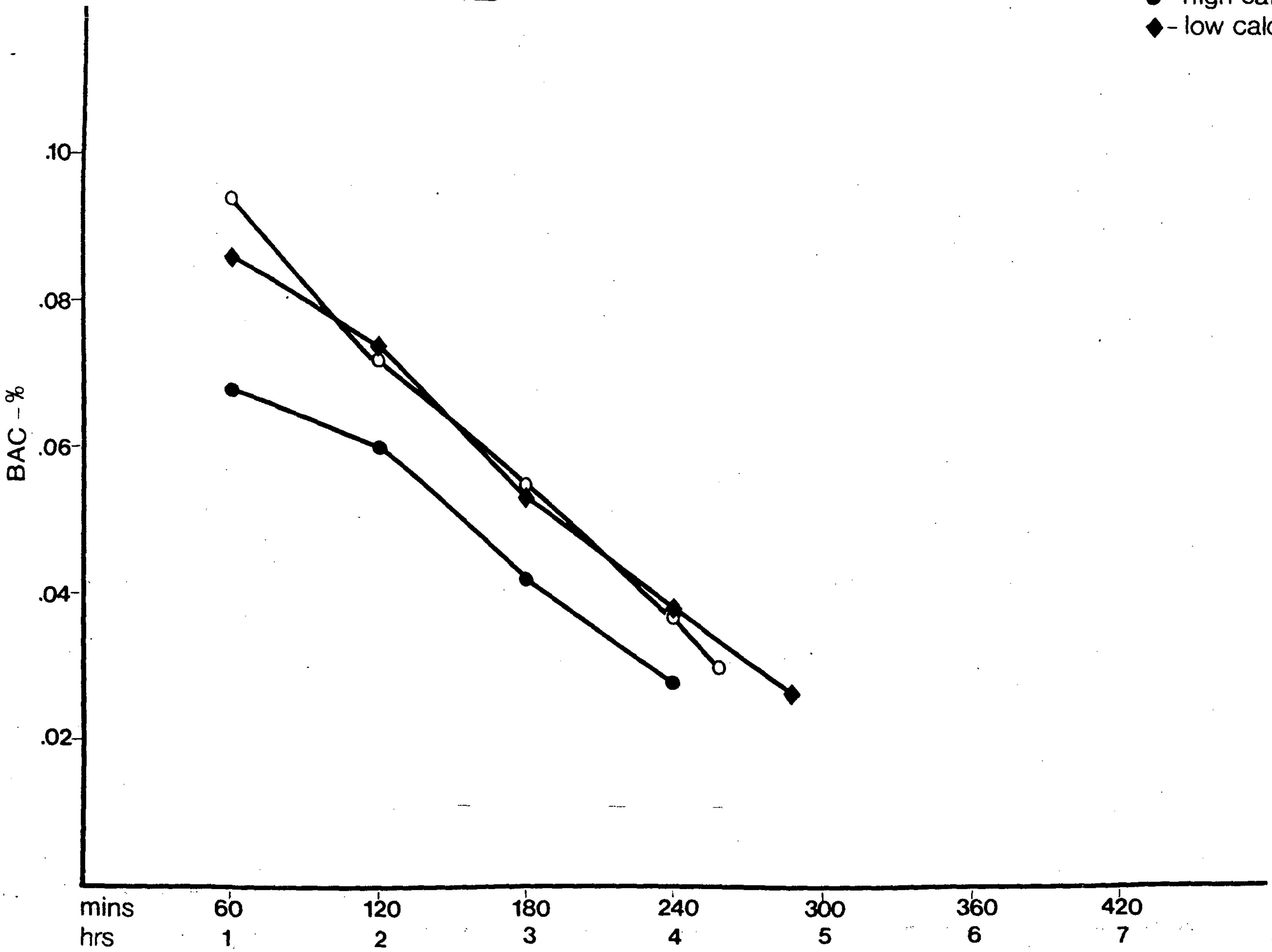
Figure 13d

FOOD EFFECTS ON BLOOD ALCOHOL CONCENTRATION

Pilot Data "Type" of Food - Series C

subject - bac 8

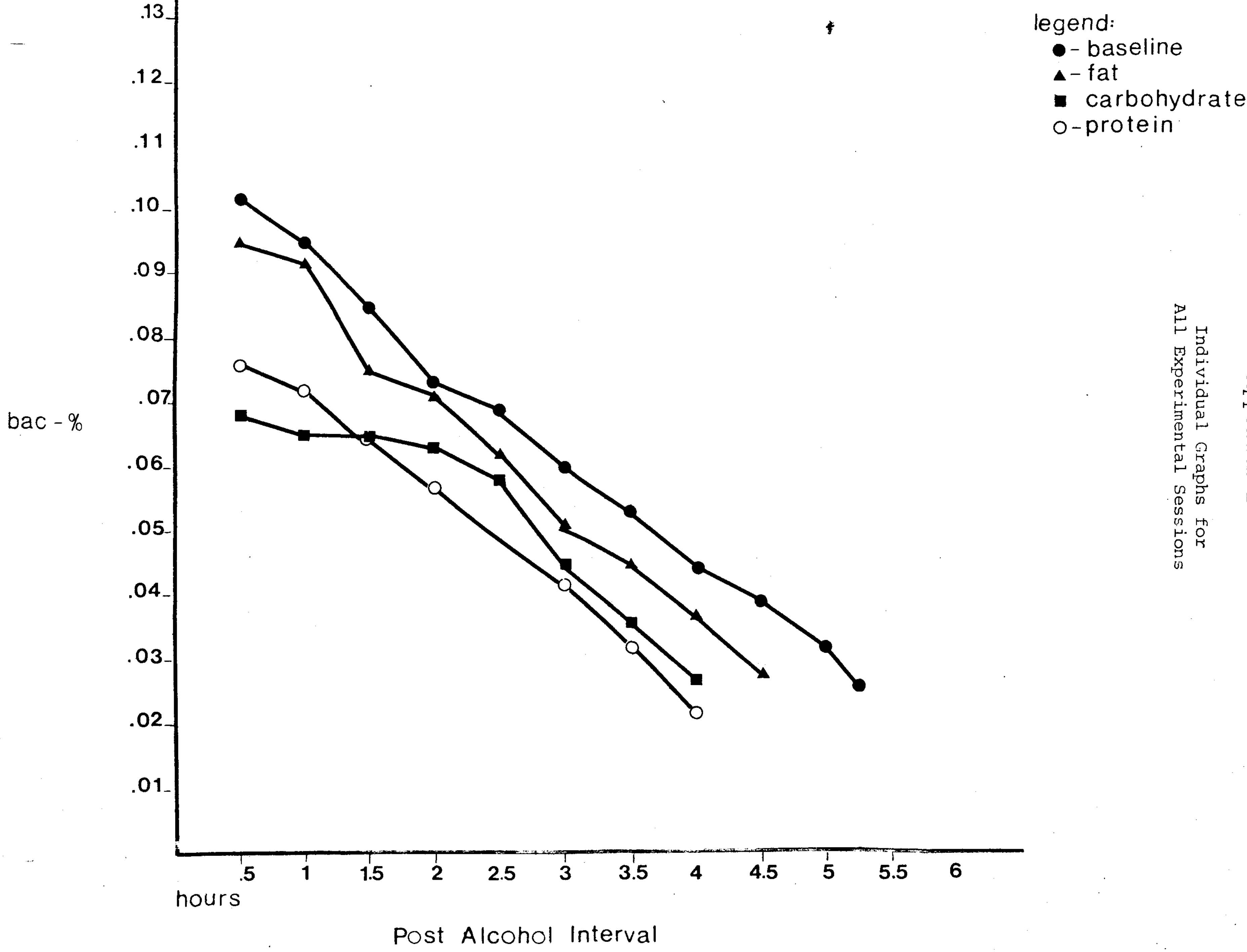
key:
o - fasting
● - high calorie: 836g; 970 cal
◆ - low calorie: 833g; 505 cal



Post Alcohol Intervals - in minutes and hours

Figure 1e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 10
calories - 1000



Appendix E

Individual Graphs for All Experimental Sessions

Figure 2e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 10
calories - 500

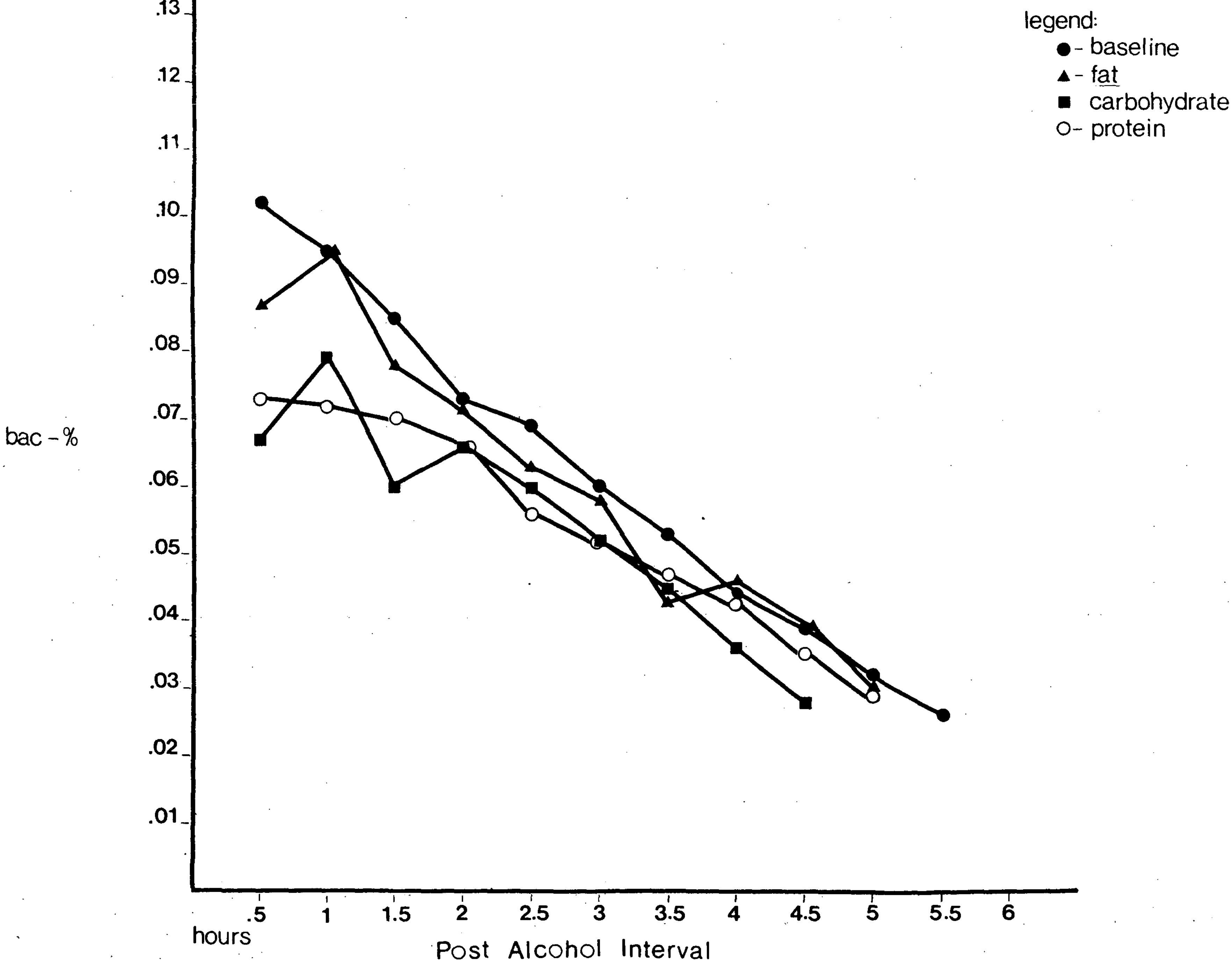
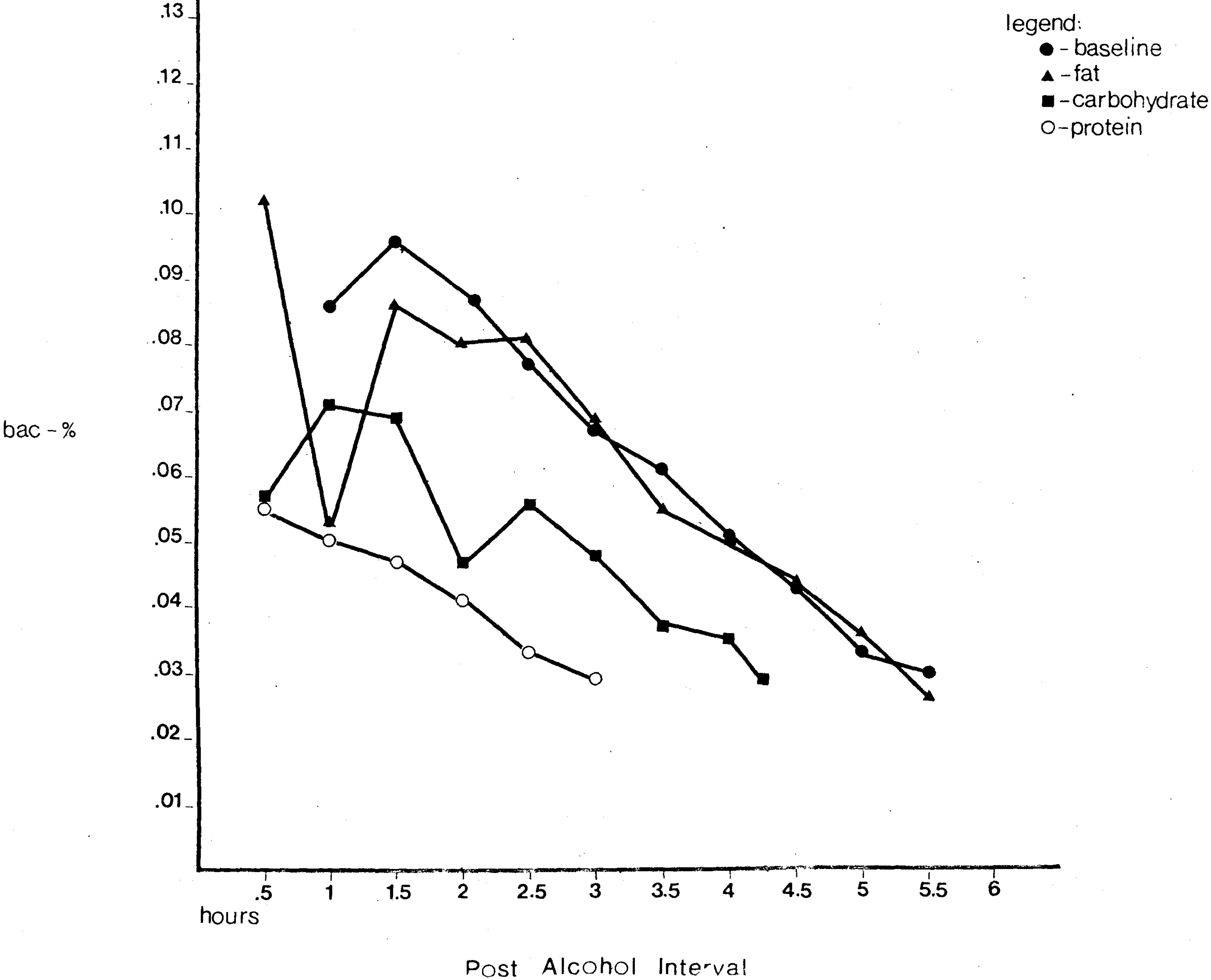


Figure 3e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 11
calories - 1000



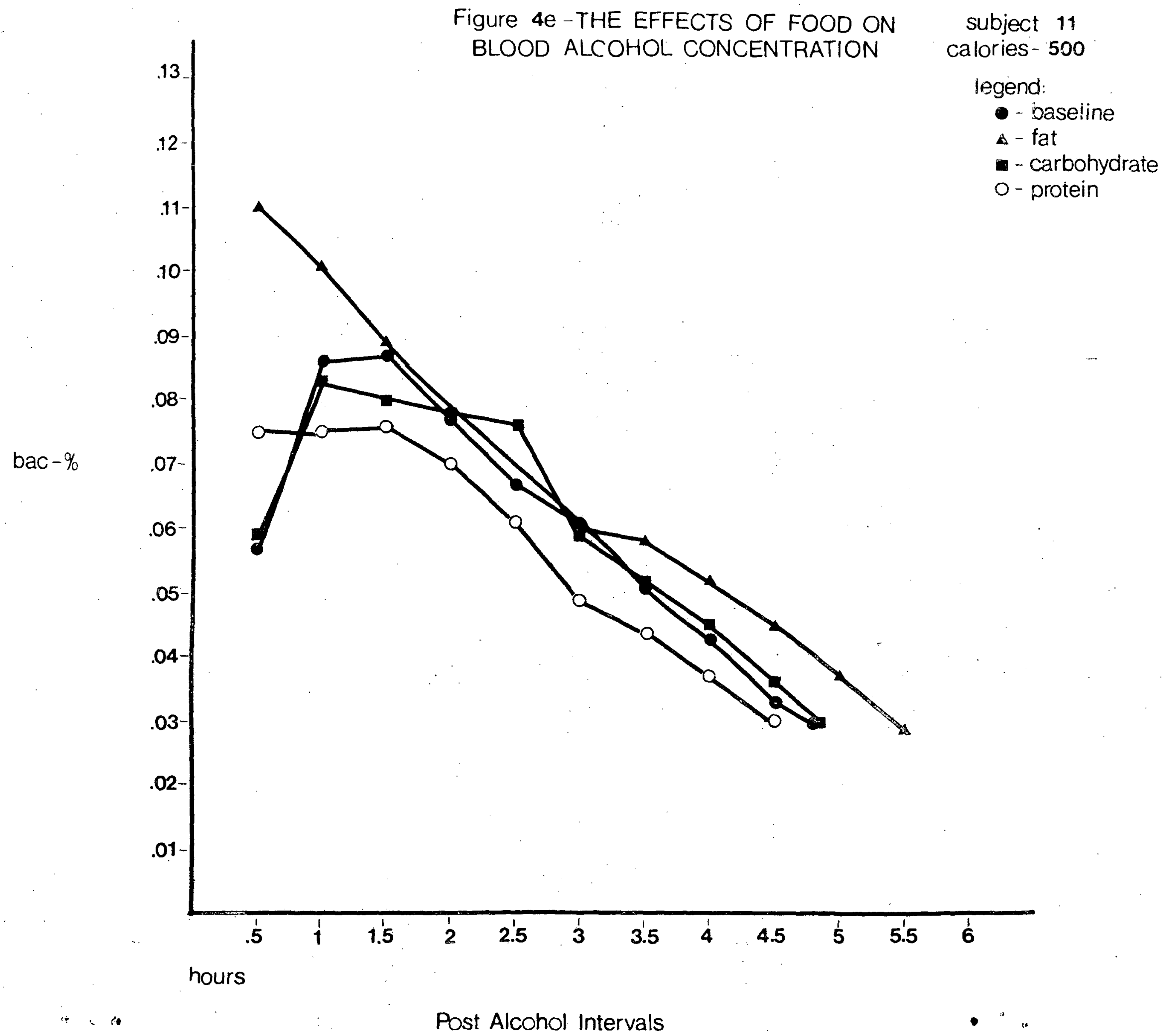


Figure 4e - THE EFFECTS OF FOOD ON
BLOOD ALCOHOL CONCENTRATION
subject 11
calories - 500
legend:
● - baseline
▲ - fat
■ - carbohydrate
○ - protein
bac - %
.13
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
hours
Post Alcohol Intervals

Figure 5e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 12
calories - 500

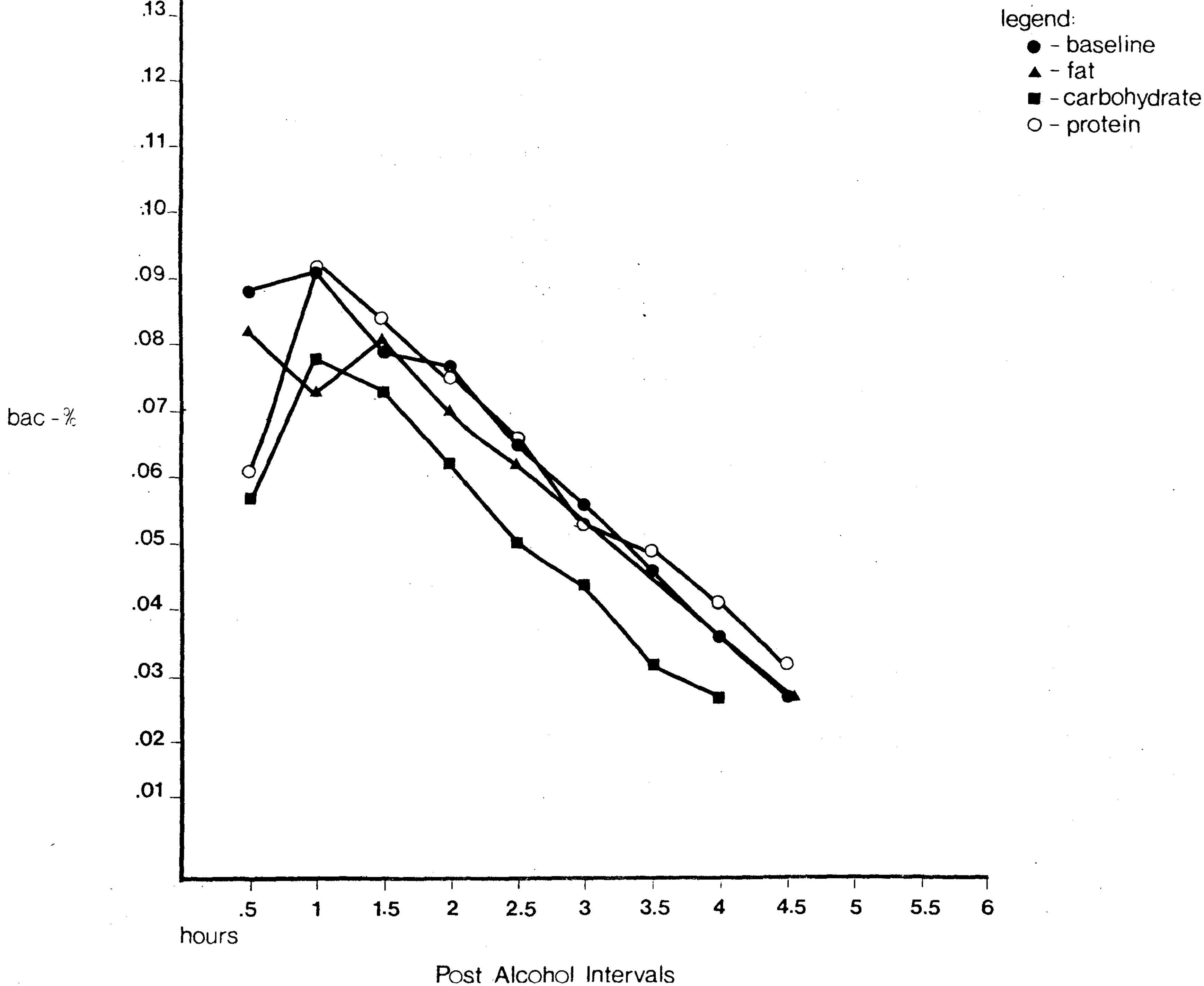


Figure 6e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 12
calories - 1000

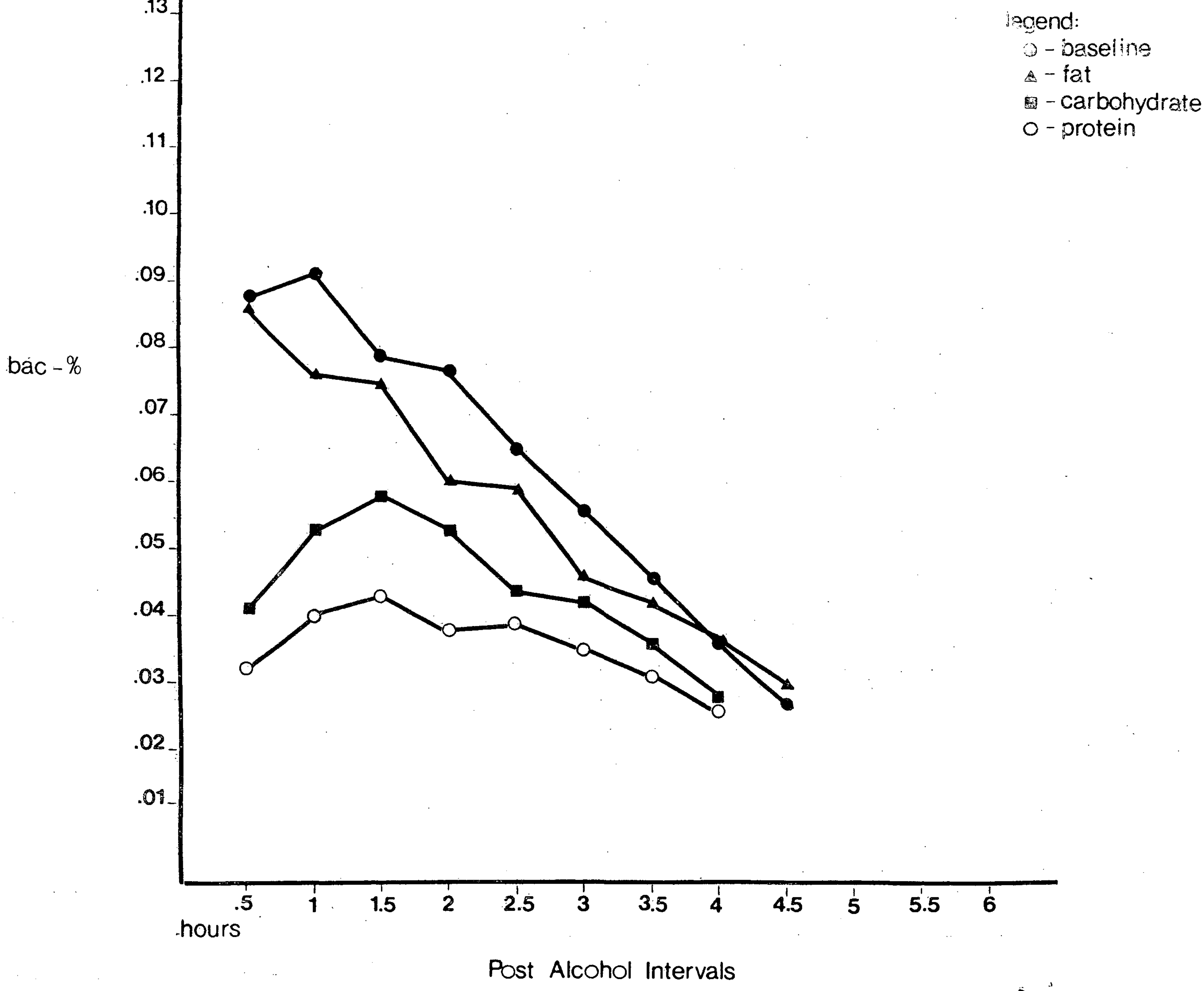
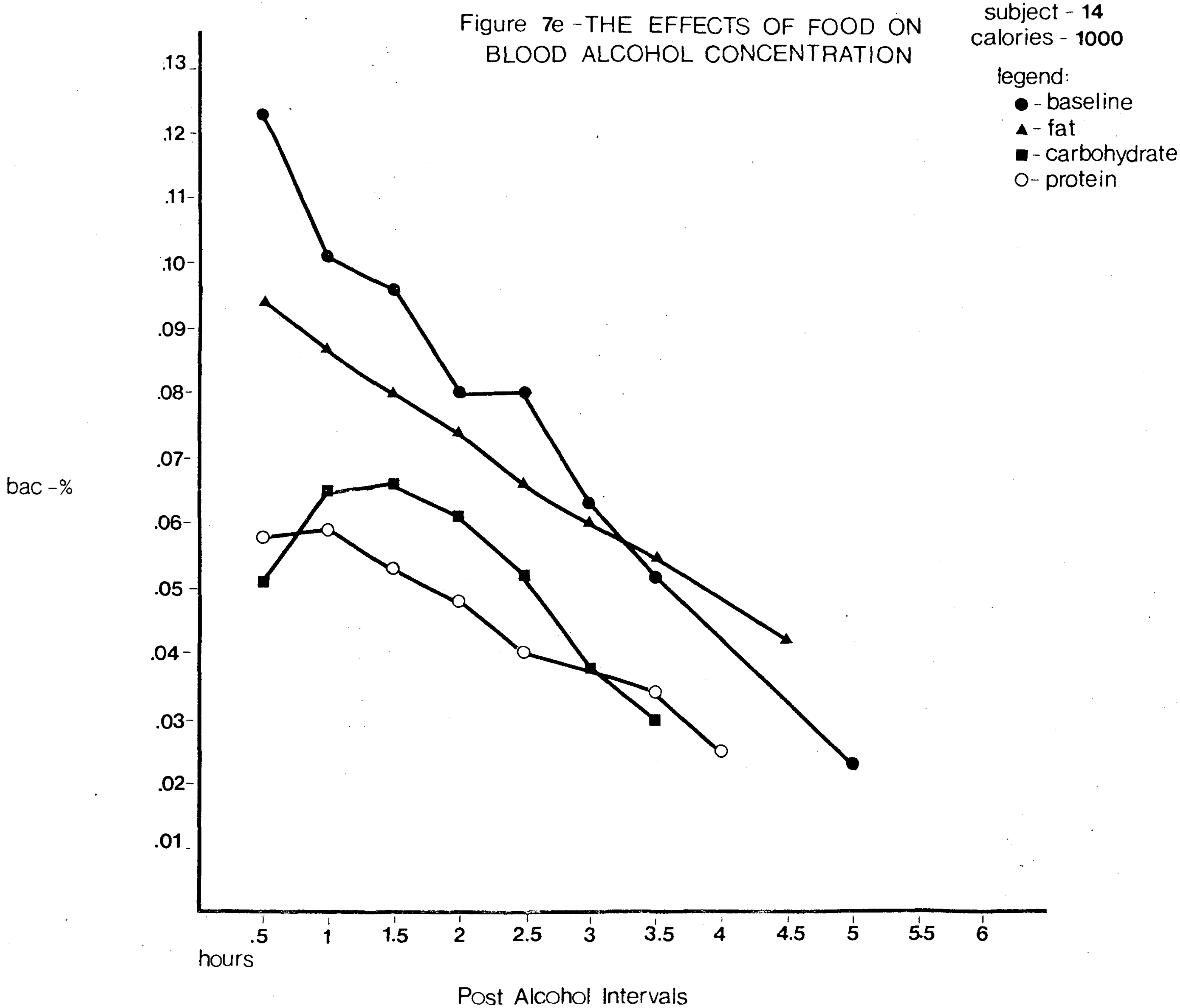


Figure 7e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION



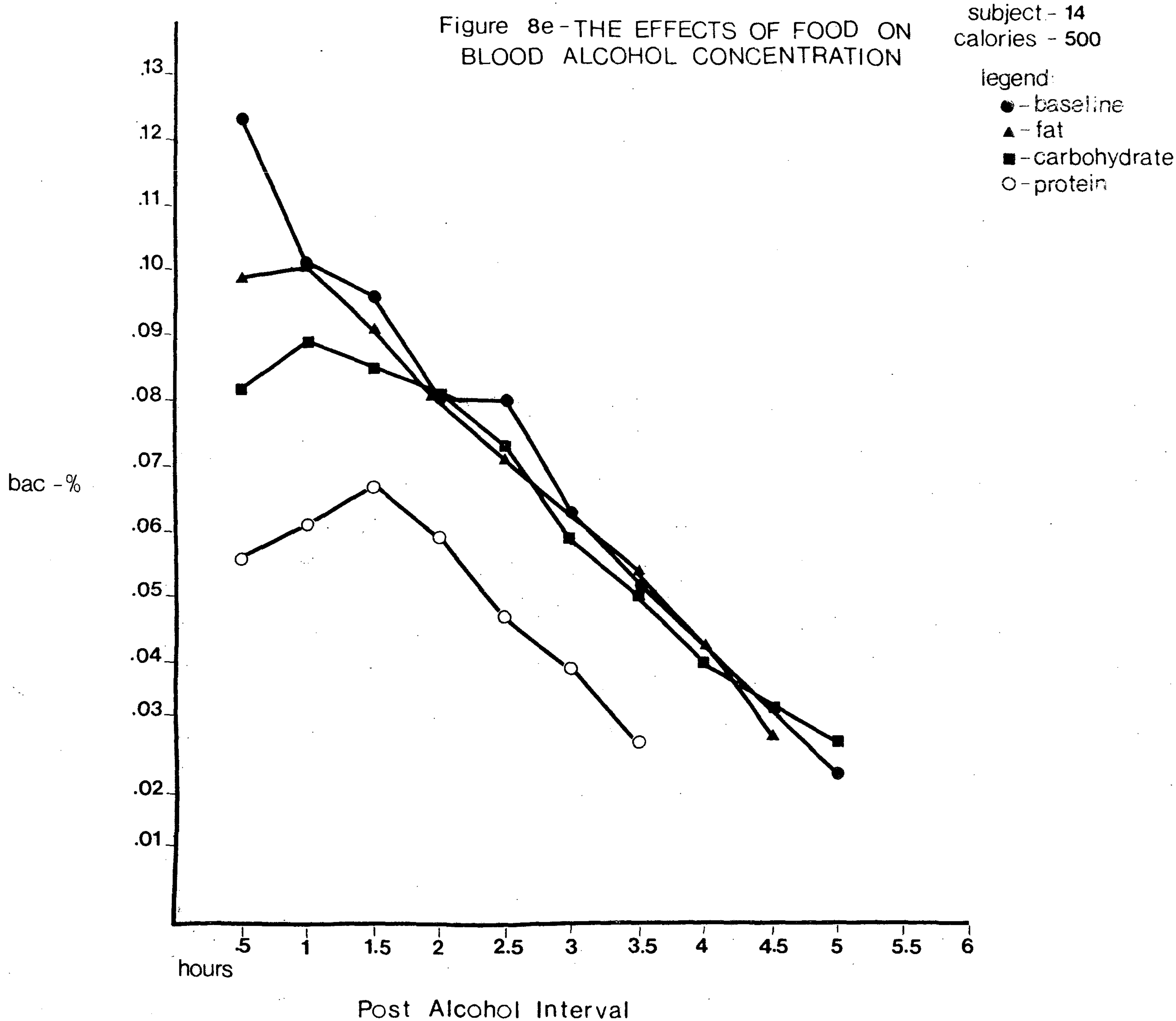


Figure 8e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION
subject - 14
calories - 500
legend
● - baseline
▲ - fat
■ - carbohydrate
○ - protein
bac - %
.13
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
hours
Post Alcohol Interval

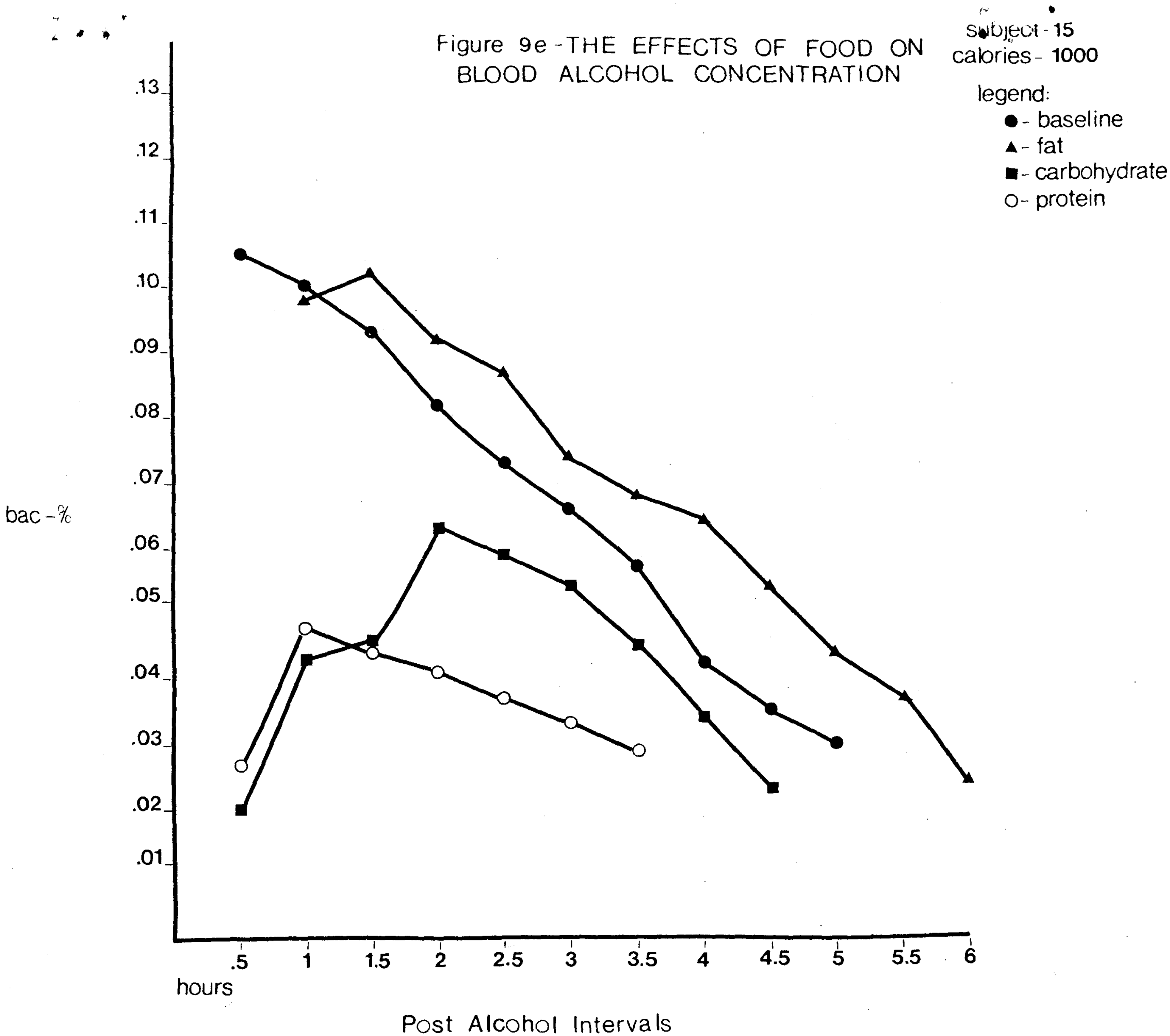


Figure 9e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

Figure 10e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 15
calories - 500

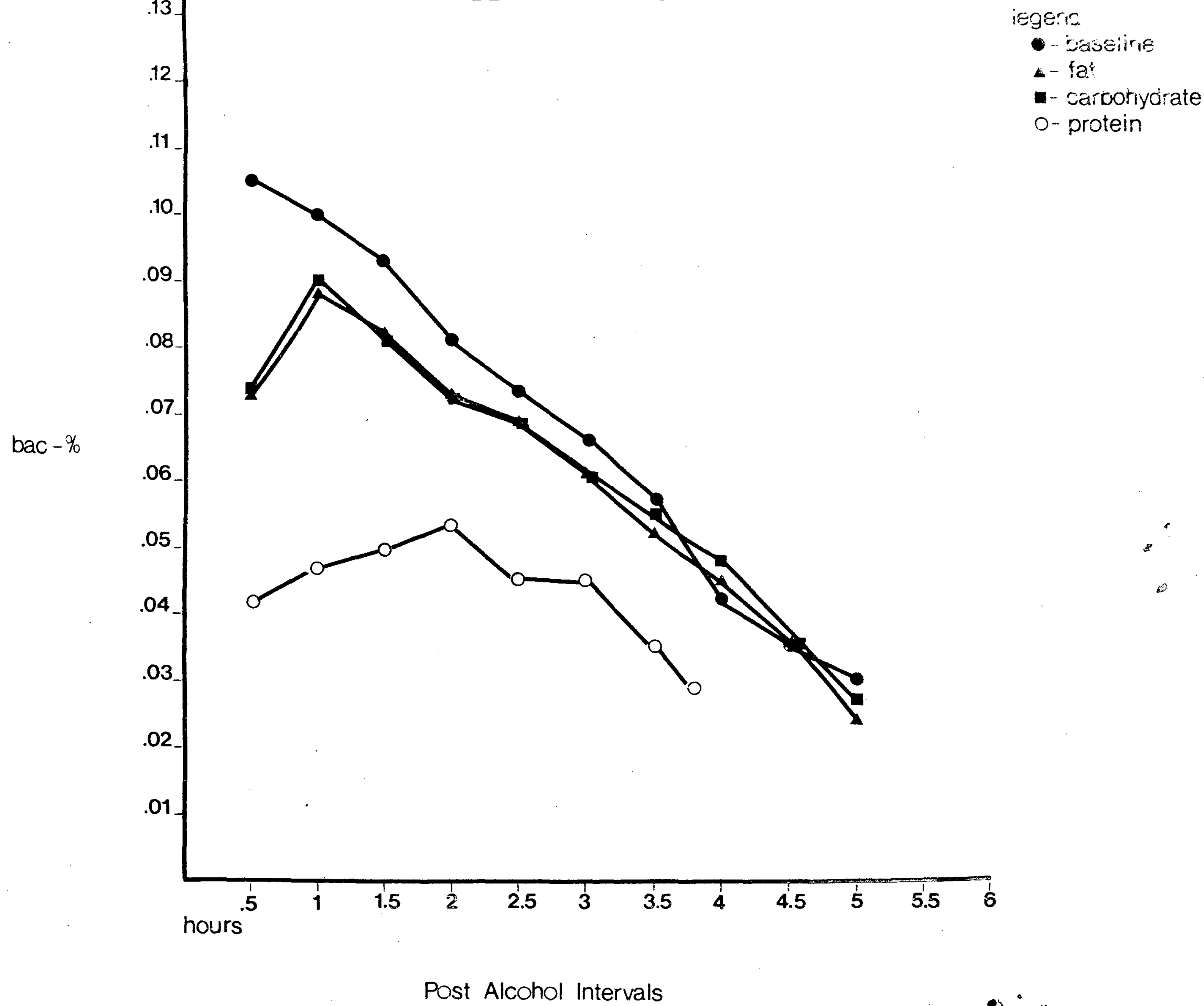


Figure 11e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 16
calories - 500

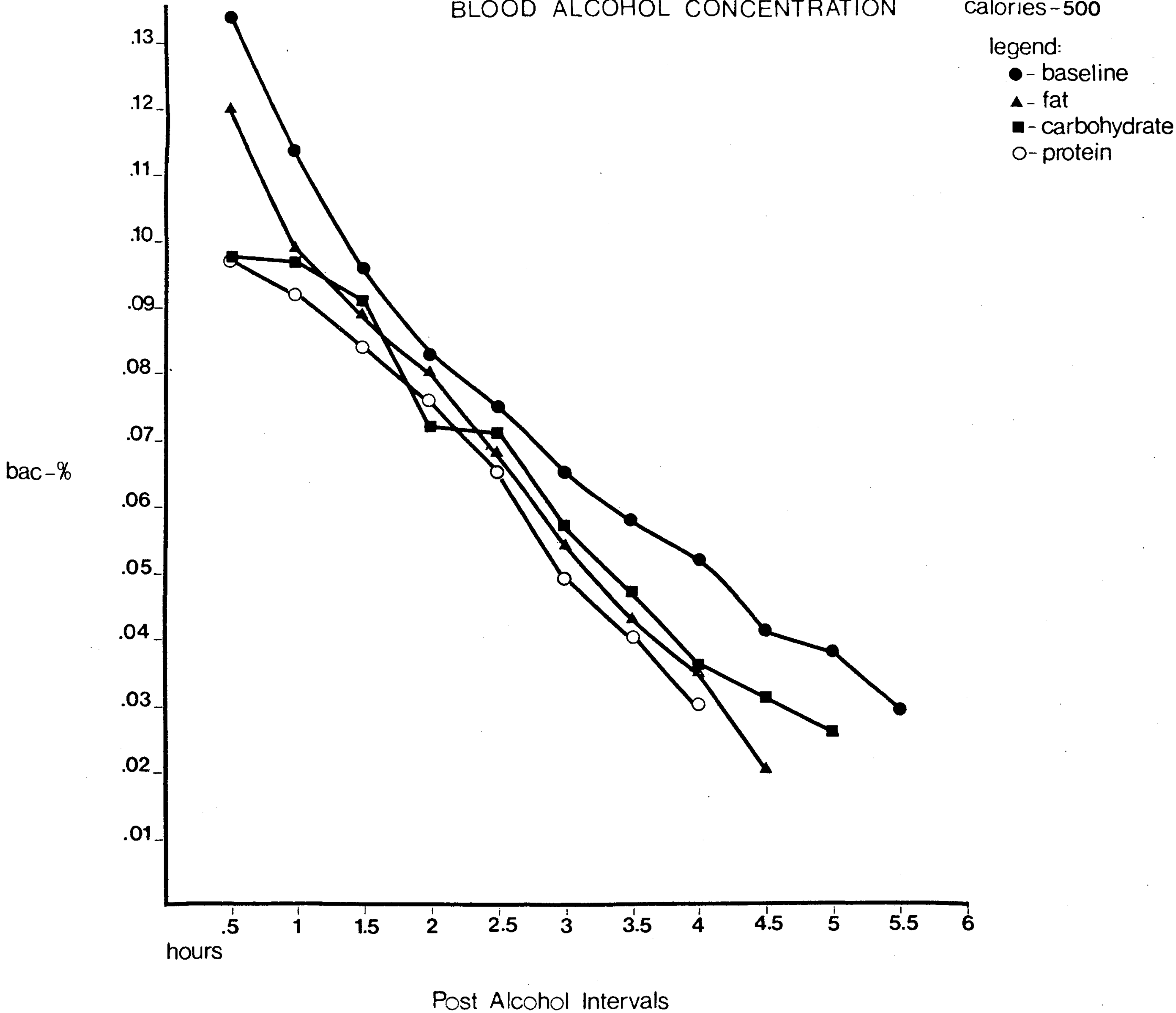


Figure 12e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 17
calories - 500

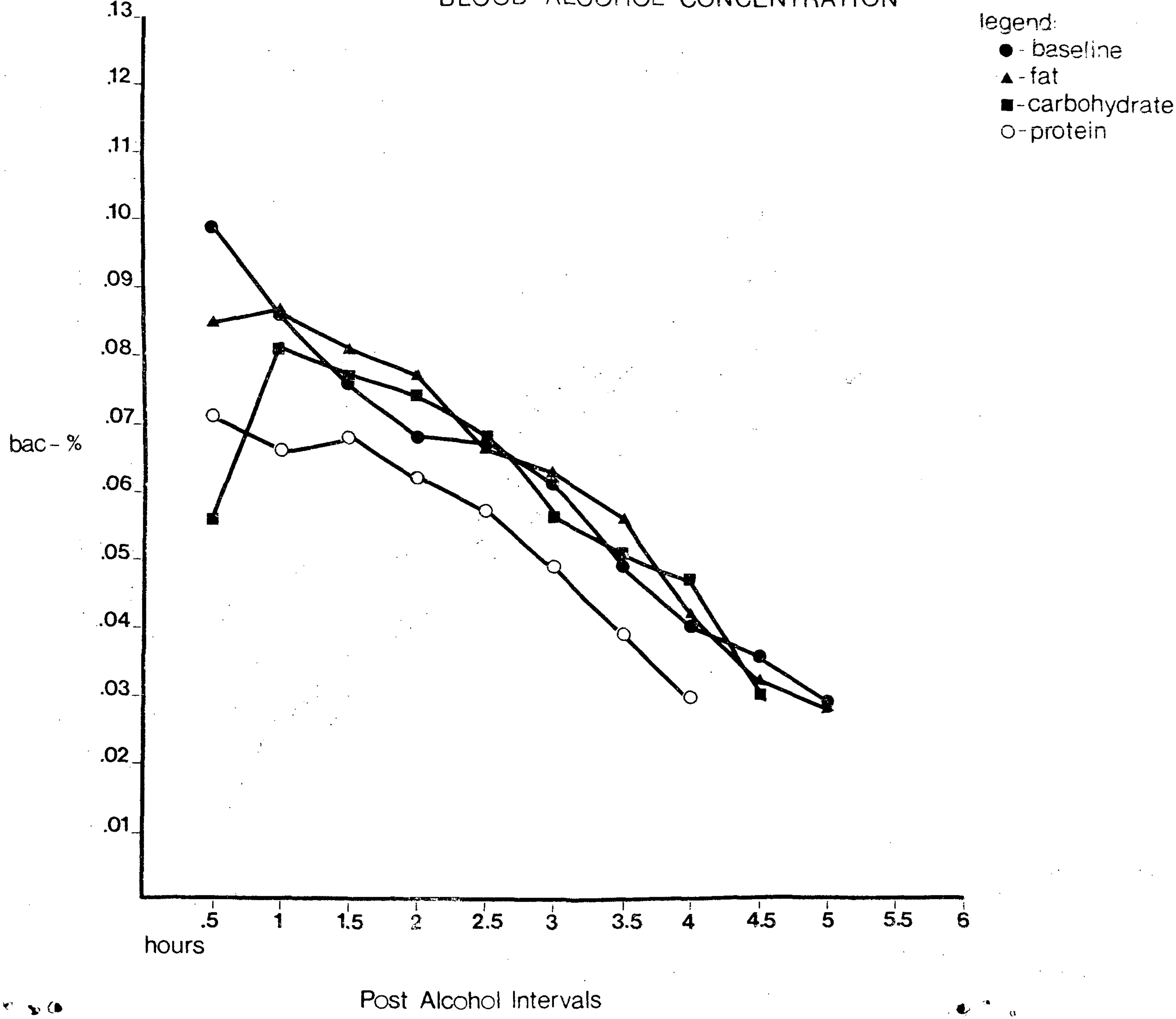


Figure 13e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

subject - 17
calories - 1000

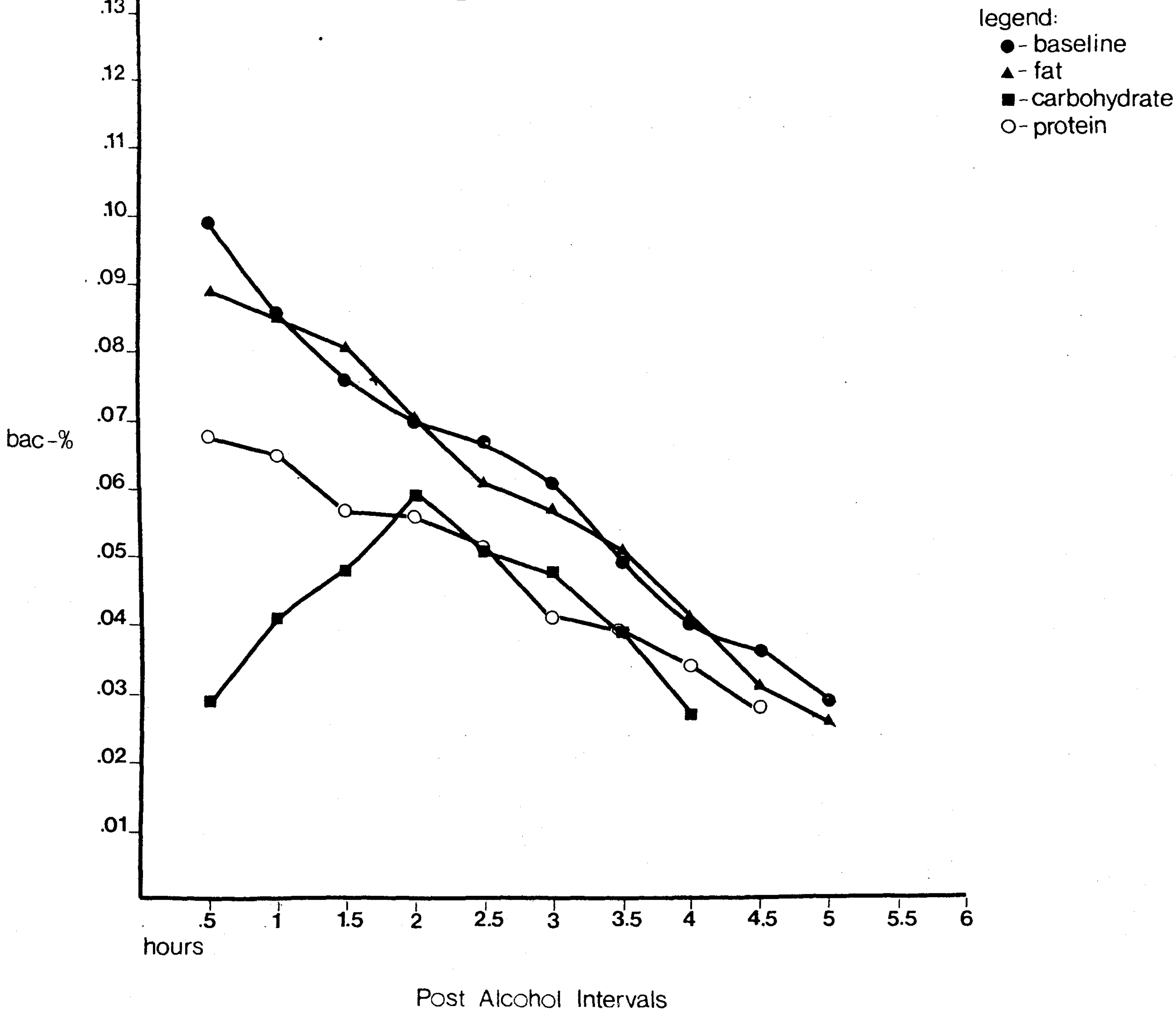


Figure 14e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

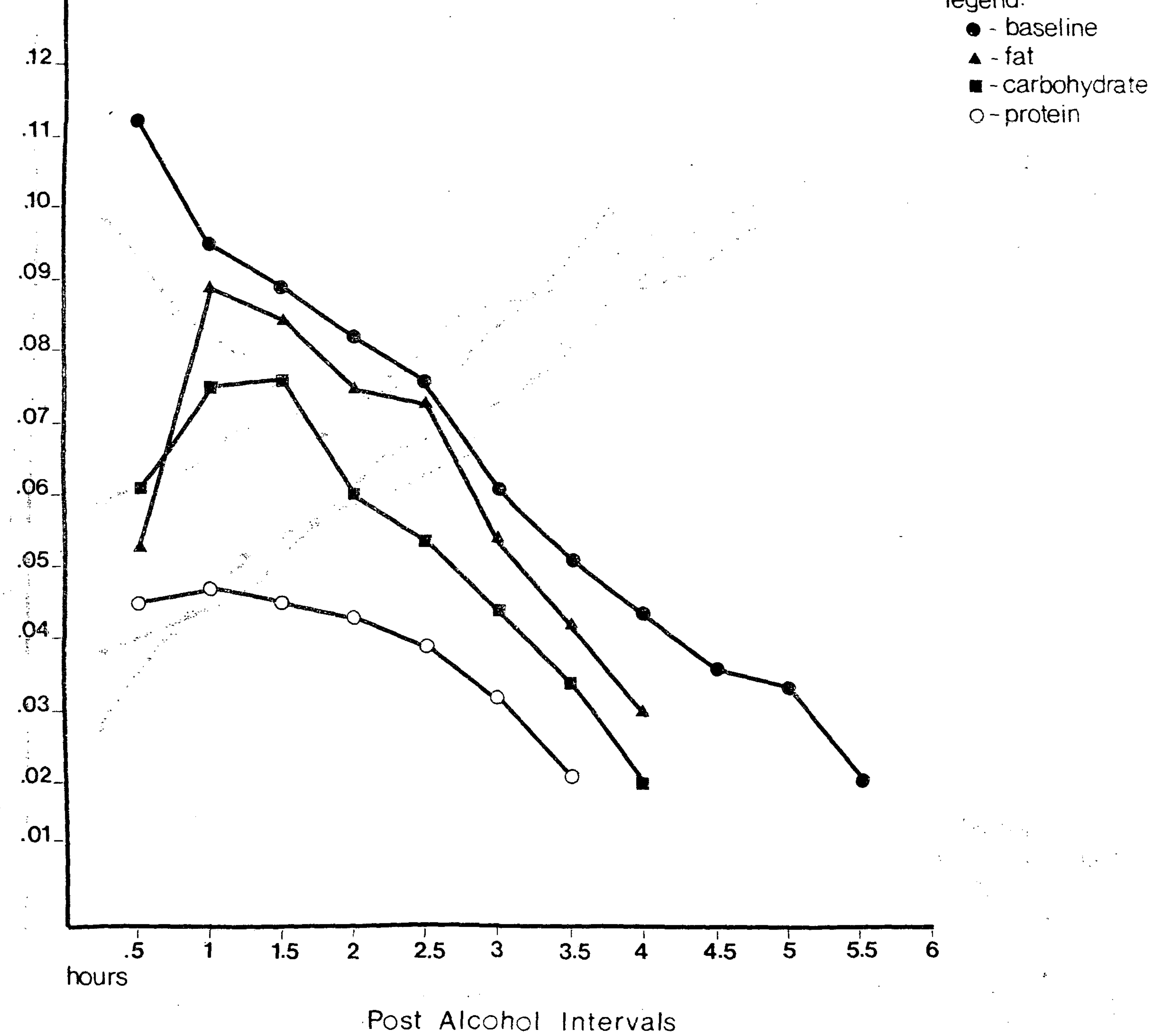


Figure 15e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION

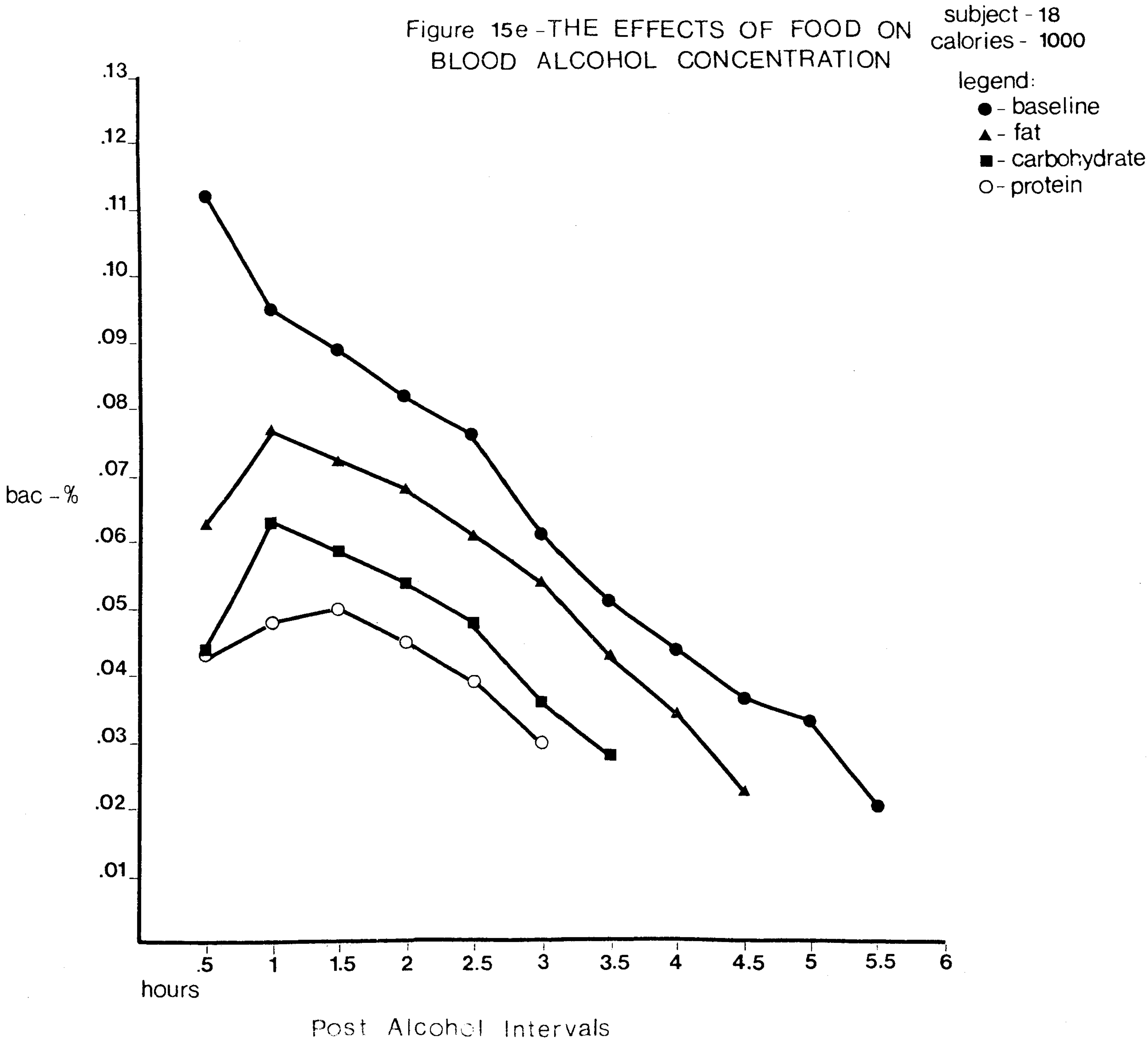


Figure 16e - THE EFFECTS OF FOOD ON BLOOD ALCOHOL CONCENTRATION