# THE RELATIONSHIP OF NUTRITIONAL PRACTICES AND RELATED DEMOGRAPHIC VARIABLES TO THE PRESENCE OF HYPERLIPOPROTEINEMIA

by

ELAINE MARION SCOTT

Dip. H.Sc., University of Otago, New Zealand, 1964
Registered Dietitian, New Zealand, 1965
B.H.E., University of British Columbia, Vancouver, 1974

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Department of HOME ECONOMICS

The University of British Columbia
2075 Wesbrook Place
Vancouver, Canada
V6T 1W5

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## ABSTRACT

At the present time, cardiovascular disease is a major public health problem in Canada, taking the lives of 78,000 Canadians each year. One of the important risk factors implicated in the pathophysiology of cardiovascular disease is hyperlipoproteinemia. Factors which have been implicated in the etiology of hyperlipoproteinemia include nutritional practices and related demographic variables such as excess body weight, lack of physical activity, smoking, alcohol consumption, abnormal carbohydrate metabolism and family history of heart disease.

Although all of the factors cited here have been investigated and their role in the development of hyperlipoproteinemia reported in the literature, the importance of the interrelationship among the individual factors has frequently been overlooked. Also the relationship of these factors to the presence of hyperlipoproteinemia in many cases is poorly understood.

A study was designed to investigate the relationship of nutritional practices and related demographic variables to the presence of hyperlipoproteinemia in males aged thirty to sixty years who were admitted to St. Paul's Hospital, Vancouver, British Columbia, for cardiac catheterization. The criterion variables measured in the study were the fasting serum triglyceride level and fasting serum cholesterol level.

The variates were categorized as nutritional practices, demographic factors and anthropometric measurements. Nutritional practices included sucrose as percent of total carbohydrate, starch as percent of carbohydrate, P:S ratio, total caloric intake, fat as percent of total calories and alcohol as percent of total calories. The nature of the relationship between the criterion variables and the variates, and amongst the variates themselves, were investigated.

Results are based on interviews conducted with 64 subjects between March 1 and October 16, 1975. Sixty-four percent of the subjects exhibited a serum triglyceride level beyond the range accepted as normal by St. Paul's Hospital laboratory while only 3% had abnormally high serum cholesterol levels. The Pearson product moment correlation coefficient revealed a significant correlation between the serum triglyceride and cholesterol concentrations at the 0.002 level of significance.

Analysis of t-distribution showed no significant correlation between the presence of hyperlipoproteinemia and the consumption of sucrose as percent of total carbohydrate, starch as percent of total carbohydrate, fat as percent of total calories, alcohol as percent of total calories or P:S ratio. Similarly, the Pearson product moment correlation coefficient failed to show a significant correlation between caloric intake and the presence of hyperlipoproteinemia at the 0.05 level of significance. However, both physical

activity and ponderal index were significant factors by t-test analysis, indicating the relationship of both overweight and inactivity to the presence of hyperlipoproteinemia. In addition, correlation analysis revealed a positive correlation between fasting blood glucose and the presence of hyperlipoproteinemia. No correlation was observed with age or smoking and the presence of hyperlipoproteinemia.

Implications relative to evaluation of the atherogenic status of an individual and possible reduction of the incidence of hyperlipoproteinemia became apparent from the interpretation of the findings of this study.

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# CHAPTER 1

# INTRODUCTION

## Background and Need

At the present time, cardiovascular disease is a major public health problem in Canada, taking the lives of 78,000 Canadians each year (British Columbia Heart Foundation). One of the important risk factors implicated in the pathophysiology of cardiovascular disease is hyperlipoproteinemia (Commentary, Pediatrics, 1974).

It has been suggested that the life-style in civilized countries contributes to the development of hyperlipoproteinemia.

> ...overeating, improper diet, empty calories, lack of exercise, obesity, diabetes, hypertension and smoking ...have all been implicated (Albrink, 1974).

Hyperlipoproteinemia may be primary or secondary where the primary type is either familial or sporadic and the secondary type is an expression of altered metabolism due to some other recognizable disease (Fredrickson, Levy and Lees, 1967).

Six different types of hyperlipoproteinemia have been defined by Fredrickson et al. (1973) of which type IV is the most common:

Type I - an inability to clear chylomicrons. This is a familial and rare disorder.

Type IIa - characterized by hyperbetalipoproteinemia (hypercholesterolemia). The pattern is a common one found at all ages.

Type IIb - a combination of type IIa and type IV. Both increased betalipoproteins and prebetalipoproteins are seen. Thus an elevation of serum triglycerides and cholesterol is exhibited.

Type III - a relatively uncommon pattern associated with the presence of an abnormal form of betalipoprotein.

Type IV - hyperprebetalipoproteinemia (hypertriglyceridemia). This suggests a malfunctioning of carbohydrate metabolism or caloric balance. The disease may be primary or secondary and is usually exacerbated by obesity. There is evidence that it may also be due to excessive alcoholic intake or some other conflict between the subject and the environment.

Type V - characterized by a mixed hyperlipidemia with both chylomicrons and prebetalipoproteins elevated.

This condition is often seen as a secondary disorder.

Fredrickson's classification of hyperlipoproteinemia (1967) was first based on electophorectic techniques. However, the expenditure of cost and the time associated with this method of classification led to the development of a simple office method (Herriman and Clarke, 1971). The serum levels of cholesterol and triglyceride together with the physical

characteristics of the refrigerated serum enable the physician to classify the type of hyperlipoproteinemia and follow the effects of therapy.

The diagnosis of hyperlipoproteinemia is of practical importance but the fundamental consideration is the underlying factors associated with the occurrence of the disorder. Knowledge of these would play an important role in decreasing the incidence of hyperlipoproteinemia.

Factors which have been implicated in the etiology of hyperlipoproteinemia include nutritional practices and related demographic variables such as body weight, physical activity, smoking and alcohol consumption (Albrink, 1974). Fredrickson, Levy and Lees (1967) in their general definition of type IV hyperlipoproteinemia suggested that abnormal carbohydrate metabolism, abnormal caloric balance, inordinate emotional stress, excessive alcoholic intake or genotype may be involved in the presence of the disorder.

Although all of the factors cited here have been investigated and their role in the development of hyperlipoproteinemia reported in the literature, the importance of the interrelationship among the individual factors in most cases has not been studied. Also the relationship of these factors to the presence of hyperlipoproteinemia in many cases is very poorly understood. An associational study to investigate this is of utmost importance to assist in the determination of the cause or causes of the disorder and hence reduce its incidence.

## Statement of the Problem

An associational study was conducted to investigate the relationship of nutritional practices and related demographic variables to the presence of hyperlipoproteinemia. The subjects investigated were men aged thirty to sixty years who were admitted to St. Paul's Hospital for cardiac catheterization under the care of Dr's. A. Dodek, J. Boone, D. Peretz and D. Kavanagh-Gray.

Personal interviews were conducted with each subject to obtain information related to nutritional practices, physical activity, smoking, alcohol consumption, current medications, age and family history of heart disease. The tricep skinfold thickness, height, weight and arm circumference measurements were obtained by the researcher during the one interview.. Serum triglyceride and cholesterol levels plus fasting blood glucose levels were requested of the hospital laboratory at the time of the interview, the fasting samples being obtained by the laboratory personnel the following morning. The computerized results were attached to the subjects medical records from whence they were secured by the interviewer.

The following objectives were established for investigating the problem:

1. To determine the relationship between the amount of sucrose in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.

2. To determine the relationship between the amount of fat in the diet, as percent of total calories, and the presence of hyperlipoproteinemia.
3. To determine the relationship between the P:S ratio in the diet and the presence of hyperlipoproteinemia.
4. To determine the relationship beyween the caloric content of the diet and the presence of hyperlipoproteinemia.
5. To determine the relationship between the amount of starch in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.
6. To determine the relationship between ponderal index and the presence of hyperlipoproteinemia.
7. To determine the relationship between the amount of alcohol consumed, as percent of total calories, and the presence of hyperlipoproteinemia.
8. To determine the relationship between physical activity and the presence of hyperlipoproteinemia.
9. To determine the relationship between smoking and the presence of hyperlipoproteinemia.
10. To determine the nature of the interrelationships between these factors and the presence of hyperlipoproteinemia.

This study was designed to meet these objectives, to develop appropriate data collection instruments for the associational study and to contribute to the present know-

ledge of the factors implicated in the presence of hyperlipoproteinemia.

## Hypotheses

The following research hypotheses were tested:

1. There will be a positive relationship between the amount of sucrose in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.
2. There will be a positive relationship between the amount of fat in the diet, as percent of total calories, and the presence of hyperlipoproteinemia.
3. There will be a negative relationship between the P:S ratio in the diet and the presence of hyperlipoproteinemia.
4. There will be a positive relationship beween the caloric content of the diet and the presence of hyperlipoproteinemia.
5. There will be a negative relationship between the amount of starch in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.
6. There will be a negative relationship between ponderal index and the presence of hyperlipoproteinemia.
7. There will be a positive relationship between the amount of alcohol consumed, as percent of total calories, and the presence of hyperlipoproteinemia.
8. There will be a negative relationship between physical activity and the presence of hyperlipoproteinemia.

9. There will be a positive relationship between smoking and the presence of hyperlipoproteinemia.

## Definition of Terms

The following terms were defined for the purpose of this study:

Associational study - A study in which the variate is manipulable but not manipulated (Baker and Schutz,1972).

P:S ratio - Polyunsaturated to saturated fatty acid ratio.

Percent sucrose - Sucrose as percent total carbohydrate in the diet.

Percent starch - Starch as percent total carbohydrate in the diet.

Percent fat - Fat as percent total calories in the diet.

Percent alcohol - Alcohol as percent total calories in the diet.

## Assumptions

The following assumptions have been made for the purpose of the study:

1. The dietary record obtained from the subject was representative of his normal dietary intake.
2. This was the subject's first admission for cardiac catheterization.

3. The physical surroundings of the hospital ward did not bias the interview.
4. The subject had no prior prescription for the treatment of hyperlipoproteinemia.
5. An accurate family history of heart disease was available from the subject.
6. Normal physical activity was factually reported by the subject.

## Organization of the Study

The following chapter comprises a review of literature pertaining to the factors associated with hyperlipoproteinemia i.e. the criterion variables (fasting serum triglyceride level and fasting serum cholesterol level), the variates (nutritional practices, demographic factors and anthropometry) and their relationship to hyperlipoproteinemia. The design of the study including the population and sample, data collection and data analysis is outlined in Chapter III. Chapter IV contains the results of the study while Chapter V consists of a discussion of these results and their implications.

Appendices contain materials used in the survey and referred to throughout this report.

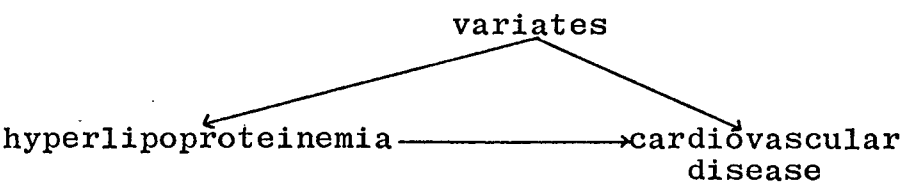
# CHAPTER II

## REVIEW OF THE LITERATURE

Diagnosis and treatment of hyperlipoproteinemia are essential but an understanding of the factors associated with the condition and thus reduction of the incidence of hyperlipoproteinemia would play a significant role in combatting cardiovascular disease, one of the major public health problems existing in Canada today.

Hyperlipoproteinemia has been identified as one of the main risk factors of cardiovascular disease (Pediatrics, 1974). The variates observed in this study (nutritional practices, demographic factors and anthropometry) together with hyperlipoproteinemia and cardiovascular disease may be considered as a triangle.

e.g.




It is of interest to determine whether the variates are directly associated with cardiovascular disease, independent of hyperlipoproteinemia, or whether there exists a relationship between the variates and hyperlipoproteinemia. If a relationship between the variates and hyperlipoproteinemia does exist, the variates then exert their effect on cardiovascular disease through the presence of hyperlipoproteinemia.

This would present an excellent point at which intervention could be introduced.

The Framingham Study, a United States National Heart Institute epidemiological investigation of cardiovascular disease, is perhaps the most thoroughly conducted and extensively quoted study relating to heart disease. In addition many other studies have been published and many theories suggested which are important to consider when investigating the factors linked with the presence of hyperlipoproteinemia.

This chapter will begin with a review of the literature concerning the classification of hyperlipoproteinemia and the importance of the criterion variables (fasting serum triglyceride level and fasting serum cholesterol level) in establishing the existence of hyperlipoproteinemia. Published research findings and theories pertaining to the variates (nutritional practices, demographic factors and anthropometry) as related to cardiovascular disease will then be reviewed. The chapter will conclude with a review of the literature concerning methodology used for the assessment of nutritional practices and anthropometry.

## Classification of Hyperlipoproteinemia

Several methods have been suggested for the classification of hyperlipoproteinemia. One of the first methods of hyperlipoproteinemia classification was that proposed by

Fredrickson, Levy and Lees (1967), which was based on electrophoresis. Although it was less quantitative than ultracentrifugation it was more convenient and economical.

This classification defined six different types of hyperlipoproteinemia:

Type I - an inability to clear chylomicrons.

Type IIa - characterized by hyperbetalipoproteinemia (hypercholesterolemia).

Type IIb - shows both increased betalipoproteins and prebetalipoproteins. (This type was added to the classification in 1973).

Type III - associated with the presence of an abnormal form of betalipoprotein.

Type IV - features hyperprebetalipoproteinemia (hypertriglyceridemia).

Type V - depicts a mixed hyperlipidemia with both chylomicrons and prebetalipoproteins elevated.

The researchers felt that of all the methods for obtaining lipoprotein patterns available at that time only ultracentifugation and electrophoresis had the necessary range to classify the different types of hyperlipoproteinemia.

Ter Welle and Willebrands (1971) adopted a screening procedure based on the estimation of total lipids, total cholesterol, and total triglycerides plus the lipoprotein electrophoresis pattern on cellulose acetate. Using as their principal criterion the total cholesterol/total triglyceride

ratio they were able to group their patients into type II, III or IV hyperlipoproteinemia.

Zorrilla, Valencia and Serrano (1974) proposed a screening test for hyperlipoproteinemia which was intended to reduce the time involved in diagnosis. This test was based on a previously developed method using a simple microcapillary tube routine which was devised to reveal hyperlipoproteinemia and to indicate whether the triglyceride or cholesterol levels were increased. The authors compared this routine with the concentration of triglyceride and total cholesterol and found a significant correlation between the lipid concentrations and the height of the corresponding aggregates. They felt that the microcapillary tube method could be useful for screening purposes although 1.8% false-negative results were found to be present.

The use of the esterified fatty acid index in the classification and quantitation of hyperlipoproteinemias has also been suggested (Billimoria, 1971). After electrophoresis and staining with oil red 0, the bands as observed by reflectance scanning are cut and the colour eluted by solvents. The relative dye uptake is observed and this together with the total esterified fatty acid content is used to determine the esterified fatty acid index.

As this method of classification is based on quantitation it differs slightly from that of Fredrickson, Levy and Lees (1967). The authors felt that the use of the estified

fatty acid index for the classification of sera is particularly useful to follow the progress of each of the lipoprotein abnormalities after the appropriate treatment has been instituted.

The development of a simple office method of hyperlipoproteinemia classification by Fredrickson and associates has been outlined by Hermann and Clarke (1971). This method is based on the determination of the serum levels of both cholesterol and triglycerides together with the physical characteristics of the serum following overnight refrigeration at four degrees centigrade. It was thought that this method may be particularly useful for the physician.

Hermann and Clarke noted:

> With this chemical and physical data he may ... classify his patient with hyperlipoproteinemia fairly accurately without going to the expense of determining the electrophoretic pattern (p.82).

Levy, Bonnel and Ernst (1971) discussing the same method stated:

> It is important to measure both cholesterol and triglyceride concentration when evaluating hyperlipoproteinemia. Approximately 75% of subjects with type IV will be missed if only a cholesterol determination is performed. Similarly, about 75% of type II subjects will be missed if the cholesterol is omitted and only the triglyceride is measured. When both lipids are measured more than 95% of individuals with hyperlipoproteinemia are detected (p.412).

The coupling of these simple lipid determinations with a good medical history and physical examination was suggested by Levy (1973) to be sufficient to determine the

lipoprotein type present. However he did propose that in certain cases, particularly type III hyperlipoproteinemia, ultracentifugation may be necessary to confirm the diagnosis. Five rules which Levy felt important to follow are:

1. Remember the concentration of all lipids and lipoproteins increase with age.
2. Chylomicrons normally appear for two to ten hours after a meal therefore use a fasting specimen.
3. Lipoprotein concentrations are under dynamic metabolic control and easily affected by diet, illness, drugs, weight gain and weight loss. Serum lipids change dramatically immediately after a heart attack.
4. Samples should be obtained from patients in a steady state and on a regular diet.
5. When hyperlipoproteinemia is secondary to another disorder, treatment of that disorder will usually modify the hyperlipoproteinemia effectively.

The discontinuation of lipoprotein electrophoresis as a routine procedure was porposed by Iammarino (1975). The author's statement was based on the following observations:

1. There is significant overlap between the interpretation given to data generated by lipid analysis and the interpretation of lipoprotein electrophoresis.
2. Types I, III and V are rarely seen.

3. There are problems associated with the study of lipids in hospitalized patients.
4. Newer concepts of lipoprotein metabolism have changed our views on the interrelationships of Fredrickson types.

Therefore Iammarino suggests that plasma lipids may be evaluated from the plasma triglyceride and cholesterol levels with electrophoresis being reserved for those specimens with triglyceride concentrations greater than 350mg/dl.

From this brief review of the literature it would appear that a practical, rapid and inexpensive approach to the diagnosis and classification of hyperlipoproteinemia is a necessary requirement which at the moment seems to be met by determination of the fasting levels of serum triglycerides and cholesterol.

## Criterion Variables

### Fasting Serum Triglyceride and Cholesterol Levels

The importance of the fasting serum triglyceride and cholesterol levels in establishing the presence of hyperlipoproteinemia has been discussed in the previous section. Levy, Bonnell and Ernst (1971) suggest that "with the personal and family history, physical findings, cholesterol and triglyceride measurements, it is often possible to establish the type of hyperlipoproteinemia." Therefore it would appear that the fasting serum levels of triglycerides

and cholesterol are the two important criterion variables which should be employed when surveying the risk factors involved in the presence of hyperlipoproteinemia.

## Variates

### Nutritional Practices

#### Dietary carbohydrate

Several studies have been conducted to investigate the effect of specific types of dietary carbohydrate on the lipid levels of hyperlipoproteinemia patients.

Kaufmann and Kapitulnik (1972) in their observations among patients with carbohydrate-induced hyperlipoproteinemia found that the isocaloric substitution of sucrose for starch usually caused a further increase in serum triglyceride and total cholesterol levels. They also found that the feeding of fructose, but not of glucose, led to an increase of serum lipids in normal subjects similar to that following sucrose feeding. Comparable findings were observed by Nikkila and Kekki (1972).

The effect of oral administration of sucrose on the turnover rate of plasma free fatty acids and on the esterification rate of plasma free fatty acids to plasma triglycerides in normal subjects, patients with primary endogenous hypertriglyceridemia (type IV hyperlipoproteinemia), and patients with well-controlled diabetes was noted by

Bolzana et al. (1972). They suggested that the plasma-free fatty acids are the primary source of endogenous plasma-triglycerides but were interested to observe if the high concentration of plasma triglycerides in type IV hyperlipoproteinemic patients was due to increased synthesis of triglycerides or to insufficent removal of triglycerides from plasma.

The study revealed that the administration of sucrose caused a significant decrease in the concentration and turnover rate of free fatty acids in the plasma but a significant increase in the fraction of plasma-free fatty acids which was esterified to plasma-triglycerides per unit time in all three groups of subjects. During sucrose loading the total esterification rate of plasma-free fatty acids to plasma triglycerides was significantly higher in hyperlipoproteinemics than in the normals. This, the authors suggested, was a result of the weaker free fatty acid lowering effect of sucrose in these patients as compared with the normal subjects.

It was concluded from the study that the high plasma triglyceride concentration in the hyperlipoproteinemic patients was due to insufficient removal of triglycerides from plasma both in the fasting state and during acute sucrose loading rather than to increased synthesis.

Hulley et al. (1972) tested the effect of an iso-caloric diet on non-obese men with type IV hyperlipoproteinemia. The subjects were maintained on the Standard American Heart

Association diet for six months followed by a second six-month treatment of a low carbohydrate modification of the standard diet. The researchers concluded from the study that:

1. Low-carbohydrate diets lower serum triglyceride concentration by reducing the rate of prebetalipoprotein production.
2. Diets of extremely high carbohydrate content increase serum triglyceride concentration by increasing the rate of prebetalipoprotein production.
3. The slightly (2%) increased carbohydrate content of the American Heart Association diet does not change prebetalipoprotein levels.

That the decreased clearance of triglycerides from plasma may contribute to carbohydrate-induced hyperlipoproteinemia in normal humans is also suggested by Mancini et al. (1973). They studied normal subjects consuming a high carbohydrate diet (7 - 7.5 gms. carbohydrate/kg.body weight/day). A compositional change was observed in the very low density lipoproteins which is not easily explained by increased rates of triglyceride uptake alone i.e. a rise in triglyceride/protein ratio and triglyceride/cholesterol ratio which marked a trend away from the normal composition of very low density lipoproteins towards that of chylomicra. Also the intravenous fat tolerance test showed a decrease in the fractional rate of disappearance of injected triglycerides from plasma during carbohydrate induction.

Therefore the authors proposed that the elevation of plasma triglyceride levels during high carbohydrate intakes may be attributable both to decreased removal and increased secretion of triglycerides.

DenBesten et al. (1973) compared the effects of high carbohydrate feeding on serum lipids and the sterol balance when identical formulas were given entravenously and intra-gastricaly to the same subject in sequential fashion. The oral administration of the high carbohydrate nutrient mixture produced a hypertriglyceridemia which was not seen when the mucosa was by-passed using intravenous administration. Although the mechanism has yet to be clearly delineated the authors suggest that the intestinal mucosa may play an important role in carbohydrate-induced hyperlipoproteinemia.

Naismith, Stock and Yudkin (1974) studied 23 students. The subjects consumed an iso-caloric diet for 14 days in which 200 gms. of sucrose were replaced by a similar amount of starch. The triglyceride, cholesterol and phospholipid plasma concentration increased but returned to normal within 14 days on a normal diet. The diets were then increased by 1800 calories. In some subjects the sucrose was reduced to 32 gms./day while in others it was increased to 219 gms./day. The results showed that the increased calorie but low sucrose diet had no significant effect on the triglyceride level while the increased calorie but high-sucrose diet was associated with an increased plasma triglyceride concentration.

The researchers concluded from their results that the elevation in plasma lipids observed when high sucrose diets were consumed cannot be ascribed to an increase in energy intake but rather is due to the hyperlipemic property of the sucrose itself.

It is now generally recognised that a high carbohydrate intake tends to elevate the plasma triglyceride level, high sucrose and fructose intakes having a more hypertriglyceridemic effect than a high starch intake.

Most of the studies conducted to observe the effect of different types of carbohydrate on the serum lipid levels of normal and hyperlipidemic subjects have noted the effect due to carbohydrate loading rather than the effect of normal dietary practices. Also the effect of carbohydrate-feeding on the hyperlipidemic patient will depend on the type of hyperlipoproteinemia present i.e. hyperlipoproteinemia due to exogenous lipids or hyperlipoproteinemia due to increased levels of endogenous lipids. The role which the quality and/or quantity of carbohydrate plays in the development of hyperlipoproteinemia would be of considerable interest in decreasing the incidence of cardiovascular disease.

Dietary lipids

The P:S ratio present in the diet has also been cited as an important factor in the presence of hyperlipoproteinemia. Little et al. (1970) in their studies with hyperlipoproteinemic

patients found that sucrose was hyperlipidemic as compared with starch only in diets containing predominantly saturated fatty acids and large amounts of cholesterol. If the diets were high in polyunsaturated fatty acids with practically no cholesterol or had mixed saturated and unsaturated fats and small amounts of cholesterol, the sucrose had no definite hyperlipidemic effect. These results show the importance of studying dietary practices as a whole rather than observing the effect of individual nutrients.

The addition of polyunsaturated fatty acids to the diet augments the cholesterol-lowering effect (Albrink, 1974). Levy, Bonnell and Ernst (1971) recommended the use of polyunsaturated fats in the dietary management of all types of hyperlipoproteinemia, except type I, in preference to saturated fats. It has also been stated by Hulley et al. (1972) that:

> Diets which contain fat of high P/S ratio and relatively little cholesterol (e.g. the standard American Heart Ass. diet) lower serum-cholesterol concentration by decreasing betalipoprotein levels (p.554).

From their experiments on the effect of diet on serum cholesterol levels in humans, Anderson, Grande and Keys (1973) found that dietary fats influence serum cholesterol depending on the proportion of saturated and polyunsaturated fatty acids. They observed that saturated fatty acid glycerides have a cholesterol-raising effect which is approximately twice the cholesterol-lowering effect of polyunsaturated fatty acid glycerides.

The amount of fat in the diet as percent of total calories is a suggested factor in the presence of hyperlipoproteinemia due to the parallel increase in exogenous fat and the caloric intake. An excess of dietary fat is considered a possible risk factor for ischemic heart disease by the Advisory Panel of the British Committee on Medical Aspects of Food Policy (Nutrition) on Diet in relation to Cardiovascular and Cerebrovascular disease (1975). They state:

> The results of comparative studies of the population of various countries agree in general that the death rate from ischemic heart disease correlates positively with the average proportion of the food energy which is derived from fat, and the correlation is better with the proportion of food energy derived from saturated fatty acids than with the proportion derived from the total amount of fat in the food (p.25).

Sherwin (1974) suggested that the fundamental characteristic of an antiatherogenic diet is one in which the fat content is 30% of the total calories with the limitation of saturated fat and cholesterol. Also the restriction of simple sugars but addition of some polyunsaturated fat was advised. Similarly Kannel (1971) proposed that the total fat content of an acceptable diet should be below 30% of the calories, the P:S ratio 2:1 and the cholesterol intake under 250 mg. daily. It should be noted that together with these suggestions Kannel also made recommendations regarding total calories (sufficient to maintain lean body weight), simple sugars (limited intake) and table salt (less than four grams

per day) emphasizing again the importance of regarding the diet as a whole rather than concentrating on one particular component.

Total calories

A relationship between obesity and plasma lipids has been demonstrated by several researchers. Okefsky, Reaven and Farquakar (1974 a) observed marked decreases, after weight reduction, in fasting plasma triglyceride and cholesterol levels, with a direct relationship between the magnitude of the fall in the plasma lipid values and the height of the initial plasma triglyceride level.

Lisck et al. (1974) in their investigation of patients with hyperlipoproteinemia found that weight reduction could be correlated with a decrease in the plasma triglyceride and cholesterol levels in patients with type IIb and type III hyperlipoproteinemia. However they did find that no effect of weight reduction could be shown in some of the type IV hyperlipoproteinemic subjects and all of the type V subjects. These results did not agree with those of Olefsky, Reaven and Farquaker (1974 a) who observed a marked decrease in fasting plasma triglyceride and cholesterol levels with weight reduction in type IIb, type III and type IV hyperlipoproteinemic patients. Nonetheless it does appear that although obesity may not be the sole or even major cause of the abnormality in the first place, weight reduction is an important factor to consider in the treatment of the endogenous hyper-

triglyceridemia (type IIb, III and IV hyperlipoproteinemia).

The importance of observing the effect on the plasma lipid levels created by several factors in the diet is illustrated by Hall et al. (1972). They used a diet "low in saturated fat and cholesterol, moderate in polyunsaturated fat, moderate in total fat and carbohydrate and calorie-controlled to lower weight." Among the 114 men, 98 of whom were obese and 50 hyperlipoproteinemic, reductions in serum triglycerides of 17.3%, serum cholesterol of 12.1% and weight of 5.3% were seen.

Serum cholesterol, blood pressure, blood glucose and uric acid values have all been suggested as risk factors of cardiovascular disease. Ashley and Kannel (1974) studied the data from the Framingham Study to examine the effect of weight reduction on all of these factors. They observed that a change in relative weight had the greatest impact on cholesterol and in descending order, on systolic blood pressure, uric acid and blood glucose. The authors suggested that weight gain is accompanied by atherogenic alterations in blood lipids and regardless of whether the nutrient composition of the calories or the positive energy balance per se is responsible for this change, ordinary obesity encountered in the general population is associated with excess presence of hyperlipoproteinemia.

The influence of obesity on the relationship between insulin and triglyceride levels in endogenous hypertriglyceri-

demia was examined by Bagdade, Bierman and Porte (1971). It was proposed that tissue insulin resistance in obese subjects may play an important role in unmasking underlying abnormalities in triglyceride transport through the secondary alterations produced in insulin secretion. The authors concluded that high insulin levels in subjects who demonstrate many of the characteristics of endogenous hyperlipoproteinemia appear to be due to obesity, when it coexists. This in turn may contribute to but not necessarily cause the disturbance to triglyceride homeostases.

It is difficult to assess if the effect of obesity per se or the effect of obesity on other risk factors such as hypertension, impaired glucose tolerance and hyperlipemia increases the occurrence of cardiovascular disease. Regardless, the maintenance of ideal body weight would appear a prudent recommendation to decrease the incidence of hyperlipoproteinemia.

Alcohol intake

Although little research appears to have been conducted to investigate the relationship of alcohol intake to levels of plasma triglyceride and cholesterol, it has been suggested that a high intake of alcohol is associated with hyperlipoproteinemia. Albrink (1974) indicated that:

> ...alcohol may raise triglyceride levels and should be omitted or curtailed in patients with hypertriglyceridemia (p.91).

It has also been proposed by Fredrickson et al. (1967) that hyperlipoproteinemia may be acquired from a pattern of excess alcohol intake. Little et al.(1970) stated that hyperlipidemic effect of alcohol may depend on the proportions of dietary saturated and polyunsaturated fat.

The precursors of plasma triglyceride fatty acids in humans were studied by Barter, Nestel and Carroll (1971). They concluded from their observations that the stored hepatic fatty acids appeared to be a source of plasma triglycerides in subjects with alcoholic fatty liver whereas in healthy subjects the plasma triglycerides newly formed in the post-absorptive state are derived predominantly from plasma free fatty acids.

Gibson and Grahame (1974) investigated the question of whether the hyperlipoproteinemia seen in subjects suffering from gout is related to their gout per se or whether it can be explained on the basis of the obesity or drinking habits that many of them display. Fasting triglyceride and cholesterol values in forty subjects demonstrating gout were compared with those observed in an equal number of abstemious controls matched for age, sex and ponderal index. The authors observed that the subjects with gout who were heavy drinkers had significantly higher triglyceride levels than the non-drinking subjects with and without gout. However the increase in serum triglyceride values associated with obesity was similar in both groups.

Balart et al. (1974) found no significant correlation between serum cholesterol and the daily intake of alcohol, cholesterol or carbohydrate when they investigated 104 medical students. No mention was made of the correlation between the above factors and the serum triglyceride levels observed in the study.

Several risk factors associated with ischemic heart disease were observed in an apparently healthy London population by Lewis et al. (1974). They noted a positive correlation between very low density lipoprotein-triglyceride concentration and alcohol intake. This correlation remained significant when the weight-height index was held constant thus allowing for any relationship between obesity and alcohol consumption.

## Demographic Factors

### Smoking

From the data obtained in the Framingham study, Kannel et al. (1964) noted that if a subject has a history of excessive cigarette smoking the risk of various manifestations of coronary heart disease is compounded.

In 1971 Kannel stated that:

> Discouraging the use of cigarettes must be a prominent feature of any comprehensive programme of life-style control designed to prevent atherosclerotic disease... It makes a unique contribution to coronary disease independent of other risk factors (p.6).

Sherwin (1974) noted that one of the risk factors in individuals who subsequently develop coronary heart disease is smoking. The risk increases with the number of cigarettes smoked each day and increases exponentially when two or more packs are smoked every day. He also observed, from data obtained in United States surveys, that a low risk of coronary heart disease existed among ex-smokers thereby emphasizing the fact that "it is never too late to quit."

The report of the Advisory Panel of the British Committee on Medical Aspects of Food Policy (Nutrition) on Diet in relation to Cardiovascular and Cerebrovascular disease (1975) includes the statement that:

> The assertion ... cannot be made that excessive smoking is an essential cause of coronary disease: nevertheless it is a risk factor in the sense that among smokers the probability of developing the disease is greater than it is among non-smokers (p.18).

It has been noted (Little 1974) that those who suffer a heart attack tend to have one or more so-called risk factors which include:

1. Elevation of plasma lipids as measured by cholesterol and triglycerides and often referred to as hyperlipoproteinemia.
2. High blood pressure.
3. Cigarette smoking.
4. Diabetes.
5. Obesity.

The actual way in which smoking is related to cardiovascular disease is of interest when investigating the variates associated with the presence of hyperlipoproteinemia. Does smoking lead to hyperlipoproteinemia and hence cardiovascular disease?

Astrup and Kjeldsen (1973) investigated the pathophysiologic mechanisms involved in the development of atherosclerosis in smokers. They exposed cholesterol-fed rabbits to carbon monoxide (170 p.p.m. for 7 weeks followed by 340 p.p.m. for 2 weeks). The cholestrol content of the aorta of the cholesterol-fed rabbits was 2.5 times higher than in the control rabbits who had also been fed cholesterol but had not been exposed to carbon monoxide.

The authors also reported that many investigators have found approximately 10-15 mg./100 mls. higher cholesterol levels in smokers in comparison with non-smokers.

Therefore it would appear that the mode of action of smoking as related to the presence of cardiovascular disease is as yet unknown. One of the objectives of this study is to determine the relationship of smoking (a variate) to the criterion variables (serum cholesterol and triglyceride levels).

Physical exercise

Kannel (1971), reporting on the Framingham study, stated:

> ... assessment of the risk of disease, using various indices of habitual energy expenditure, has indicated that sedentary men are more susceptible to coronary attacks than are physically active men. The least active men had about three times the risk of those most active physically (p.6).

The effects of a six-month programme of endurance exercise on the serum lipids of middle-aged men was studied by Holloszy et al. (1964). They attempted to determine whether or not regular exercise protects against the development of coronary heart disease through the alteration of lipid metabolism. Serum cholesterol, phospholipid and triglyceride levels were observed during the six-month period. From the results of the study the authors concluded that regular exercise will significantly lower serum triglyceride levels but will have no effect on the serum cholesterol or phospholipid levels.

Mann et al. (1955) had earlier proposed that a positive caloric balance over a long period elevates the serum lipid levels and contributes to atherogenesis. The effect of increased caloric intake both with and without increased energy expenditure was observed in four young male subjects. So long as the excess energy was dissipated as exercise no increase was observed in the level of serum lipids.

Blood lipid and glucose levels during a ten-day period of zero caloric intake and increased exercise were observed in twelve men by Carlson and Froberg (1967). They suggested that although, independently, exercise or fasting do not

appear to decrease the plasma cholesterol concentration, when weight loss occurs in conjunction with physical training a reduction in the plasma cholesterol level may occur. Plasma triglyceride and phospholipid levels dropped markedly during the study while the mean blood glucose level decreased during the first 6 days and then increased $12 \pm 5$ mg./100 ml. above the initial value - an effect which is normally seen during fasting.

It has been suggested that physical exercise may increase the clearing of visible lipemia following a fatty meal (Cohen and Goldberg, 1960). In their studies with twenty-two young men and women the researchers observed that in a significant number of cases the plasma turbidity was less after exercise than after resting.

The underlying mechanism causing the effect of exercise on lipid and carbohydrate metabolism is one which generates a great deal of discussion. Several systems have been proposed including those based on nutritional, hormonal or nervous factors. Issekutz, Miller and Rodahl (1966) conducted radioisotopic studies with dogs in order to attempt to shed more light on this subject. Since both plasma glucose and plasma free fatty acids can serve as fuel, the authors attempted to determine what factors regulated the substrate supply during exercise. In a fit dog during strenuous exercise the free fatty acid turnover increased but in the unfit dog a decrease in the free fatty acid turnover was observed.

The unanswered question is whether the rapid formation of lactic acid or the inadequate oxygen supply causing this rapid formation reduces the free fatty acid turnover. Nonetheless, whatever the reason or reasons for the metabolic changes, physical exercise has been offered as an important factor to consider when evaluating the variates associated with hyperlipoproteinemia (Kannel, 1971 and Albrink, 1974).

Kannel, Sorlie and McNamara (1971) reported from the findings of the Framingham study that the sedentary individuals in each age group had a coronary incidence almost twice that of those who were at least moderately active. However the physical activity assessment data of the study revealed that physical activity contributes to coronary risk independent of other factors such as relative weight, blood pressure and cholesterol. The authors concluded that:

> It is time ... to consider engineering physical activity back into daily living to counteract the sloth and gluttony promoted by modern technology (p.260).

The hypothesis that "men in physically active jobs have a lower incidence of coronary heart disease in middle age than men in physically inactive jobs" was proposed by Morris and Crawford (1958). They reported the results of a study investigating the frequency of ischemic myocardial fibrosis in a sample of 3,800 middle-aged men dying from causes other than coronary heart disease. Data obtained during the study supported the view that physical activity of work is a pro-

tection against coronary heart disease. It would appear than men in physically active jobs have less coronary heart disease during middle-age, what disease they have is less severe, and they develop it later than men in physically inactive jobs.

Schaefer (1974) compared the serum cholesterol concentration and tricep skinfold thickness of Eskimos in hunting camps with those of their counterparts living in settlements. He found that the hunting Eskimo aged eighteen to thirty-nine years who was very active had a significantly lower cholesterol concentration and skinfold measurement than his counterpart in the settlement. However the older hunter who became sedentary exhibited similar results to his settlement counterpart.

The World Health Organisation report on exercise tests in relation to cardiovascular function (1968) states that:

> One factor that may cause increased incidence and prevalence of coronary heart disease in man is a change in his habitual physical activity, which may be defined as the physical workload to which a person is usually subjected during his work and leisure. Both the total load and the pattern of such activity are of interest to the investigator. (p.24).

From this brief review on physical activity it can be seen that energy expenditure plays an important role in the prevention of cardiovascular disease. The interrelationship of various components can also be noted since physical activity can counter overweight and benefit serum lipids,

blood pressure and carbohydrate tolerance. Hence the relationship of physical activity to the presence of hyperlipoproteinemia is of interest when investigating the factors associated with the presence of hyperlipoproteinemia.

Family history of heart disease

Hyperlipoproteinemia may be familial and therefore an investigation of the family history has been suggested when researching the presence of this condition. Glueck et al. (1974) studied children from families where one parent had a myocardial infarct (M.I.) before the age of 50. They documented familial hyperlipoproteinemia in 85% of the M.I. kindreds, with the predominant phenotypes being type IIa, and type IV hyperlipoproteinemia. Goldstein et al. (1973) suggested that a genetic analysis of families with elevations in plasma lipids would contribute to an understanding of the inheritance of coronary atherosclerosis and ultimately provide clues for determining the underlying biochemical lesions.

Fredrickson et al. (1973) stated that "type I hyperlipoproteinemia is nearly always familial" while "type IIb may be familial and if so is a common inheritable disorder thought to be transmitted as an autosomal dominant trait thus affecting both sexes equally." The authors also suggested that "type III is usually familial and apparently transmitted

as a recessive trait" whereas "type IV may be familial and it is likely that several different mutations are responsible." Type IIb, being a combination of type IIa and type IV, may also be familial as is the case with type V.

Brown and Goldstein (1975) discussed the reasons for the existence of familial hypercholesterolemia. They proposed that the familial entity of hypercholesterolemia is due to a lack of H.M.G. coenzyme A reductase feedback control. This, they felt, was probably caused by a cell membrane receptor defect.

Thus, it would appear that hyperlipoproteinemia may be familial and consequently the inherited predisposition of the subject is an important risk factor to consider when investigating the reasons for the presence of hyperlipoproteinemia.

Drugs

Drugs have an important position in the treatment of hyperlipoproteinemia and therefore should be considered in any survey where plasma levels of triglycerides and cholesterol are recorded. Clofibrate is perhaps the most commonly used hypolipidemic agent. Berkowitz (1971) carried out a long term study (8 years) on 50 hyperlipidemic patients using a daily dosage of 2 grams of clofibrate. He observed a mean plasma cholesterol reduction of 30% and a mean plasma triglyceride reduction of 60% in his subjects. The mode of

action of clofibrate is not completely clear and several mechanicms have been suggested by Berkowitz including an inhibition of cholesterol synthesis in the liver and intestine and a decrease in the release of triglycerides into the plasma.

Nicotinic acid may also be used to decrease plasma triglyceride and cholesterol levels. Carlson and Oro (1973) from their work suggested that removal from blood of serum triglycerides in chylomicrons and in very low density lipoproteins may be improved with nicotinic acid. Other lipid lowering drugs which may be used include cholestyramine, dextrothyroxin sodium, neomycin and aminosalicylic acid all of which increase the rate of very low density lipoprotein removal and are thus most effective in disturbances of low density lipoprotein clearance (Levy, 1973).

Therefore when conducting any survey where serum levels of triglyceride and cholesterol are noted, the subject's medication should be investigated. Elimination from the study of those subjects on lipid-lowering drugs would then be necessary.

Age

In a study using 276 men and women aged 20-69 years living in London, Lewis et al. (1974) found that the serum cholesterol and triglyceride concentrations increased with

age, reaching the highest concentration in the 50-59 year age-group and decreasing in the 60-69 year group. The relationship of age to serum lipid levels is important as the concentration of all lipids and lipoproteins appear to be affected by age.

Levy (1973) in his review of the diagnosis and treatment of hyperlipoproteinemia stated:

> Remember that the concentration of all lipids and lipoproteins increases with age. A normal value for cholesterol and/or lipoprotein concentration in a 40 or 50-year old person might be quite alarming in a 10-year old child (p.649).

Both the incidence of type IV hyperlipoproteinemia and the plasma concentration of serum triglycerides increases with age (Fredrickson, Levy and Lees, 1967). Therefore, although ageing cannot be prevented it should be considered when studying the factors affecting the presence of hyperlipoproteinemia.

Sherwin (1974) suggested that:

> Men have a much greater risk than women in early middle age ... the risk with increasing age rises much more steeply in women than in men so that the rates converge in old age (p.82).

Glucose intolerance

It has been suggested that glucose intolerance may predispose to the development of ischemic heart disease (Report of the Advisory Panel of the British Committee on Medical Aspects of Food Policy (Nutrition) on Diet in relation to Cardiovascular and Cerebrovascular Disease, 1975).

Therefore the method by which glucose intolerance affects the presence of cardiovascular disease is of interest, particularly the relationship between glucose intolerance and hyperlipoproteinemia.

Fredrickson, Levy and Lees (1967) observed that in their experience the incidence of abnormal glucose tolerance in subjects with type IV hyperlipoproteinemia exceeded 90%. Glucose intolerance may be demonstrated by diabetes, a trace or more of sugar in the urine or a casual (non-fasting) whole blood glucose level of 120 mg./100 ml. or more (American Heart Association, 1973).

Olefsky, Reaven and Farquhar (1974b) studied the role of obesity in causing hyperglycemia, hyperlipemia, hyperinsulinemia and insulin resistance. The hypothesis they used as the basis of their research was that insulin resistance leads to hyperinsulinemia which leads to accelerated hepatic triglyceride production which in turn leads to elevated plasma triglyceride concentrations. Following weight reduction among their subjects, the researchers noted a significant decrease in the insulin and glucose responses to the oral glucose tolerance test. The effect of obesity on hyperglycemia, hyperlipemia, hyperinsulinemia and insulin resistance illustrates the complexity of the factors involved in the presence of hyperlipoproteinemia.

Carbohydrate, lipid and lipoprotein metabolism are closely related (Schonfield et al., 1974) and therefore it would seem

to follow that changes in one of these factors would automatically lead to changes in the metabolism of the other two components. Rodger, Squires and Du (1971) studied changes in plasma insulin related to the type of dietary carbohydrate in overweight hyperlipidemic male patients. They observed that when 75% of the dietary carbohydrate was derived from food containing polysaccharides, the mean plasma insulin response to oral glucose was decreased relative to that seen following complementary diets providing carbohydrate mainly as simple sugars. From their studies the authors concluded that the type of dietary carbohydrate may contribute to the abnormalities of insulin secretion known to exist in states of obesity and glucose intolerance.

Albrink (1974) suggested that "it is the endogenous triglycerides that have been implicated in atherosclerotic cardiovascular disease and that are associated with mild obesity, mild diabetes and hyperinsulinemia."

Therefore glucose intolerance as designated by diabetes mellitus, hyperglycemia or abnormal urine glucose levels should be regarded as a risk factor associated with the presence of hyperlipoproteinemia.

## Anthropometry

A discussion related to the relationship between obesity and plasma lipids has already been conducted under the heading of Nutritional Practices-Total calories. The use of the

height, weight, ponderal index, skinfold thickness and arm circumference measurements to determine anthropometric status will be discussed in the following section.

## Methodology for Assessment of Nutritional Practices and Anthropometric Status

### Anthropometric Status

The measurement of height and weight can be examined collectively as the ponderal index (Height (in.)/ cube root of weight (lbs.)). This is an assessment of weight in relation to height. The low index is an indicator of excess body weight whereas a high index is an indicator of leanness (Nutrition Canada, 1973). According to Jelliffe (1966) weight is a key anthropometric measurement which should be combined with information related to height, frame size, proportions of fat, muscle and bone and the presence of pathological weight (eg. edema).

The tricep skinfold thickness is an indicator of the development of subcutaneous fat (Frisancho, 1974). Standards for height and weight are not sufficient to determine the degree of leanness or obesity exhibited by an individual and therefore the amount of subcutaneous fat present as measured by the skinfold thickness may be used for a more direct indication (Tanner and Whitehouse, 1962). These researchers suggested that the skinfold thickness correlates highly with the fat-width as measured by x-ray.

Jelliffe (1966) suggested that the skinfold thickness is a good method of analysis of distribution and amount of human subcutaneous fat and hence caloric reserves. He advised that:

> The most appropriate "pinch" sites depend on the purpose of the study, the age of the population examined (fat distribution varies with age, even in childhood), sex, precision in locating the particular site, the relative homogeneity of the thickness of the layer of fat and skin in a given region, and the ease of otherwise of accessibility when problems of undressing and modesty exist (p.72).

Local standards should be used when evaluating the skinfold measurements as it has been suggested that sex differences, muscle hypertrophy, climatic conditions and the fat content of the diet may all contribute to a false measurement. Several sites may be chosen for the skinfold thickness measurement including the triceps, subscapular and supra iliac sites (Jelliffe, 1966).

Durnin and Rahaman (1967) studied 105 young adults and 86 adolescents. Measurements of height (standing and sitting), bi-acromial and bi-iliac diameters, girth of the upper arm, upper thigh and calf, skinfold thickness and body density were recorded. The researchers discovered a high correlation between the skinfold measurement and the body density.

The tricep skinfold thickness is not only useful as an index of caloric reserves but enables the underlying mid-upper arm muscle circumference to be calculated. Muscle mass may be assessed by direct physical anthropometry of a limb -

either the mid-calf or mid-upper arm. From the arm circumference and the tricep skinfold thickness measurement it is possible to calculate the inner circle - the mid-arm-muscle circumference (Jelliffe, 1966).

Thus the height, weight, ponderal index, amount of subcutaneous fat (skinfold thickness) and the amount of muscle mass (arm circumference) together indicate the anthropometric status of the individual.

## Nutritional Practices

Several methods have been used for the collection of food consumption data e.g. food balance sheets, food accounts, the weight method, questionnaires, chemical analysis and interviewing (diet history, seven-day food record and twenty-four hour recall). The purpose of the survey determines the accuracy of the consumption data needed which in turn affects the choice of method.

Food balance sheets are normally used in order to determine the consumption figures of the whole population whereas the food accounts method is often employed when studying the food consumption of people living in institutions.

The weighing method presents accurate data on food consumption. This method requires the weighing of all foodstuffs used for the preparation of the meal, the cooked food, amounts eaten at meals, the plate waste and the discarded food (Pekkarinen, 1970). However the time and organisation

required for this method limits the situations in which it can be used.

Chemical analysis provides precise data on the actual intakes of various nutrients but due to the expense involved may only be used for very small surveys. However chemical analysis may be used to control the reliability of results obtained by calculations (Pekkarinen, 1970).

The principle of the questionnaire method is very similar to that of the dietary history apart from the fact that no interviewer is required. Balogh et al. (1968) developed a dietary questionnaire for an ischemic heart disease survey. They tested the validity of this method against both the dietary history and a combined week's record and weighing of representative food items. The authors concluded from their results that the questionnaire is a practical tool for the assessment of dietary intake.

Interviewing is perhaps the most commonly practised method for the collection of food consumption data on an individual basis. Variations of this method include the dietary history, seven-day or three-day food record and the twenty-four hour food recall.

According to Young (1959) several points should be clarified before the interview is conducted. The first factor to be determined is the purpose of the interview. Is it to obtain quantitative information, qualitative

information or searching information on the dietary habits of the individual? Secondly, the interviewer should be carefully chosen as "competent dietary interviewing is a highly skilled process." The time element is extremely important including both the length of the interview and the time of day at which it is conducted. Charlotte Young (1959) feels that it is not possible to obtain meaningful information in less than thirty to fourty-five minutes. This impression is similar to that held by Burke (1947) who states that "the interview should consume approximately one hour."

Fourthly, the environment in which the interview is conducted contributes to the success of failure of the exercise as a private and calm atmosphere is desirable. Finally, the technique to be employed and that data collection instruments to be used should be chosen prior to the interview.

Burke (1947) emphasizes that the average dietary intake over a considerable period of time can only be obtained by the dietary history method. In order to improve the accuracy of the dietary history she suggests that a cross-check be made in order to verify and clarify the information given in the usual intake. As a further method of corroboration the three-day record may also be used.

Young et al. (1952) conducted a comparison of the dietary history versus twenty-four hour recall and the seven-day record versus twenty-four hour recall method of dietary study.

They found that the twenty-four hour recall and the seven-day record did not give the same estimates of intake of individuals as the dietary history and therefore concluded that these two methods could not be used interchangeably to describe the intake of individuals but could perhaps be interchanged when estimating group intakes.

The validity of the twenty-four hour recall method as a dietary tool was studied by Linusson, Sanjur and Erickson (1974). Eighty-six lactating women in Cornell Medical Centre were employed as subjects. From the results of the survey the authors concluded that:

> The recall method appears fairly accurate for qualitative estimation of average for a population group but not highly valid for ascertaining quantity of food consumed (p.277).

Pekkarinen (1970) suggested that twenty-four hour recall and diet history can be used to replace each other in group surveys if the sample is large and the daily and seasonal variations of the diet are small. Thus, it would appear from the literature that several methods may be used for the collection of food consumption data and that the application of more than one of these methods may increase the accuracy of the information.

## Summary

The brief review of literature included in this chapter illustrates the vast amount of knowledge still required to

determine the reasons for the high incidence of cardiovascular disease in our population. It can be seen from this resume that the picture is a complex one. No one factor is solely responsible and even geographical differences may affect national statistics of cardiovascular disease, illustrating the potential dangers of assuming that the results of investigations made in one country necessarily apply in another (Report of the Advisory Panel of the British Committee on Medical Aspects of Food Policy (Nutrition) on Diet in relation to Cardiovascular and Cerebrovascular Disease, 1975).

Many of the scientific papers reported here have discussed the effect of one particular factor rather than considering all of the predisposing components. Limited research has been reported on the nature of the interrelationships between these constituents and the presence of hyperlipoproteinemia. Similarly, the effect of various nutrients on the turnover of plasma triglycerides in normal and hyperlipemic subjects is, as yet, poorly understood.

Kannel (1971) stated:

> What we know now about the evolution of atherosclerosis indicates that any prophylactic effort should begin as early in life as possible. Once begun, it must remain a continuous lifetime endeavour (p.3).

A preventative approach is obviously the positive method of dealing with a major public health problem. However in order to practise this technique solid knowledge of the means of prevention must be within our reach. A vast amount of

scientific work has been undertaken in order to achieve this knowledge but, as yet, we do not have a full understanding of the cause or causes of hyperlipoproteinemia.

Several risk factors have been suggested in the preceding review. Apart from age, sex and genetic coding all of these factors are closely associated with our life-style. To manipulate the life-style of a whole population is a large and seemingly near impossible undertaking. Therefore we must have definite evidence that factors such as smoking, alcohol consumption, obesity, lack of exercise, a low P:S ratio in the diet or an excess consumption of sucrose or fat are indeed associated with hyperlipoproteinemia. Once this evidence is obtained a large scale method of public health education must be commenced in order to reduce the unnecessary loss of life occurring in Canada today as a result of cardiovascular disease.

Speckmann (1975) states:

> Not only must researchers continue to find new information concerning this disease entity, but they must seek to pass the knowledge thus gained to those who have assumed the role of watchdogs over the nation's heart health. Studies reflecting the influence of ... smoking and other risk factors ... have not been adequately brought to the public's attention (p.33).

# CHAPTER III

# DESIGN OF THE STUDY

This study is designed to investigate the relationship of nutritional practices and related demographic variables to the presence of hyperlipoproteinemia in males aged thirty to sixty years who were admitted to St. Paul's Hsopital for cardiac catheterization.

## Research Design

An associational study was conducted to investigate the relationship of certain criteria to the presence of hyperlipoproteinemia. The criterion variables (Baker and Schutz, 1972) measured in this study were:

1. Fasting serum triglyceride level
2. Fasting serum cholesterol level

The variates (Baker and Schutz, 1972) were categorised as:

1. Nutritional practices
2. Demographic factors
3. Anthropometry

The nature of the relationship between the criterion variables and the variates and amongst the variates themselves were investigated according to the model outlined in Figure 1.

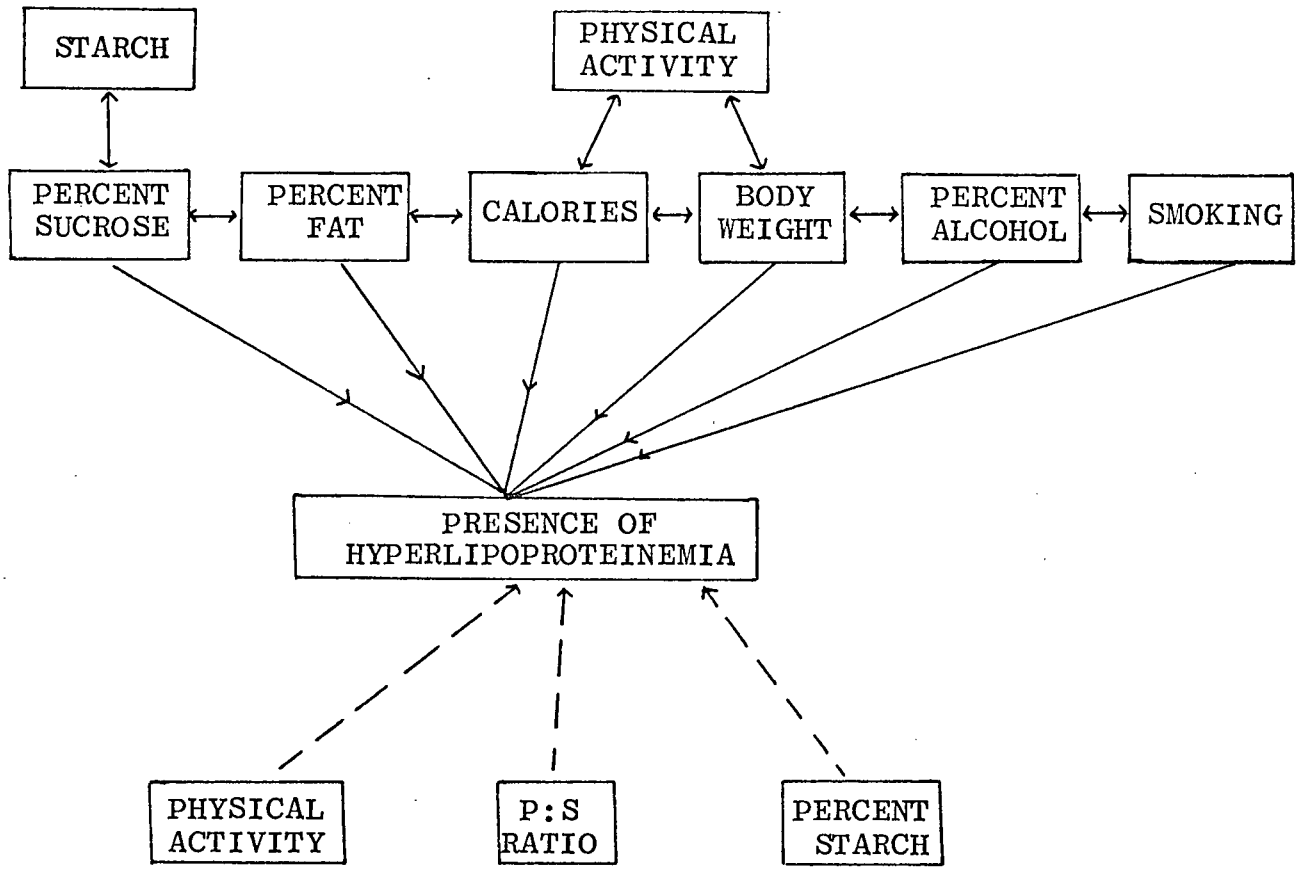



Figure 1. The nature of the relationship between the criterion variables and the variates and amongst the variates themselves.

In this design ←——————→ refers to an interrelationship,

——————→ refers to a positive relationship, and

— — — — → refers to a negative relationship.

## Population and Sample

The population investigated in this study were men aged thirty to sixty years who were admitted to the Clinical Investigation Unit at St. Paul's Hospital for cardiac catheterization under the care of Dr's. A Dodek, J Boone, D Peretz and D Kavanagh-Gray. Scheduled interviews were conducted with prior permission of the medical and nursing staff and therefore only those subjects able to participate were included in the study. Ninety-one subjects were involved in the survey.

## Data Collection

Data collection instruments (see Appendix A) were developed for measurement of the three variates. Three methods of data collection were used (Figure 2). The interview was based on the method suggested by Young (1959). Approximately one hour was used for this interview on the day of the subject's admission to hospital.

### Nutritional Practices

A three-day food record form (see Appendix A) was mailed to each subject (whenever possible) at least one week prior to their intended admission to hospital. Where notice of the patient's admission was not received by the researcher in time to contact the subject, a twenty-four hour dietary

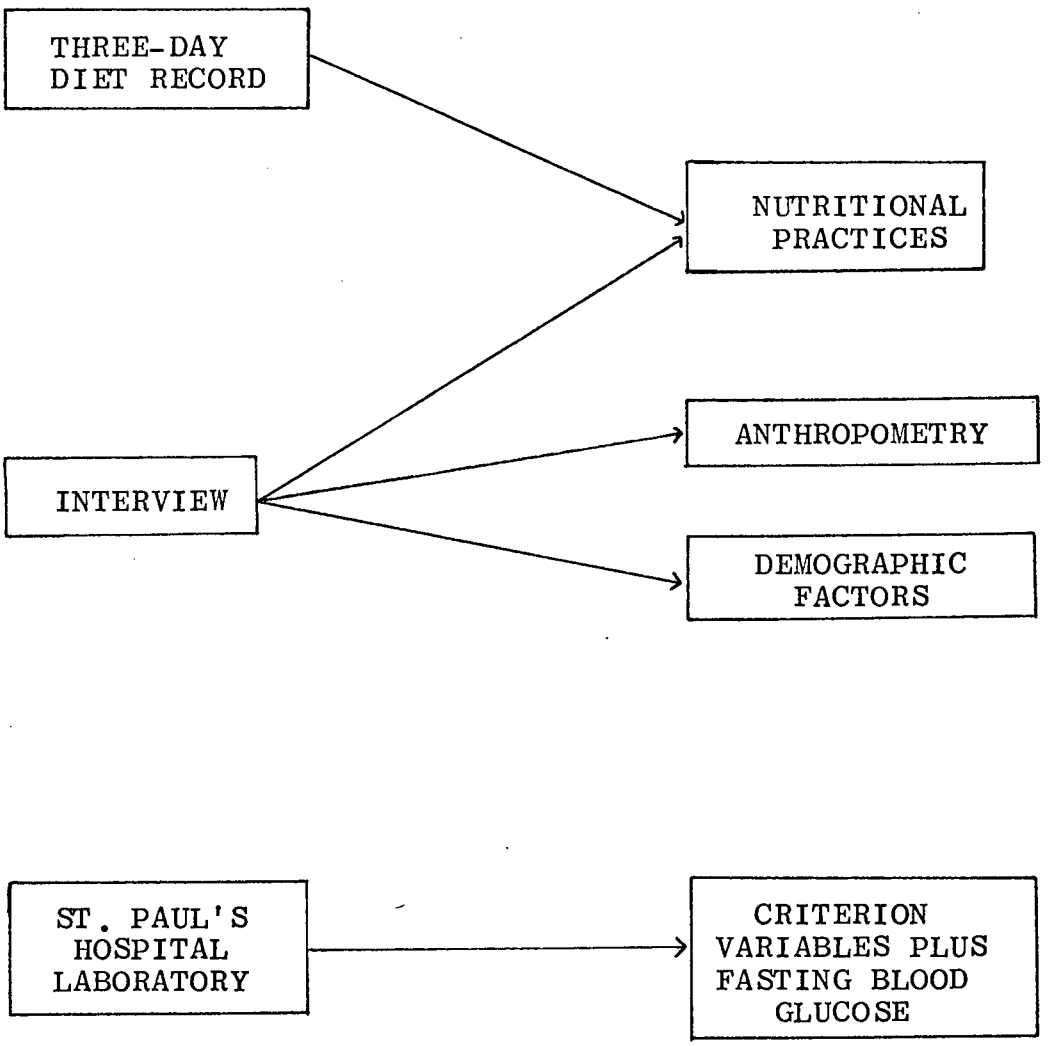



Figure 2. Data collection model.

recall was obtained during the interview. The three-day food record or twenty-four hour dietary recall was cross-checked with a dietary history taken during the interview with the subject. The instrument used for the dietary history was based on the method described by Burke (1947).

The information obtained from the food consumption data included:

1. Sucrose as percent total carbohydrate in the diet.
2. Starch as percent total carbohydrate in the diet.
3. P:S ratio.
4. Total caloric intake.
5. Fat as percent total dietary calories.
6. Alcohol as percent total calories in the diet.

Data relating to P:S ratio, total caloric intake, and total fat consumption were secured with the aid of the General Nutrient Analysis Programme of the School of Home Economics, University of British Columbia. The intake of sucrose, starch and alcohol was not available through this programme.

Alcohol consumption was calculated by the researcher with the aid of composition tables produced by Bowes and Church (1969). Hardinger, Swarner and Crooks (1965) published composition tables in which both available and unavailable carbohydrate figures are included. These tables, although useful, are not extensive. Therefore the sucrose and starch content of some foods had to be estimated from the carbohydrate

content of these foods included either in the Bowes and Church or the Department of National Health and Welfare (1973) composition tables. A list of these estimations is included in Appendix B.

## Demographic Factors

The information required was obtained during the one interview conducted between the researcher and the subject. The extent of physical activity habitually undertaken by the subject was assessed with the aid of a questionnaire (Health and Welfare Canada, 1973). The results were scored for data analysis (Table 1).

TABLE I

SCORING SYSTEM FOR PHYSICAL ACTIVITY

| | PHYSICAL ACTIVITY | SCORE |
|---|---|---|
| SEDENTARY | work and leisure less than 5 flights of stairs or $\frac{1}{2}$ mile walking each day. | 1 |
| LOW MODERATE | some activity, work and leisure between 5 and 15 flights of stairs or 0.5 - 1.5 miles walking or comparable daily activity. | 2 |
| HIGH MODERATE | programmed exercise 4 times/week or 1.5 - 2 miles walking or 15-20 flights of stairs or comparable daily activity. | 3 |
| VIGOROUS | greater than moderate. | 4 |

Information pertaining to smoking, family history of heart disease, age and medications taken by the subject were obtained during the interview. This information was recorded for data analysis. Smoking and age were reported on a continuous scale while family history was treated as a dichotomous variable (1=no and 2=yes). If the subject was currently taking a hypolipemic agent exclusion of that subject from the survey was necessary. The fasting blood glucose level was obtained by St. Paul's Hospital Laboratory using the Technicon Auto-analyzer method N-166 for simultaneous glucose/BUN.

## Anthropometry

The height (in cms.) and weight (in kgs.) were obtained by the researcher during the one interview conducted with the subject. Continental Health O Meter balance scales were used. This information was converted by computer to the ponderal index (Nutrition Canada, 1973). The skinfold thickness was measured during the interview using Harpender Skinfold Calipers. One measurement was taken i.e. triceps, according to the directions set out by Weiner and Laurie (1969). The arm circumference measurement was obtained at the same time. All of the anthropometric measurements were recorded on a continuous scale.

## Criterion Variables

Information relevant to the criterion variables was secured in the following manner;

### Fasting serum triglyceride level

This was obtained from the results of anaylsis of the subject's serum by St. Paul's Hospital laboratory. The Gemsaec automatic analyzer procedure for triglyceride calculation was used.

### Fasting serum cholesterol level

This was obtained from the results of analysis of the subject's serum by St. Paul's Hospital laboratory. The Technicon auto-analyzer method N-37a for total cholesterol by continuous filter was used.

## Procedure

Ninety-one interviews were conducted between May 1st. and October 16th, 1975. The subjects were admitted to St. Paul's Hospital from Sunday to Thursday every week. Where notice of the patient's admission had been obtained in advance of admission, information describing the survey (Appendix A) was mailed to the subject together with the three-day food record forms. This information was transmitted to the remaining subjects at the time of the interview.

Following admission to St. Paul's Hospital the patient was visited by the interviewer and permission obtained to secure

the required data. Only one individual declined the invitation to be included in the study.

After collection of the anthropometric and demographic (excluding fasting blood glucose) information, the twenty-four hour dietary recall was obtained or the three-day food record discussed. A dietary history was then secured. At this time requisitions for the fasting blood glucose, fasting serum triglyceride and fasting serum cholesterol levels were sent to the laboratory. The patient was instructed to fast for twelve hours prior to collection of the blood by the laboratory personnel the following morning. Results of the laboratory analysis were obtained from the patient's medical chart at a later date.

The data collected was coded and submitted to the Key-punching Service of the Computing Centre at the University of British Columbia, for key-punching.

In order to facilitate completion of the study a time schedule was designed. This schedule follows:

Schedule

State 1 - Planning and Preparation

| | | |
|---|---|---|
| 1. | Design study | February - March 1975 |
| 2. | Obtain permission from U.B.C. Committee for research with human subjects. | March 1975 |
| 3. | Develop and print interview forms i.e. dietary history and interviewer's recording forms. | |

Stage 1 (continued)

| | | |
|---|---|---|
| 4. | Develop coding sheets | |
| 5. | Familiarize ward staff with the procedure of data collection | |
| 6. | Familiarize Medical Records Department with study | |
| 7. | Practice data collection procedure | April 1975 |
| 8. | Check with St. Paul's laboratory regarding method of analysis | |
| 9. | Mail letters to the Cardiologists | |

Stage 2 - Data Collection

| | | |
|---|---|---|
| 1. | Mail diet-record forms at appropriate time | |
| 2. | Interview subjects | May 1 - Oct. 16, 1975 |
| 3. | Compile cross-check form of the subject's name and survey number | |

Stage 3 - Data Analysis and Interpretation

| | | |
|---|---|---|
| 1. | Code obtained information and check coding | Nov. 1975 |
| 2. | Key-punching | Dec. 1975 |
| 3. | Data analysis by computer | Dec. - Jan. 1976 |
| 4. | Final report | Feb. 1976 |

## Data Analysis

Data collected were coded, key punched on cards, and treated statistically by computer analysis.

1. Comparison of data collected by the two dietary data collection methods used in the study was conducted by t-test for significant differences in the group means.
2. The relationship between the individual criterion variables was investigated by correlation analysis using the Pearson product moment correlation coefficient. The same method of analysis was used to determine the relationship between the individual variates.
3. Analysis of the t-distribution was used to study the relationship of the variates (other than the caloric intake) to the presence of hyperlipoproteinemia (hypotheses 1,2,3,5,6,7,8,9). The correlation between caloric intake and the presence of hyperlipoproteinemia (hypothesis 4) was investigated with the use of the Pearson product moment correlation coefficient.
4. The relationship of the variates to the individual criterion variables (serum triglyceride and cholesterol concentration) was determined by correlation analysis.
5. The Pearson product moment correlation coefficient was employed to determine the correlation between smoking, cessation of smoking or non-smoking and the individual criterion variables.
6. Analysis of variance was conducted to observe if any difference existed between smokers, ex-smokers and non-smokers and their serum triglyceride concentration.

7. The correlation between selected combinations of variates and the presence of hyperlipoproteinemia (objective 10) was investigated by multivariate canonical correlation analysis.
8. Multiple regression analysis was employed to determine the relationship of selected combinations of variates to the individual criterion variables.

# CHAPTER IV

## FINDINGS AND INTERPRETATIONS

In this study of men aged thirty to sixty years who were admitted to St. Paul's Hospital for cardiac catheterization, the nature of the relationships between the criterion variables (fasting serum trigylceride and fasting serum cholesterol) and the variates (nutritional practices, demographic factors and anthropometry) were explored. The interrelationships among the variates themselves were also investigated.

Ninety-one subjects were involved in the study. However twenty-seven subjects had to be eliminated leaving a total of sixty-four participants. The reasons for the elimination of the subjects were:

| | | |
|---|---|---|
| a. | currently on antiatherogenic treatment | 15 |
| b. | currently taking hypolipidemic drugs | 4 |
| c. | diagnosed as diabetic | 4 |
| d. | dietary data not available | 4 |

A summary of the data obtained from the study is outlined in Table II.

### Criterion Variables

#### Triglycerides

The fasting serum triglyceride levels showed a wide range (Table III). Of the sixty-four subjects included in

TABLE II

MEAN AND STANDARD DEVIATION FOR VARIABLES OBSERVED IN THE STUDY

| Variable | Mean | Standard Deviation |
|---|---|---|
| Carbohydrate (gm.) | 210.1562 | ± 90.9762 |
| Fat (gm.) | 118.3906 | ± 55.8492 |
| Polyunsaturated fatty acid (gm.) | 8.8750 | ± 5.2144 |
| Saturated fatty acid (gm.) | 43.5781 | ± 23.2889 |
| Calories | 2374.2812 | ± 882.7813 |
| Alcohol (gm.) | 14.9844 | ± 25.7882 |
| Height (c.m.) | 171.8625 | ± 8.6811 |
| Weight (kg.) | 76.3328 | ± 12.4134 |
| Arm circumference (c.m.) | 31.3578 | ± 2.9516 |
| Age (years) | 49.7188 | ± 7.4332 |
| Triglycerides (mg./100ml.) | 184.5781 | ± 84.1212 |
| Cholesterol (mg./100ml.) | 208.2031 | ± 28.9341 |
| Blood Glucose (mg./100ml.) | 103.4062 | ± 10.9599 |
| Starch (gm.) | 101.5156 | ± 50.4500 |
| Sucrose (gm.) | 59.1563 | ± 48.3867 |
| Converted skinfold | 196.8874 | ± 19.8468 |
| Ponderal index | 12.3104 | ± 0.6337 |
| Percent sucrose | 26.4353 | ± 16.5223 |
| Percent fat | 43.8233 | ± 9.7232 |
| P:S ratio | 0.2866 | ± 0.2986 |
| Percent starch | 48.9476 | ± 19.0905 |
| Percent alcohol | 4.1830 | ± 7.3010 |

the survey only twenty-three exhibited levels with the range accepted as normal by St. Paul's Hospital laboratory i.e. 35-135 mg./100 ml. serum. This would appear to support the view of Levy, Bonnel and Ernst (1971) that both cholesterol and triglyceride concentration must be measured when evaluating hyperlipoproteinemia.

TABLE III

FASTING SERUM TRIGLYCERIDE LEVELS OF PARTICIPANTS

| Measure | Serum triglyceride (mg./100ml.) |
|---|---|
| Mean and S.D.[b] | 184.58 ± 84.12[a] |
| Range | 59.00 - 552.00 |

a The mean fasting serum triglyceride level exceeds the upper limit of the normal range.

b Standard deviation

## Cholesterol

Table IV shows the range of the fasting serum cholesterol levels to be much less than that of the fasting serum triglyceride concentration.

TABLE IV

FASTING SERUM CHOLESTEROL LEVELS OF PARTICIPANTS

| Measure | Serum cholesterol (mg./100ml.) |
|---|---|
| Mean and S.D. | 208.20 $\pm$ 28.93 |
| Range | 143.00 - 275.00 |

Only two of the sixty-four subjects produced fasting serum cholesterol levels greater than the range accepted as normal by St. Paul's Hospital laboratory i.e. 150-260 mg./100ml.serum. One of these subjects exhibited a serum triglyceride level of 162 mg./100ml. while the other subject had a fasting serum triglyceride level of 552 mg./100ml., illustrating the importance of measuring both cholesterol and triglycerides in order to evaluate the type of hyperlipoproteinemia present (Fredrickson, 1973).

It is interesting to note the almost normal levels of serum cholesterol demonstrated by the subjects. According to Lewis et al. (1974) serum cholesterol concentrations

have been found to increase with age. Also a relationship has been demonstrated between obesity and plasma lipids (Olefsky, Reaven and Farquaker, 1974a; Hall, et al. 1972; Lisck, et al. 1974; Ashley and Kannel, 1974; Bagdade et al. 1971). The anthropometric results of this study show that 67% of the subjects suffered from overweight. Therefore, considering these two risk factors alone, a greater number of abnormally high levels of serum cholesterol would have been expected in this survey.

Although an attempt was made to prevent bias, the fact that these subjects were patients admitted to hospital for cardiac catheterization must be considered. Weight reduction, dietary modifications, increased exercise, and cessation of smoking could have been instituted by the subject as soon as an indication of a cardiac problem was made known to him. This particular factor was investigated during the interview but could not be controlled entirely.

## Variates

### Nutritional Practices

All of the nutritional measurements were recorded on a continuous scale.

#### Total carbohydrate

The total carbohydrate consumption of the participants varied considerably (Table V).

TABLE V

CARBOHYDRATE CONSUMPTION OF PARTICIPANTS

| Measure | Carbohydrate (gms.) | Carbohydrate Calories |
|---|---|---|
| Mean and S.D. | 210.16 ± 90.98 | 840.62 ± 363.9 |
| Range | 89.00 - 546.00 | 356.00 - 2184.00 |

Sucrose and starch

It should be noted that the figures obtained for both sucrose and starch consumption must be considered only as an estimation due to the difficulty in securing reliable composition tables. However, as a result of the research which has been conducted to investigate the relationship of sucrose and starch to the presence of hyperlipoproteinemia (Kaufmann and Kapitulnik, 1972; Nikkila and Kekki, 1973; Bolzana et al., 1972), it is of interest to investigate the estimated intake of sucrose and starch obtained from this study.

Table VI shows the distribution of the consumption of sucrose by the participants in this study.

TABLE VI

SUCROSE CONSUMPTION OF PARTICIPANTS

| Measure | Sucrose (gm.) | Percent Sucrose [a] |
|---|---|---|
| Mean and S.D. | 59.16 ± 48.39 | 26.44 ± 16.52 |
| Range | 0.00 - 201.00 | 0.00 - 69.36 |

[a] Sucrose as percent total carbohydrate consumed.

It has been recommended by the Committee on Nutrition of the American Heart Association (1974) that a dependence on foods containing complex natural carbohydrate is preferable to excessive use of refined sugar.

Table VII illustrates that the consumption of starch was extremely varied.

TABLE VII

STARCH CONSUMPTION OF PARTICIPANTS

| Measure | Starch (gm.) | Percent Starch [a] |
|---|---|---|
| Mean and S.D. | 101.52 ± 50.45 | 48.95 ± 19.09 |
| Range | 0.00 - 317.00 | 0.00 - 95.16 |

[a] Starch as percent total carbohydrate consumed.

Fat

Tables VIII and IX show the fat and fatty acid consumption, respectively.

TABLE VIII

FAT CONSUMPTION OF PARTICIPANTS

| Measure | Fat (gm.) | Fat Calories | Percent Fat [a] |
|---|---|---|---|
| Mean and S.D. | 118.39 ± 55.85 | 1065.51 ± 502.64 | 43.82 ± 9.72 |
| Range | 20.00 - 272.00 | 180.00 - 2448.00 | 18.97 - 67.12 |

[a] Fat as percent total calories consumed.

It is of interest to note that the mean percent total calories from fat is 43.82. Sherwin (1974) and Kannel (1971) recommended that the fat content of a diet should be 30% or less of the total calories while the Committee on Nutrition of the American Heart Association (1974) recommended that the total calories from fat should be no more than 35%.

Only three of the sixty-four subjects consumed diets with a P:S ratio greater than or equal to one. Kannel (1971) proposed that the P:S ratio should be 2:1 and Hulley (1972) suggested that diets of a high P:S ratio lower serum cholesterol.

A mean P:S ratio of 0.287 is extremely low particularly

when higher ratios are recommended. According to Fredrickson (1971) the average American diet contains a P:S ratio of 0.3 showing that this group of subjects demonstrated a mean P:S ratio near the American average.

TABLE IX

FATTY ACID CONSUMPTION OF PARTICIPANTS

| Measure | P.U.F.A.[a] (gm.) | Sat. F.A.[b] (gm.) | P:S Ratio |
|---|---|---|---|
| Mean and S.D. | 8.88 ± 5.21 | 43.58 ± 23.29 | 0.29 ± 0.30 |
| Range | 0.00 - 23.00 | 5.00 - 102.00 | 0.00 - 1.67 |

[a] Polyunsaturated fatty acid.

[b] Saturated fatty acid.

Total calories

The caloric intake data obtained during the study are presented in Table X.

TABLE X

CALORIC CONSUMPTION OF PARTICIPANTS

| Measure | Calories |
|---|---|
| Mean and S.D. | 2374.28 ± 882.78 |
| Range | 922.00 - 5408.00 |

As can be seen from the above table the caloric intake varied considerably. The energy requirement of an individual is extremely difficult to predict due to the large number of variables affecting such a requirement e.g., age, height and physical activity. The recommended intakes of energy for adults in the Canadian Dietary Standards (1975) are presented as influenced by age and activity.

Alcohol intake

Table XI displays the wide variation observed in the alcohol consumption of the subjects.

TABLE XI

ALCOHOL CONSUMPTION OF PARTICIPANTS

| Measure | Alcohol (gm.) | Alcohol Calories | Percent Alcohol [a] |
|---|---|---|---|
| Mean and S.D. | 14.98 - 25.79 | 103.84 - 178.71 | 4.18 - 7.30 |
| Range | 0.00 - 108.00 | 0.00 - 748.44 | 0.00 - 31.66 |

[a] Alcohol as percent total calories consumed.

As can be seen from the table above, the alcohol intake ranges from 0-108 grams a day. Thus, 64% of the participants consumed no alcohol at all giving an extremely unusual distribution of alcohol consumption.

Type of nutritional data collection

Two methods were used to record the dietary intake of the subjects i.e. the three-day food record or twenty-four hour recall method (Table XII).

TABLE XII

DISTRIBUTION OF THE DIETARY DATA COLLECTION METHODS USED

| Method | Number of Subjects |
|---|---|
| Twenty-four hour recall | 42 |
| Three-day food record | 22 |
| TOTAL | 64 |

T-distribution analysis was conducted to investigate the possibility of inconsistencies between the data obtained by the twenty-four hour recall and that obtained from the three-day food record. The food recorded on the final day of the three-day food record was used for data analysis. All of the dietary variates were studied and no significant variation was observed at the 0.05 level of significance between the data collected by the three-day food record and that obtained from the twenty-four hour recall.

Demographic Factors

Smoking

Smoking has been suggested as a risk factor in the

presence of hyperlipoproteinemia (Kannel, 1971; Sherwin, 1974). Only three of the subjects involved in the present study smoked a pipe while not one subject smoked a cigar. Information regarding cigarette smoking is included in Table XIII.

TABLE XIII

DISTRIBUTION OF PARTICIPANTS
BY CIGARETTE SMOKING HABITS

| Average number of cigarettes/day | Absolute frequency |
|---|---|
| 0.0[a] | 15 |
| 1.0[b] | 27 |
| 2.0 | 1 |
| 6.0 | 1 |
| 10.0 | 2 |
| 12.0 | 1 |
| 15.0 | 3 |
| 20.0 | 9 |
| 30.0 | 1 |
| 40.0 | 1 |
| 50.0 | 3 |
| TOTAL | 64 |

[a] non-smoker

[b] ex-smoker

As can be seen from the table above, 15 of the subjects were non-smokers while 27 (42%) were ex-smokers. Only 34% of the subjects were smoking at the time of the study.

Physical activity

Physical activity was scored according to the system outlined previously (p.54). Table XIV presents the frequency distribution of physical activity using this scoring system.

TABLE XIV

DISTRIBUTION OF PARTICIPANTS
BY PHYSICAL ACTIVITY SCORE

| Code | Absolute frequency |
|---|---|
| 1.0 | 13 |
| 2.0 | 18 |
| 3.0 | 29 |
| 4.0 | 4 |
| Total | 64 |

Therefore, 23% of the participants were classed as sedentary and 28% as low moderately active. It has been suggested by Kannel (1971) that sedentary men are more susceptible to coronary attacks than physically active men. Thus it is of interest to note the large percentage of participants (51%) who were not indulging in high moderately active or vigorous activity.

Family history of heart disease

It has been suggested (Glueck et al., 1974; Goldstein et al., 1973; Fredrickson et al., 1973) that hyperlipoproteinemia may be familial. Of the sixty-four participants in the study, twenty-one reported to have no family history of heart disease while forty-three reported that a parent and/or sibling had been diagnosed as suffering from some type of heart disease.

Age

Table XV outlines the measures of central tendency and dispersion for age among the participants of the study.

TABLE XV

DISTRIBUTION OF PARTICIPANTS BY AGE

| Measure | Age (years) |
|---|---|
| Mean and S.D. | 49.72 $\pm$ 7.43 |
| Range | 34.00 - 60.00 |

The levels of serum cholesterol and triglyceride concentration have been found to increase with age (Lewis et al., 1974; Levy, 1973; Fredrickson, Levy and Lees, 1967). Lewis et al. (1974) found in their study that the highest concentration of serum triglycerides and cholesterol was seen in the 50-59 year age-group. Fifty-six percent of the

participants were shown to fall within this group.

Glucose intolerance

The measures of dispersion and central tendency showing the fasting blood glucose of the participants is indicated in Table XVI.

TABLE XVI

FASTING BLOOD GLUCOSE LEVELS OF PARTICIPANTS

| Measure | Fasting Blood Glucose (mg./100ml.) |
|---|---|
| Mean and S.D. | 103.41 $\pm$ 10.96 |
| Range | 76.00 - 140.00 |

The range of fasting blood glucose considered normal by St. Paul's Hospital laboratory is 65 - 110mg./100ml. An abnormally high fasting blood glucose level was found among 18.7% of the participants.

Anthropometry

Table XVII shows the data obtained on height, weight and ponderal index.

TABLE XVII

HEIGHT, WEIGHT AND PONDERAL INDEX OF PARTICIPANTS

| Measure | Height (c.m.) | Weight (kg.) | Ponderal Index |
|---|---|---|---|
| Mean and S.D. | 171.87 ± 8.69 | 76.33 ± 12.41 | 12.31 ± 0.63 |
| Range | 148.50 - 190.50 | 43.70 - 113.60 | 10.94 - 14.33 |

According to Nutrition Canada (1973), 12.5 is the standard ponderal index while a ponderal index of 11.6 indicates obesity. In this study, 12.5% of the subjects exhibited a ponderal index less than 11.6 while a total of 67% of the subjects presented with a ponderal index below the standard. Therefore, 67% of the participants in the study may be classified as overweight.

The tricep skinfold thickness and arm-circumference measurement scores are presented in Table XVIII.

TABLE XVIII

ARM CIRCUMFERENCE AND TRICEP SKINFOLD THICKNESS OF PARTICIPANTS

| Measure | Arm Circumference (c.m.) | Skinfold (m.m.) | Skinfold conversion [a] |
|---|---|---|---|
| Mean and S.D. | 31.36 ± 2.95 | 11.98 ± 4.00 | 196.89 ± 19.85 |
| Range | 23.00 - 38.00 | 4.10 - 23.40 | 136.17 - 233.45 |

[a] According to Edwards et al. (1955):

Because the values obtained with the skinfold caliper give a markedly non-normal frequency distribution it it necessary for most purposes to transform them into a log scale before use (p.133).

The transformation used for this purpose is:

100 log 10 (reading in 0.1 m.m - 18)

Jelliffe (1966) stated that the standard tricep skinfold thickness of the adult male is 12.5 m.m. whereas the standard arm circumference is 29.3 c.m. In the present study, 43.7% of the subjects exhibited a skinfold thickness greater than 12.5 m.m. indicating excess energy stores. An arm circumference of less than the standard (showing low muscle reserves) existed in 25% of the subjects.

Relationship Between the Criterion Variables

The relationship between the criterion variables was investigated using the Pearson product moment correlation coefficient. The serum triglyceride concentration and the

serum cholesterol concentration were found to be positively correlated (Table XIX).

TABLE XIX

PEARSON PRODUCT MOMENT CORRELATION COEFFICIENT OF THE CRITERION VARIABLES

| Variables | Coefficient | Cases | Level of significance |
|---|---|---|---|
| Serum triglyceride and cholesterol concentration | 0.3796 | 64 | 0.002 |

Although only two of the subjects exhibited abnormally high levels of serum cholesterol, 67% of the participants had serum cholesterol concentrations within the upper 25% of the normal range. The concentration of all lipids and lipoproteins tend to increase with age (Levy, 1973). Therefore with an age range of 30-60 years and with 56% of the respondents being 50-59 years of age, one would expect the levels of both lipids to be at the upper limit or higher than normal.

## Relationships Among the Variates

The Pearson product moment correlation coefficient was used to determine the relationships between the variates used in the study. Table XX shows some of the correlation coefficients obtained by this analysis.

From the table it is possible to see that some inter-

relationship does exist between the variates but that this relationship is limited.

### Exercise and Caloric Intake

No relationship was observed between exercise and calories. This finding was similar to that of the Nutrition Canada Survey (1973).

TABLE XX

PEARSON PRODUCT MOMENT CORRELATION COEFFICIENTS OF SELECTED VARIATES

| Variables | Coefficient | Cases | Level of significance |
|---|---|---|---|
| Exercise and Calories | 0.1824 | 64 | 0.149 |
| Exercise and Skinfold | -0.3746 | 64 | 0.002 [a] |
| Exercise and Ponderal Index | 0.2336 | 64 | 0.063 |
| Blood glucose and Ponderal Index | -0.1843 | 64 | 0.145 |
| Blood glucose and Calories CHO[b] | 0.2017 | 64 | 0.110 |
| Calories and Age | -0.1974 | 64 | 0.118 |

[a] Significant at the 5% level of significance.

[b] Dietary calories derived from carbohydrate.

### Exercise and Ponderal Index

The non-significant relationship between exercise and ponderal index at the 0.05 level of significance is of interest as both exercise and ponderal index were shown to be related to the criterion variables by the t-test. A correlation between either exercise or calories and ponderal index would have been expected. The small sample size of the study may have affected the results as the level of significance for the correlation between exercise and ponderal index was 0.063.

The Nutrition Canada results (1973) suggested that calories alone do not account for the overweight problem. In the report of the Nutrition Canada national survey it was proposed that both factors, caloric intake and physical activity, need to be considered when dealing with the problem of overweight.

### Exercise and Tricep Skinfold Thickness

A negative relationship between exercise and the tricep skinfold thickness was observed at the 0.002 level of significance. This relationship supports the suggested relationship between ponderal index and exercise and implies that physical activity affects the development of subcutaneous fat.

### Blood Glucose and Ponderal Index

The effect of certain parameters on the fasting blood glucose level is interesting as it has been suggested that

abnormal glucose tolerance may be associated with the presence of hyperlipoproteinemia (Schonfield et al., 1974; Fredrickson, Levy and Lees, 1967). Olefsky, Reaven and Farquakar (1974b) suggested that obesity is related to hyperglycemia which in turn is associated with hyperlipoproteinemia. The non-significant (at the 0.05 level) relationship existing in this study between ponderal index and blood glucose does not support the view that obesity is associated with hyperglycemia.

### Dietary Carbohydrate and Blood Glucose

No association between a high carbohydrate diet and blood glucose level was observed using the Pearson product moment correlation coefficient. The relationship of blood glucose to hyperlipoproteinemia will be discussed in the following section.

### Caloric Intake and Age

No correlation was observed between caloric intake and age by Pearson product moment correlation coefficient analysis. No explanation, other than population size, can be provided for this observation.

## Relationships Between the Criterion Variables and the Variates

The serum levels of triglycerides and cholesterol were subjected to a nominal measurement which was dichotomized (Table XXI).

TABLE XXI

SERUM TRIGLYCERIDE AND CHOLESTEROL CONCENTRATIONS REPORTED AS A DICHOTOMOUS VARIABLE

| Group | Lipid | Number |
|---|---|---|
| 1 | High triglyceride cholesterol | 41 |
| 2 | Normal triglyceride and cholesterol | 23 |
| | Total | 64 |

The normal serum ranges of cholesterol and triglyceride concentrations used were those observed by St. Paul's Hospital laboratory i.e. triglycerides 35-135 mg./100ml. and cholesterol 150-260 mg./100ml. The relationship between the variates and the presence of hyperlipoproteinemia was investigated using these groups. In addition triglyceride and cholesterol concentrations were considered individually. The relationship between the variates and triglyceride concentration as well as between the variates and cholesterol concentration was explored.

The frequency distribution of the triglyceride and cholesterol concentrations of the respondents is shown in Table XXII.

TABLE XXII

DISTRIBUTION OF PARTICIPANTS BY TRIGLYCERIDE AND CHOLESTEROL CONCENTRATIONS

| Category | Absolute Frequency |
|---|---|
| Normal triglyceride and cholesterol concentration | 23 |
| Elevated triglyceride; normal cholesterol | 39 |
| Elevated triglyceride and cholesterol | 2 |
| Total | 64 |

It is of interest to note that only two of the subjects showing abnormally high triglyceride concentrations also exhibited a high cholesterol concentration.

## Analysis of Relationship of Selected Variates to the Presence of Hyperlipoproteinemia

The relationship of selected variates to the presence of hyperlipoproteinemia was investigated by the t-test or by the Pearson product moment correlation coefficient. The criterion variables were grouped according to the format shown in Table XXI. The results of t-test analysis are reported in Table XXIII.

TABLE XXIII

T-DISTRIBUTION OF THE RELATIONSHIP OF SELECTED VARIATES TO THE PRESENCE OF HYPERLIPOPROTEINEMIA

| Variate | T-Value | Significance P 0.05 |
|---|---|---|
| Percent sucrose | 0.65 | N.S.[a] |
| Percent fat | -1.68 | N.S. |
| P:S ratio | -0.59 | N.S. |
| Percent starch | -0.34 | N.S. |
| Ponderal index | -2.95 | S.[b] |
| Percent alcohol | 0.76 | N.S. |
| Exercise | -2.25 | S. |
| Cigarette smoking | -0.16 | N.S. |
| Converted skinfold | 2.58 | S. |
| Age | 1.32 | N.S. |

[a] non-significant

[b] significant

A negative correlation was shown to exist between the ponderal index and the presence of hyperlipoproteinemia (as defined by abnormally high triglyceride and/or cholesterol concentrations) and between exercise and presence of hyperlipoproteinemia. The relationship between skinfold thickness (transformed to the log scale) and the presence of hyperlipo-

proteinemia was shown to be positive. All of these relationships existed at the 0.05 level of significance for the two-tailed test.

The other variates examined by this method of analysis i.e. sucrose as percent total carbohydrate, fat as percent total calories, P:S ratio, starch as percent total carbohydrate, alcohol as percent total calories and cigarette smoking were shown to have no significant relationship to the presence of hyperlipoproteinemia.

Ponderal index

Ashley and Kannel (1974) suggested that ordinary obesity encountered in the general population is associated with an increased incidence of hyperlipoproteinemia. The negative correlation shown to exist between the ponderal index and the presence of hyperlipoproteinemia in this study supports this statement.

Lisck et al. (1974) found from their studies that weight reduction could be associated with a reduction in the plasma triglyceride and cholesterol concentrations in some patients with hyperlipoproteinemia. Unfortunately, due to the organization of the study, long-term follow-up of the subjects could not be undertaken. The findings of this study therefore support hypothesis 6.

Skinfold thickness

This anthropometric measurement provides an indication of the energy stores of the subject studied. The positive relationship between tricep skinfold thickness and the presence of hyperlipoproteinemia found in this study supports the relationship found between ponderal index and the presence of hyperlipoproteinemia. Together these measurements support the view that a relationship exists between obesity and plasma lipids (Olefsky, Reaven and Farquahar, 1974a,b; Hall et al., 1972; Lisck et al., 1974; Ashley and Kannel 1974).

Exercise

The extent of physical activity normally conducted by the respondent was scored within a range of one to four i.e. sedentary to vigorous. Among the participants of this study, lack of physical activity appeared to be closely associated with an abnormally high triglyceride and/or cholesterol concentration. This finding supports the suggestion of Kannel, Sorlie and McNamara (1971) that physical activity contributes to coronary risk. Hypothesis 8 is accepted.

Sucrose as percent total carbohydrate

No relationship was found to exist between this variate and the presence of hyperlipoproteinemia. This finding therefore rejects hypothesis 1.

Several researchers have suggested that the substitution of sucrose for starch in the diet causes an increase in the serum triglyceride and cholesterol levels (Kaufmann and Kapitulnik, 1972; Nikkila and Kekki, 1973; Bolzana et al., 1972). The reason for the conflicting finding of this study could be due to the fact that the data relating to sucrose consumption can only be regarded as an estimate. Multivariate analysis using several combinations of the dietary factors may reveal stronger relationships between selected dietary variates and the criterion variables.

Starch as percent total carbohydrate

Hypothesis 5 was not accepted as no correlation was found between starch as percent total carbohydrate and the presence of hyperlipoproteinemia. It is now generally accepted that a high sucrose content in the diet has a more hyperlipidemic effect that a high starch content. This was not observed in the present study. However, multivariate analysis of the dietary factors will be conducted to investigate the interrelationships between the dietary variates and the presence of hyperlipoproteinemia.

Fat as percent total calories

An excess of dietary fat is considered a possible risk factor for hyperlipoproteinemia (Sherwin, 1974; Kannel, 1971). This view is not supported by the findings of the present study and hypothesis 2 must be rejected.

P:S ratio

The polyunsaturated to saturated fatty acid ratio has been cited as an important factor in the presence of hyperlipoproteinemia (Little et al., 1970; Albrink, 1974; Anderson, Grande and Keys, 1973). No relationship was shown to exist between the dietary P:S ratio and the combined criterion variables. As a result of this finding hypothesis 3 is rejected.

Little et al. (1970) suggested that sucrose is hyperlipidemic only in diets containing predominantly saturated fatty acids and large amounts of cholesterol. Therefore, multivariate analysis of the dietary variates is necessary to establish the existence, if any, of interrelationships between the dietary factors when observing their association with the presence of hyperlipoproteinemia.

Alcohol as percent total calories

No relationship was found between alcohol as percent total calories and the presence of hyperlipoproteinemia thereby making necessary the rejection of hypothesis 7. Little et al. (1970) proposed that the hyperlipidemic effect of alcohol may depend on the proportions of dietary saturated and unsaturated fat. Therefore, it would be of interest to observe the relationship between alcohol content plus other dietary factors and the presence of hyperlipoproteinemia.

Cigarette smoking

As only three of the subjects smoked a pipe and no subject smoked a cigar, analysis was conducted using only the data related to cigarette smoking. No relationship was found between cigarette smoking and the presence of hyperlipoproteinemia. Hypothesis 9 was therefore rejected.

Total caloric intake

The relationship of dietary calories to the presence of hyperlipoproteinemia was found to be non-significant in the present study by the Pearson product moment correlation coefficient analysis. Also, although ponderal index was found to be negatively related to the presence of hyperlipoproteinemia, no relationship could be seen between caloric intake and ponderal index. A relationship between obesity and plasma lipids has been demonstrated by several researchers (Olefsky, Reaven and Farquahar, 1974 a,b; Hall et al., 1972)

Age

No correlation could be seen between age and the presence of hyperlipoproteinemia using the t-test. This is an interesting observation as 56% of the respondents were within the 50-59 year age-group which, according to Lewis et al., (1974), tends to have the highest triglyceride and cholesterol concentrations. Again, the reason for this result could have been the small population used for the study.

Family history of heart disease

A family history of heart disease was reported by 67% of the participants. As hyperlipoproteinemia has been shown to be familial (Glueck et al., 1974; Goldstein et al., 1973; Fredrickson et al., 1973), it is surprising to note that no relationship existed in this study between family history of heart disease and the presence of hyperlipoproteinemia.

## Analysis of the Relationship of Selected Variates to the Individual Criterion Variables

The Pearson product moment correlation coefficient was employed to establish the correlation between suggested risk factors of hyperlipoproteinemia and the individual criterion variables (Table XXIV).

TABLE XXIV

PEARSON PRODUCT MOMENT CORRELATION COEFFICIENTS FOR SELECTED VARIATES AND THE CRITERION VARIABLES

| Variable | Coefficient | Cases | Significance P 0.05 |
|---|---|---|---|
| Triglycerides and percent alcohol | 0.1858 | 64 | N.S. |
| Triglycerides and age | 0.2081 | 64 | N.S. |
| Cholesterol and age | 0.2482 | 64 | S. |
| Triglycerides and ponderal index | -0.3911 | 64 | S. |
| Cholesterol and ponderal index | -0.3086 | 64 | S. |
| Triglycerides and blood glucose | 0.3740 | 64 | S. |
| Triglycerides and exercise | -0.1833 | 64 | N.S. |
| Cholesterol and exercise | -0.3644 | 64 | S. |
| Triglycerides and percent fat | -0.2026 | 64 | N.S. |

Triglycerides and alcohol as percent total calories

No relationship was discovered between alcohol as percent total calories and the serum triglyceride concentration

(see Appendix C). This does not support Albrink's (1974) suggestion that alcohol may raise triglyceride levels. Also no association was observed between alcohol as percent total calories and the serum cholesterol concentration which compares with the findings of Balart et al. (1974). These results influenced the correlation between alcohol as percent total calories and the presence of hyperlipoproteinemia thereby causing the rejection of hypothesis 7.

Triglycerides and age

Levy (1973) stated that the concentration of all serum lipids increases with age. This statement is not upheld by the findings of the present study as no relationship was observed between age and the serum triglyceride levels.

Cholesterol and age

The positive correlation observed between the serum cholesterol concentration and age partially supports the suggestion that the serum lipid levels increase with age (Levy, 1973).

Triglycerides and Ponderal Index

The result of the Pearson product moment correlation coefficient analysis substantiates the significant negative relationship between triglyceride concentration and ponderal index revealed by t-test analysis.

Cholesterol and ponderal index

The negative relationship observed between the serum cholesterol concentration and the ponderal index supports the result of analysis of t-distribution between ponderal index and the presence of hyperlipoproteinemia.

Triglyceride concentration and blood glucose

Schonfield et al. (1974) suggested that carbohydrate, lipid and lipoprotein metabolism are closely related. From the Pearson product moment correlation coefficient it can be seen that a positive correlation exists between the fasting blood glucose level and the serum triglyceride concentration.

Olefsky, Reaven and Farquahar (1974 b) studied the role of obesity in causing insulin resistance. They hypothesized that insulin resistance caused by obesity lead to elevated plasma triglyceride levels through accelerated hepatic triglyceride production.

In this study:

a. No relationship exists between fasting blood glucose and ponderal index.

b. A negative relationship exists between ponderal index and the serum triglyceride concentration.

c. A positive relationship exists between fasting blood glucose and the serum triglyceride concentration.

Therefore, in the present study, the hypothesis of

Olefsky, Reaven and Farquakar (1974 b) would appear to be partially supported. Overweight, as defined by a ponderal index less than 12.5 (Nutrition Canada, 1973), is not associated with fasting blood glucose in this study. However, overweight is associated with the serum triglyceride concentration as is the fasting blood glucose level.

Exercise and triglyceride concentration

No significant relationship was observed between the triglyceride concentration and physical activity at the 0.05 level of significance.

Exercise and serum cholesterol concentration

The relationship shown, with the use of the t-test, between the presence of hyperlipoproteinemia and physical activity is supported by the negative relationship which exists between exercise and serum cholesterol concentration.

Triglyceride concentration and fat as percent total calories

In the present study no significant relationship is shown between triglyceride concentration and fat as percent total calories and similarly no relationship has been revealed between fat as percent total calories and the serum cholesterol level (see Appendix C).

In addition, calorie intake does not appear to be associated with serum triglyceride concentration or serum cholesterol concentration. Similarly P:S ratio is not related to triglyceride concentration or cholesterol concentration

in this study (see Appendix C).

Smoking

As 42% of the subjects were ex-smokers, it was considered of interest to investigate the relationship of both ex-smokers and current-smokers to the individual triglyceride and cholesterol levels. No correlation was found between either ex-smokers or smokers and the triglyceride and cholesterol concentration (see Appendix C). Smoking has been suggested as a risk factor or coronary heart disease (Kannel et al., 1964; Sherwin, 1974; Little, 1974). Sherwin (1974) observed that a low risk of coronary heart disease existed among ex-smokers.

The data from the present study, as well as not displaying a relationship between ex-smokers and the presence of hyperlipoproteinemia, exhibited very little difference between ex-smokers and smokers and their association with the presence of hyperlipoproteinemia. Analysis of variance was conducted to observe if any difference existed between smokers, ex-smokers and non-smokers and their serum triglyceride concentration. Very little difference was seen between the measures of central tendency in these three groups (Table XXV). The difference beween these measures was shown to be non-significant at the 5% significance level.

TABLE XXV

TRIGLYCERIDE CONCENTRATION OF
NON-SMOKERS, EX-SMOKERS AND SMOKERS

| Group | Number | Triglyceride concentration (mg./100ml.) | |
|---|---|---|---|
| | | Mean | S.D. |
| Non-smokers | 15 | 164.2667 | ± 57.1546 |
| Ex-smokers | 27 | 207.0741 | ± 102.5539 |
| Smokers | 22 | 170.8182 | ± 69.9017 |
| Total | 64 | | |

Table XXVI shows a similar observation was made when the same procedure was conducted using cholesterol concentration as the criterion variable. The difference between smokers, ex-smokers and non-smokers was non-significant at the 0.05 level of significance.

TABLE XXVI

CHOLESTEROL CONCENTRATION OF
NON-SMOKERS, EX-SMOKERS AND SMOKERS

| Group | Number | Cholesterol concentration (mg./100ml.) | |
|---|---|---|---|
| | | Mean | S.D. |
| Non-smokers | 15 | 201.5333 | ± 29.7319 |
| Ex-smokers | 27 | 212.9259 | ± 29.2982 |
| Smokers | 22 | 206.9545 | ± 28.2379 |
| Total | 64 | | |

## Multivariate Analysis of the Relationship Between the Variates and the Presence of Hyperlipoproteinemia

Multivariate canonical correlation analysis was conducted to determin the relationship between selected combinations of the variates and the presence of hyperlipoproteinemia. (Table XXVII).

TABLE XXVII

CANONICAL CORRELATIONS INDICATING THE RELATIONSHIP BETWEEN SELECTED COMBINATIONS OF THE VARIATES AND THE CRITERION VARIABLES

| Variables | Canonical correlations | Significance P 0.05 |
|---|---|---|
| Triglycerides, cholesterol, percent sucrose and blood glucose | 0.38246 | S. |
| Triglycerides, cholesterol, percent starch and blood glucose | 0.37440 | N.S. |
| Triglycerides, cholesterol, percent sucrose and P:S ratio | 0.14526 | N.S. |
| Triglycerides, cholesterol, percent sucrose and percent fat | 0.28366 | N.S. |
| Triglycerides, cholesterol, percent alcohol, percent sucrose, P:S ratio | 0.22999 | N.S. |
| Triglycerides, cholesterol, percent fat and P:S ratio | 0.28922 | N.S. |
| Triglycerides, cholesterol, ponderal index and exercise | 0.48464 | S. |
| Triglycerides, cholesterol, ponderal index, exercise, percent fat and percent alcohol | 0.48534 | S. |
| Triglycerides, cholesterol, ponderal index, exercise, percent fat, percent alcohol and calories | 0.49738 | S. |

Sucrose as percent total carbohydrate and blood glucose

The dietary intake of sucrose has been suggested as a risk factor to the presence of hyperlipoproteinemia (Kaufmann and Kapitulnik, 1972; Bolzana et al., 1972). Non relationship between this individual variate and the criterion variables was revealed by analysis of t-distribution.

Multivariate analysis was conducted to determine the relationship of sucrose as percent total carbohydrate plus fasting blood glucose to the criterion variables. The canonical correlation of this relationship was found to be significant at the 0.039 level. However, it would appear from the individual coefficients that this correlation is mainly influenced by the fasting blood glucose rather than the dietary intake of sucrose.

Starch as percent total carbohydrate plus blood glucose

A similar relationship was researched between starch as percent total carbohydrate plus fasting blood glucose and the criterion variables (triglyceride and cholesterol concentrations). The canonical correlation obtained here was found to be non-significant at the 0.05 level.

It has been suggested that a high carbohydrate intake tends to elevate plasma triglyceride levels, high sucrose and glucose having a more hyperlipidemic effect than a high starch intake (Nikkila and Kekki, 1973). Therefore, the fact that

sucrose as percent total carbohydrate and fasting blood glucose were found in this study to be related to the criterion variables while starch as percent total carbohydrate plus fasting blood glucose were not is an interesting observation.

Although hypotheses one and five were rejected, it does appear that the dietary sucrose may have a role to play in determining the blood lipid levels. However, the relationship is not clear. From these observations it would appear that the combination of various risk factors, including dietary sucrose and starch, is important when studying the possible determinants of hyperlipoproteinemia.

Sucrose as percent total carbohydrate and P:S ratio

The individual dietary variates were found to be unrelated to the criterion variables by analysis of t-distribution. Therefore, the relationship between combinations of dietary factors and the blood lipid levels were investigated to observe if an accumulative effect of the dietary variates was present. The canonical correlation between sucrose as percent total carbohydrate plus P:S ratio and the criterion variables was found to be non-significant at the 0.05 level. In addition, analysis of the data obtained in this study does not indicate any relationship between the P:S ratio and serum triglyceride and cholesterol concentration.

Sucrose as percent total carbohydrate plus fat as percent calories

No relationship was observed between these variates and the criterion variables when treated by canonical correlation analysis.

Alcohol as percent calories, sucrose as percent total carbohydrate and P:S ratio

Multivariate analysis showed no significant correlation between these variates and the criterion variables at the 5% level of significance. Similarly, the three dietary variates when observed individually by Pearson product moment correlation coefficient were found to be unrelated to either triglyceride or cholesterol concentration.

Fat as percent total calories and P:S ratio

No significant relationship at the 0.05 level of significance was found between these variates and the criterion variables using canonical correlation analysis. Also the two dietary factors, when observed individually, were found to be unrelated to either triglyceride or cholesterol concentration or to hyperlipoproteinemia. Therefore, the analysis of the data obtained in this study does not support the view that fat as percent total calories and/or P:S ratio are related to the presence of hyperlipoproteinemia (Kannel, 1971; Sherwin, 1974).

Ponderal index and exercise

A significant relationship was observed when the triglyceride plus cholesterol concentration and ponderal index plus exercise were studied as two separate sets of variables. The eigenvalue of this relationship was 0.23487 thereby showing that approximately 23% of the variance of triglyceride and cholesterol concentration was accounted for by the ponderal index and exercise. This further supports the strong relationship (observed by analysis of t-distribution) of ponderal index and exercise to the presence of hyperlipoproteinemia.

Ponderal index, exercise, percent fat and percent alcohol

When the relationship of ponderal index, exercise, fat as percent total calories and alcohol as percent total calories to triglyceride and cholesterol concentration was investigated by canonical correlation the association was found to be significant. However, the eigenvalue was approximately the same as when only ponderal index and exercise were used as the variables of the second set. This suggests that the significant relationship found here was mainly due to the effect of ponderal index and exercise rather than to the dietary intake of fat and alcohol.

Percent fat, percent alcohol, calories, exercise and ponderal index

The eigenvalue of the correlation between the first set of canonical variables (triglyceride and cholesterol concentration) and the second set of canonical variables (ponderal

index, exercise, fat as percent calories, alcohol as percent calories and total calories) was 0.24739. This was only slightly increased from the value observed when only ponderal index and exercise were used as the variables of the second set. This observation suggests that, of the variables studied, ponderal index and exercise are the major determinants of triglyceride and cholesterol concentration while percent alcohol, percent fat and calories have little effect.

### Multiple Regression Analysis of the Relationship of Selected Variate Combinations to the Individual Criterion Variables

The results of multiple regression analysis of selected variates and the triglyceride concentration is shown in Table XXVIII. Although calories, ponderal index and exercise combined are shown to be associated with serum triglyceride concentration it can be seen that this equation is significantly affected by the ponderal index. The F-ratio of the analysis of variance between the ponderal index and triglyceride concentration is significant at the 0.05 level. Therefore, ponderal index rather than calories and exercise is affecting the significant relationship found from the multivariate analysis of the association of ponderal index, calories and exercise to triglyceride concentration.

A similar effect can be observed in the relationship of calories and ponderal index to triglyceride concentration. Therefore, although several combinations of the suggested

risk factors of hyperlipoproteinemia have been studied in this survey, no composite of variates has been shown to have an association with the serum triglyceride concentration.

TABLE XXVIII

MULTIPLE REGRESSION ANALYSIS SHOWING RELATIONSHIP BETWEEN SELECTED VARIATES AND THE SERUM TRIGLYCERIDE CONCENTRATION

| Dependant variable | Variates | F-ratio | Significance P 0.05 | F-ratio of individual variates | Significance P 0.05 |
|---|---|---|---|---|---|
| Triglycerides | Calories | 3.87314 | S. | 0.026 | N.S. |
| | P.I.[a] | | | 9.211 | S. |
| | Exercise | | | 0.569 | N.S. |
| Triglycerides | Calories | 0.30111 | N.S. | 0.006 | N.S. |
| | Height | | | 0.547 | N.S. |
| Triglycerides | Calories | 5.56439 | S. | 0.099 | N.S. |
| | P.I. | | | 11.064 | S. |
| Triglycerides | Calories | 0.57745 | N.S. | 0.312 | N.S. |
| | Percent sucrose | | | 1.099 | N.S. |
| Triglycerides | Calories | 0.15324 | N.S. | 0.081 | N.S. |
| | Percent starch | | | 0.252 | N.S. |
| Triglycerides | Calories | 0.03527 | N.S. | 0.068 | N.S. |
| | P:S ratio | | | 0.016 | N.S. |
| Triglycerides | Calories | 1.33820 | N.S. | 0.063 | N.S. |
| | Percent fat | | | 2.620 | N.S. |
| Triglycerides | Percent alcohol | 1.15217 | N.S. | 2.248 | N.S. |
| | Calories | | | 0.118 | N.S. |

[a]ponderal index.

Sherwin (1974) and Kannel (1971) suggested that one of the components of an anti-atherogenic diet should be a fat content of less than 30% of the total calories. It should

be noted from the above table that, although insignificant, there is the suggestion of a relationship between fat consumed as percent total calories and the serum triglyceride concentration. Such a suggested association was not observed between dietary fat and serum cholesterol concentration.

The multiple regression analysis also exhibited the suggestion of a relationship between alcohol as percent of total calories and the serum triglyceride concentration. Albrink (1974) suggested that alcohol may raise triglyceride levels. Sixty-four percent of the participants of this study did not partake of any alcohol. Therefore, the failure to find a significant correlation between alcohol as percent total calories and the triglyceride concentration may be due to the small percentage of the respondents exhibiting an extremely wide range of alcohol consumption.

Little significant correlation was seen between selected combinations of variates and the serum cholesterol concentration (Table XXIX). Again ponderal index appears to have played an important role in influencing the significant correlations seen when multivariate analysis using calories, ponderal index and exercise or calories and ponderal index data was conducted. In addition however, exercise also has an effect when the relationship between calories, ponderal index and exercise and the serum cholesterol concentration was studied. This further strengthens the significant

TABLE XXIX

MULTIPLE REGRESSION ANALYSIS SHOWING RELATIONSHIP BETWEEN SELECTED VARIATES AND THE SERUM CHOLESTEROL CONCENTRATION

| Dependant variable | Variates | F-ratio | Significance P 0.05 | F-ratio of individual variates | Significance P 0.05 |
|---|---|---|---|---|---|
| Cholesterol | Calories | 4.89725 | S. | 0.826 | N.S. |
| | P.I. | | | 4.162 | S. |
| | Exercise | | | 5.644 | S. |
| Cholesterol | Calories | 1.77570 | N.S. | 0.871 | N.S. |
| | Height | | | 1.995 | N.S. |
| Cholesterol | Calories | 4.20390 | S. | 1.798 | N.S. |
| | P.I. | | | 6.734 | S. |
| Cholesterol | Calories | 0.77005 | N.S. | 1.490 | N.S. |
| | Percent sucrose | | | 0.032 | N.S. |
| Cholesterol | Calories | 0.79870 | N.S. | 1.569 | N.S. |
| | Percent starch | | | 0.088 | N.S. |
| Cholesterol | Calories | 1.25130 | N.S. | 2.158 | N.S. |
| | P:S ratio | | | 0.971 | N.S. |
| Cholesterol | Calories | 1.40587 | N.S. | 2.307 | N.S. |
| | Percent fat | | | 1.273 | N.S. |
| Cholesterol | Calories | 0.76170 | N.S. | 1.478 | N.S. |
| | Percent alcohol | | | 0.016 | N.S. |

relationship between cholesterol and exercise observed by the Pearson product moment correlation coefficient analysis - a relationship which was not observed between exercise and triglyceride levels.

## Limitations of the Study

The investigator was aware of the following limitations in this study:

1. To prevent seasonal variation of dietary data obtained during the study, interviews were conducted during the period of May 1 to October 16, 1975. Therefore, the sample population was restricted by the number of patients admitted for cardiac catheterization during that time.

2. The at-risk population investigated introduced bias to the study.

3. Elimination of subjects from the study was based on the criteria established for the study. This further reduced the amount of material available for data analysis.

4. It is unlikely that slight correlations between the variates and the criterion variables will be observed with a population of sixty-four.

5. Two types of dietary data collection had to be

used due to difficulties in contacting the subjects.

6. Habitual physical activity is difficult to assess in a cardiac at-risk population.

# CHAPTER V

# SUMMARY AND IMPLICATIONS

This chapter contains a brief commentary of the purpose, design and major findings of the study reported herein. Conclusions that may be drawn and implications that became apparent from the interpretation of the findings will also be discussed.

## Summary

The associational study was conducted to investigate the relationship of nutritional practices and related demographic variables to the presence of hyperlipoproteinemia. The subjects investigated were men aged thirty to sixty years who had been admitted to St. Paul's Hospital for cardiac catheterization under the care of Dr's A. Dodek, J Boone, D. Peretz and D. Kavanagh-Gray.

The following objectives were established for investigation of the problem:

1. To determine the relationship between the amount of sucrose in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.
2. To determine the relationship between the amount of fat in the diet, as percent of total calories, and the presence of hyperlipoproteinemia.

3. To determine the relationship between the P:S ratio in the diet and the presence of hyperlipoproteinemia.

4. To determine the relationship between the caloric content of the diet and the presence of hyperlipoproteinemia.

5. To determine the relationship between the amount of starch in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.

6. To determine the relationship between ponderal index and the presence of hyperlipoproteinemia.

7. To determine the relationship between the amount of alcohol consumed, as percent of total calories, and the presence of hyperlipoproteinemia.

8. To determine the relationship between physical activity and the presence of hyperlipoproteinemia.

9. To determine the relationship between smoking and the presence of hyperlipoproteinemia.

10. To determine the nature of the interrelationships between these factors and the presence of hyperlipoproteinemia.

Data collection instruments were designed for this study to assess the nutritional practices, anthropometric status and obtain the required demographic information. One interview was conducted with each subject immediately following

his admission to hospital. The interviews were completed between May 1 and October 16, 1975. The sample consisted of ninety-one subjects, twenty-seven of whom had to be eliminated from the study in order to control bias.

Nutritional practices were assessed from either the final day of the three-day food record or from the twenty-four hour dietary recall. The three-day food record or twenty-four hour recall was cross-checked with a dietary history taken during the interview with the subject.

Anthropometric status was determined from the height, weight, tricep skinfold thickness and arm circumference measurements obtained by the researcher during the one interview conducted with the subject.

The extent of physical activity habitually undertaken by the subject was assessed with the aid of a questionnaire. Data pertaining to smoking, family history of heart disease, age and medications taken by the subject were obtained during the interview. The fasting blood glucose, serum cholesterol and serum triglyceride levels were obtained by St. Paul's Hospital laboratory.

The data were treated statistically to test the following research hypotheses:

1. There will be a positive relationship between the amount of sucrose in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.

2. There will be a positive relationship between the amount of fat in the diet, as percent of total calories, and the presence of hyperlipoproteinemia.
3. There will be a negative relationship between the P:S ratio in the diet and the presence of hyperlipoproteinemia.
4. There will be a positive relationship between the caloric content of the diet and the presence of hyperlipoproteinemia.
5. There will be a negative relationship between the amount of starch in the diet, as percent of total carbohydrate, and the presence of hyperlipoproteinemia.
6. There will be a negative relationship between ponderal index and the presence of hyperlipoproteinemia.
7. There will be a positive relationship between the amount of alcohol consumed, as percent of total calories, and the presence of hyperlipoproteinemia.
8. There will be a negative relationship between physical activity and the presence of hyperlipoproteinemia.
9. There will be a positive relationship between smoking and the presence of hyperlipoproteinemia.

The relationship between the two criterion variables was investigated using the Pearson product moment correlation coefficient as was the relationship between the variates. The correlation of selected variates to the presence of hyperlipoproteinemia was assessed by correlation analysis and

investigation of the t-distribution.

Analysis of the relationship of selected variates to the individual criterion variables was conducted with the use of the Pearson product moment correlation coefficient. Multivariate canonical correlation analysis was used to determine the relationship of selected combinations of the variates to the presence of hyperlipoproteinemia. The relationship of selected combinations of the variates to the individual criterion variables was explored using multiple regression analysis. All hypotheses were tested at the 5% level of significance.

The major findings of the study were:

1. 64% of the subjects exhibited a serum triglyceride level beyond the range accepted as normal by St. Paul's Hospital laboratory, while only 3% had abnormally high serum cholesterol levels.

2. A positive correlation between serum triglyceride and cholesterol concentration was observed at the 0.002 level of significance.

3. The range of carbohydrate consumption was extremely wide extending from a daily consumption of 89 gm. to 546 gm.

4. No significant correlation was observed between the consumption of sucrose or starch as percent carbo-

hydrate and the presence of hyperlipoproteinemia. A similar observation was made when the two criterion variables were considered individually.

5. A wide dispersion was observed in fat consumption with the fat as percent total calories ranging from 18.97 to 67.12%.

6. No significant correlation was observed between fat as percent total calories and the presence of hyperlipoproteinemia. However, during multiple regression analysis the suggestion (between the 10 and 20% level of significance) of a relationship between fat as percent total calories and the triglyceride concentration was seen.

7. 95% of the participants consumed a diet containing a P:S ratio of less than 1. The mean P:S ratio observed in the study was 0.287.

8. No significant correlation was observed between the dietary P:S ratio and the presence of hyperlipoproteinemia.

9. The daily caloric intake was extremely varied ranging from 922 to 5408 calories. No association was seen between calories and ponderal index or calories and exercise.

10. No significant correlation was revealed between caloric consumption and the presence of hyperlipoproteinemia, between caloric consumption plus ponderal index and the presence of hyperlipoproteinemia or between caloric consumption, ponderal index plus exercise and the presence of hyperlipoproteinemia.

11. The distribution of alcohol consumption was very uneven. 64% of the participants consumed no alcohol at all while the highest daily intake of alcohol was 108 gm.

12. No significant correlation was identified between consumption of alcohol as percent total calories and the presence of hyperlipoproteinemia. However, multiple regression analysis revealed a slight suggestion (between the 10 and 20% level of significance) of association between alcohol as percent total calories and the serum triglyceride concentration.

13. No significant correlation was observed between smoking and the presence of hyperlipoproteinemia.

14. Physical activity demonstrated a negative relationship to the presence of hyperlipoproteinemia. 23% of the participants were classed as sedentary and 28% as low moderately active. When the

criterion variables were treated separately, a significant correlation was observed between physical activity and cholesterol concentration, but not triglyceride concentration.

15. Exercise and ponderal index showed no correlation at the 0.05 level of significance but a positive correlation was observed at the 0.063 significance level.

16. Although 67% of the participants reported a family history of heart disease, no significant correlation was shown to exist in this study between family history of heart disease and the presence of hyperlipoproteinemia.

17. No significant correlation was observed between age and the presence of hyperlipoproteinemia. However, a positive correlation between age and serum cholesterol concentration was observed although no such observation was made between age and serum triglyceride concentration.

18. Fasting blood glucose data demonstrated a positive correlation with the presence of hyperlipoproteinemia. When the criterion variables were studied individually a positive correlation was observed between fasting blood glucose and serum triglyceride concentration but no such observation could be made

between fasting blood glucose and serum cholesterol concentration.

19. A negative correlation was observed between ponderal index and the presence of hyperlipoproteinemia. This observation was supported by individual relationships of ponderal index to serum cholesterol and serum triglyceride concentrations.

20. Skinfold thickness was shown to be positively related to the presence of hyperlipoproteinemia. A relationship between skinfold thickness and physical activity was also observed.

21. No significant correlation was observed between selected combinations of the variates and the presence of hyperlipoproteinemia.

## Implications

The findings of this study will be of interest to the nutritionist concerned with the prevention and treatment of coronary heart disease. The range in carbohydrate intake, including the type of carbohydrate consumed, as well as the wide dispersion in the dietary content of fat, indicates a great variation in the intake of men within this age group. In addition, the low P:S ratio observed throughout this survey and the wide range of alcohol and caloric consumption reveal some interesting points to consider.

The results of the survey, however, also indicate that the relationship of nutritional factors to the presence of hyperlipoproteinemia must be carefully evaluated. Several anti-atherogenic dietary guidelines have been suggested (Committee on Nutrition, American Heart Association, 1974; Kannel, 1971; Sherwin, 1974). The widespread practise of these guidelines would entail manipulation of the lifestyle of an entire population. Therefore, strong evidence of the relationship of these dietary factors to the presence of hyperlipoproteinemia or to demographic factors which are themselves related to the serum lipid levels is required.

The anthropometric status of the group observed suggests that a large number of men within this age group could be classed as overweight. Also, the physical activity data revealed a high percentage of the participants to be in the sedentary or low moderately active groups.

The proportion of ex-smokers among the respondents appeared to be a result of the wide-spread public health education regarding smoking which has been undertaken in recent years.

The data related to lipid levels obtained during the study will be of interest to the physician. It has been suggested that the serum levels of both triglyceride and cholesterol increases with age (Lewis et al., 1974; Levy, 1973). However, although 56% of the respondents were in

the 50-59 year age-group, 64% of the subject exhibited abnormally high serum triglyceride levels while only 3% showed high levels of cholesterol.

The following implications became apparent from the interpretation of the findings of this study:

1. Serum triglyceride as well as cholesterol concentration should be considered when evaluating the antherogenic status of an individual. This implication supports the recommendation of Levy, Bonnell and Ernst (1971) and Iammarino (1975).

2. Achievement and maintenance of ideal body weight should be regarded as an important recommendation for reduction of the incidence of hyperlipoproteinemia.

3. Physical activity is significantly related to the presence of hyperlipoproteinemia as well as to the tricep skinfold thickness. Therefore, this factor should be considered when evaluating the risk factors of hyperlipoproteinemia.

4. These two variates, exercise and ideal body weight, provide excellent points at which intervention be be introduced.

5. A positive correlation was observed between fasting blood glucose and serum triglyceride concentration. Therefore, the presence and, if necessary, treatment

of high serum triglyceride concentration should be considered in the individual who displays an abnormal glucose metabolism.

Recommendations for additional research in this area include:

1. A survey of larger population size should be undertaken to observe the relationship of fat as percent total calories, alcohol as percent total calories and carbohydrate as percent total calories to the serum triglyceride and cholesterol concentration.

2. More extensive accurate food composition tables for sucrose and starch should be developed to assist in studies similar to that reported herein.

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# LITERATURE CITED

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# APPENDIX A

# DATA COLLECTION INSTRUMENTS

FOOD RECORD FOR ____ DAYS

DATE _____

NAME _____

CODE NUMBER_____

STUDY NUMBER _____

# HOW TO RECORD FOODS EATEN

STATE THE KIND OF FOOD EATEN:

EXAMPLES: MILK - WHOLE, SKIM OR CHOCOLATE, ETC.
- STATE IF MILK HAS VITAMIN D ADDED.

CREAM - WHIPPING, TABLE CREAM, CEREAL CREAM.

CHEESE - CHEDDAR, CHEESE SPREAD, COTTAGE CHEESE, MOZARELLA.

FRUIT - APPLESAUCE, BANANA, VITAMINIZED APPLE JUICE ORANGE JUICE.

VEGETABLES - PEAS, FRIED OR BAKED POTATOES, RAW OR COOKED CARROTS.

BREAD - WHITE, WHOLE WHEAT, HOVIS, CRUSTY ROLL.

BUTTER OR MARGARINE.

CEREALS - SUGAR POPS, QUICK CREAM OF WHEAT, SHREDDED WHEAT.

MEAT, FISH,POULTRY, EGGS - HAMBURGER, SAUSAGES, FRIED CHICKEN, PORK LIVER, SCRAMBLED EGGS, FISH STICKS, COD FILLETS.

MISCELLANEOUS - STRAWBERRY JAM, SUGAR, GRAVY, FRENCH DRESSING, PUMPKIN PIE, OATMEAL COOKIES, TOFFEE, CHOCOLATE SUNDAE, COKE, TEA.

NUTRITIONAL SUPPLEMENTS - COD-LIVER OIL, GERITOL, VITAMIN PILLS.

NOTE: IF YOU ARE NOT SURE OF THE DETAILS, STATE THE BRAND NAME.

STATE THE AMOUNT OF FOOD EATEN:

EXAMPLES: MILK - 1 CUP, ½ PINT, 1 SMALL OR LARGE GLASS.

CREAM - 1 TABLESPOON (IN COFFEE)

CHEESE - 1 " CUBE CHEDDAR OR 1 TABLESPOON CREAM CHEESE.

FRUIT - ½ CUP PEACHES, 1 SMALL APPLE, 1 SMALL GLASS GRAPEFRUIT JUICE, 12 GRAPES.

VEGETABLES - ½ CUP TURNIP, 2 SLICES CUCUMBER, ½ CUP COOKED CABBAGE, 1 MEDIUM BAKED POTATO.

BREAD - 2 SLICES, 1 MEDIUM ROLL.

BUTTER OR MARGARINE - 1 TABLESPOON, 3 TEASPOONS, 2 PATS.

CEREALS - 1 CUP OATMEAL PORRIDGE, 1 SHREDDED WHEAT BISCUIT.

MEAT, FISH, POULTRY, EGGS - 3 SAUSAGES, 1 PORK CHOP 1 SMALL SERVING OF ROAST BEEF, 1½ CUPS BEEF STEW WITH 4 - 1" CUBES BEEF (WITH ½ CUP POTATOES AND ¼ CUP CARROTS.

MISCELLANEOUS - 1 TEASPOON JAM, 1 TABLESPOON BROWN SUGAR, 3 OATMEAL COOKIES, ½" WEDGE CHOCOLATE BAR (10¢), 10¢ BAG OF POTATO CHIPS, ¼ CUP PEANUTS, 1 BOTTLE ORANGE, 1 CUP TEA.

NUTRITIONAL SUPPLEMENT: 1 TEASPOON, 5 DROPS, 1 PILL. STATE THE AMOUNT OF VITAMIN IN DOSAGE EXAMPLE: 400 I.U. VITAMIN D, 12 MG IRON.

DESCRIBE COMBINATIONS OF FOOD EATEN:

EXAMPLE: MILK - ½ CUP MILK ON OATMEAL PORRIDGE.
- 1 CUP MILK IN CREAM OF TOMATO SOUP.
CREAM - 1 TABLESPOON IN COFFEE.
CHEESE - 1 CUP MACARONI AND CHEESE.
FRUIT - ½ CUP FRUITCUP (¼ ORANGE, 3 GRAPES)
VEGETABLE - ½ CUP COLESLAW (¼ CUP RAW CABBAGE, ¼ CUP RAW CARROT, SALAD DRESSING)
BREAD - 1 SANDWICH (2 SLICES BROWN BREAD, WITH MARGARINE AND 1 SLICE OF BOLOGNA OR ½ CUP EGG FILLING)
CEREALS - ½ CUP CORNFLAKES AND ¼ CUP RAISINS.
MEAT, FISH, POULTRY, EGGS - 1 CUP BAKED BEANS AND PORK, 1 CUP TUNA CASSEROLE (NOODLES, PEAS AND TUNA), 1 CUP BEEF MEAT LOAF WITH ¼ CUP TOMATO SAUCE.
MISCELLANEOUS - ½ CUP BAKED APPLE PUDDING WITH OATMEAL TOPPING, CHOCOLATE COATED 10¢ ICE CREAM CONE.
NUTRITIONAL SUPPLEMENTS - 1 PILL WITH VITAMIN D (400 I.U.), A (4,000 I.U.) AND C(75 MG).

Day 1

Nutritional Supplements and Medications

Day 2

Nutritional Supplements and Medications

Day 3

Nutritional Supplements and Medications

INTERVIEW FORM

STUDY NO. _____ DATE _____

HOSPITAL NO. _____

AGE _____

HEIGHT _____ WEIGHT _____

TRICEP SKINFOLD THICKNESS _____ ARM CIRCUMFERENCE _____

CIGARETTES: YES _____ NO _____ HOW LONG _____

PIPE TOBACCO: YES _____ NO _____ HOW LONG _____

NUMBER OF PIPES PER DAY _____

CIGARS: YES _____ NO _____ HOW LONG _____ NO. PER DAY _____

FAMILY HISTORY YES _____ NO _____

MEMBER OR MEMBERS _____

MEDICATIONS _____

HOW LONG _____

PHYSICAL ACTIVITY:

Sedentary: work and leisure. Under 5 flights of stairs or $\frac{1}{2}$ mile walking per day _____ How long _____

Low Moderate: Between 5 and 15 flights of stairs or $\frac{1}{2}$ to $1\frac{1}{2}$ miles of walking or comparable activity per day. _____

How long _____

High Moderate: Programmed exercise 4 times per week or $1\frac{1}{2}$ to 2 miles or 15 to 20 flights of stairs or comparable daily activity _____ How long _____

Vigorous: Greater than Moderate. _____ How long _____

THERAPEUTIC DIET (if any) _____ How long _____

IMPRESSION OF INTERVIEW _____

BLOOD PRESSURE: DIASTOLIC _____ SYSTOLIC _____

FASTING SERUM TRIGLYCERIDE _____

FASTING SERUM CHOLESTEROL _____

FASTING BLOOD GLUCOSE _____

ospital No. _____ Date _____

urvey No. _____

| | Food | Average Portion | 3x/day | 2x/day | 1x/day | 3x/wk. | 1x/wk. | seldom/never | score | | Food | Average Portion | 3x/day | 2x/day | 1x/day | 3x/wk. | 1x/wk. | seldom/never | score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Cereal | 1 cup | | | | | | | | 31 | Syrup | 1 tbsp. | | | | | | | |
| 2 | Bread | 1 slice | | | | | | | | 32 | Jam or Jelly | 1 tsp. | | | | | | | |
| 3 | Pancakes | 1x6" diam. | | | | | | | | 33 | Sugar | 1 tbsp. | | | | | | | |
| 4 | Cake | 1x2"square | | | | | | | | 34 | Ice Cream | ½ cup | | | | | | | |
| 5 | Cookies | 1 | | | | | | | | 35 | Berries(not strawberries) | 1 cup | | | | | | | |
| 6 | Pie | 1/6 pie | | | | | | | | 36 | Citrus juice or fruit | ½ cup | | | | | | | |
| 7 | Rolls, buns, muffins | 1 | | | | | | | | 37 | Other fruit or juice | ½ cup | | | | | | | |
| 8 | Sweet Rolls, doughnuts | 1 | | | | | | | | 38 | Tomato or tomato juice | ½ cup | | | | | | | |
| 9 | Crackers (any kind) | 4 | | | | | | | | 39 | Vegetable soup | 1 cup | | | | | | | |
| 10 | Macaroni and cheese | 1 cup | | | | | | | | 40 | Salad or coleslaw | ½ cup | | | | | | | |
| 11 | Spaghetti and rice | ½ cup | | | | | | | | 41 | Green veg. (no peas) | ½ cup | | | | | | | |
| 12 | Beef or lamb | 4 ozs. | | | | | | | | 42 | Yellow veg. or beets | ½ cup | | | | | | | |
| 13 | Beef stew | 1 cup | | | | | | | | 43 | Peas or corn | ½ cup | | | | | | | |
| 14 | Ham or pork | 4 ozs. | | | | | | | | 44 | Potatoes | ½ cup | | | | | | | |
| 15 | Chili or luncheon meat | 4 ozs. | | | | | | | | 45 | Dried peas or beans | ½ cup | | | | | | | |
| 16 | Sausage | 2 ozs. | | | | | | | | 46 | Candy (not chocolate) | 5 pcs. | | | | | | | |
| 17 | Liver or kidney | 2 ozs. | | | | | | | | 47 | Candy bar (chocolate) | 1 | | | | | | | |
| 18 | Bacon | 2 strips | | | | | | | | 48 | Chocolate | 1 oz. | | | | | | | |
| 19 | Shellfish | ½ cup | | | | | | | | 49 | Butter | 1 tbsp. | | | | | | | |
| 20 | Fish | 4 ozs. | | | | | | | | 50 | Margarine | 1 tbsp. | | | | | | | |
| 21 | Sardines or tuna | 2 ozs. | | | | | | | | 51 | Nuts and seeds | 2 ozs. | | | | | | | |
| 22 | Chicken or turkey | 4 ozs. | | | | | | | | 52 | Peanut butter | 1 tbsp. | | | | | | | |
| 23 | Egg | 1 | | | | | | | | 53 | Oil Dressing | 1 tbsp. | | | | | | | |
| 24 | Creamed soup | ½ cup | | | | | | | | 54 | Mayonnaise, 1000 Island | 1 tbsp. | | | | | | | |
| 25 | Whole milk | 1 cup | | | | | | | | 55 | Fried Food | | | | | | | | |
| 26 | 2% milk | 1 cup | | | | | | | | 56 | Alcohol | 2 ozs. | | | | | | | |
| 27 | Skim or buttermilk | 1 cup | | | | | | | | 57 | Beer | 12 ozs. | | | | | | | |
| 28 | Cheese (except C/C) | 1 oz. | | | | | | | | 58 | Wine | 4 ozs. | | | | | | | |
| 29 | Milk desserts | ½ cup | | | | | | | | 59 | Soft drink | 4 ozs. | | | | | | | |
| 30 | Cottage cheese | ½ cup | | | | | | | | | | | | | | | | | |

# APPENDIX B

## SUCROSE AND STARCH ESTIMATIONS

SUCROSE AND STARCH ESTIMATIONS

| Food | Estimated % of Carbohydrate Content | |
|---|---|---|
| | Sucrose | Starch |
| Alcohol | 100 | 0 |
| Cereal | 0 | 100 |
| Mayonnaise | 0 | 100 |
| Bread | 0 | 100 |
| Macaroni and cheese | 0 | 100 |
| Vegetable soup | 60 | 40 |
| Gravy | 0 | 100 |
| Chicken noodle soup | 0 | 100 |
| Cake - plain | 50 | 50 |
| Fruit pie | 50 | 50 |
| Cookies | 50 | 50 |
| Icing | 100 | 0 |
| Rice | 0 | 100 |
| Carbonated Beverage | 100 | 0 |
| Cheese whiz | 0 | 100 |
| Chocolate pudding | 50 | 50 |
| Chocolate quick | 100 | 0 |
| Pizza | 0 | 100 |
| Jam | 100 | 0 |
| Chocolate bar | 100 | 0 |
| Lemonade | 100 | 0 |
| Ketchup | 50 | 50 |
| Flour | 0 | 100 |
| Liquorice | 100 | 0 |
| Spaghetti sauce | 50 | 50 |
| Spaghetti | 0 | 100 |
| Tang | 100 | 0 |
| Cream Puff | 50 | 50 |
| Pancake | 50 | 50 |
| Olives | 100 | 0 |
| Doughnut | 50 | 50 |
| Meat Pie | 0 | 100 |
| Baked beans | 0 | 100 |

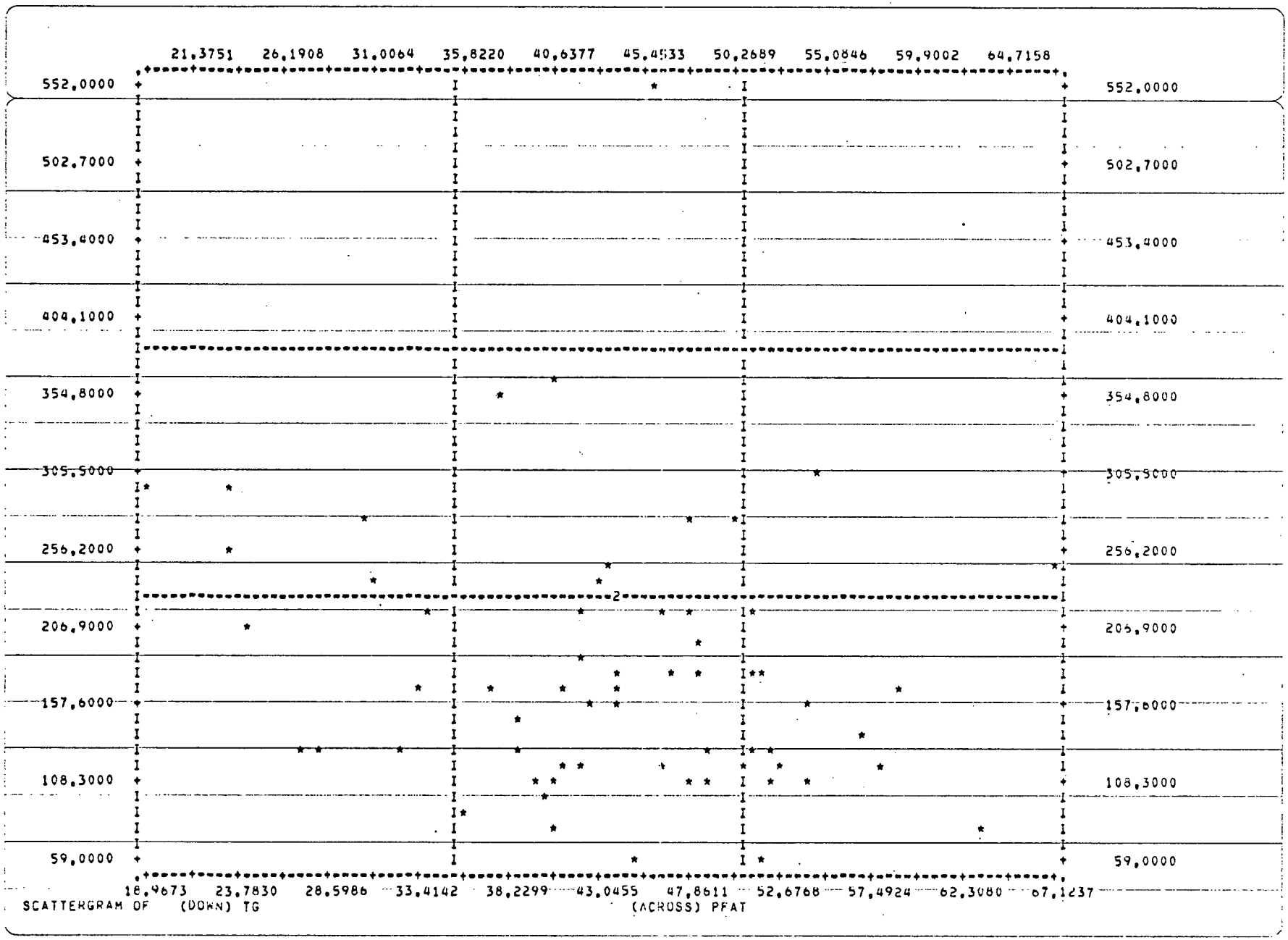
Lasagne - used macaroni and cheese figures.

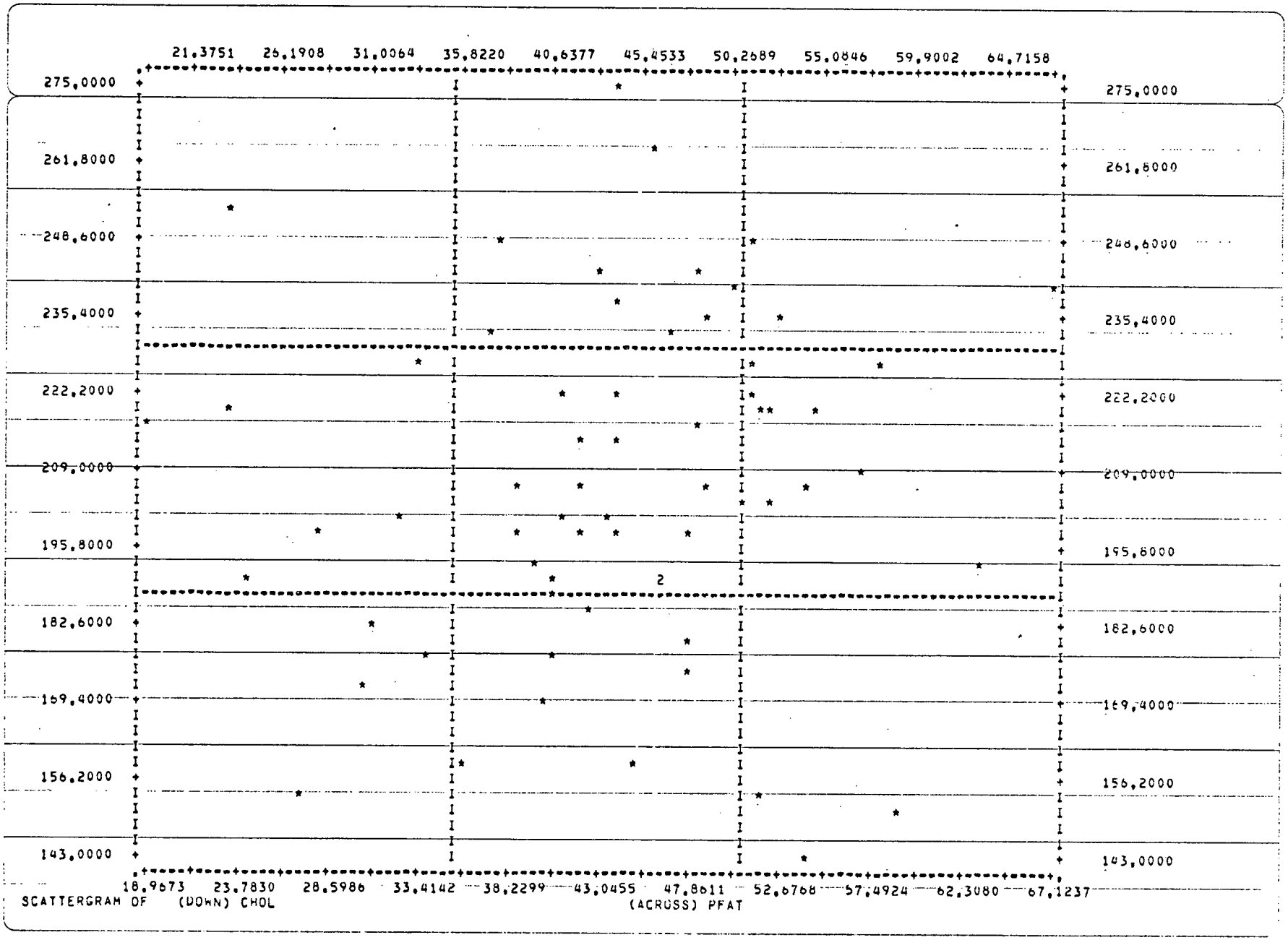
Granola - used carbohydrate content of cornflakes plus 2 tsp. sugar

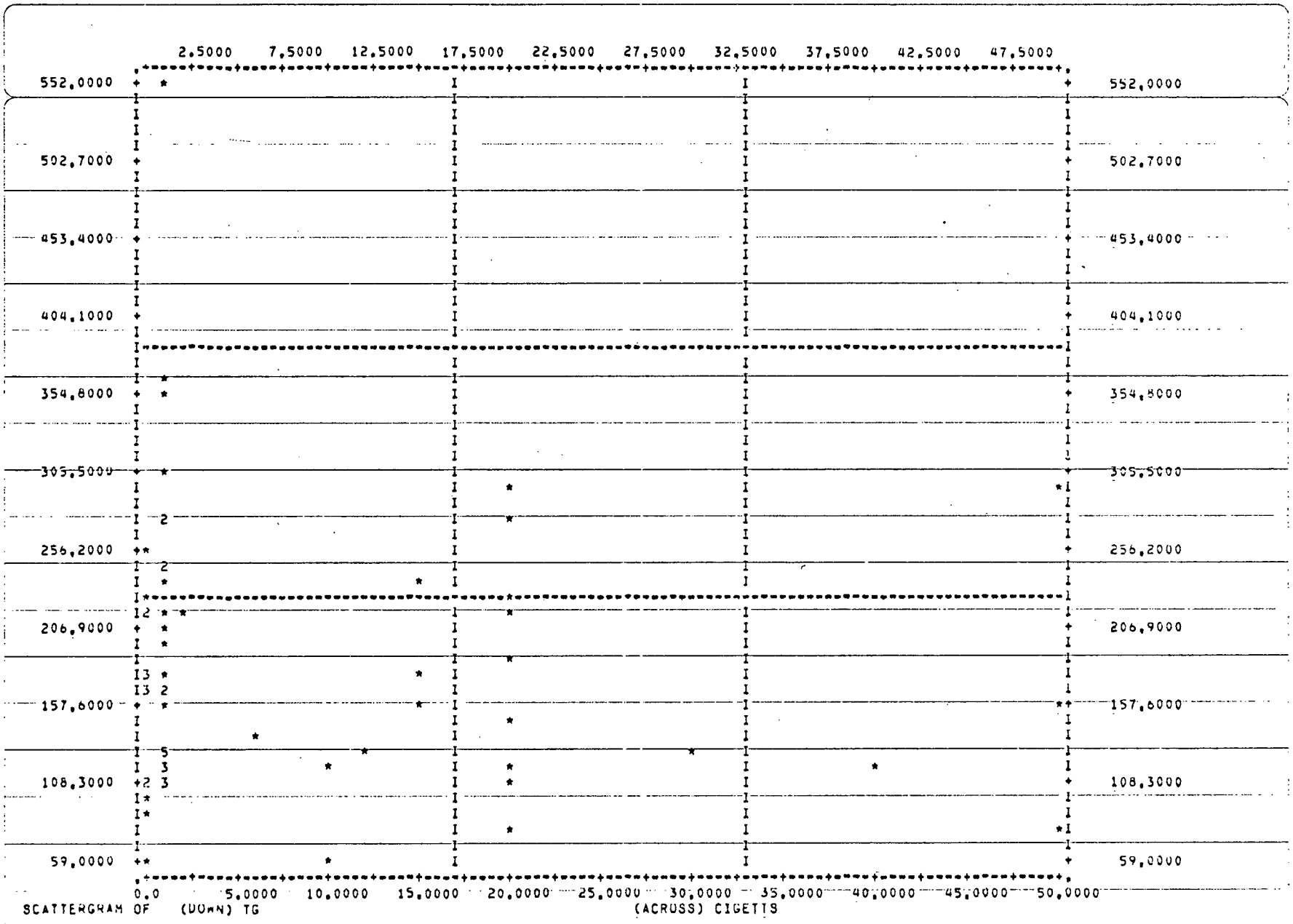
Sweet roll - calculated carbohydrate as 12.6 gm. starch and rest as sucrose.

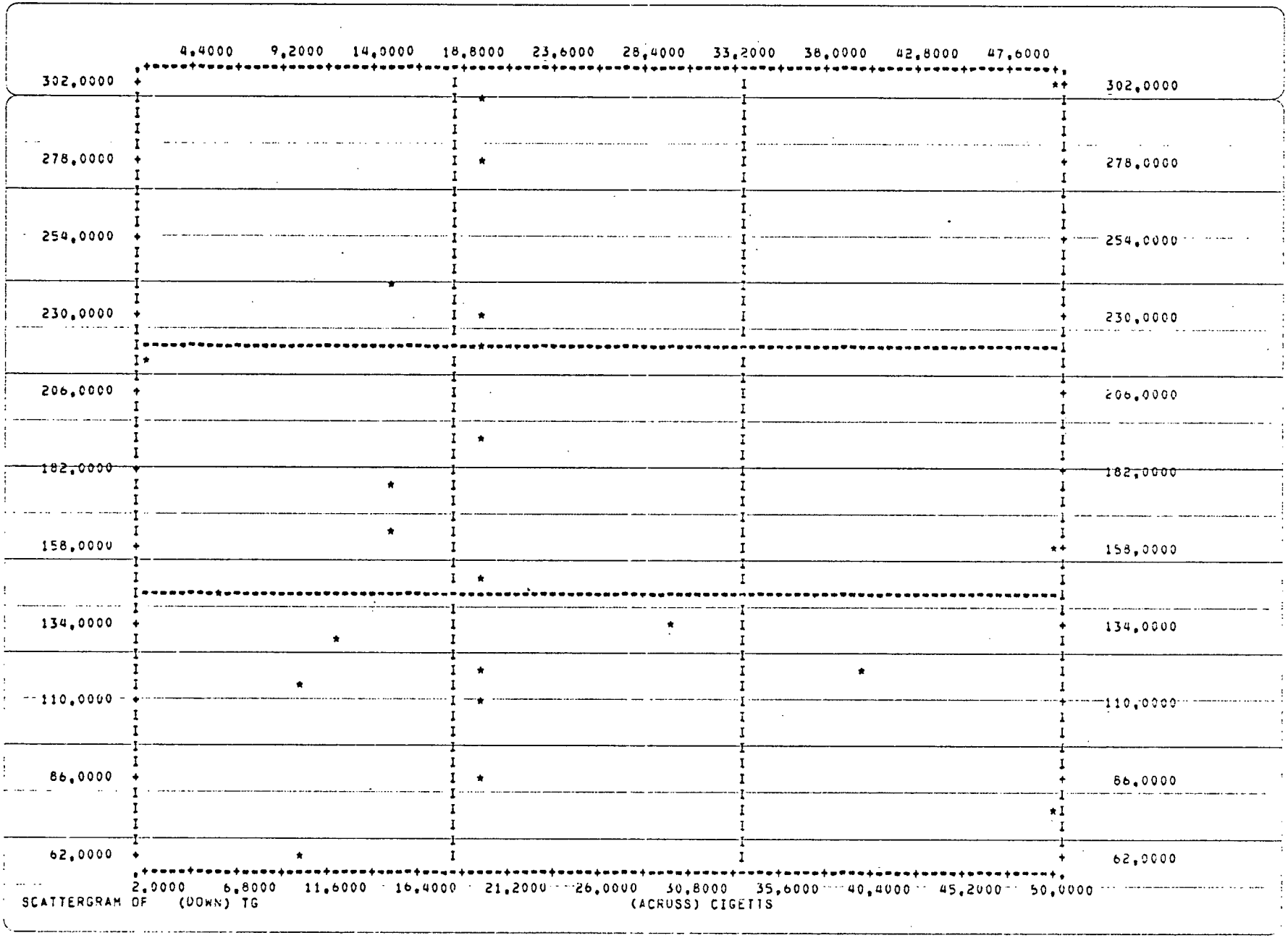
# APPENDIX C

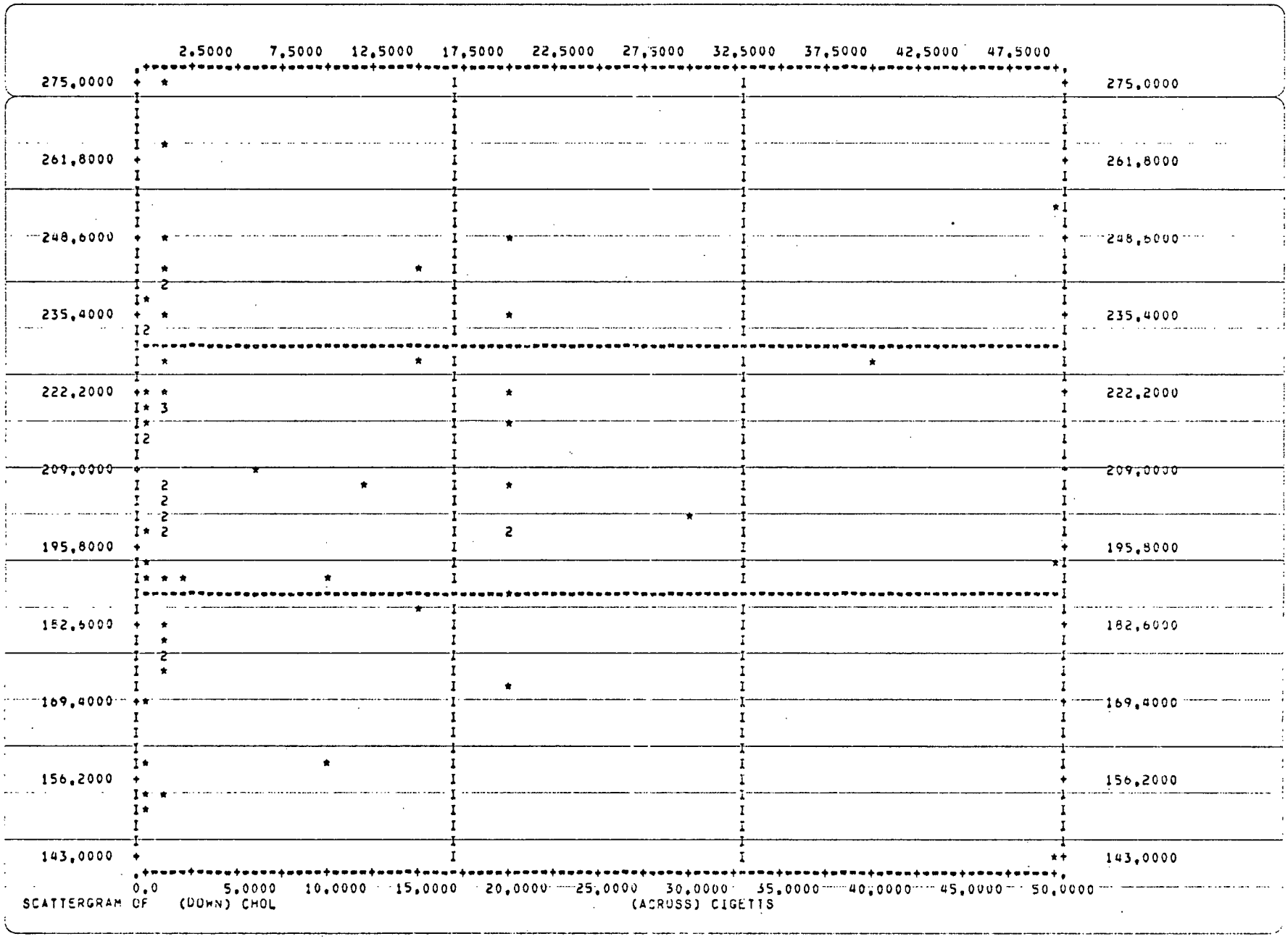
## SCATTERGRAMS SHOWING RELATIONSHIP OF SELECTED VARIATES TO THE INDIVIDUAL CRITERION VARIABLES

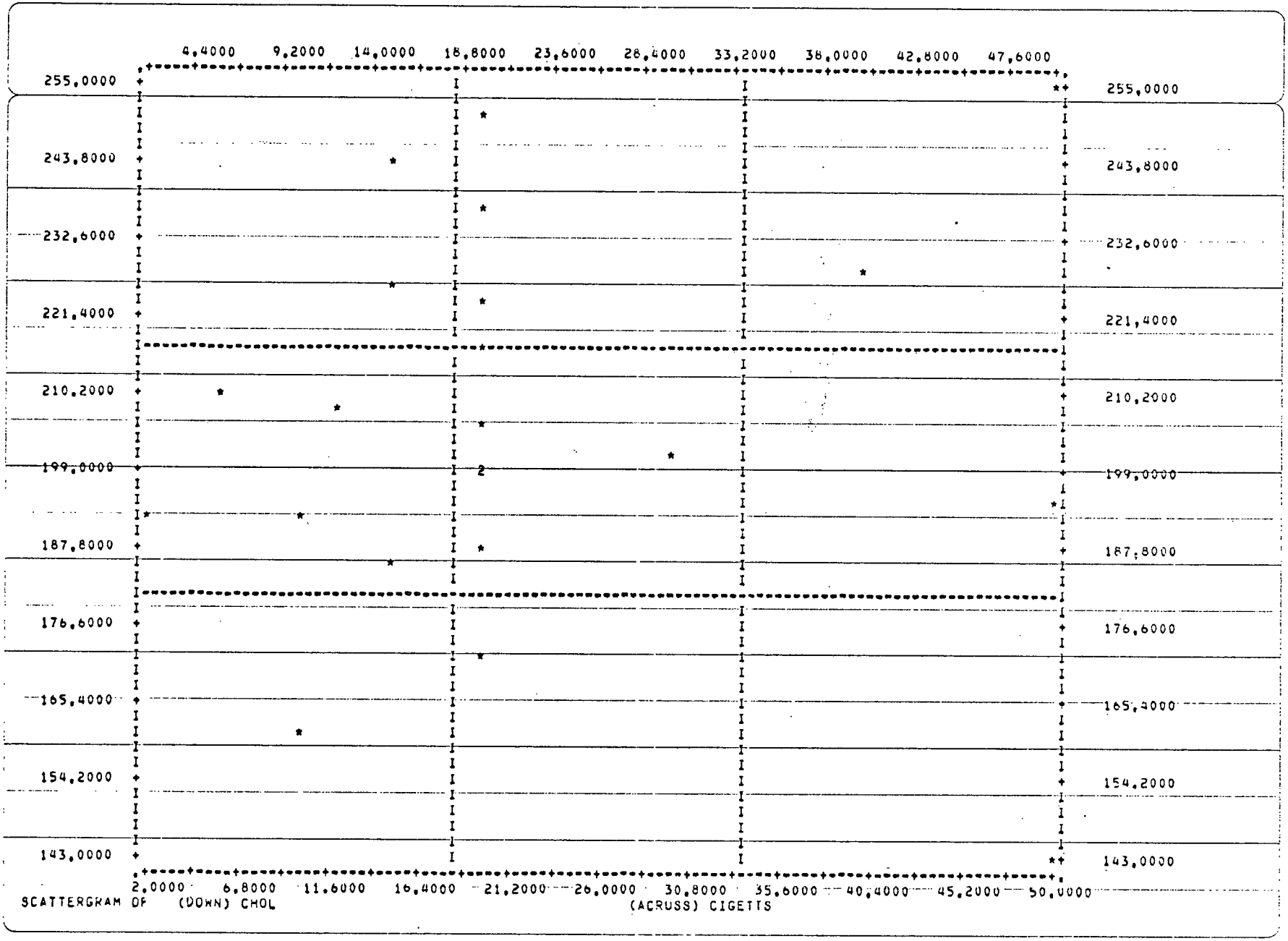

21,3751 26,1908 31,0064 35,8220 40,6377 45,4533 50,2689 55,0846 59,9002 64,7158
552,0000
502,7000
453,4000
404,1000
354,8000
305,5000
256,2000
206,9000
157,6000
108,3000
59,0000
18,9673 23,7830 28,5986 33,4142 38,2299 43,0455 47,8611 52,6768 57,4924 62,3080 67,1237
SCATTERGRAM OF (DOWN) TG
(ACROSS) PFAT


21.3751 26.1908 31.0064 35.8220 40.6377 45.4533 50.2689 55.0846 59.9002 64.7158
275.0000
261.8000
248.6000
235.4000
222.2000
209.0000
195.8000
182.6000
169.4000
156.2000
143.0000
18.9673 23.7830 28.5986 33.4142 38.2299 43.0455 47.8611 52.6768 57.4924 62.3080 67.1237
SCATTERGRAM OF (DOWN) CHOL
(ACROSS) PFAT


2,5000 7,5000 12,5000 17,5000 22,5000 27,5000 32,5000 37,5000 42,5000 47,5000
552,0000
502,7000
453,4000
404,1000
354,8000
305,5000
256,2000
206,9000
157,6000
108,3000
59,0000
0,0 5,0000 10,0000 15,0000 20,0000 25,0000 30,0000 35,0000 40,0000 45,0000 50,0000
SCATTERGRAM OF (DOWN) TG
(ACROSS) CIGETTS


4,4000 9,2000 14,0000 18,8000 23,6000 28,4000 33,2000 38,0000 42,8000 47,6000
302,0000
278,0000
254,0000
230,0000
206,0000
182,0000
158,0000
134,0000
110,0000
86,0000
62,0000
2,0000 6,8000 11,6000 16,4000 21,2000 26,0000 30,8000 35,6000 40,4000 45,2000 50,0000
SCATTERGRAM OF (DOWN) TG
(ACROSS) CIGETTS


2,5000 7,5000 12,5000 17,5000 22,5000 27,5000 32,5000 37,5000 42,5000 47,5000
275,0000
261,8000
248,6000
235,4000
222,2000
209,0000
195,8000
182,6000
169,4000
156,2000
143,0000
0,0 5,0000 10,0000 15,0000 20,0000 25,0000 30,0000 35,0000 40,0000 45,0000 50,0000
SCATTERGRAM OF (DOWN) CHOL
(ACROSS) CIGETTS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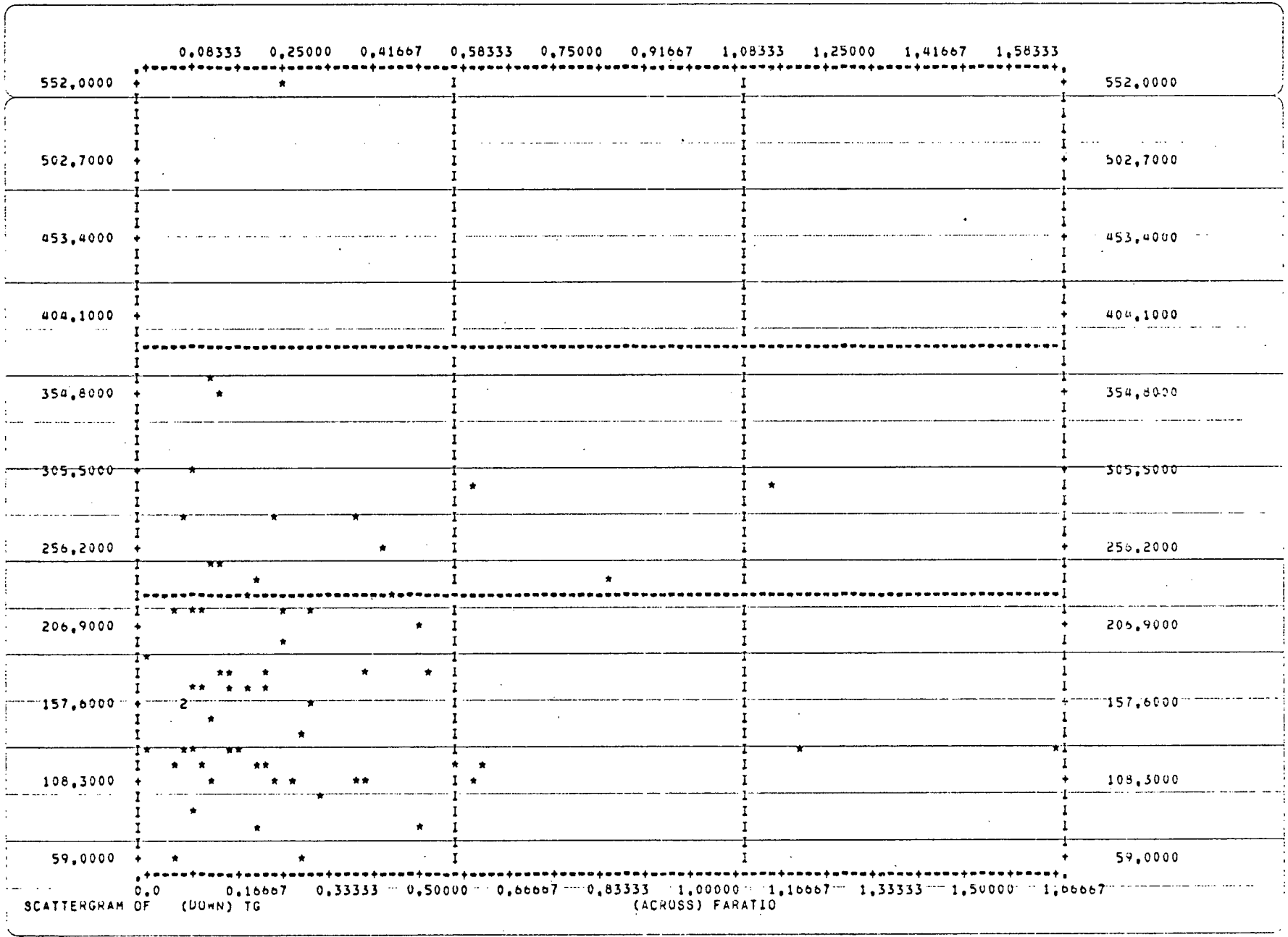
255,0000
243,8000
232,6000
221,4000
210,2000
199,0000
187,8000
176,6000
165,4000
154,2000
143,0000
2,0000 6,8000 11,6000 16,4000 21,2000 26,0000 30,8000 35,6000 40,4000 45,2000 50,0000
SCATTERGRAM OF (DOWN) CHOL
(ACRUSS) CIGETTS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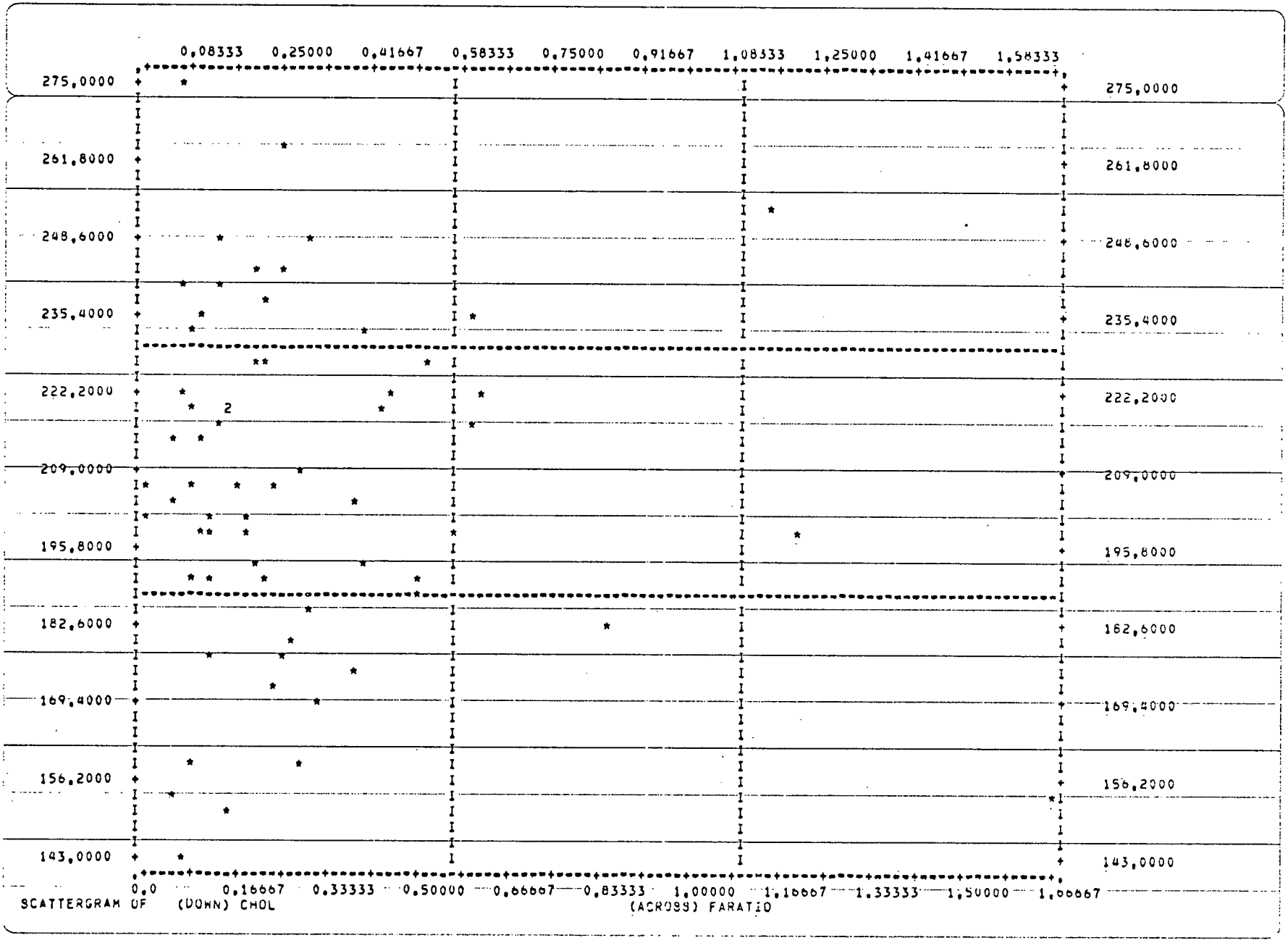
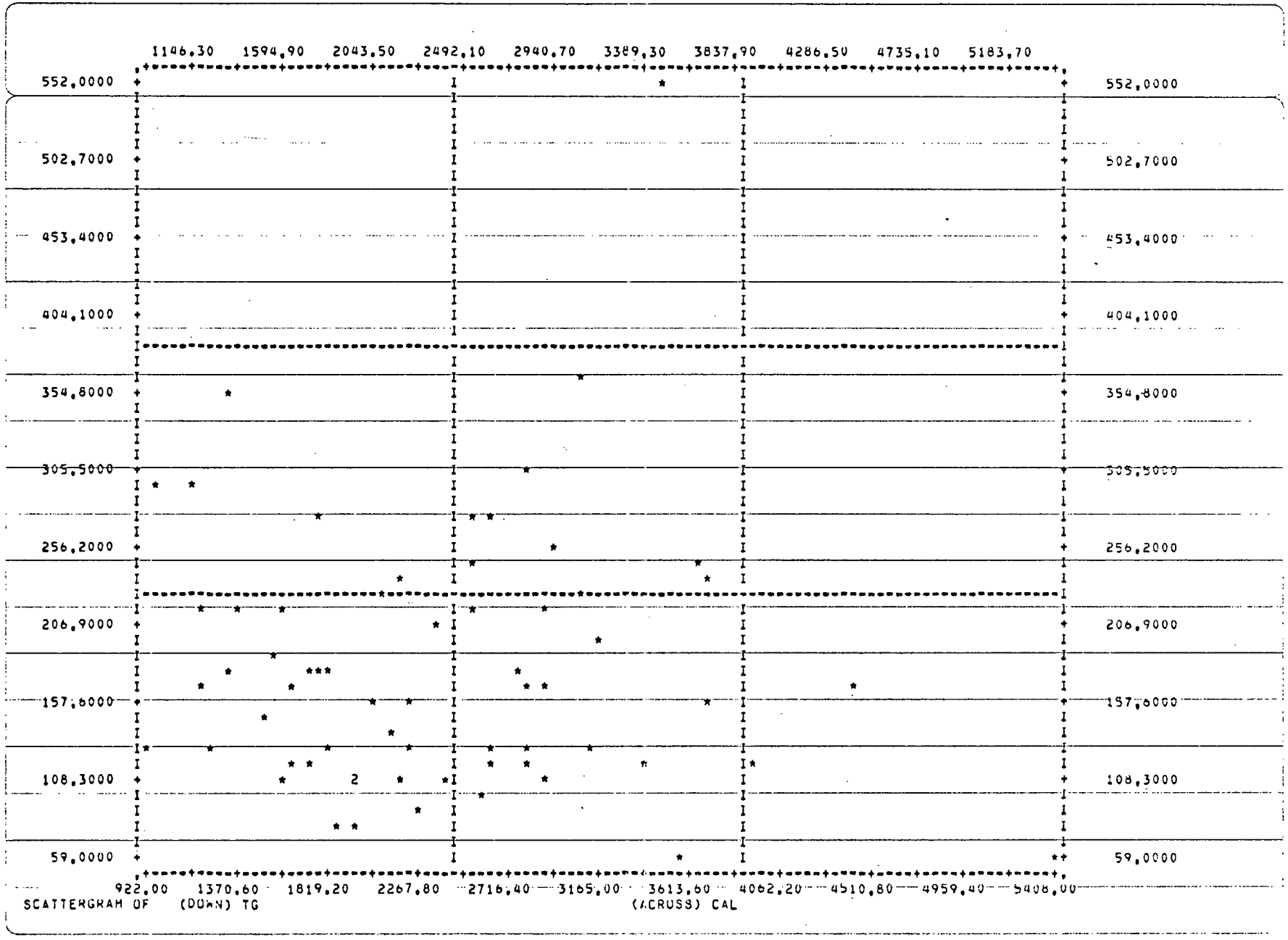
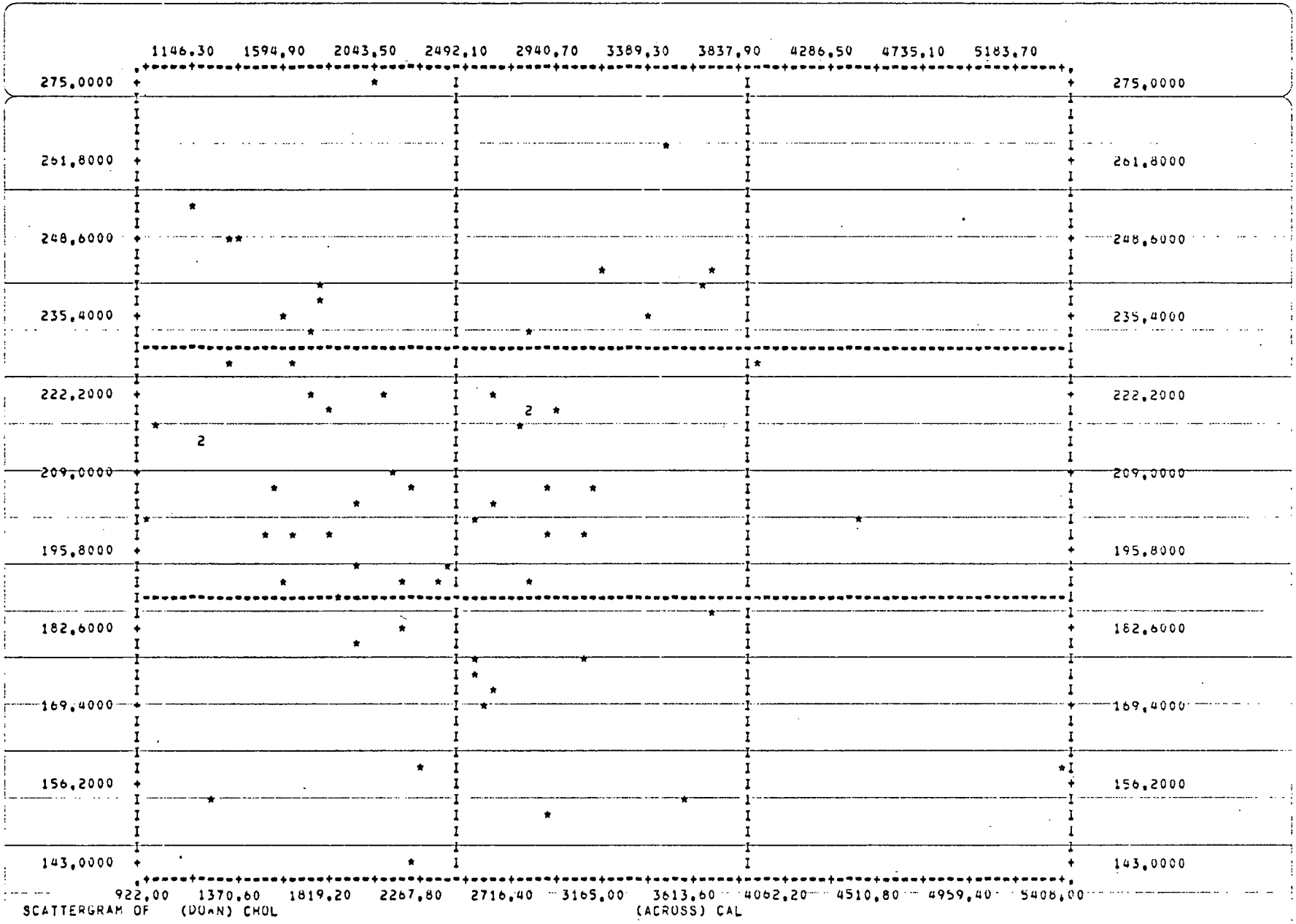
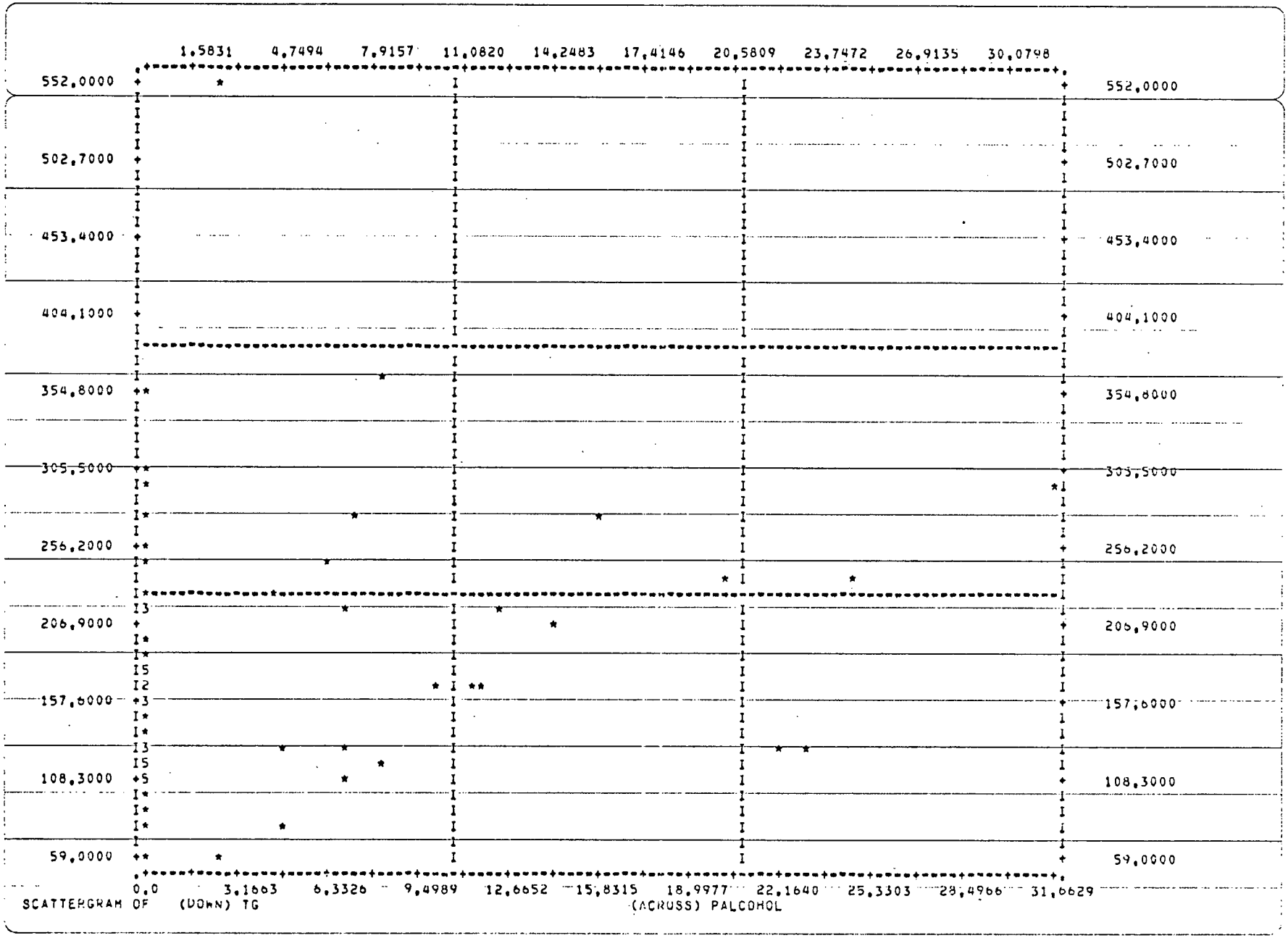
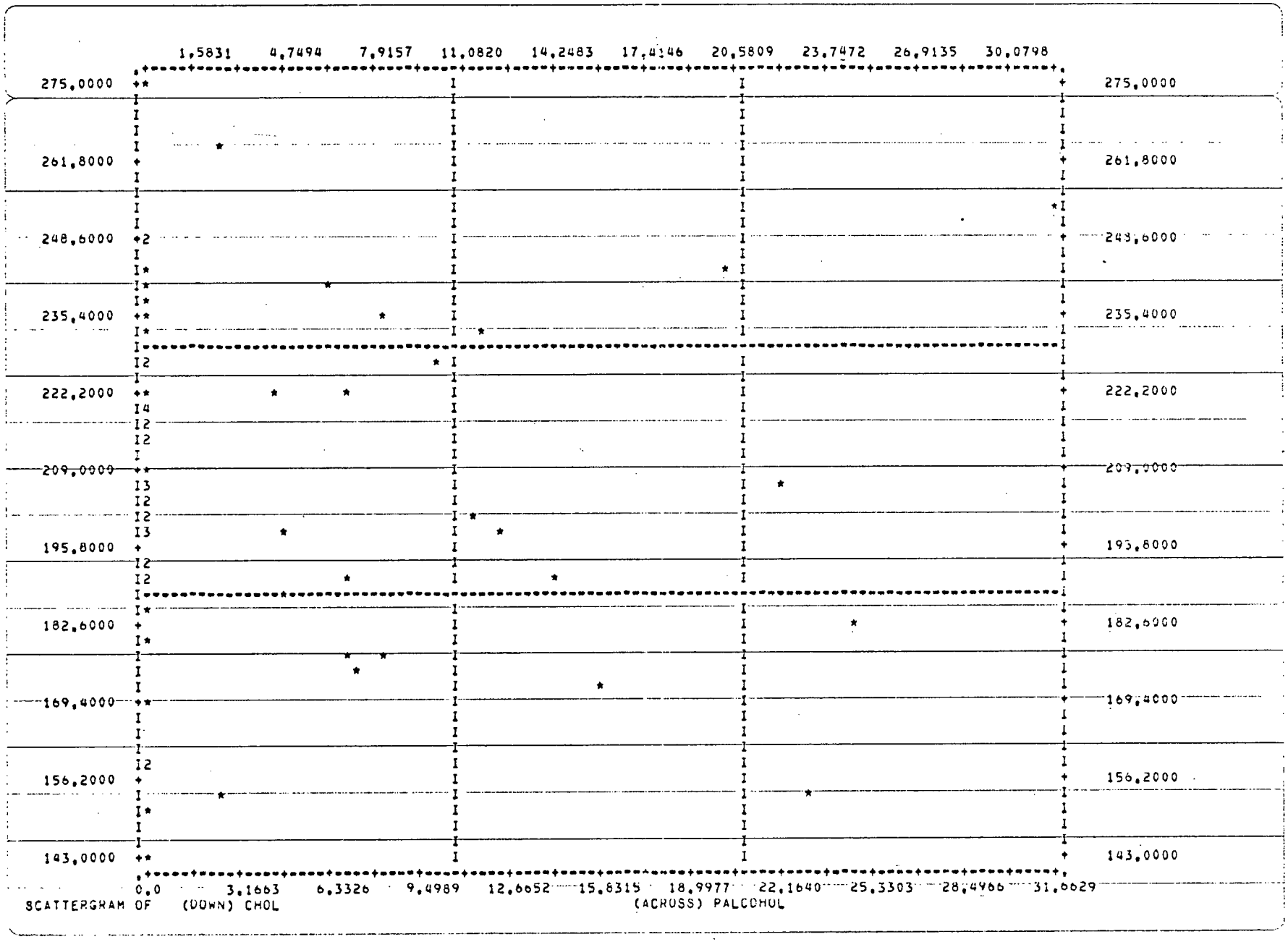
552,0000
502,7000
453,4000
404,1000
354,8000
305,5000
256,2000
206,9000
157,6000
108,3000
59,0000
0,0 0,16667 0,33333 0,50000 0,66667 0,83333 1,00000 1,16667 1,33333 1,50000 1,66667
SCATTERGRAM OF (DOWN) TG
(ACROSS) FARATIO

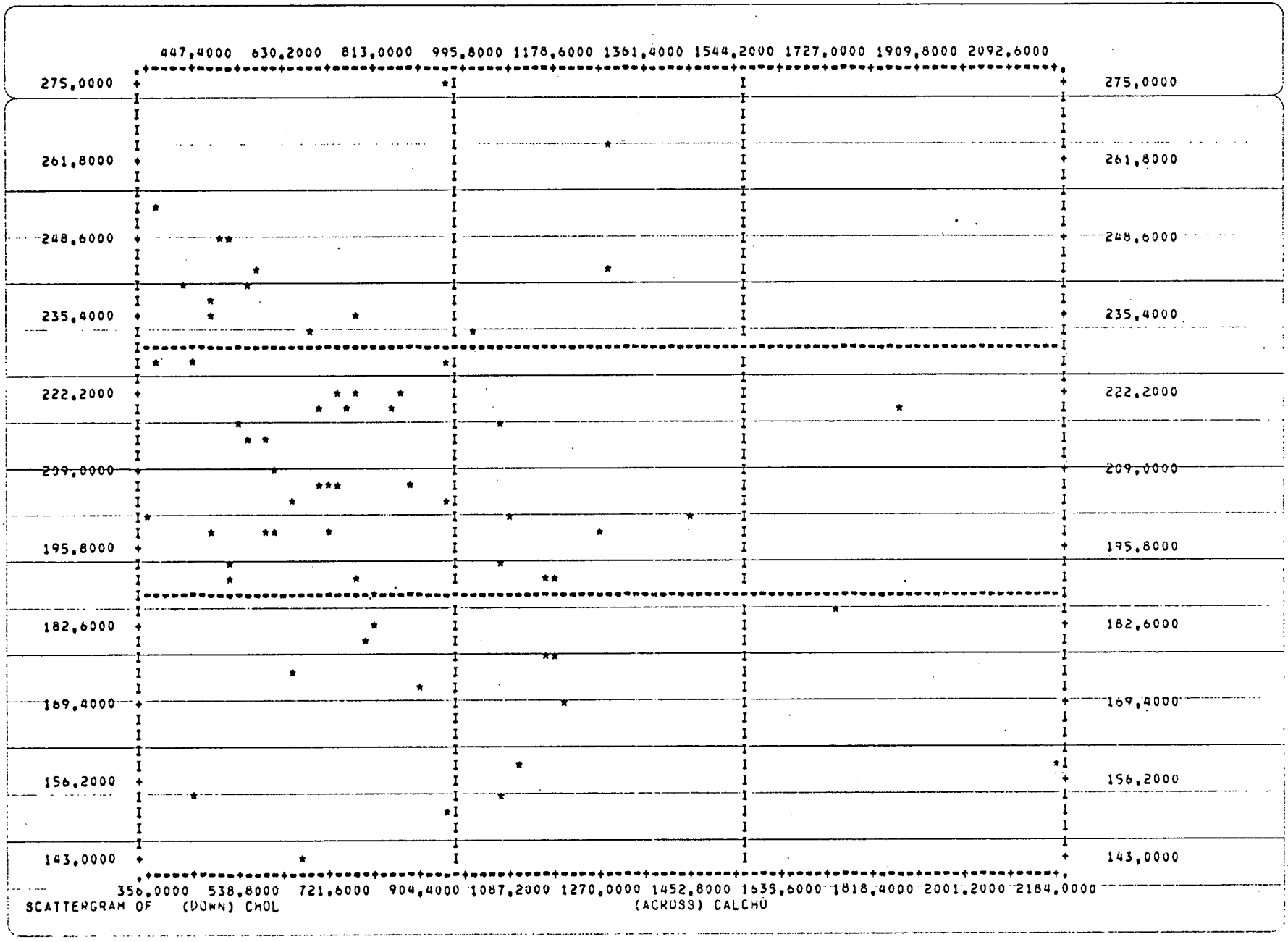

0,08333 0,25000 0,41667 0,58333 0,75000 0,91667 1,08333 1,25000 1,41667 1,58333
275,0000
261,8000
248,6000
235,4000
222,2000
209,0000
195,8000
182,6000
169,4000
156,2000
143,0000
0,0 0,16667 0,33333 0,50000 0,66667 0,83333 1,00000 1,16667 1,33333 1,50000 1,66667
SCATTERGRAM OF (DOWN) CHOL
(ACROSS) FARATIO


1146.30 1594.90 2043.50 2492.10 2940.70 3389.30 3837.90 4286.50 4735.10 5183.70
552.0000
502.7000
453.4000
404.1000
354.8000
305.5000
256.2000
206.9000
157.6000
108.3000
59.0000
922.00 1370.60 1819.20 2267.80 2716.40 3165.00 3613.60 4062.20 4510.80 4959.40 5408.00
SCATTERGRAM OF (DOWN) TG
(ACROSS) CAL


1146.30 1594.90 2043.50 2492.10 2940.70 3389.30 3837.90 4286.50 4735.10 5183.70
275.0000
261.8000
248.6000
235.4000
222.2000
209.0000
195.8000
182.6000
169.4000
156.2000
143.0000
922.00 1370.60 1819.20 2267.80 2716.40 3165.00 3613.60 4062.20 4510.80 4959.40 5408.00
SCATTERGRAM OF (DOWN) CHOL
(ACROSS) CAL


1.5831 4.7494 7.9157 11.0820 14.2483 17.4146 20.5809 23.7472 26.9135 30.0798
552.0000
502.7000
453.4000
404.1000
354.8000
305.5000
256.2000
206.9000
157.6000
108.3000
59.0000
0.0 3.1663 6.3326 9.4989 12.6652 15.8315 18.9977 22.1640 25.3303 28.4966 31.6629
SCATTERGRAM OF (DOWN) TG
(ACROSS) PALCOHOL


1,5831 4,7494 7,9157 11,0820 14,2483 17,4146 20,5809 23,7472 26,9135 30,0798
275,0000
261,8000
248,6000
235,4000
222,2000
209,0000
195,8000
182,6000
169,4000
156,2000
143,0000
0,0 3,1663 6,3326 9,4989 12,6652 15,8315 18,9977 22,1640 25,3303 28,4966 31,6629
SCATTERGRAM OF (DOWN) CHOL
(ACROSS) PALCOHOL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275,0000
261,8000
248,6000
235,4000
222,2000
209,0000
195,8000
182,6000
169,4000
156,2000
143,0000
356,0000 538,8000 721,6000 904,4000 1087,2000 1270,0000 1452,8000 1635,6000 1818,4000 2001,2000 2184,0000
SCATTERGRAM OF (DOWN) CHOL
(ACROSS) CALCHO