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AN APPLICATION OF MULTIVARIATE STATISTICAL TECHNIQUES IN ASSESSING STRUCTURE IN A COMPLEX MEDICAL DATA SET

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AN APPLICATION OF MULTIVARIATE STATISTICAL TECHNIQUES IN ASSESSING STRUCTURE IN A COMPLEX MEDICAL DATA SET

by

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A DISSERTATION

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CHAPTER ONE

STATEMENT OF THE PROBLEM

In gaining more reliable knowledge, social science, education and medical research have focused on the examination of multiple variable situations. During the last 10 or 15 years, there has been a subtle but definite trend toward the utilization of more sophisticated statistical procedures in analyzing data sets. Traditionally, much research in the social sciences, education and medicine was generally classified as qualitative or theoretical in nature. That is, it emphasized general rather than exact or empirical knowledge.

In terms of the present research, the actual research problem can be presented in the following manner: First, is the application or multivariate statistical procedures in analyzing complex nominal and ordinal data sets, feasible in the field of Hand Surgery research? Second, how might this research effect the future training of Hand Surgery residents? That is, can the employment of multivariate techniques enrich or enhance the present diagnostic and/or evaluative procedures in current Hand Surgery research?

It should be apparent that the application of multivariate techniques to Hand Surgery research raises certain difficulties for the prospective researcher. Generally, a large proportion of the measures employed at present in most examination - treatment settings, are categorical or nominal in nature. Additionally, other problems are present such as the degree of correlation among variables, the existence of interactions among variables, the presence or non-presence of an additive (interaction free) model and a large quantity of variables (25 or more).

Currently, the more conventional multivariate procedures incorporate some or all of the following assumptions. They are: interval or higher scale of measurement, a linear additive model and homogeneity of variance. As a result, the application of common multivariate procedures such as, Multiple Regression , Canonical Correlation, Factor Analysis and Discriminant Function Analysis, generally prove to be inappropriate for nominal and/or ordinal sets of data. As a consequence, one is required to seek other multivariate techniques which provide answers to these 5 major questions. They are: 1) Collectively, how well do the independent variables explain or account for the variability in the dependent variable? 2) In examining the total data set, what is the relationship between each particular independent variable and dependent variable while holding constant all other predictor variables? 3) Is there a significant amount of variance accounted for by a specific independent variable over and above the variance accounted for by all other independent variables? 4) Can prediction scores for each individual or observation be calculated from scores on the predictor variables? 5) Is there an underlying structure in the data set?

In demonstrating the applicability of multivariate techniques to nominal and ordinal data, this dissertation will examine the application of multivariate techniques in analyzing Dupuytren's Contracture in order to assess to what extent the above questions of multivariate analysis can be employed in researching this aspect of Hand Surgery. Contingent upon the actual results, relevant suggestions will be offered concerning the possible applications for the training of hand surgery residents as well.

In terms of the actual significance of this dissertation, several reasons can be cited. First, in confronting the research problem, it utilizes multivariate procedures rather than the more limited and simplistic univariate or bivariate techniques. Historically, a plurality of studies have been carried out in the field of Surgery of the hand. However, the actual statistical procedures employed in the bulk of this research have been univariate or bivariate in nature. Such analysis are necessarily limited in terms of their scope and applicability of the information they provide. Harris (1975, P.5) concisely delineates the future trend of research in the sciences:

> In the classic scientific experiment involving a

single manipulated (as possible casual factors either through explicit experimental control or through the statistical provided by randomization) and a single outcome measure, questions of patterns or optimal combinations of variables scarcely arise; nor do the problems of multiple comparisons becloud the interpretations of any t-test or correlation coefficient (or predictor) variable and the dependent (or outcome) variable. However, researchers in all of the sciences-behavioral, biological, or physical-have long since abandoned sole reliance on the classic, univariate design for very (sic) excellent reasons. It has become abundantly clear that a given experimental manipulation (for example, positively reinforcing a class or responses on each of N trials) will affect many somewhat different but partially correlated aspects (for example, speed, strength, consistency, "correctness") of the organism's behavior. Similarly, many different pieces of information about an applicant (for example, the socioeconomic status of his parents; his high school grades in math, English, and journalism; his attitude toward authority) may be of value in predicting his grade point average in college, and it is necessary to consider how to combine all of these pieces of information into a single "best" prediction of college performance.

The second reason for supporting the significance of this research is that it could supply a valid and useful strategy for analyzing complex problem areas in the field of medicine. The intricateness of almost any research problem must be handled in the multivariable sense. As a consequence, the results of this research may very well indicate that medical research, as it stands at present, may be in need of some drastic revisions. It is essential that the contemporary medical practitioner be conversant with not only the basic univariate and bivariate techniques, but with the more powerful and sophisticated multivariate procedures as well.

The third and final reason why this dissertation topic is significant is that the research will provide a concise model or framework for any researcher who is confronted with a very large and complicated data set. In addition, it may also supply the required procedural steps for devising strategies by which large and cumbersome data sets can be efficiently transferred to computer disk and/or magnetic tape.

Since a large, complex set of data is to be collected and analyzed in this dissertation, it appears evident that a Dupuytren's Contracture Protocol must possess certain essential qualities and characteristics. If the collected data are to be serviceable in providing a worthwhile and exact analysis of the proposed research questions, an instrument is needed which will provide information on all relevant areas central to the research problems. The Dupuytren's Contracture Protocol devised will collect data which meets the requirements stated above. Documentation is provided regarding the procedures for the transfer of the collected data to computer disk/tape.

In conclusion, this dissertation provides relevant and significant research since it conducts the researching of a problem through the use of multivariate statistical techniques, as opposed to employing the more limited and simplistic univariate and bivariate statistical procedures. In addition, this research may have a lasting effect on the future training of Hand Surgery residents. That is, by demonstrating the importance for analyzing medical data via multivariate statistics, medical residents may be required to obtain additional training in advanced multivariate procedures. Lastly, the significance of this research is supported in that a model will be provided which illustrates the exact and efficient collecting of a large intricate data set.

CHAPTER TWO

LITERATURE REVIEW

The review of the related literature will be conducted in the following manner. The first section will provide a brief explanation of multivariate statistics in general and their application to the study of Dupuytren's Contracture. The second section will involve a review of the medical literature where multivariate statistical procedures are employed in the research process. This will then be followed by a literature review involving articles specifically related to the study of Dupuytren's Contracture.

Upon examining the nature of multivariate statistics, various definitions can be presented. One definition considers multivariate statistical analysis as a branch of statistics which is devoted to the study of multivariate distributions (Tatsuoka, 1971). A more precise formulation of multivariate statistics can be stated thus, "multivariate statistics refers to an assortment of descriptive and inferential techniques developed to handle situations where sets of variables are involved as predictors or as measures of performance." (Harris, 1975,p.5)

Lastly, multivariate analysis can refer to any situation where it is necessary to handle interrelationships among more than 2 variables (Blalock, 1972). All of the above definition can be applied to the analysis of Dupuytren's Contracture.

The first step in any statistical analysis, whether bivariate or multivariate, involves a searching or ransacking procedure. (Morgan and Messenger,1978). The purpose of this searching is to determine the basic structure of the data. In other words, a statistical description of the data set is required. Statistically, variables may be described in a variety of fashions. One approach is through the use of frequency counts and percentages obtained for each variable. Other descriptive techniques include means, standard deviations, intercorrelations and other graphic displays of variable distributions and relationships.

Since this research examining Dupuytren's Contracture involves cases no later than 1971, descriptive frequency counts and percentages will not be employed. Rather, the analysis will utilize only multivariate statistical procedures.

Apart from the basic description of a data set, multivariate analysis is engaged with the structure of the data set as a statistical model. Frequently, one obtains a set of data where little is known in terms of the variables. Consequently, it is required to explore the data set structure to assess whether the basic assumptions of the more elegant multivariate statistical procedures are in fact present in the data.

The examination of the data related to Dupuytren's Contracture complicates the situation since the variables to be studied are typically at the nominal and/or ordinal scale of measurement rather than at the interval or ratio scale. As a result, the classical, model building, multivariate procedures are not applicable to the analysis of Dupuytren's Contracture. Structural Equation Models, Principle Components Analysis and Canonical Correlation Analysis, all demand a more rigorous scale of measurement.

Despite the aforementioned difficulties, the OSIRIS IV statistical package contains a program called SEARCH. The SEARCH program requires no assumptions as to either the scale or measurement or as to the linear additive relationship of the variables. Thus, the program searches the data set for highly interactive and intercorrelated variables.

After defining the structure of the data set, the employment of the multivariate statistical analysis can be initiated. The procedure utilized or applied in the dissertation is termed MNA or Multivariate Nominal Scale Analysis, a technique developed at the University of Michigan. This procedure is designed to accomodate situations where the dependent variable is at the nominal scale of measurement and the independent variables are at any scale of measurement. Typically however, the independent variables are categorical in nature. (Andrews and Messenger, 1973)

It must be mentioned that the use of Multivariate Nominal Scale Analysis involves a relaxation of the scale of measurement on the dependent variables. Consequently, the researcher must be concerned with the effects such a relaxation of the assumptions will ultimately have on the linear and additive nature of the model.

A major requirement resulting from a scale of measurement change is the need for a larger number of cases in order to meet the condition of homogeneity or equality of the variances. According to Maxwell (1971), Discriminant Function Analysis works well with dichotomously scored data. However, Maxwell goes on to state further that the samples selected are typically large.

RELATED LITERATURE

The literature review involves an actual searching of 1,372 articles related to statistical application in the general area of medical research. From this source, 310 articles were actually selected for close inspection. Of these 310 articles actually reviewed, the author discovered a number of interesting applications of multivariate statistical analysis to medical data.

M'aln'ansi, Jakab, Inczne, Apostol, Csap'o, Szab'o, Csap'o and Jakab (1976), using bivariate correlational analysis, examined the possible relationships between the incidence of gastric cancer and geographical - environmental condition in Romania.

Over a period of 21 years, 325,000 inhabitants were surveyed to detect gastric cancer mortality rates. These findings were then compared to geographical and environmental factors reflecting a specific area in Romania of some 13,000 square kilometers and a population of 905,100 individuals.

The authors discovered that a 2-3.5 times larger incidence of gastric cancer was found within certain areas of the country characterized by low depressions as opposed to areas characterized by hilly terrain. Of these natural conditions, the presence of a magmatic substrata displays a significant degree of correlation with cancer as does the presence of low PH peaty soils with a high content of organic matter. In addition to these factors, the authors found that soft drinking water, high altitude, cold climate and the excessive growing of vegetable and animal food on the same soil for generations, also represent gastric cancer risk factors.

The authors conclude that some progress in early cancer detection may be possible as a result of the correlations between environmental factors and the incidence of gastric cancer (P.340). However, it must be maintained that the simple bivariate correlations employed above are generally inadequate in assessing a research problem involving multiple interrelated variables. An alternative analysis might have involved multiple regression where incidence of gastric cancer is the dependent variable and environmental factors are the predictors. This would permit one to determine the joint and individual contribution of the independent variables in explaining incidence of gastric cancer.

In examining multivariate statistical applications in medical research, the author encountered numerous articles employing multiple regression analysis. In an interesting article examining mental health data, Singer, Cohen, Garfinkel and Srole (1976), apply multiple regression analysis in answering three basic research questions. First, can regression be used to predict psychiatrists judgements on their patients? Second, if they can, could these ratings be valid measures of mental health for the same sample at some later point in time? Third, is there a relationship between prior mental health ratings and subsequent self-reported behavioral conditions?

In terms of the findings, the authors report that the regression derived mental health rating scores scores are an adequate substitute for the original ratings of patient behavior. In fact, the regression analysis accounts for approximately 69 percent of the variance in the ratings. However, the regression derived ratings are not useful in predicting subsequent self-reported behavior.

An example of multiple regression analysis applied to life tables is presented by Holford (1976). A regression model for analyzing survival data while controlling for related variables is developed. The data were extracted from a clinical trial analyzing treatment for lung cancer. The author concludes that the model developed can be applied to the analysis of data from the more commonly used actuarial life tables.

Another excellent example of multiple regression analysis involves a more theoretical perspective of the procedure and its applicability to medical research. Kobashigawa and Berki (1977) conducted a multivariate study of the 1970 National Health Interview Survey. The dependent variables of utilization, acute and chronic conditions were found to have properties which violated the assumptions of normality in regression analysis. In resolving this dilemma, the authors proceeded to compare other theoretically appropriate multivariate procedures (e.g. logit analysis, discriminant analysis, and Poisson based regression analysis) with the standard least squares regression.

The results of these comparisons indicate that the other more theoretically correct multivariate techniques provide only limited gains over the standard regression procedure. Apparently, in some instances, standard least squares regression is robust to violations of the normality assumption.

Another interesting article involving the application of multiple regression, addresses the problem of multicollinearity in medical research. Gunst and Mason (1977) were involved in examining spinal cord injuries in order to illustrate the advantages of searching out which, if any, multicollinearities are contained among the independent variables. The authors maintain that existing multicollinearities in a data set are helpful in that they can determine characteristics of the population from which the sample was extracted and in explaining any possible inconsistencies in the variable selection methods. In illustrating this situation, the authors performed biased regression techniques (latent root regression).

Elwood, MacKenzie, and Cran (1971) employed a binary regression analysis in examining infant mortality risk. This study is of particular interest to the author since it involves the use of a large number (15) of dichotomous predictor variables in explaining a single dichotomous dependent variable. This study illustrates the application of regression techniques to situations where both predictor and criterion variable are categorical and where a large number of cases are employed. Indeed, the authors point out that binary regression is appropriate when very large samples are encountered. Futhermore, the authors conclude that the binary regression model has definite applicability in multivariable medical research settings (P.103).

Cohen (1979), examined the application of regression procedures on drug abuse data. The author pointed out that from the personal interview surveys recently taken, estimates have been obtained concerning the use of marijuana, heroin and other substances. It has been found that over a number of years , consistent relationships have been observed between drug abuse and geographic area, age, sex and education.

The author concludes that regression procedures have also been employed in determining drug abuse patterns for states (P.213).

Another example of regression analysis involved the estimation of relative risk from vital statistical data. Beral, Chilvers and Fraser (1979) describe a method for the prediction of a measure of relative risk. The method they presented was linear regression.

Madsen, Rasmussen and Suendsen (1979) used regression analysis in the development of a short-term prognostic index for heart patients. The author examined survival time following acute myocardial infarction. 18 prognostic factors occurring during the first five days following the infarction were employed as predictor variables.

The author discovered that heart failure, cardiogenic shock, artrioventricular block and age were the significant prognostic variables.

Lastly, Economas (1980) applied regression analysis in a study involving the brain weight and life span of mammals. Earlier research, utilizing body weights, discovered that 60% of the life span variance was explained by body weight.

The author found that brain weight explained 70% of the life span variance.

Consequently, it was concluded that the weight of the brain is a better predictor than body weight primarily because brain weight is more stable (P 89).

Additional articles related to the application of regression analysis in medical research are as follows: Prentice and Gloeckler (1978) employed regression analysis to explain race differences in breast cancer survival using disease progression and other various demographic characteristics. Gee and Forthofer (1975) used binary multiple regression analysis to assess the effect of ethnic group membership on neonatal and postnatal mortality. Bookstein, DePaola and Warram (1976) used regression to estimate the fluoride level of surface enamel in large sample groups. The authors found that regression techniques were effective in permitting the removal of the sample - weight effect from the estimate of the fluoride level in surface enamel (P. 105). Breslow (1976) regards regression analysis as an important tool for retrospective studies in epidemiology. Furukawa, Inque, Kajiya, Inada and Takusugi (1975) employ multiple regression analysis to predict biological age of healthy individuals. The authors found that the predicted ages of hypertensive subjects were significantly higher that their chronological age. (P.427)

Donner (1979) employed regression analysis in studying family resemblance. Gordon and Bachar (1980) applied regression analysis in the development of predictor models in exotropia surgery.

Another multivariate statistical procedure frequently applied in recent medical research is Discriminant Function Analysis. Tomlinson, French, and Storey (1975) examined and compared the prediction of glaucoma from other tests used to diagnose the disease. The study was conducted to evaluate the accuracy of already existing discriminant function equations.

The data for these equations came from an independent sample consisting of 29 open angle glaucoma, 22 angle closure glaucoma and 44 normal subjects. The results indicate that the efficiency of glaucoma prediction from occular biometric data would appear to be equal to that of data obtained from other types of tests (tonography and provocative tests). (P. 821)

Fletcher, Rice and Ray (1978) address the uses and misuses of discriminant analysis in neuropsychological research. Problems concerning stepwise selection procedures and shrinkage are often overlooked in a number of research settings. The authors provide numerous examples of the misapplication of Linear Discriminant Function Analysis, and data from a previous study is utilized to demonstrate techniques and procedures which will enhance the accuracy of the results and interpretations. The authors correctly point out the great utility and power of multivariate analysis. (P. 573) However, they go one to caution that correct application is imperative if the results are to be meaningful.

In an article by Schildkraut, Orsulak, LaBrie, Schatzberg, Gudeman, Cole and Rhode (1978), Multivariate Discriminant Function Analysis is applied to the classification of certain depressive psychological disorders using biochemical data from urine specimens.

In a previous, but related study, the authors discovered a differential urinary excreti, MHPG, in patients who were clinically diagnosed with various depressive disorders. In this current study, the authors supplemented their initial findings by reporting further biochemical discrimination among the various depressive subtypes. The equation used in the analysis was derived through the application of discriminant analysis.

In terms of the actual findings, the authors discovered that low sources were related to biopolar, manic-depressive depression types and high scores were related to unipolar nonendogonous depression types.

In addition, the authors conclude that perhaps as many as three biochemically discrete subgroups of depression can be discriminated. (P. 1439)

In an excellent article by Parker and Boyd (1974), 60 Predictor variables were used to discriminate or predict appropriate level of care for patients. The actual data were 644 cases with a dependent variable consisting of six categories.

The authors report on the findings indicated that approximately 77 percent of the cases were correctly classified by the discriminant function. (P. 951) Of the 60 independent variables initially used in the analysis, a total of 24 were found to provide a significant contribution to the prediction process.

Lachin and Schacter (1974) Present a general nonmathamatical explanation of discriminant analysis along with an application of the technique to physiologic data. In this application, the authors compare and contrast the results of the analysis when using stepwise and non-stepwise discriminant analysis.

In terms of the results, the stepwise procedure consistently produced significant results under no stimulus conditions while non-stepwise procedures did not produce significant results under no stimulus conditions. Under stimulus conditions, stepwise procedures consistently over estimated the extent of differences uncovered by the non-stepwise analysis. (P. 707)

In a study by Carey (1979), Discriminant function Analysis was used in the identification of foci of vector borne diseases. Stepwise Discriminant Analysis was applied to data collected on wood ticks on animals infected with the Colorado tick fever virus and on other environmental variables. In addition, various trap stations were grouped according to the relative frequency of wood ticks encountered.

The author concluded that Discriminant Function Analysis provides a useful statistical tool for analyzing the structure of ecosystems and for identifying foci of infections.

Suziki and Kudo (1979) presented a new technique for using Discriminant Analysis. This procedure, termed Haypshi's Quantification II, provides for the manipulation of attribute data as predictor variables. According to the authors, the procedure is useful in medical research for diagnosis, prognosis estimation and generally any situation which involves several attribute variables.

Another study, which employed Discriminant Function Analysis, examined the determination of sex from postcranial skeletal measurements. Richman, Michel, Schulter-Ellis and Corruccini (1979) analyzed data previously obtained from black skeletons of known sex. Since the classification accuracy was inconsistent from sample to sample, the prediction suffered. However, the authors reported that two of the samples reached 91% correct classification or better.

It was concluded that sex accounts for a large proportion of the total variation and race accounted for most of that remaining.

Other articles which present a more theoretical treatment of discriminant analysis are provided by Eklund (1970) and Waard (1972). Ekland presents a terse explanation of discriminant analysis while Waard presents a more theoretical explanation of the discriminant analysis for two or more groups on the dependent variable. Also, he discusses applications of the procedure to the fields of Anthropology and Epidemiology. (P. 31)

In returning to the application of discriminant analysis to medical research, Pipberger, Klingeman and Cosma (1968) employ discriminant analysis in identifying factors necessary to describe and discriminate among disease types. In this study, 1,238 individuals were measured on a total of 429 categorical and 69 continuous independent variables. After statistically reducing this extremely large data set, the authors found six independent variables which correctly classified 95.3 percent of the patients as having either heart disease or pneumonia. With these same six variables, it was also possible to correctly classify 78 percent of the patients in terms of having angina pectoris or acute myocardial infarction. Finally, when employing seven independent variables, it became possible to classify 95.2 percent of the patients as either having various heart diseases or having pneumonia. (P. 86)

The above study illustrates convincingly the intricate methodologies required in collecting extremely large sets of data. The author's use of coding sheers (P. 81) for information collection, demonstrates a viable technique for the transfer of large quantities of information to computer disk and/or tape.

In an article examining fetal skeletons, Choi and Trotter (1970), apply discriminant analysis to the classification of skeleton by sex group membership. The authors examined 115 fetal skeletons along with 21 interval scaled predictor variables. The results indicate that the authors could correctly classify the fetal skeletons by sex with 72 percent accuracy.

Hall, Selander and Wolodarski (1973) employ discriminant analysis in order to provide an equation which can accurately classify patients according to specific diagnosis categories. The data categories which were developed were patients having lung cancer and patients not having lung cancer. In a total sample of 152 individuals, 77 patients had lung cancer and the remaining 75 possessed a variety of other non-cancer chest ailments. A total of 22 predictor variables were included in the analysis, of which 20 were catagorical and two were continuous.

The authors discovered that the discriminant function or mathematical equation produced by the discriminant analysis, correctly classified 80 percent of the patients with lung cancer and 90 percent of the patients with other diseases of the chest.

Additional studies or articles employing discriminant analysis are as follows: Anderson and Blair (1975) used discriminant analysis to classify individuals afflicted with rheumatoid arthritis involving a specific joint. In an article by Jenden, Fairchild, Mickey, Silverman and Yale (1972), discriminant analysis was used to study the effects of a specific drug on EEG results.

Feldman, Klein and Konigsfield (1969) applied discriminant analysis to psychiatric interview data in an effort to provide an efficient and accurate guide for group assignment. The results indicated that the techniques analyzed were highly effective.

In an article by Jones, Lennard - Jones, Morson, Chapman, Sackin, Sneath, Spicer and Card (1973), discriminant analysis is used to classify a group of individual suffering from proctorolitis or colonic Cromn's disease. From an initial 107 independent variables entered in the analysis, stepwise discriminant analysis reduced the total number to five predictors. The authors reported that these five independent variables were virtually perfect in correctly classifying the 109 patients. (P.724)

Garside and Roth (1978) examined the utility of applying discriminant function analysis to classification problems in psychiatry. The authors agree with Maxwell (1971) that discriminant analysis can effectively be used with dichotomous variables as long as the number of observations in a sample is large and the item incidence are within the 20-80 percent range.

Lastly, Walker and Johnston (1980) used Discriminant Analysis in predicting the success of a sympathectomy. In this study, 72 limbs were treated with phenol sympathalysis for inoperable peripheral arterial occlusive disease. The purpose was to determine which factors or combination of factors could be employed in predicting the success or failure of sympathetic interruption. Prior to the phenol sympathalysis, measurements were taken on seven variables.

The authors, in reporting their results, stated that the level of ankle systolic pressure, the presence or absence of neuropathy and the extent of ischemic damage were the most important variables in predicating success of a sympathectomy (P. 221)..

A prior study of considerable significance to the present research of this author was a dissertation examining Carpal Tunnel Syndrome. Posch Jr. (1976) extracted a large data set involving over 1500 cases. THAID, binary regression and Discriminant Function Analysis were performed to determine which variables contributed to the occurrence of this disease.

In addition to the discovered relationships among the variables, the author demonstrated the appropriatesness of applying multivariate techniques to a complex data set.

At this stage in the literature review, the articles cited will relate to Dupuytren's Contracture of the hand. It is interesting to note that in the articles pertaining to Dupuytren's Contracture, the statistical analysis of the data sets (if any) incorporate rather basic descriptive statistical procedures.

In a early paper on Dupuytren's disease Posch (1962) pointed out that this disease has an unknown etiology and that the only course for a cure is to surgically treat the palmar fascia involved (P. 17). Of the many variables which might contribute to the occurrence of the disease, the author believed that no single factor has yet been clearly identified in medical research.

Mikkelsen (1978) studied the influence of handedness, type of work and previous hand trauma on incidence of Dupuytren's Contracture. In Norway, 901 persons with the disease were examined. Although Dupuytren's disease occurs in all occupational groups, the author found that the condition was more prevalent and severe among persons performing hard manual work as opposed to persons involved in less strenuous activity. Also, persons with a history of hand trauma were found to have a higher incidence of the disease. (P.7) It should be noted that Mikkelsen employed basic descriptive procedures in arriving at these conclusions.

Ravid, Dinal and Schar (1977) employed percentages in studying diabetes and occurrence of Dupuytren's Contracture. The disease was discovered in 169 of 959 diabetics (17.6%) and in nine of 1,396 non-diabetic patients (.64%). (P. 174)

In another study by Mikkelsen (1977), wherein he examines the occurrence of Dupuytren's disease with area of initial onset, age of patient and spontaneous courses of the disease, basic statistical techniques are employed. The author points out that of 647 men and 254 women with Dupuytren's disease, 90% stated that the disease began in the ulnar part of the palm of the right hand. In 10 percent of the individuals, the disease started in both hands simultaneously.

In terms of age, only one woman and two men noticed the first symptoms before the age of 10. Approximately 50 percent of the men stated that the disease appeared between 40-59 years of age. For women the figures were 40-69 years of age. Among men, the disease increases at a constant rate during the initial 20 years which is then followed by a slowing or stagnation phase of roughly 20-35 years duration. After this period, the disease apparently diminishes. Among women, the disease increased steadily for its entire duration.

In an article by Crithchley, Vakil, Hayward and Owen (1976), percentages are used to describe the occurrences of epilepsy and Dupuytren's Contracture. In a study of chronic epileptic's, a 56 percent incidence of Dupuytren's disease was discovered. The actual lesions were bilateral and usually were associated with knuckle pads and plantar warts. The authors point out that the incidence of the hand disease increases with the duration of epilepsy and may in fact be related to constant exposure to anti-epileptic drugs. (P. 502)

Rafter, Kenny, Gilmore and Walsh (1980) employed basic descriptive measures in associating Dupuytren's Contracture with a number of pathological conditions. From a sample of 403 males, information was obtained on age, occupation, alcohol and tobacco consumption, drug and medical history.

The authors found that persons with Dupuytren's disease had a relativly higher occurence of diabetes. Tobacco and alcohol intake and lung disease were found not to be associated with the occurrence of Dupuytren's Contracture.

Rodrigo, Niebaver, Brown and Doyler (1976) employing frequencies and percentages, report the reoccurrence of Dupuytren's disease after certain types of surgical treatment are performed. Of 65 hands treated by excision of the involved fascis, 63% had reoccurences in the area operated on. Of the 41 hands treated by palmas fasciotomy 43% had to undergo repeated operations. (P. 384)

In general, the use of statistical procedures with Dupuytren's Contracture data reveal that situations involving multiple variables are usually analyzed with rather basic and simple descriptive statistical procedures. Usually, these techniques involve proportions, frequency counts and percentages. It is extremely rare that the more sophisticated inferential procedures are applied to the analysis of these data.

SUMMARY

The review of the general and related literature illustrates quite clearly the point that multivariate statistical procedures can indeed be applied to many areas of medical research. Additionally, this literature review indicates that little research has been conducted on sets of data which approach the intricateness and singularity of data characteristic to Dupuytren's Contracture.

Indeed the Dupuytren's data set is complex and unique. The categories of the sets of variables incorporate a number of phases in the data collection process. First, background information, previous treatment, symptoms, symptom deviation and medical histories are determined for each case. Second, findings for examinations are recorded. Third, treatment prescribed, fourth, surgical and pathological findings and fifth postoperative duration of treatment.

This Dupuytren's Contracture study will examine variables which are at the nominal and interval scales of measurement. However, the large proportion of variables to be studied are at the nominal level.

In providing a description of the methodology for this dissertation, records for approximately 1000 Dupuytren's cases will be available. These records will be obtained from patients treated at the Detroit Medial Center over the last 20 years. Furthermore, the records are extensive and complete with respect to the variables being chosen for this study. For example, included will be variables reflecting age, sex, occupation, previous hand trauma and hand involvement. These variables will be available for each case. Overall, each case is expected to provide information on at least 20 variables.

The next methodological phase will involve transcribing the information from the records to the Dupuytren's

Contracture Protocol. Assisting with this procedure will be three coders. These coders will be selected on the basis of their prior secretarial and/or medical related experience. Upon completing the data coding, the information from the protocol will then be copied to computer disk/tape.

As previously mentioned, this dissertation will provide an approach in the development of statistical models which will assist medical practitioners and educators in identifying the pertinent variables related to this disease. In other words, statistical techniques will be employed which will "ransack" or search the data set for underlying structure(s). In addition to the model building function of each method, a comparative analysis of the three techniques will be provided. The purpose of this comparison will be to demonstrate which statistical procedure is most appropriate in a given situation.

There are three statistical techniques which will be applied in this treatise. The first, SEARCH analysis, is a statistical procedure which searches the data for a large set of alternative models. The technique accomplishes this through a simple subgrouping of the data in order to provide strong explanatory power. The second procedure, Multivariate Nominal Scale Analysis, is primarily a classification procedure where the dependent variable is at the nominal scale of measurement. The independent variables are typically at the nominal scale but may be at any level of measurement. The technique involves ascertaining whether or not a linear combination of predictor variables accurately classifies observation into the categories of a nominal dependent variable. The third technique, Discriminant Function Analysis, is similar to Multivariate Nominal Scale Analysis with the exception that it assumes an interval scale measurement for the independent variables. However, the purpose is to classify observations on a nominal dependent variable.

Since this research is involved with a subject possessing an unknown etiology, the results can not be predicted at this point in time. It is anticipated however, that appropriate multivariate techniques, which are applicable to a given situation, will be identified and variables which previously were not considered relevant will be utilized in the identification of the disease.

CHAPTER THREE

PROTOCOL, PROCEDURES AND METHODOLOGY

The Dupuytren Contracture Protocol was designed and constructed to provide data extracted from a patients medical record. Of primary concern in the development of the Dupuytren's Contracture Protocol is that this instrument should provide useful and relevant information. The following discussion examines the construction of the protocol employed in obtaining data for this research.

The bulk of the current Dupuytren's Contracture Protocol was developed from an earlier Dupuytren's protocol produced by Dr. J.L. Posch Jr. (1976) for abstracting data from patients medical records with the disease. This original protocol was used to acquire information on 200 cases with Dupuytren's disease covering a time period from 1950 through 1976.

Subsequent to the above research, the Dupuytren's Contracture Protocol was updated and modified by Gary J. Clor (1981). The revised Dupuytren's Contracture Protocol includes a more precise specification of variables which were not incorporated in the original protocol. The inclusion of additional variables into the present instrument was a result of the information obtained from the data collected during the initial analysis involving 200 cases with Dupuytren's disease.

The insertion of these additional variables into the protocol was also accomplished so it would be possible to identify as many variables as possible that may be related to the occurrence of Dupuytren's Contracture. In addition, the extension of the number of variables also provides more certainty that the important patient information found in the medical record will be included by the coders during the abstracting process.

In terms of piloting the revised Dupuytren's Contracture Protocol, 50 medical records involving Dupuytren's disease were utilized. Subsequent to the testing of the updated protocol, a finalized Dupuytren's Contracture Protocol was obtained.

The final form of the Dupuytren's Contracture Protocol displays certain advantages over the previously developed protocol. That is, it provides for: 1. Increased accuracy by including a larger number of possible related variables. 2. A more efficient format ,that is, one which makes the coding process more understandable and logical to the coder. 3. Greater efficiency in the transfer of data from the protocol to computer disk and/or tape.

Because of the large number of variables involved in this research, it is necessary to employ a computer for describing and analyzing the data. As a result, the final version of the Dupuytren's Contracture Protocol provides for the efficient coding of the variables. This is accomplished by specifying the column numbers on a Hollerith card associated with the specific variables. The following figures summarize the entry format for the variables on the Hollerith cards.

Figure 1. Format for Hollerith Card #1.

Column(s)	Entry
1	Card Number
2-5	Patient Number
7-12	Date of First Office Visit
13-18	Date of Birth
19	Sex:
	1= Male
	2= Female
	9= Missing Information
20	Hand Dominance:
	1= Right
	2= Left
	3= Ambidextrous
	9= Missing Information
21-31	Medical History
	1 column each for eleven measures
	1= Yes
	2= No
	2= Non-White
	9= Missing Information
32	Family Origin:
	1= White
	2= Non-White
	9= Missing Information
33	Occupation:
	1= Manual
	2= Non-manual
	9= Missing Information
34-41	Heredity
	1 column each for eight measures:
	1= Yes
	2= No
	3= Missing Information
42	Hand Involved:
	1= Right
	2= Left
	3= Both
	4= Missing Information
43-59	Involved Areas
	1 column each for seventeen measures
	1= Yes
	2= No
	9= Missing Information
60-61	Extent of Involvement
	1 column each for two measures
	1= Severe
	2= Moderate
	3= Mild

		4= Missing Information
62-69	Treatment	
	1 column each for eight measures	
		1= Yes
		2= No
		9= Missing Information
70-71	History of Trauma	
	1 column for two measures	
		1= Yes
		2= No
		9= Missing Information
72-73	Time from Trauma to Onset of Disease	
	1 column each for two measures	
		1= Under Six Months
		2= Six Month to Five Years
		3= Over Five Years
		4= Missing Information
		Blank= Not Applicable

Figure 2. Format for Hollerith Card #2.

Column(s)	Entry
1	Card Number
2-5	Patient Number
7-12	Date of Surgery Right Hand (Blank Not applicable)
13-18	Date of Surgery Left Hand (Blank Not applicable)
19-36	Type of Operation in Palm 1 column each for eighteen measures. 1= Yes 2= No 9= Don't Know Blank= Not Applicable
37-48	Incision in Palm, 1 column each for twelve measures 1= Yes 2= No 9= Don't Know Blank= Not Applicable
49-62	Type of Closure of the Palmar Wound 1 measure each for twelve measures 1= Yes 2= No 9= Don't Know Blank= Not Applicable
63-72	Type of Operation for Fingers 1 column each for ten measures 0= None 1= Fasciotomy (Closed) 2= Fasciotomy (Open) 3= Fasciotomy with skin graft 4= Local fasciotomy and skin graft 5= Regional fasciotomy 6= Dermofasciectomy 7= Extensive fasciectomy 8= Amputation 9= Don't Know Blank= Not Applicable

Figure 3. Format for Hollerith Card #3.

Column(s)	Entry
1	Card Number
2-6	Patient Number
7-16	Type of Incision in Fingers 1 column each for ten measures 0= None 1= Lingitudinal 2= Transverse 3= Lazy-S 4= Zig Zag 5= YV 6= Other 9= Don't Know Blank= Not Applicable
17-26	Type of Closure in Fingers 1 column each for ten measures 0= None 1= Primary Suture 2= Primary Suture w/ z-plasty 3= Leave incision open 4= Split thickness skin graft 5= Full thickness skin graft 6= Local pedicle flap 7= Distant pedicle flap 9= Don't Know Blank= Not Applicable
27-43	Complications 1 column each for seventeen measures 1= Yes 2= No 9= Don't Know Blank= Not Applicable
44-47	Duration of Follow-up Days Right Hand Blank= Not Applicable
48-51	Duration of Follow-up Left Hand Blank= Not Applicable
52-55	Post-Operative Therapy 1 column each for four measures 1= Yes 2= No 9= Don't Know Blank= Not Applicable
56-59	Recurrence 1 column each for four measures 1= Yes 2= No

9= Don't Know
Blank= Not Applicable

60-61 Reoperation -1 column each for two measures
1= Yes
2= No
9= Don't Know
Blank= Not Applicable

Since it is necessary to use a computer to analyze the large volume of data, two computer statistical packages will be employed in the analysis phase of this research. They are: Statistical Package for the Social Sciences (SPSS) and OSIRIS IV. The SPSS package will be used to provide statistical description of variables, recoding of variables, grouping and transformation of variables and to perform specific multivariate statistical procedures. The OSIRIS IV package will be employed to ascertain the basic structure of the data and to perform specific multivariate statistical analyses on the data.

Lastly, it must be stated that certain precautions were taken with regard to patient confidentiality. The safeguarding of the patients right to confidentiality of treatment by a physician cannot be over-emphasized. With regards to this research, great care has been taken to protect the patients right of privacy of information concerning their treatment. The protection was provided for in the following manner: 1. Only individuals who were employed by Joseph L. Posch M.D. and Associates P.C. were allowed access to the patient medical records identified as Dupuytren's Contracture cases. 2. Only individuals who were employed by Joseph L. Posch M.D. and Associates P.C. were allowed access to the completed Dupuytren's Contracture Protocol. 3. Any Dupuytren's Contracture data that was stored or manipulated outside the offices of Joseph L. Posch M.D. and Associates P.C. are in a numerical coded format. This special format will completely safeguard the patients identity.

METHODOLOGY

The preparation of the data for processing with the computer involved the following procedures:

1. The identification of Dupuytren's Contracture cases.

2. The location and isolation of medical records of patients diagnosed with Dupuytren's Contracture.

3. The transfer of data from the medical records to the Dupuytren's Contracture Protocol.

4. The transfer of data from the protocol to the computer disk.

All patients who were diagnosed positively for Dupuytren's disease, treated and released from care in the offices of Joseph L. Posch M.D. and Associates, P.C. were included in the sample. 853 cases of Dupuytren's Contracture were obtained.

The medical records of all 853 patients were separated and stored in file cabinets located in the research facility.

The transfer of data from the medical records to the protocol was accomplished with the assistance of three coders and one coding supervisors. The three coders were selected on the basis of their previous experience in secretarial related work. The coding supervisor was an individual with at least two years medical secretary experience and at least two years supervisor experience at the office of Joseph L. Posch M.D. and Associates, P.C..

In providing for the accurate and efficient transfer of data from the medical records to the Dupuytren's Contracture Protocol, random samples of completed protocols were examined and checked by the researcher and the coding supervisor for errors or missing information.

The work schedule for abstracting the patients medical records with Dupuytren's Contracture lasted 14 days, with each of the three coders abstracting approximately 20 records per day.

The transfer of data from the Dupuytren's Contracture Protocol to the computer disk was accomplished with the assistance of the Director of Data Processing in the office of Dr. Joseph L. Posch M.D. and Associates P.C. The person chosen for this task possessed considerable experience in computer and mathematical related fields. In providing the highest degree of accuracy in the data transferral process, the entry into the computer disk were checked by the researcher on a daily basis.

The entire process involving the transfer of data from the protocols onto computer disk encompassed a period of 20 days. Approximately 42 cases were entered onto computer disk per day. This deliberation was required in order to efficiently assess the accuracy of the entered data. Furthermore, additional checks were performed. Upon completing the entire data transfer to computer disk, the completed data file was meticulously debugged by the researcher using the Editor on MTS at Wayne State University. All erroneous characters and blanks were deleted from the data file before any data analyses were conducted.

Lastly, back-up provisions for the disk data file were acquired. A magnetic tape was procured from the Wayne State Computing Center and the data file on disk was then copied to the tape. This additional safeguard provides the highest degree of protection for the data file.

In elucidating the limitations of this research, the following applies:

1. The study involves the descriptive nature of the Dupuytren's Contracture data set and, as a consequence, no inferences are or will be made to other Dupuytren's Contracture cases not involved in the current data set .
2. Due to economic restrictions, only those cases of Dupuytren's Contracture from 1950 through 1971 were selected for the analysis.
3. The hand will be employed as the unit of datum rather than the patient. Since there are bilateral cases of Dupuytren's

Contracture, 1095 hands will be analyzed rather then 853 patients.

4. Since computer time is relatively expensive when conducting advanced multivariate statistical analyses , this research will be confined to one research question.

The research question examined in this study is as follows:

What is the difference among patients classified as mild Dupuytren's cases verses moderate and severe Dupuytren's cases based upon an analysis of 16 predictor variables?

For this research question the statistical analysis will be:

1. Statistically, search the data set for discriminating variables employing the OSIRIS IV SEARCH procedure.

2. The application of Multivariate Nominal Scale Analysis to ascertain which variables attribute to classification as mild, moderate or severe Dupuytren's cases.

3. The application of Discriminate Function Analysis to generate discriminate functions that provide maximal prediction for mild, moderate or severe Dupuytren's cases.

CHAPTER FOUR

RESULTS

A direct comparison of the three statistical procedures; SEARCH, Discriminant Function Analysis and Multivariate Nominal Scale Analysis, will be the focus of discussion in this chapter.

The first portion of the analyses compares Discriminant Function Analysis and Multivariate Nominal Scale Analysis to ascertain these procedure's ability in answering the research question. To restate, the research question asked the following: Which variables contribute to the classification of mild, moderate and severe cases of Dupuytren's Contracture? For this analysis, 16 predictor or independent variables were used in conjunction with the dependent variable. The selection of these 16 predictor variables was based on a careful screening of the data set for only those variables which displayed acceptable frequency distributions. That is, those variables which exhibited a potential for discrimination were selected for the subsequent analyses.

The second portion of the analyses examines the results of a SEARCH analysis using the same pre-selected 16 independent variables. The purpose for employing this statistical procedure is to assess the ability of SEARCH in answering the research question posited above.

The third and final phase of the analyses involves another comparison between Discriminant Function Analysis and Multivariate Nominal Scale Analysis. In this particular situation however the two statistical techniques utilize only those independent or predictor variables found to be significant as a result of the SEARCH analysis. Again, the results are examined in terms of how well the two procedures answer the research question.

Before discussing the results of the analyses, further information must be provided. Since the data set contains cases no later than 1971 a statistical description employing frequencies and percentages is not presented. In addition, both comparisons involving Discriminant Function Analysis and Multivariate Nominal Scale Analysis include an analysis and discussion of the residual scores. An important assumption when employing certain multivariate statistical procedures is that the residual scores must approximate a normal distribution. If this criterion is not satisfied, the results of the statistical analysis must be interpreted with a higher degree of caution. Histograms are provided so that the exact nature of the distribution of residual scores can be inspected visually.

<u>A comparison of Discriminant Function Analysis and Multivariate Nominal Scale Analysis employing 16 predictor variables</u>

A Discriminant Function Analysis was conducted using the Statistical Package for the Social Sciences. The purpose of using this statistical procedure was to determine the possibility of classifying cases into mild, moderate or severe categories of Dupuytren's Contracture on the basis of 16 independent variables.

The Discriminant Analysis resulted in four tables. The first table presented, exhibits the variables included in the analysis and the order in which they were selected. In explaining the results of this Discriminant Analysis in terms of the research question, the following applies. Tables 1,2,3 and 4 are presented first and then a discussion, describing the results, follows.

TABLE 1

VARIABLES INCLUDED IN DISCRIMINANT ANALYSIS
WITH 16 PREDICTOR VARIABLES

Step	Action Enter	Var In	Wilkes Lambda	Sig.	Label
Variables Entered					
1	v10	1	0.75	0.00	Surgery performed
2	v6	2	0.71	0.00	Little finger involved
3	v9	3	0.70	0.00	Vitamin E treatment
4	v12	4	0.68	0.00	History of trauma
5	v18	5	0.67	0.00	Duration of followup
6	v13	6	0.65	0.00	Closed fasciotomy
7	v4	7	0.65	0.00	Middle finger involved
8	v7	8	0.64	0.00	Palm involved
9	v5	9	0.64	0.00	Ring finger involved
10	v3	10	0.63	0.00	Age of respondent
11	v2	11	0.63	0.00	Occupation of respondent
12	v15	12	0.63	0.00	Tranverse incision
Variables Not Entered					
v1					Sex
v14					Other operation
v16					Primary incision
v17					Closure, little finger

TABLE 2

CANONICAL DISCRIMINANT FUNCTIONS
FOR DISCRIMINANT ANALYSIS
WITH 16 PREDICTOR VARIABLES

Function	Eigenvalue	% of Variance	Cumulative Percent	Canonical Correlation
1	.49747	88.36	88.36	.5763723
2	.06552	11.64	100.00	.2479825

After Function	Wilks' Lambda	Chi-Squared	D.F.	Sig
0	.6267287	444.24	24	0.0
1	.9385047	60.072	11	0.0

TABLE 3

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS
FOR DISCRIMINANT ANALYSIS
WITH 16 PREDICTOR VARIABLES

	Function 1	Function 2
v2	.10665	-.12292
v3	-.02405	.40521
v4	.153	.02615
v5	.16887	.03734
v6	.34259	.13053
v7	.17950	.05001
v9	-.3634	.06393
v10	.51112	-.07197
v12	-.30696	.14753
v13	.09376	.58519
v15	.05594	-.31266
v18	.03278	.63823

TABLE 4

CLASSIFICATION RESULTS
FOR DISCRIMINANT ANALYSIS
WITH 16 PREDICTOR VARIABLES

Actual Group		# of Cases	Predicted Group Membership 0	1	2
Severe	0	216	114 52.8%	61 28.2%	41 19.0%
Moderate	1	456	132 28.9%	209 45.8%	115 25.2%
Mild	2	283	22 7.8%	31 11.0%	230 81.3%

In Table 1, variable 10 is the first variable entered into the discriminant function equation. This indicates that after all other variables are considered, variable 10 contributed the most in explaining the variance in the dependent variable. Variable 6 was the next variable to be entered into the equation. This signifies that variable 6 explained the greatest amount of the remaining variance in the dependent variable. A total of 12 such steps were performed in this particular analysis. Each variable entered at each step was the best at that point in accounting for the remaining variance in the dependent variable.

Table 2 indicates the amount of variation accounted for in the analysis by all 12 predictor variables collectively. In this particular situation, two discriminant functions were derived. However, even though both functions are significant, the first function clearly displays the greatest explanatory power. By squaring the Canonical Correlation coefficient for the first discriminant function, 33.22 percent of the variation is explained while only 5.71 percent is accounted for by the second discriminant function.

Table 3 summarizes the standardized discriminant function coefficients for both discriminant functions. The more deviant a coefficient is from 0 the greater its effect in the discriminant function. For the first discriminant function, variables 10,9,6 and 12 are the most effective.

In the second discriminant function, variables 3,13,15 and 18 exhibit the greatest contribution.

Lastly, Table 4 provides information relating to the overall accuracy of the classification of groups. In total, the 12 predictor variables correctly classified 57.91 percent of all the cases. The strongest prediction occurred with the mild Dupuytren's Contracture cases with 81.3 percent correctly classified. The weakest prediction occurred with the moderate Dupuytren's Contracture cases where 45.8 were correctly classified.

In summary, a significant proportion was explained by the 12 predictor variables as indicated by the Canonical Correlation coefficient and Chi-Squared statistic. Overall, the precision of the prediction is moderately accurate with the best classification achieved with the mild Dupuytren's Contracture cases.

In conducting the Multivariate Nominal Scale Analysis, 16 independent variables were employed. Again, the purpose for utilizing this multivariate statistical procedure is to determine how accurately the 16 predictor variables can classify patients as mild, moderate and severe Dupuytren's cases.

This particular analysis provides two tables. Tables 5 and 6 are first presented and then are followed by a discussion of the results.

TABLE 5A

RESULTS OF FIRST MULTIVARIATE NOMINAL SCALE ANALYSIS
WITH 16 PREDICTOR VARIABLES

3 Codes for Dependent Variable v8, Extent of Involvement

Code:	0	1	2	Total
Frequency	216	456	283	955
Percent	22.6	47.7	29.6	100.0

Generalized R-Squared = .1984
Multivariate THETA = .6230

TABLE 5B

PART TWO OF TABLE FIVE

	Results for BETA Squared				
Code:	Sev 0	Mod 1	Mild 2	Gen ETA Squared	Bivariate THETA
Variable					
v1	.52E-4	.0007	.001		
Sex				.5E-4	.4775
v2	.0003	.0012	.0028		
Occupation				.0002	.4775
v3	.0091	.0116	.0013		
Age				.0075	.4775
v4	.0022	.0004	.0044		
Middleinvolved				.0119	.4775
v5	.002	.0015	.007		
Ringinvolved				.0132	.4775
v6	.0111	.0045	.029		
Littleinvolved				.0371	.4775
v7	.0037	.0007	.0073		
Palminvolved				.0021	.4775
v9	.0028	.0049	.0155		
Vitamine				.042	.5225
v10	.0182	.0281	.0943		
Surgery				.124	.5696
v12	.0192	.0102	.0003		
Histoftrauma				.0104	.4775
v13	.0036	.0002	.0015		
Closfasciotomy				.0213	.4775
v14	.0075	.0063	.0001		
Otheroperation				.0398	.4775
v15	.0005	.05E-4	.0005		
Transvincision				.0502	.4775
v16	.0003	.0012	.0005		
Primaryincision				.0652	.489
v17	.0294	.0252	.0007		
Clostypinlittle				.0426	.4859
v18	.0092	.0049	.0116		
Durfollow				.1128	.5508

TABLE 6

CLASSIFICATION MATRIX
FOR MULTIVARIATE NOMINAL SCALE ANALYSIS
WITH 16 PREDICTOR VARIABLES

		Predicted			
		Severe (0)	Moderate (1)	Mild (2)	Totals
Severe	0	51	129	36	216
Row	%	23.6	59.7	16.7	100
Moderate	1	31	311	114	456
Row	%	6.8	68.2	25.0	100
Mild	2	6	44	233	283
Row	%	2.1	15.5	82.3	100
Totals:		88	484	383	955
Row	%	9.2	50.7	40.1	100

The results presented in Table 5A provide important information in answering the research question. First, the overall frequencies and percents indicate the probability of correctly classifying a patient without considering any predictor variables. In other words, without information on any of the independent variables, a subject selected at random would have a 47.7 percent probability of being a moderate Dupuytren's Contracture case. Incidentally, the best group membership prediction at this point would be the moderate Dupuytren's category.

In considering the 16 predictor variables, which variables improve the ability to accurately classify the cases as mild, moderate or severe Dupuytren's Contracture? Again, reference to Table 5A provides valuable information in answering this question. The Generalized R-Squared indicates that 19.84 percent of the variation in the dependent variable has been explained by the 16 independent variables collectively. Also, the Multivariate THETA provides a value which indicates the increase in prediction accuracy as a result of the independent variables. When no predictor variables were considered, the best prediction at that point was the 47.7 percent associated with the moderate Dupuytren's Contracture category. The Multivariate THETA of 62.3 percent illustrates that, when considering the 16 predictor variables collectively, an additional 14.6 percent in accuracy of classification was achieved. In other words in randomly selecting a patient one would be correct 62.3

percent of the time in classifying that patient as having mild, moderate or severe Dupuytren's Contracture.

When examining variable specific relationships, the following summary statistics from Table 5B are employed. The Bivariate THETA and Generalized ETA Squared statistics both provide a method for measuring the strength of the relationship between each independent variable and the dependent variable. The Generalized ETA Squared signifies the amount of variation accounted for on the dependent variable by each independent variable. The Bivariate THETA indicates each predictor variable's contribution to improving the accuracy of the prediction. Upon examining Table 5B, it is apparent that variable's 1,2,3,4,5,6,7,9,12,13,14 and 15 provide no additional predictive power beyond that already demonstrated by the overall frequencies on the dependent variable codes. In each situation, the probability for classification is 47.75 percent. It appears that variables 10,16,17, and 18 are the only predictors which provide improvement in the classification of groups. Variable 10 is the strongest with 56.96 percent.

In examining the BETA-Squared statistics, these measures provide an indication of the importance of each independent variable as a predictor of each category of the dependent variable when holding constant all other independent variables. That is, when holding constant all other independent variables, variable's 1,2,4,5,6,7,9,10,and

18 are important in predicting mild cases of Dupuytren's Contracture. Variables 3 and 16 are important in predicting moderate cases of Dupuytren's Contracture. Variables 12,13,14 and 17 are important in predicting severe Dupuytren's cases and variable 15 is equally important in predicting both mild and severe Dupuytren's Contracture cases.

Table 6 provides a classification table summarizing the overall accuracy of prediction on the dependent variable codes. Upon inspection, it is evident that the best prediction was obtained with the mild cases of Dupuytren's Contracture where 82.3 percent of the cases were classified correctly. Of the 283 mild cases, 233 were classified as mild while 44 were erroneously classified as moderate and six were erroneously classified as severe. Moderately accurate classification was also achieved with the moderate Dupuytren's cases with 68.2 percent correctly classified. Severe cases however, were not as accurately classified with only 23.6 percent of the severe cases being classified as such.

Before comparing the results of the Discriminant Function Analysis and the Multivariate Nominal Scale Analysis, an examination of the residuals obtained for both analyses is indicated. Figures 4, 5, 6 and 7 provide histograms illustrating the shape of the distribution of residuals.

Figure 4. Histogram of Residuals for Discriminant Analysis with 16 Predictor Variables.

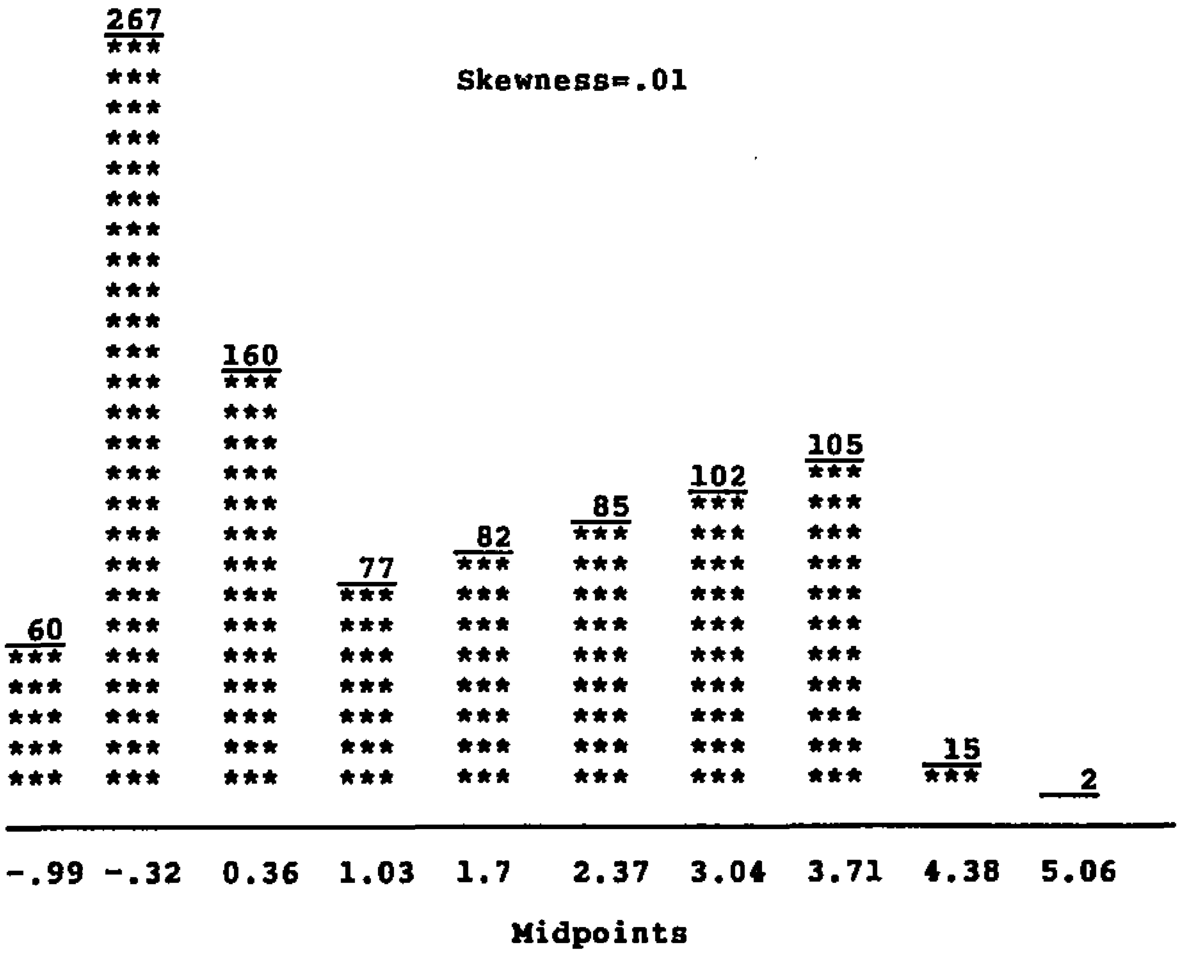


Figure 5. Histogram of Residuals on Severe Cases for Multivariate Nominal Scale Analysis with 16 Predictor Variables.

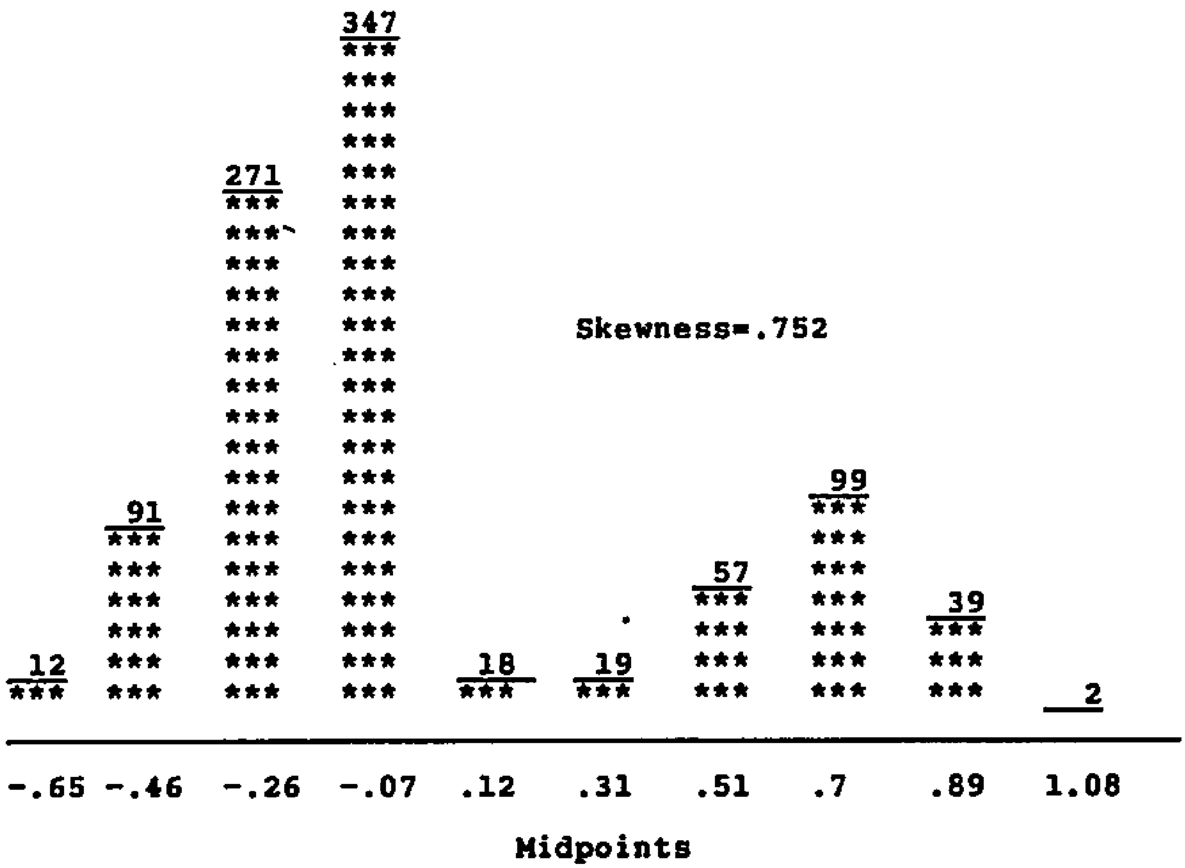


Figure 6. Histogram of Residuals on Moderate Cases for Multivariate Nominal Scale Analysis with 16 Predictor Variables.

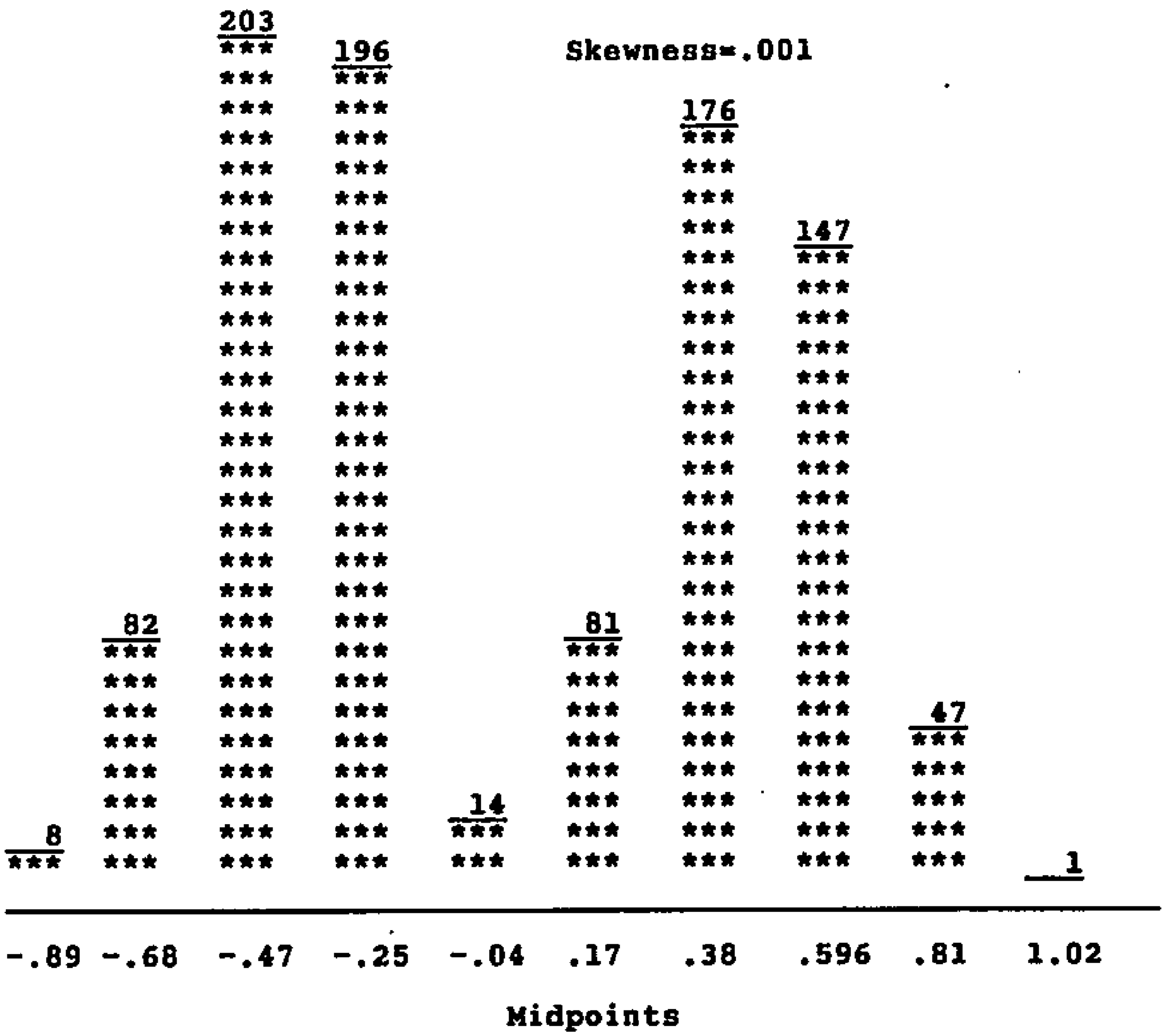
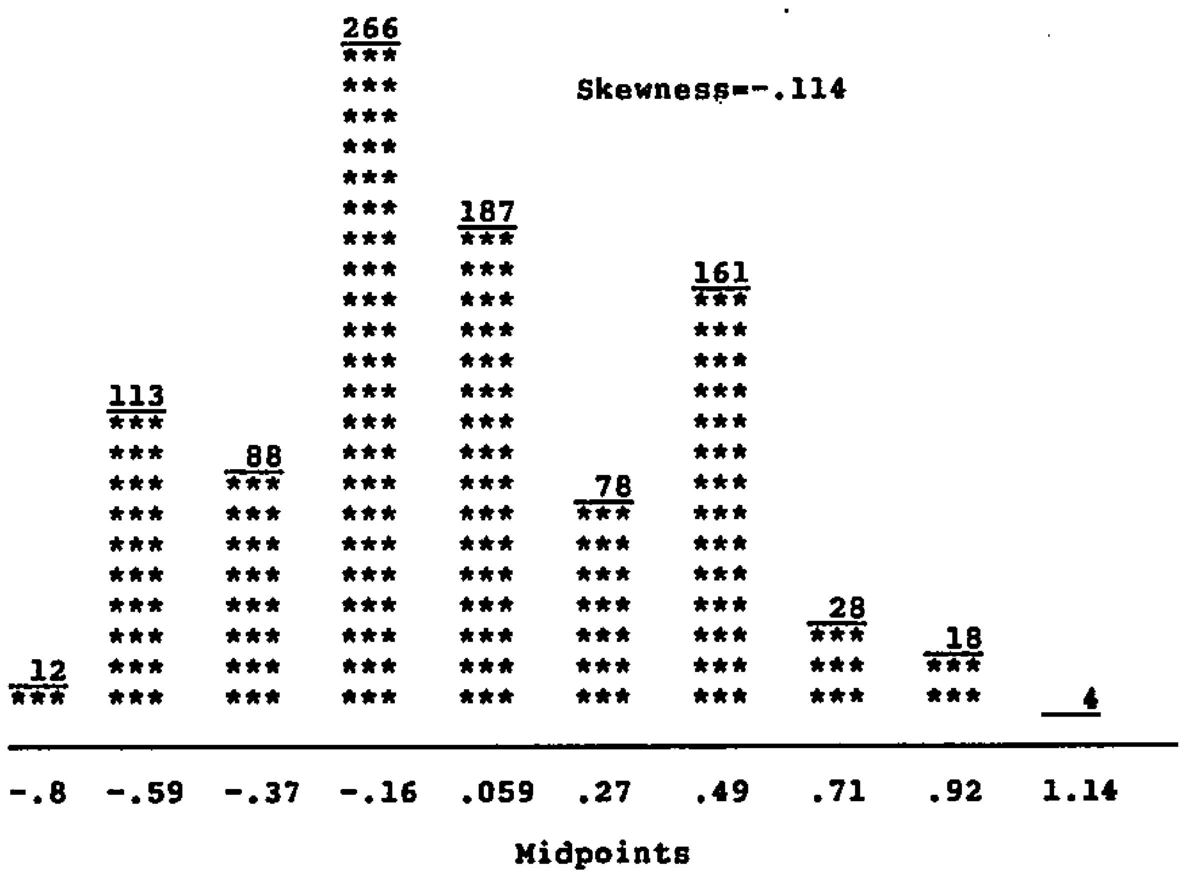


Figure 7. Histogram of Residuals on Mild Cases for Multivariate Nominal Scale Analysis with 16 Predictor Variables.



For the Discriminant Function Analysis, negligible skewness is present, however, the distribution of residual scores is not normal in shape. For the Multivariate Nominal Scale Analysis, non-normal residual distribuations are apparent for each category of the dependent variable. The above situation constitutes a violation of the assumption of normally distributed residuals. As previously mentioned, many multivariate procedures require this condition. Since this is patently not the case the results for the above analyses must be interpreted with a degree of caution.

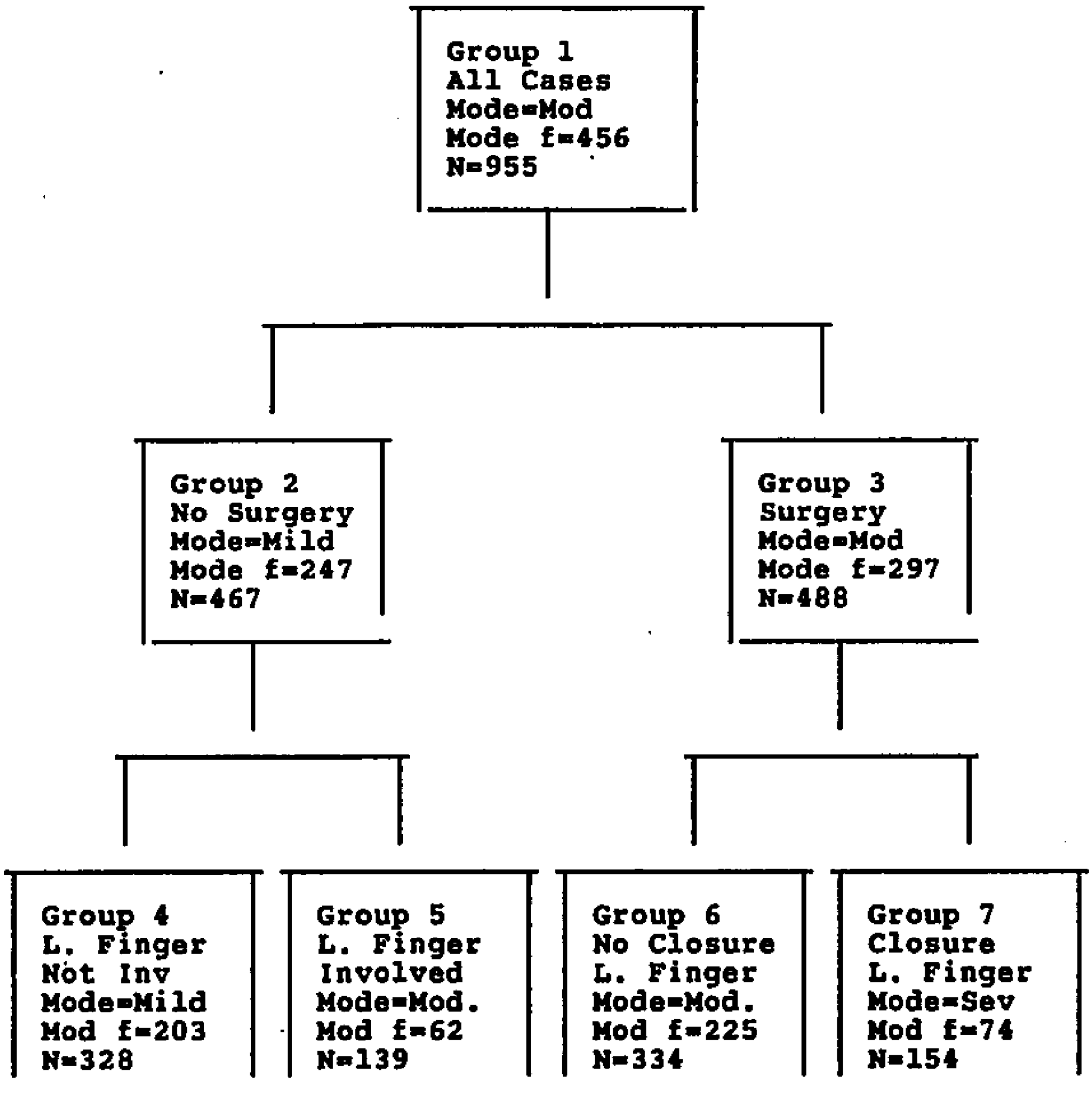
In summarizing the results for the above two analyses, it was found that for the Discriminant Function Analysis, 12 independent variables were selected in the stepwise process. These 12 predictor variables collectively explained 33.22 percent of the variation in the dependent variable for the first discriminant function. For the Multivariate Nominal Scale Analysis, of the original 16 predictor variables, only four displayed an observable improvement in the prediction. The 16 predictor variable combined however, explained 19.84 percent of the variation in the dependent variable.

In terms of the accuracy of the classification of groups, overall both multivariate statistical procedures provided greater precision in classifying the cases into the dependent variable categories. Both techniques however, were especially accurate in classifying mild Dupuytren's Contracture cases with 81.3 percent correctly classified in the Discriminant Function Analysis and 82.3 percent classified correctly in the Multivariate Nominal Scale Analysis.

SEARCH Analysis

The next portion of the analyses involved an application of the 16 predictor variables to a SEARCH analysis. Figure 8 illustrates the results of the analysis. (A discussion follows on page 66)

Figure 8. Results of SEARCH Analysis with 16 Predictor Variables.



Amount of Explained Variation = 16.4%

Of the original 16 predictor or independent variables entered, only three were considered as important in providing a significant contribution to the explanation of variation in the dependent variable. Figure 8 suggests the variable 10, variable 6 and variable 17 are important predictors. These three variables collectively, account for 16.4 percent of the variation.

On interpreting Figure 8 further, groups 2 and 3 represent no surgery and surgery cases respectively. Groups 4 and 5 represent no surgery cases split into little finger not involved and little finger involved cases respectively. Groups 6 and 7 represent surgery cases stratified into no closure for little finger and closure for little finger cases respectively. For group 2, the mode for the dependent variable is mild Dupuytren's Contracture and for group 3 the mode is moderate Dupuytren's Contracture. This suggests that mild cases generally require no surgery while moderate cases do require surgery. For group 4, the mode is mild and in group 5 the mode is moderate. This suggests that for patients with no surgery and where the little finger is not involved, the extent of Dupuytren Contracture is mild. For patients with no surgery and where the little finger is involved, the extent of Dupuytren's disease is moderate. For patients with surgery and where closure in the little finger was indicated, the extent of Dupuytren's disease is severe.

It is evident that SEARCH has significantly reduced the number of predictor variables without seriously reducing the amount of explained variation. The Multivariate Nominal Scale Analysis previously calculated involved all 16 predictor variables and produced a Generalized R-Squared of 19.84 percent. The SEARCH analysis has reduced this to three independent variables with 16.4 percent of the variation explained. As a result, the final section of the analysis compares, once again, Discriminant Function Analysis and Multivariate Nominal Scale Analysis. At this point, the three independent variables selected by the SEARCH analysis were included in these two subsequent analyses.

Second Comparison of DFA and MNA

As previously stated, the third portion of the analyses provides a comparison of Discriminant Function Analysis with Multivariate Nominal Scale Analysis employing the three predictor variables selected by the SEARCH procedure. As before, four tables are presented for the Discriminant Function Analysis. The tables are presented first and a discussion of the results ensues.

TABLE 7

VARIABLES ENTERED INTO DISCRININANT ANALYSIS
WITH 3 PREDICTOR VARIABLES

Step	Var Ent	Var In	Wilks' Lambda	Sig	Variable Label
1	v10	1	.749	0.00	Surgery Performed
2	v6	2	.7096	0.00	Little Finger Involved
3	v17	3	.707	0.00	Closure Type in Little Finger

TABLE 8

CANONICAL DISCRIMINANT FUNCTIONS
FOR DISCRIMINANT ANALYSIS
WITH THREE PREDICTOR VARIABLES

Function	Eigenvalue	Percent of Variance	Cumulative Percent	Canonical Correlation
1	.40324	98.20	98.20	.5360643
2	.00740	1.8	100.00	.0857269

After Function	Wilk's Lambda	Chi-Sq.	D.F.	Sig.
0	.7073979	329.20	6	.00
1	.9926509	7.0148	2	.03

TABLE 9

STANDARDIZED CANNONICAL DISCRIMINANT FUNCTION COEFFICIENTS
FOR DISCRIMINANT ANALYSIS
WITH THREE PREDICTOR VARIABLES

	Function 1	Function 2
v10	0.80774	-0.26752
v6	0.41087	0.88642
v17	0.1224	-0.279

TABLE 10

CLASSIFICATION RESULTS
FOR DISCRIMINANT ANALYSIS
WITH THREE PREDICTOR VARIABLES

	# of Cases	Predicted Group Membership 0	1	2
Actual Group				
Severe 0	216	95 44.0%	63 29.2%	58 26.9%
Moderate 1	456	140 30.7%	161 35.3%	155 34.0%
Mild 2	283	12 4.2%	25 8.8%	246 86.9%

Table 7 illustrates the variables included in the analysis and the order in which they were entered. Variable 10 is the first variable entered in the stepwise process. This signifies that after all other variables are considered, variable 10 was the most effective in explaining the variation in the dependent variable. Variable 6 was the next important variable entered and variable 17 was entered last. Of the three predictor variables employed all were included in this analysis.

Table 8 provides the amount of variation the three predictor variables collectively explained. In this particular situation, two discriminant functions were derived. As Table 8 suggests, both functions are statistically significant with 28.73 percent being explained by the first function. Even though the second discriminant function is statistically significant, the amount of variation explained is very low, .73 percent. Clearly, the first discriminant function is making the greatest contribution to the classification of groups.

For Table 9, a summary of the standardized discriminant function coefficients for both discriminant functions is provided. As previously stated, the more deviant a coefficient is from 0 the greater its effect or contribution in the classification process. In the first discriminant function, variables 6 and 10 are the most effective contributors in the classification of groups. In the second discriminant function, variable 6 is clearly the most effective in improving the accuracy of the prediction.

In examining Table 10, information relating to the overall accuracy of the prediction is provided. Overall, the three independent variables correctly classified 52.57 percent of the cases.

The best classification was achieved with the mild Dupuytren's Contracture group where 86.9 percent of the cases were classified correctly. The weakest classification was achieved with the moderate Dupuytren's group where only 35.3 percent were classified correctly.

In summary, a significant amount of variation was accounted for by the three predictor variables as indicated by the Canonical Correlation coefficients and Chi-Squared values. Overall, the precision of classification is moderately accurate with the best prediction being achieved with the mild Dupuytren's Contracture cases.

The Multivariate Nominal Scale Analysis conducted at this point also includes the three SEARCH selected independent variables employed in the preceding Discriminant Function Analysis. This particular analysis provides two tables. Tables 11 and 12 are presented first and then a discussion of the results follows.

TABLE 11

RESULTS OF SECOND MULTIVARIATE NOMINAL SCALE ANALYSIS WITH THREE PREDICTOR VARIABLES

3 Codes for Dependent Variable (v8), Extent of Involvement

Code	0	1	2	Totals
Frequency	216	456	283	955
Percent	22.6	47.7	29.6	100.0
Generalized R-Squared		0.1857		
Multivariate THETA		0.5791		

Code	Severe 0	Moderate 1	Mild 2
v10 Surgery			
BETA-Squared	0.0184	0.0976	0.2170
Generalized ETA-Squared = 0.1240			
Bivariate THETA = 0.0596			
v6 Little Involved			
BETA-Squared	0.0129	0.0046	0.0317
Generalized ETA-Squared = 0.0371			
Bivariate THETA = 0.4775			
v17 Closetypeinlittle			
BETA-Squared	0.0369	0.0281	0.0006
Generalized ETA-Squared = 0.0426			
Bivariate THETA = 0.4859			

TABLE 12

CLASSIFICATION MATRIX
FOR MULTIVARIATE NOMINAL SCALE ANALYSIS
WITH THREE PREDICTOR VARIABLES

Predicted	0 Severe	1 Moderate	2 Mild	Totals
Severe (0)	17	139	60	216
Row %	7.9	64.4	27.8	100.0
Moderate (1)	10	289	157	456
Row %	2.2	63.4	34.4	100.0
Mild (2)	2	34	247	283
Row %	0.7	12.0	87.3	100.0
Totals	29	462	464	955
Row %	3.0	48.4	48.6	100.0

The results obtained in Table 11 provide the following important information. First, the overall frequencies and percents for the dependent variable codes, indicate the probability of correctly classifying a patient without considering any predictor variables. As stated earlier, without information on the independent variables, a patient randomly selected would have a 47.7 percent probability of being a moderate Dupuytren's Contracture case.

In examining the three predictor variables, which variables contribute to the accuracy of the classification of subjects as mild, moderate and severe groups? Upon inspecting Table 11, the following results are uncovered. The Generalized R-Squared indicates that 15.87 percent of the variation in the dependent variable has been explained by the three independent variables collectively. In addition, the Multivariate THETA of 57.91 percent, indicates that the prediction was improved by 10.21 percent.

Upon examining variable specific relationships, Table 11 indicates that variable 6 provides no additional predictive power beyond the frequencies and percents obtained for the dependent variable codes. In this situation, when considering variable 6, the probability of correct classification is 47.75 percent. It is apparent that variables 10 and 17 are the only predictors which provide improvement in the classification of groups. Variable 10 is most effective with 59.96 percent.

In inspecting the BETA-Squared statistics, variables 10 and 6 are important in predicting mild cases of Dupuytren's Contracture and variable 17 is important in predicting severe Dupuytren's cases.

Table 12 illustrates the classification table summarizing the overall accuracy of prediction on the codes of the dependent variable. In examining Table 12, it is evident that the best classification was achieved with the mild Dupuytren's Contracture cases where 87.3 percent of the cases were classified correctly. Of the 283 mild cases, 247 were classified as mild, two were misclassified in the severe category and 34 were misclassified in the moderate category. Moderately accurate classification was obtained for the moderate Dupuytren's category with 63.4 percent of the cases correctly classified. Severe Dupuytren's cases were not as accurately classified with only 7.9 percent of the severe cases being classified as such.

An analysis of the residuals for the Discriminant Function Analysis and Multivariate Nominal Scale Analysis again indicates that the distribution of residuals for the former procedure reflects a negligible amount of skewness. However, the distribution is not normal in shape. For the latter procedure, all three histograms reflect a non-normal distribution of residual scores. Figures 9, 10, 11 and 12 provide histograms illustrating these conditions.

Figure 9. Histogram of Residuals for Discriminant Analysis with 3 Predictor Variables.

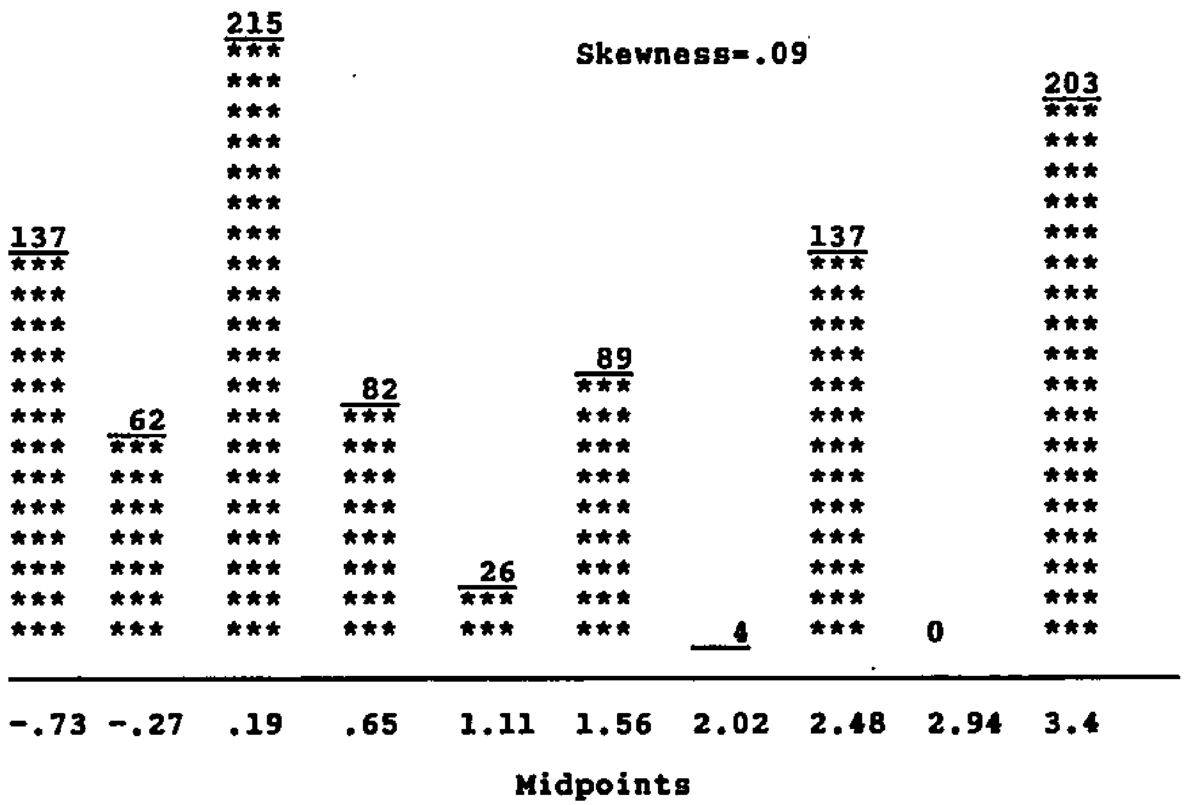


Figure 10. Histogram of Residuals on Severe Cases for Multivariate Nominal Scale Analysis with 3 Predictor Variables.

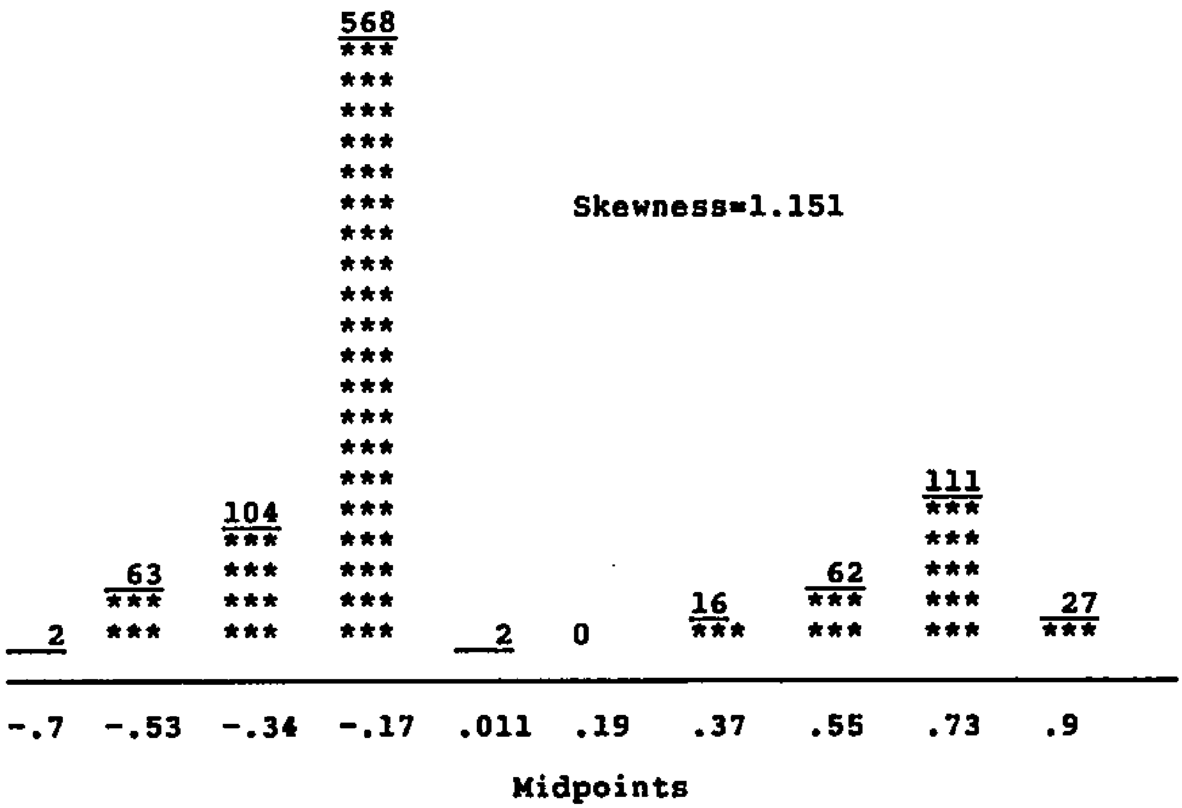


Figure 11. Histogram of Residuals on Moderate Cases for Multivariate Nominal Scale Analysis with 3 Predictor Variables.

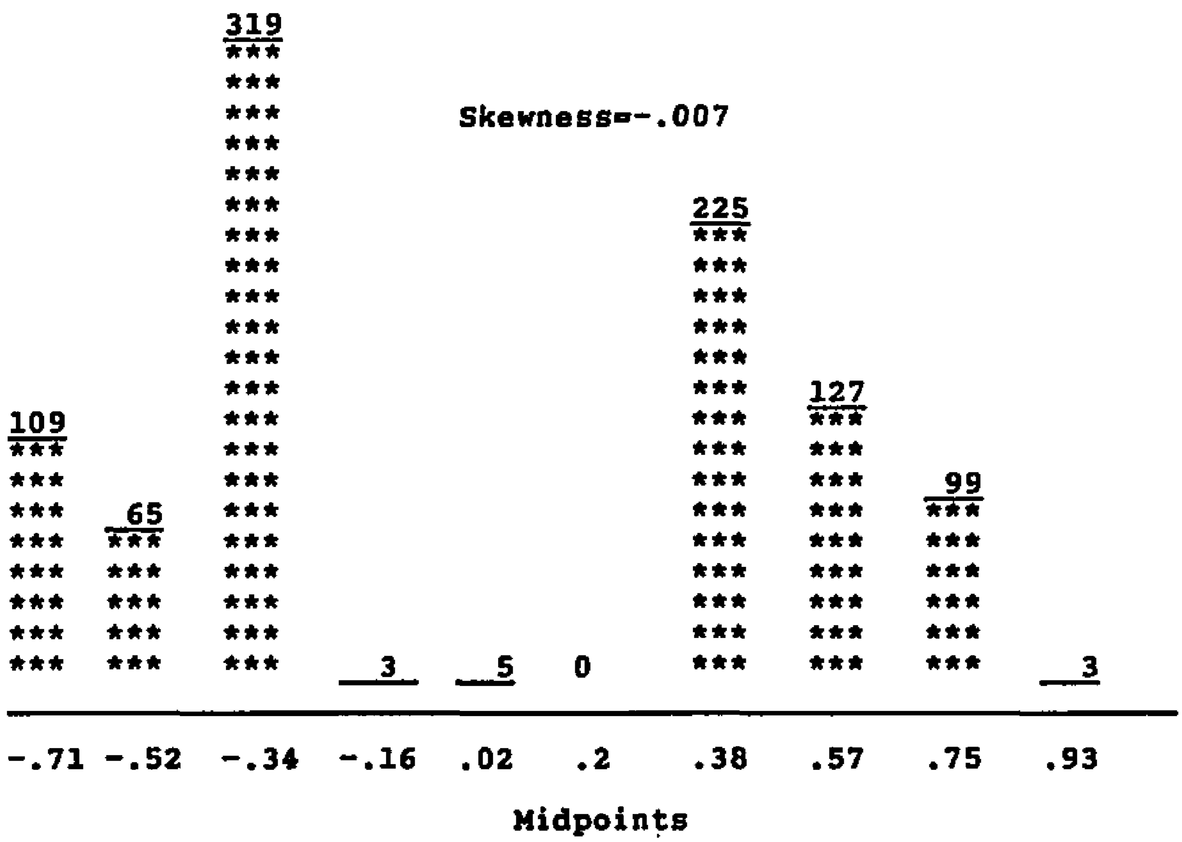
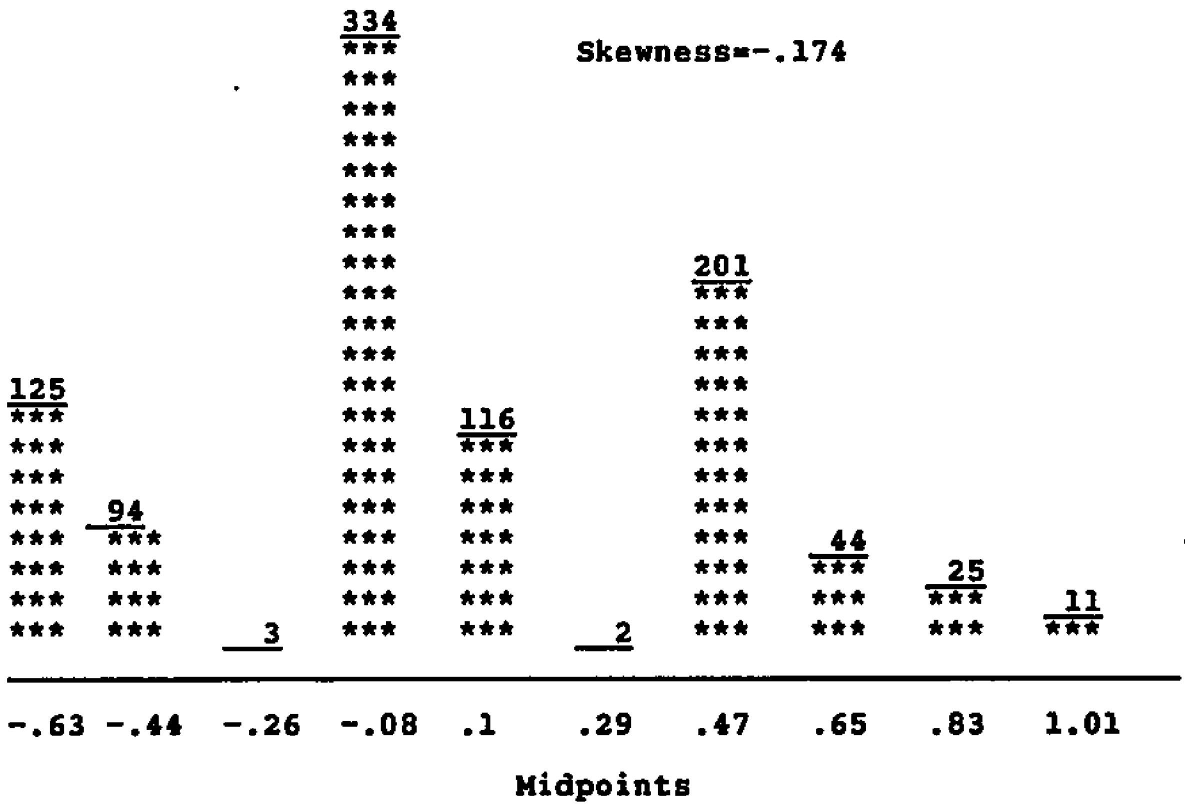


Figure 12. Histogram of Residuals on Mild Cases for Multivariate Nominal Scale Analysis with 3 Predictor Variables.



As stated before, this represents a violation of the normality assumption for residuals and, as a consequence, caution is required when interpreting the results.

In summarizing the results for the above two analyses, for the Discriminant Function Analysis it was discovered that all three of the SEARCH selected predictors were included in the analysis and that 28.73 percent of the variation in the dependent variable was explained by the first discriminant function. This is close to the 33.22 percent explained variation when 12 predictor variables were included. It appears that the SEARCH selected variables explain a sizable proportion of the variation.

In examining the Multivariate Monomal Scale Analysis with the three SEARCH selected variables, two variables provided an observable improvement in the classification of groups. In considering all three predictor variables collectively, 15.87 percent of the variation in the dependent variable was explained. Again, it appears that with the three SEARCH selected variables, a sizeable proportion of explained variation is still obtained. When 16 predictor variables were included in the previous Multivariate Nominal Scale Analysis, 19.84 percent of the variation was explained. With only three predictors however, nearly 16 percent of the variation is still accounted for.

In terms of the accuracy of classification, overall, both Discriminant Function Analysis and Multivariate Nominal

Scale Analysis provide a higher degree of precision in classifying the cases into the dependent variable categories. Again, both techniques were especially accurate in predicting mild cases of Dupuytren's Contracture. 86.9 percent were classified correctly in the Discriminant Function Analysis and 87.3 percent were correctly classified in the Multivariate Nominal Scale Analysis.

In concluding this chapter, it seems evident that the SEARCH statistical procedure is quite effective in reducing the number of predictor variables to an optimal quantity. This was demonstrated convincingly with the above analyses. It was found that three SEARCH selected independent variables could account for almost as much explained variation as could 12 or 16 predictor variables.

CHAPTER FIVE

CONCLUSIONS

The preceding statistical analyses demonstrate that it is possible to utilize advanced multivariate statistical procedures in the analysis of large and complex data sets.

The first comparison presented in this research, involved Discriminant Function Analysis and Multivariate Nominal Scale Analysis. The 16 independent variables selected for this analysis were chosen on the basis of their potential to discriminate the categories of the dependent variable . For the Discriminant Function Analysis, 12 variables of the original 16 predictor variables were included in the equations of both discriminant functions. It was found that these two discriminant functions explained 33.22 percent and 5.71 percent of the variation in the dependent variable respectively. In addition, based on the standardized discriminant function coefficients for the first discriminant function, variable 10 (surgery performed), variable 9 (vitamin E treatment), variable 6 (little finger involved) and variable 12 (history of trauma) were the most important contributors in the classification of mild, moderate and severe Dupuytren's Contracture.

In examining the Multivariate Nominal Scale Analysis the following results were obtained. Without any prior information on the independent variables, the best prediction for the cases of Dupuytren's Contracture was achieved with the moderate category of the dependent variable, where 47.7% of the cases were classified as such. The Generalized R-Squared value of 19.84 percent, indicated that a sizable proportion of the variation in the dependent variable was explained by the 16 independent variables collectively. In addition, the Multivariate THETA indicated that an additional 14.6 percent in accuracy of prediction was achieved by the 16 predictor variables .

Upon inspecting the variable-specific summary statistics provided by this statistical procedure, the following applies. Both the Bivariate THETA and Generalized ETA Squared provided summary statistics which indicated the strength of the relationship between the independent variables individually and the dependent variable. Based on the previous results, variable 10 (surgery performed), variable 16 (primary incision), variable 17 (closure type in little finger) and variable 18 (duration of follow up) were the predictor variables which improved the accuracy of the classification. Variables 10 and 18 were especially strong contributors with 55.08 percent and 56.96 percent respectively.

This first comparison involving Discriminant Function Analysis and Multivariate Nominal Scale Analysis did provide an increase in the accuracy of group classification. It is interesting to note that the Discriminant Analysis was the more effective procedure in explaining variation in the dependent variable. Perhaps, in this respect, Discriminant Analysis may be judged to be superior to Multivariate Nominal Scale Analysis. Nevertheless, the summary statistics provided by Multivariate Nominal Scale Analysis yielded values which permitted the researcher to ascertain which independent variables were or were not contributing directly to the improvement in classification.

In terms of similarities, both procedures were equally accurate in classifying mild cases of Dupuytren's disease. Over 81 percent of the mild cases of Dupuytren's Contracture were classified as such with both statistical procedures.

The SEARCH procedure included the same 16 predictor variables as in the preceding two analyses. The SEARCH technique is often used when one wishes to reduce the number of categorical variables in an analysis. For example, in data sets with large numbers of independent variables, a researcher may wish to identify those predictors which provide the strongest explanatory power.

The SEARCH procedure applied in this particular situation was effective in eliminating the less optimal independent variables. Of the 16 original independent variables included in the analysis, the SEARCH statistical procedure selected three optimal predictors which contributed effectively to the classification of the dependent variable groups. The variables chosen, variable

10, variable 6 and variable 17, accounted for 16.4 percent of the variation in the dependent variable. Compared with the Discriminant Function Analysis this is a substantial loss of explained variation. However, when compared with the results of the Multivariate Nominal Scale Analysis, the reduction in amount of explained variation is small. Perhaps, it may be argued that when analyzing categorical data, the first stage in the analysis should involve screening techniques such as the SEARCH procedure so as to eliminate extraneous predictor variables.

The second comparison in this research again involved Discriminant Function Analysis and Multivariate Nominal Scale Analysis. The independent variables included in this particular comparison were the three SEARCH selected variables. When applied in the Discriminant Analysis, the resulting two discriminant functions explained 28.73 percent and .73 percent of the variation in the dependent variable respectively. When contrasted with the explained variation obtained in the first comparison, it was evident that little information is lost when only three predictor variables were utilized. Furthermore, based on the standardized discriminant function co-efficients for the first discriminant function, variables 10 and 17 were considered to be the most effective in classifying cases into the categories of the dependent variable.

In examining the Multivariate Nominal Scale Analysis conducted with the three SEARCH selected variables, the following results were obtained. As before, without considering the independent variables, the best prediction for cases of Dupuytren's disease was achieved with the moderate level of the dependent variable. 47.7 percent of all cases with Dupuytren's disease were classified as having a moderate degree of involvement. The Generalized R-Squared indicated that 15.87 percent of the variation in the dependent was explained by variables 10, 6 and 17 collectively. In addition, the Multivariate THETA indicated that an additional 10.21 percent in accuracy of prediction was achieved by the three predictor variables.

The variable specific summary statistics obtained in this particular analysis indicated that variable 10 and variable 17 provided an increase in the accuracy of prediction. Variable 10 was particularly strong with 56.96 percent.

The second comparison involving Discriminant Function Analysis and Multivariate Nominal Scale Analysis did provide an increase in the accuracy of classifying cases. Again, the Discriminant Function Analysis explained the most variation. However both statistical procedures were similar in their ability to classify mild cases of Dupuytren's disease accurately.

An important observation to be made at this point is the level of efficiency in which the three SEARCH selected independent variables accounted for variation in the dependent variable. The indices of explained variation for the Discriminant Analysis and Multivariate Nominal Scale Analysis when three independent variables were employed are close to the values obtained when 16 variables were included in the analysis.

This situation appears to substantiate the statement previously made, regarding the efficacy of using SEARCH as a screening device. This procedure appears to efficiently select only those variables which contribute to the amount of explained variation in the dependent variable. As indicated above, the three SEARCH selected predictor variables explained nearly as much variation as the original 16 independent variables.

Due to the non-normal distribution of the residual scores, caution must be exercised in interpreting the results of this research. Nevertheless, the information and methodology presented in this dissertation might serve as a model for future research endeavors in the medical and/or social science fields. Furthermore, the results and discussion reported in the preceding chapter may have some influence on the future training of Hand Surgery residents. Without doubt this research did provide some degree of greater clarity on a rather complex medical condition. Consequently, an increased understanding and application of multivariate statistical procedures in medical research would be beneficial to the field.

In terms of making recommendations for future research, the following applies. First, the use of coders with medical training and/or experience is indicated for any research involving medical related variables. Although the coders employed for this research possessed secretarial related experience, the use of individuals conversant with medical terminology might increase the overall accuracy of the coding process.

Second, more recent cases of Dupuytren's Contracture should be incorporated into any future analyses. Due to economic limitations, cases no later than 1971 were included in this study. As a result of improvements made recently in record maintenance, treatment of Dupuytren's disease and surgical techniques, the inclusion of current Dupuytren's Contracture cases would provide additional valuable information on better understanding what contributes to the occurrence of this medical condition.

Third, further investigations should be made into the reasons why different independent variables were considered to be important predictors of the extent of Dupuytren's Contracture among the three statistical techniques employed. Discriminant Function Analysis, Multivariate Nominal Scale Analysis and SEARCH all yielded different results in terms of selecting important predictor variables. Further research might provide better understanding of each statistical procedures algorithm for selecting optimal variables.

A fourth recommendation would involve a more detailed examination of the potential effect of heredity on the occurrence of Dupuytren's disease. Due to the limited amount of information on heredity contained in the patient's medical records, this problem could not be dealt with at a satisfactory level. More precise data should be collected on the patient and on the patients family history in order to better understand what role, if any, heredity plays in the occurrence of Dupuytren's Contracture.

The fifth recommendation involves extending a study of Dupuytren's disease so that data for different geographic locations can be collected and compared. Admittedly, such an endeavor might involve considerable expense. However, data collected from only one geographic area is not sufficient to permit a generalization of the findings to the population of individuals with Dupuytren's disease. In making this possible, a more representative cross-section would be necessary.

A sixth recommendation involves the further applications of SEARCH as a screening device. Even though the results of this research indicated the utility of SEARCH as a selector of optimal predictor variables, further demonstrations in other research settings would be necessary before this application of the SEARCH procedure can be accepted as a viable research strategy. In addition, it would be advisable to incorporate Multivariate Nominal Scale Analysis when using SEARCH since both statistical procedures were designed to analyze categorical data.

The seventh and final recommendation is involved with the analysis of residuals. In much research employing multivariate statistical procedures, a thorough examination of the residual scores is often overlooked. In this dissertation, an attempt was made to examine the distribution of residuals for both the Discriminant Function Analysis and the Multivariate Nominal Scale Analysis. This examination went no further than a description of the residual distributions.

It would seem advisable that future research involving multivariate techniques, might also investigate not only the distribution characteristics of the residual scores, but provide further statistical analyses as well. For example, additional procedures, particularly Multiple Regression Analysis might provide more information as to the nature of the residuals in a specific research setting.

BIBLIOGRAPHY

Agnese, G. and Balestra, V. "Classification problems in epdemiology studied by multivariate analysis." Giornale di Igiene e Medicina Preventiva, July-September, 1970;11 (9): pp.1034-1046.

Aherne, W.A.; Camplejohn, R.S. and Al-Wiswasy, M. and Ford, D. and Kellerger, A.M. "Assement of inherent fluctuations of mitotic and labelling indices of human tumors," British Journal of Cancer, November, 1977;36(5): pp. 577-582.

Alexakos, C.E. "Predictive efficiency of two multivariate statistical techniques in comparison with clinical predications." Journal of Educational Psychology, October, 1955;57(5): pp. 297-306.

Anderson, D.E. and Lydic, R. "A simulation program examining the use of ratios as raw variables in analysis of variance." Computer Programs BioMedical, June, 1978;8(2): pp. 87-90.

Anderson, J.A. and Blair, G.S. "Screening in a Dental Clinic for Adult Rheumatiod Arthritis Involing The Temporomandibular Joint using a Statistical Discriminant Function." Journal or Oral Rebilitation, 1975;2(2): pp. 189-197.

Andrews, F.M. and Messenger, R.C. "Multivariate Nominal Scale Analysis." Ann Arbor: Institute for Social Research, 1973.

Ariyan, S. and Enriquez, R. and Krizek, T.J. "Wound

Contraction and fibicontractive disorders." Archives of Surgery, September, 1978;113(9): pp. 1034-1046

Ariyan, S. and Krizek, T.J. "In defense of the open wound." Archives of Sugery, March, 1976;111(3): pp. 293-296.

Baggaley, A.R. and Riedel, W.W. "A diagnostic assembly of MMPI items of Comrey's factor analysis." Journal of Clinical Psychology, October, 1972;28(4): pp. 459-463.

Bailey, A.J. and Sims, T.J. and Gabbiani, C. and Baxin, S. and LeLeous, M. "Collagin of Dupuytren's disease." Clinical Science and Molecular Medicine, November, 1977;53(5): pp. 499-502.

Barclay, T.L. "Observation on Skoog's operation for Dupuytren's contracture." Hand, June, 1972;4(2): pp. 187-189.

Barker, D.G. "Factor analysis of body hair distributions." American Journal-Physical Anthropology, January, 1976;44(1): pp. 27-30.

Barrett, J.C. "A method of mortality analysis: application to breast cancer." Revue of Epidemiologide Sante Publique, 1978;26(5): pp. 419-425.

Barton, K. and Cattell, R.B. and Conner, D.V. "The identification of "state" factor through P-techinque factor analysis." Journal of Clinical Psychology, October, 1972;28(4): pp. 459-463.

Bell, R.C. and Furness, J.A. "A study of the effect of recurrent trauma on the development of Dupuytren's contracture." British Journal of Plastic Surgery, April, 1977;30(2): pp. 149-150.

Beltran, J.E. "Dupuytren's contracture." Journal Hand Surgery, May, 1978;3(3): p. 299.

Beltran, J.E. and Jimeno-Urban, F. and Yunta, A. "The open palm and digit technique in the treatment of Dupuytren's contracture." Hand, February, 1976;8(1): pp. 73-77.

Benedetti, A. and Nocco, C. "Juvenile diabetic chiroarthropathy." Acta Diabetalogica Latina, January-April, 1976;13(1-2): pp. 54-67.

Beral, V. Chilvers, C. and Fraser, P. "On the estimation of relative risk from vital statistial data." Journal of Epidemiology and Community Health, June, 1979;33(2): pp. 159-162.

Berg,E. and Marino, A.A. and Becker, R.O. "Dupuytren's contracture: some associated biophysical abnormalities." Clinical Orthopic, April, 1972; 83: pp. 144-148.

Berger, M.R. "Dupuytren's contracture." American Journal of Nursing, February, 1978;78(2): pp. 244-245.

Bishop, Y.M. "Statistical methods for hazards and health." Environmental of Health Perspectives, October, 1977;20: pp. 149-157.

Blalock, H.M. Social Statistics, New York: Mcraw Hill, Inc., 1972.

Blomqvist, N.; Cederblad, G.; Korsan-Bengtsen, K. and Wallerstedt, S. "Application of a method for correcting an observed regression between change and initial value." Clinical Chemistry, October, 1977: 23(10); pp. 1845-1848.

Bolton, C.F. and McFarlane, R.M., "Human pneumatic tourniquet paralysis." Neurology, Minneapolis, August, 1978;28(8): pp. 787-793.

Bookstein, F. and Depaola, P.F. and Warram, J. "Regression based techinques for estimating fluoride in surface enamel in large study groups." Journal of Dental Research, January-February, 1976;55(1): pp. 97-106.

Booth, R.F. and Berkshire, J.R. "Factor analysis of aviation training measures and post-training performance evaluation." NAMI-1050, United States Naval Aerospace Medical Institute, May, 1969; pp. 1-7.

Bowser-Riley, S. and Bain, A.D. and Noble, J. and Lamb, D.W. "Chromosome abnormalities in Dupuytren's disease." Lancet, December 27, 1975;2(7948): pp. 1282-1283.

Boyes, J.H. and Jones, F.E. "Dupuytren's disease involving the volar aspect of the wrist." Plastic Reconstructure Surgery, March, 1968;41(3): pp. 204-207.

Brambilla, F. "Stability of distance between structured groups in a social organism: empirical research." Experientia, 1976;(22): pp. 213-220.

Breslow, L. "Rish factor intervention for health maintenance." Science, May 26, 1978;200(4344): pp. 908-913.

Breslow, N. "Regression analysis of the log odds ratio: a method for retrospective studies." Biometrics, ;32(2) :

pp. 409-416.

Breslow, N. and Powers, W. "Are there two logistic regressions for retrospective studies? Biometrics, March, 1978;34(1): pp. 100-105.

Briedis, J. "Dupuyten's contracture: Lack of complications with the open palm technique." British Journal of Plastic Surgery, October, 1974;27(4): pp. 311-317.

Bruner, J.M. "Recent advances in the treatment of Dupuytren's disease." Journal of Iowa Medical Society, March, 1966;48(2): pp. 204-207.

Burch, P.R. "Dupuytren's contracture: an auto-immune disease?" British Journal of Bone and Joint Surgery, May, 1966;48(2): pp. 312-319.

Bystro'om, J. and Rubio, C. "Induratic penis plastica Peyronie's disease. Clincal features and etiology." Scandinavian Journal Of Urology and Nephrology, 1976;10(1): pp. 12-20.

Carly, A.B. "Discriminant analysis: A method of identifying foci of vertor-bone diseases." America Journal of Tropical Medical Hygiene, July, 1979;28(4): pp. 750-755.

Carr, T.L. "Local radical fasciectomy for Dupuytren's contracture." Hand, February, 1974: pp. 40-49.

Carter, M. "The brigand of the Hotel Dieu." Guy Dupuytren. Midwife Health Visit, June, 1967;3(6): pp. 248-249.

Cattell, R.B. and Gibbons, B.D. "Personality factor structure of the combined Guilford and Cattell personality questionaires." Journal of Personal and

Social Psychology, May, 1968;9(1): pp. 107-120.

Cattell, R.B. "Comparing factor trait and state scores across ages and cultures." Journal of Gerntology, July, 1969;24(3): pp. 348-360.

Chiu, H.F. and McFarlane, R.M. "Pathogenesis of Dupuytren's contracture: a correlative clinical-pathological study." Journal on Hand Surgery, January, 1978;3(1): pp. 1-10.

Choi, S.C. and Trotter, M. "A statistical study of the multivariate structure and race-sex differences of American White and Negro fetal skeletons." American Journal of Physical Anathropology, November, 1970;33(3): pp. 307-312.

Clark, C. "Dupuytren's contracture." Lancet, August 26, 1973;2(774): p.435.

Cliff, N. and Hamburger, C.D. "the study of sampling error in factor analysis by means of artifical experiments." Psychology Bulletin, December, 1967;68(6): pp. 430-445.

Cohen, R. "Drug abuse applications: some regression explorations with national survey data." National Institute for Drug Abuse and Research Monograph Series, February, 1979;24: pp. 194-213

Colton, C.L. "The treatment of Dupuytren's fracture-dislocation of the ankle." British Journal of Bone Joint Surgery, February, 1971;53(1): pp.63-71.

Comrey, A.L. "Tandem criteria for analytic rotation in factor analysis." Psychometrika, June, 1967;32(2):

pp. 143-154.

Critchley, E.M.; Vakil, S.D.; Hayward, H.W. and Owne, V.M. "Dupuytren's disease in epilepsy: result of prolonged administration of anticonvulsants." Journal of Neurology and Neurosurgery Psychiatry, May, 1976;39(5): pp. 498-503.

Crockett, D.; Klonoff, H. and Bjering, J. "Factor analysis of neuropsychological tests." Perceptives of Motor Skills, Dececember, 1969;29(3); pp. 791-802.

Crump, P.P. "The results of some factor analysis which have been computed from conference data." Journal of Periodontology, November-December, 1967;38(6); pp. 793-795.

D'abrowski, T. "Treatment of Dupuytren's contracture by excision of the base of the palmar aponeurosis." Acta Media Polona, 1967;8(4): pp. 499-504.

Das Gupta, P. "A general method of decomposing a difference between two rates into several components." Demography, February, 1978;15(1): pp. 99-112.

Davis, C.E. "The effect of regression to the mean in epidemiologic and clinical studies." American Journal of Epidemiology, November, 1976;104(5):pp. 493-498.

Davis, J.E. "Treatement of Dupuytren's contracture." Plastic Reconstructure Surgery, Septmeber, 1965;36(3): pp. 277-314.

Dickie, W.R. and Hughes, N.C. "Dupuytren's contracture: a review of the late results of radical fasciectomy."

Plastic Reconstucture Surgery, June, 1967;39(6): pp. 603-613.

Dickie, W.R. and Hughes, N.C. "Dupuytren's contracture: the value of hypotension in surgical correction." Plastic Reconstructure Surgery, June, 1967;47(2); pp. 433-444.

Dobbins, D.A. "Factor analysis: a problem with age and factor descriptions of the motor domain (proceedings)." British Journal of Sports Medicine, December, 1977: 11(4) p. 187.

Doehring, D.G. and Hoshko, I.M. "Classification of reading problems by the Q-Technique of factor analysis." Cortex, September, 1977;13(13): pp.281-294.

Donner, A. "The use of correlation and regression in the analysis of family resemblance." American Journal of Epidemiology, September, 1979; 110; 110(3): pp. 335-342.

Doyle, J.R. "Dupuytren's contracture--etiology and principles of treatment." California Medical, April, 1969;110(4): pp. 292-299.

Drach, G.W. "Baron Dupuytren, lithotomist (1777-1835). Investigative Urology, March, 1974;11(5): pp. 434-435.

Drews, R.C. and Sabiston, D.W. "Letter; Cataracts, Dupuytren's contracture, and alcohol addiction." American Journal of Opthalmology, March, 1974;77(3): p. 418.

Ducimetiere, P.; Warnet, J.M. and Richard, J.L. "Raised serum alpha-2 globulins as an independent risk factor or coronary heart disease." Journal of Chronic Diseases, July, 1976;29(7): pp. 423-429.

Dunham, J.L.; Guilford, P.P. and Hoepfner, R. "Multivariate approaches to discovering the intellectual components of concepts learning." Psychology Review, May, 1968;75(3); pp. 206-221.

Dymond, A.M. and Coger, R.W. and Serafetinides, E.A. "Preprocessing by factor analysis of cento-occiptial EEG power and asymmetry from three subject group." Annals of Biomedical Engineering, June, 1978;6(2): pp. 108-116.

Early, P.F. "Dupuytren's contracture." Lancet, September, 1972: 2(778); pp. 656-657.

Economos, A.C. "Brain-life span conjective: a reevaluation of the evidence." Gerontology, 1980;26(2): pp. 82-89.

Efron, H.Y. and Piotrowski, Z.A. "A factor analytic study of the Rorschach prognostic index." Journal Projected Techniques and Personality Assessment, April, 1966;30(2); pp. 179-183.

Eisler, H. "Measurement of perceived accoustic quality of sound-reproducing systems by means of factor analysis." Journal Accustic Society of America, March, 1966: 39(3): pp. 484-492.

Eklunn, G. "Discriminant Analysis." Scandinavian Journal of Clinical and Laboratory Investigation, 1970,26: (4) pp. 305-306.

el-Lozy, M. "Multivariate analysis in nutritional anthropometry: an analysis of the Robinow-Jelliffe correlation matrix." Journal Tropical Pediatrics, June, 1972;18(2): pp. 132-133.

Elsahy, N.I. "Doppler ultrasound detection of displaced neurovascular bundles in Dupuytren's contracture." Plastic Reconstructive Surgery, January, 1976; 57(1): pp. 104-105.

Elwood, J.H.; MacKenzie, G. and Cran, G.W. "The measurement and comparison of infant mortality risks by binary multiple regression analysis." Journal of Chronic Diseases, July, 1971;24(2): pp. 93-106.

Falls, H.B.; Ismail, A.H.: MacLeod, D.F.; Wiebers, J.E.; Christian, J.E. and Kessler, M.V. "Development of physical fitness test batteries by factor analysis techniques." Journal of Sports Medical Physical Fitness, December, 1965;5(4); pp. 185-197.

Fenton, G. and Ward, J.H. Jr. "Regression models in the study of circadian rhythms in nursing research." International Journal of Nursing Studies, 1977;14(3): pp. 151-161.

Field, P.B. and Palmer, R.D. "Factor analysis: hypnosis inventory." International Journal of Clinical Experimental Hypnosis, January, 1969;33(2): pp. 160-167.

Fleiss, J.L. and Shrout, P.E. "The effects of measurement errors on some multivariate procedures." American Journal of Public Health, December, 1977;67(12): pp. 1188-1191.

Fletcher, J.M.; Rice, W.J. and Ray, R.M. "Linear discriminent function analysis in neuropsychological research: some uses and abuses." Cortex, December, 1978;14(4); pp. 564-577.

Florescu, A.; Vasilescu, C. and Milicescu, S. "Polyneuropathy in Dupuytren's disease: an electorneurographi Neurology Psychiatric (Bucur), July-September, 1978;16(3): pp. 191-202.

Forsythe, A.B.: May, P.R. and Engelman, L. "Prediction by multiple regression how many veriables to enter?" Journal Psychiatrics Research, June, 1971;8(2): pp. 119-126.

Fraser-Moodie, A. "Dupuytren's contracture and cigarette smoking." British Journal Plastic Surgery, July, 1976;29(3): pp.214-215.

Furlong, R. "Three deformities of the hand; mallet finger, clicking finger, Dupuytren's contracture." Practitioner, November, 1968;201(205): pp. 736-741.

Furukawa,T.; Inoue, M.; Kajiya, F.: Inada, H. and Takasugi, S. "Assessment of biological age by multiple regression anlysis. " Journal of Gerontology, July, 1975;30(4): pp. 422-434.

Gabbiani, G, and Majno, G. "Dupuytren's contractue: fibroblast contraction? An ultrastructural study." American Journal of Pathology, January, 1972;66(1): pp. 131-146.

Gardner, R.C.; Wonnacott, E.J. and Taylor, D.M. "Ethnic stereotypes: a factor analytic investigation." Cancer

Journal Psychology, February, 1968;22(1): pp. 35-44.

Garside, R.F. and Roth, M. "Multivariate statistical methods and problems of classification in Psychiatry," British Journal of Psychiatry, July, 1978;133: pp. 53-67.

Gee, S.C.; Lee, E.S. and Forthofer, R.N. "Ethnic differentials in neonatal and postneonatal mortality: a birth cohort analysis by a binary variable multiple regression method." Socala Social Biology, Winter, 1976; 23(4): pp. 317-325.

George, L.K. and Okun, M.A. "Misuse of analysis of covariance in aging research revisited." Experimetal Aging Research, Septmeber, 1976;2(5); pp. 449-459.

Gilliam, T.B.; Katch, V.L.: Thorland, W. and Weltman, A. "Prevalence of coronary heart disease risk factors in active children, 7 to 12 years of age." Medical Science of Sports, Spring, 1977;9(1): pp. 21-25.

Gocka, E.F. and Reed, L.J. "A method of fitting nonsymmetric Gompertz functions for characteristing malignant growth." International Journal of Biomedic Computing, October, 1977;8(4): pp. 247-254.

Gokel, J.M. and H''ubner, G. "Intracellular fibrous long spacing collagen in morbus Dupuytren (Dupuytren's contracture)." Beitraege Pathology, October, 1977; 161(2): pp. 176-186.

Gokel, J.M. and H''uber, G. "Occurrence of myofibroblasts in the different phases of morbus Dupuytren (Dupuytren's contracture). Beitraege Pathology, October, 1977;161(2):

pp. 166-175.

Goldstein, G. and Shelly, C.H. "Univariate vs. multivariate analysis in neuropsycholgical test assessment of lateralized brain damage." Cortex, June, 1973;9(2); pp. 204-216.

Goldwyn, R.M. "Guillaume Dupuytren." Plastic Reconstrstructure Surgery, September, 1968;42(3): pp. 195-202.

Goldwyn, R.M. "Guillaume Dupuytren: his character and contributions." Bulletin New York Academy of Medicine, August, 1969;45(9): pp. 1037-1041.

Gonzalez, R.I. "Dupuytren's contracture of the fingers: a simplified approach to the surgical treatment." California Medical, August, 1971;115(2): pp. 25-31.

Gordon, Y.J. and Bachar, E. "Multiple regression analysis predictor moden exotropia surgery." American Journal of Ophthalmology, November, 1980;90(5): pp. 687-691.

Gray, R.G. and Gottlieb, N.L. "Hand flexor tenosynovities in rheumatoid arthritis. Prevalence, distribution, and associated rheumatic features." Arthritis Rheumatism, May, 1977;20(4)L pp.1003-1008.

Gunst, R.F. and Mason, R.L. "Advantages of examining multicollinearities in regression analysis." Biometrics, March, 1977;33(1): pp. 249-260.

Hackett, M.E. "The use of thermography in the assessment of depth of burn and blood supply of flaps, with preliminary reports on its use in Dupuytren's contracture and treatment of varicose ulcers." British Journal of Surgery, October , 1974;27(4): pp.311-317.

Hagstr''om, P. "Ulnar nerve compression at the elbow. Results of surgery in 85 cases." Scandinavian Journal of Plastic Reconstructure Surgery, 1977;11(1): pp.59-62.

Hall, P.; Selander, H. and Wolodarski, J. "A Discriminarory Analysis System in a Health Screening Project." Methods of Information in Medicine Supplemental, 1973;(7): pp. 325-329.

Halliday, D.R.: Lipscomb, P.R. and Seldon, T.H. "Rasciectomy and controlled hypotension in treatment of Dupuytren's contracture." American Journal of Surgery, February, 1966;111(2): pp. 282-285.

Halperin, M.; Blackwelder, W.C. and Verter, J.I. "Estimation of the multivariate logistic risk function: comparsion of the discriminant function and maximum likelihood approaches." Journal of Chronic Disease, July, 1971;24(2): pp. 125 -158.

Harris, M.L. "A factor analytic study of flexibility." Research Quarterly American Association Physical Education, March, 1969;40(1): pp. 62-70.

Harris, R.J. A Primer of Multivariate Statistics. New York: Academic Press, (1975).

Harrison, S.H. and Morris, A. "Dupuytren's contracture: the dorsal transposition flap. Hand, June,1975: 7(2): pp. 145-149.

Hazelwood, J.G. "An operation for Dupuytren's contracture."

Bristol Medico-Chirsurgical Journal, October,1972;87: (324): P. 60.

Heuston, J.T. "The control of recurrent Dupuytren's contracture by skin replacement." British Journal of Plastic Surgery, April,1969: 22(2): pp. 152-156.

Hightower, W.L. "Development of an index of health utilizing factor analysis." Medical Care, March 1978; 16(3): pp. 245-255.

Hill, A.P.: Pike, M.C.; Smith, P.G. and Ory, H.W. "Stratified analysis of case-control studies with the factor under study taking multiple values." Journal Chronic Diseases, 1978: 31(9): pp.547-555).

Hoffman, N.G. and Overall, P.B. "Factor structure of the SCL-90 in a Psychiatric population." Journal of Consulting and Clinical Psychology, December,1978; 46(6): pp.1187-119L.

Hogan, M.D.; kupper, L.L.; most, B.M. and Hasman, J.K. "Alternative to Rothman's approach for assessing synergism (or antagonism) in chohort studies." American Journal of Epidemiology, July,1978;108(1): pp.60-67.

Holford, T.R. "The analysis of pair-mathched case-control studies a multivariate approach." Biometrics, December, 1978;34(4): pp.665-672.

Holford, T.R. "The analysis of pair-matched case-control studies, a multivariate approach." Biometics, December, 1978;32(3): pp. 587-597.

Holford, T.R.; white, C. and Kelsey, J.L. "Multivariate analyis for matched case-control studies." <u>American Journal of Epidemiology</u>, March,1978;107(3): pp. 245-256.

Holley, J.W. and Will'en K. "The factor analysis method of studying intracusaneous skin reactions." <u>Acta aallergologia (Kbh)</u>.November,1969;24(4);pp. 284-293.

Honner, R.; lamb, D.W. and James, J.I. "Dupuytren's contracture. long term results after fasciectomy." <u>British Journal of Bone and Joint Surgery</u>, May, 1971;53(2): pp. 240-246.

Hoopes, J.E.; Jabaley, M.E.; Su, C.T.; Wilgis, S. and Im, M.J. "Enzymes of glucose metabolism in palmer fascia and Dupuytren's contracture." <u>Journal of Hand Surgery</u>, January, 1977;2(1): pp. 62-65.

Horner, R.L. and Bralliar, F. "Dupuytren's contracture." Analysis of 100 consecutive surgical cases." Medial Journal, October,1971; 68(10): pp. 49-52.

Howard, K.I. and Hill, J.A. "Some vicissitudes of chain p-factor analyis: criterion of meaningfulness." <u>Psychological Reports</u>, December,1967;21(3): pp. 1005-1013.

Hueston, J.T. "Dupuytren's contracture and Specific injury." <u>Australia Medical Journal</u>, June 22, 1968;1(25): pp. 1084- 1085.

Hueston, J.T.; Hurley, J.V. and Whittingham, B. "The contracting fibroblast as a clue to Dupuytren's contracture." <u>Hand</u>, February, 1976;8(1): pp. 10-20.

Humphreys, L.G. "To understand regression from parent to offspring, think statistically." Pharmacology Bulletin, November, 1978;85(6): pp. 1317-1322.

Ismall, A.H.; falls, H.B. and Macleod, D.F. "Development of a criterion for physical fitness tests from factor analysis results." Journal of Applied Physiology, Septemeber, 1965;20(5): pp. 991-999.

Ito, K. and Kud'o, A. "(Certain multivariate problems arising in human genetics) (Jap)II. An analysis of the relative importance of variables in multivariate regression model." Japanese Journal of Human Genetic, December, 1964;9(4); pp.216- 229.

Jackson, A.S. "Factor analysis of selected muscular strength and motor performance tests." Research Quarterly American Association for Health and Physical Eduation, May, 1971;42(2): pp. 164-172.

Jacobsen, K. and Holst-Nelsen, F. "A modified McCash operation for Dupuytren's contracture. Scandinavian Journal Plastic Reconstructure Surgery, 1977;11(3): pp. 231-233.

Jenden, D.J.; Fairchild, M.D.; Mickey, M.R.; Silverman, R.W. and Yale, C. "A multivariate approach to the analysis of drug effects on the electroencephalogram." Biometrics, 1972;28(1): pp. 73-80.

Jones, J.H.; Lennard-Jones, J.E.; Morson, B.C.; Chapman, M.; Caskin, M,J.; Sneath, P.H.; Spicer, C.C. and Card, W.I. "Numerical Taxonomy and Discriminant Analysis Applied to non-specific colitis." Quarterly Journal of Medicine, 1973;42(168);p. 715-732. pp.715-732.

Jones, K.G. "Office orthopaedics: duputytren's contracture." Journal of Arkansas Medical Society, June, 1975;72(1): pp. 67-90.

Joossens, J.V. and Brems-heyns, E. "High power polynomial regression for the study of distrance, velocity and Acceletion of growth." Growth, December,1975;39(4): pp. 535-551.

Kanda, S. "Factor analysis of cranial length." Zeitschrift Fur Morphologie und Anthropolgie, September, 1973;65(2): pp. 152-159.

Karagancheva, S. and Matev, I. "A two-stage operation in Dupuytren's contracture." Acta Chirurgica Plasticae (Praha), 1972;14(1): pp. 52-59.

Kazarian, S.S. "Modification and factorial analysis of the Leyton Obsessional Inventory." Journal of Clinical Psychology, April, 1977;33(2): pp. 422-425.

Kennard, D. "Identifying dimensions of perceived patient change: some problms in the use of facctor analyis." British Journal of Medical Psychology, March, 1978;51(1): pp.41-52.

Kerlinger, F.N. and Pedhazur, E.J. Multiple Regression in Behavioral Research, New York: Holt, Rinehard, Winston, Inc., (1973).

Ketchum, L.D.: Robinson, D.W. and Master, F.W. "Dupuytren's contracture. When and What to do about Dupuytren's contracture." Journal Kansas Medical Society

, March, 1972;73(3): pp. 108-111.

Kipika'sa A. "The share of heredity in the formation of Dupuytren's contracture." Acta Chirurgiae Plasticae (Praha), 1972: 14(1): pp. 561-566.

Kipika'sa, A. and Gregorov'a, I. "The task of sex and age in formation of Dupuytren's contracture." Acta Chirurgiae Plasticae (Praha), 1970;12(3): pp.166-172.

Kleinbaum, D.G.; kupper, L.L.; Cassel, J.C. and Tyroler, H.A. "Multiariate analysis of risk of coronary heart diseases in Evans County, Georgia." Archives of Internal Medicine, December, 1971;128(6); pp. 943-948.

Kobashigawa, B. Andberki, S.E. "Alternative regression approaches to the analysis of medical care survey data." Medial Care, May, 1977;15(5); pp.396-408.

Kosh, G.G.; Landis, J.R.; Freeman, J.L.; Freeman, D.H. JR. and Lehnen, R.C. "A general methodology for the analysis of experiments with repeated measurement of categorical data." Biometrics, March, 1977;33(1): pp.133-158.

Krall, J.M.; Uthoff, V.A. and Harley, J.B. "A step-up procedure for selecting variables associated with survival." Biometics, March, 1975;31(1): pp. 49-57.

Lachin, J.M. and Schachter, J. "On stepwise discriminant analysis applied to physiologic data." Psychophysiology, 1974,11(6);pp. 703-709.

Lagier, R. and Meinecke, R. "Pathology of "Knuckle Pads" Study of four cases." Virchows Archiv. A pathogical Anatomy and Histology (Berlin), 1975;365(3); pp. 185-191.

Landis, J.R. and Koch, G.G. "The measurement of observer for categorical data." Biometrics, March, 1977;33(1): pp. 159-174.

Lanyon, R.I. "Factor structure of psychological screening inventory scales." Psychology Report, April, 1978; 42(2): pp 383-386.

Lazare, A.; Klerman, G.L. and Armor, D.J. "Oral obsessive. and hysterical personality patterns. An investigation of psychoanalytic concepts by means of factor analysis." Archives General Psychiatry, June, 1966;14(6): pp. 624-630.

Lehr, I,; Messinger, H.B. and Rogers, E.S. "Usefulness of factor and Cluster analysis in grouping census tracts." Hsmha Health Report, February, 1972;87(2); pp. 154-163.

Levin, J. "Three-mode factor analysis. Psychology Bulletin , December, 1965;64(6); pp. 442-452.

Levy, P. "Properties of the Holley-Guilford 'g index of agreement' in R and Q factor analyis." Scandinavian Journal Psychology, 1966;7(4): pp.239-243.

Lewi, P.J. "The use of multivariate statistics in industrial pharmacology." Pharmacology and Therapeutics. Part B. General and Systematic Pharmacology (Oxford), 1978;3(4); pp.481-537.

Lewi, P.J. and Symoens, J. "Levamisolein rheumatoid arthritis--a multivariate analysis of a multicentric study." Journal Rheumatology [Supplement]. 1978;5(4); pp. 17-25.

Lewis, G.K. "Dupuytren's contracture." International Surgery, June, 1966;45(6); pp. 634-645.

Liba, M.R. "Factor analysis of strength variables." Research Quarterly Amerian Association of Health and Physical Education, December, 1967;38(4): pp. 649-662.

Liedtke, C.E.; Greenberg, W. and Tuna, N. "Influence of population on the classification of ecg-vcg's using linear regression techniques." International Journal of Biomedial Computers, January, 1977;8(1): pp.35-44.

Liedtke, C. and Tuna, N. "The use of linear regression for the wave morphological classificatin of ecg-vcg's" Advanced Cardiology, 1978;21: pp. 173-176.

Lindskog, G.E. "Guillaume Dupuytren's 1777 to 1835." Surgical Gynecology and Obstetrics., October, 161(2): pp. 166-175.

Lo Cascio, V.; Cominacini, L; Adami, S.; Galvanini, G.; Bianchi, I.; Zanini, R. and Scuro, L.A. "Primary hyper-parathyroidism: diagnostic value of a model of multivariate statistical analysis." Ricerca in Clinica e in Laboratorio, July-September, 1976;6(3): pp.267-275.

LoPicColo, J. "Factor analysis of the sexual interaction inventory. A reply to Mccoy and D'Agostino (Letter)." Archives on Sex Behavior, March, 1977;6(2): pp. 169-171.

Lyons, J.B. "Pioneers in medicine: Baron Guillaume Dupuytren: 1777-1835." Nursing mirror, October 16, 1975; 72(1): pp. 67-69.

McFarlane, R.M. "Patterns of the diseased fascia in the fingers in Dupuytren's contracture. Displacement of the neurovascular bundle." Plastic Reconstrucation Surgery, July, 1974;54(1): pp.31-44.

McFarlane, R.M. and Jamieson, W.G. "Dupuytren's contracture. The management of one hundred patients." Journal of Bone and Joint Surgery, September, 1966;48(6): pp.1095-1105.

McNeil, D.R. and Tukey, J.W. "Higher-order diagnosis of two-way tables, illustrated on two sets of demographic empirical distributions." Biometrics, June, 1975;31(2): pp. 487-510.

McWhinnie, H.J. "A factor analytic study of perceptual behavior in 4th and 5th grade children." Acta Psychology, (Amsterdam), September, 1970;34(1): pp. 89-97.

M'aln'asi, G.; Jakab, S.; Incze, A.; Apostol, A.; Csap'o, J.M.; Szab'o, E.; Csap'o, J.J. and Jakab, K. "An assay for selecting high risk population for gastric cancer by studying environment factors." Neoplasma, 1976;23(3): pp.333-341.

Madden, J.S. "Letter: chromosome abnormalities in Dupuytren's disease." Lancet, January 24, 1976;1(7952); P.207.

Madden, J.W.; Carlson, E.C. and Hines, J. "Presence of modified fibroblasts in ischemic contracture of the intrinsic musculature of the hand." Surgery Gynicology and Obstetrics, April, 1975;140(4);pp.509-516.

Madsen, E.B.; Rasmussen, S. and Suendsen, T.L. "Short-term prognostic index in acute myocardial infarction. Multivariate analysis by Cox model." European Journal of Cardiology, November, 1979;19(5): pp. 359-368.

Magar, M.E. "Membrane conformation: a factor analysis approach." International Journal of Neuroscience, July, 1972;4(1): pp 25-29.

Maisto, A.A. "Comments on the use of the additive factor method with mentally retarded persons: a reply to Silverman." American Journal Mental Deficiency, September, 1978;83(2): pp.191-193.

Mann, J.L.; Doll, R.; Thorogood, M.; Vessey, M.P. and Waters, W.E. "Risk factors for myocardial infraction in young women." British Journal Preventive Social Medicine , June, 1976;30(2): pp.94-100.

Mann,R.J. "Of Guillaume Dupuytren, who feared nothing but mediocrity." Mayo Clinic Proceedings, December, 1977;52(12): pp. 819-822.

Mantel, N. and Brown, C. "Alternative tests for comparing normal distribution parameters based on logistic regression" Biometrics, September, 1974;30(3): pp.485-497.

Maxwell, A.E. "Factor analysis: Thomson's sampling theory recalled." British Journal Mathamatical Statistical Psychology, May, 1972;25(1): pp.1-21.

Maxwell, A.E. "Multivariate statistical methods and Classification problems." British Journal of Psychiatry,

, 1971;119(549): pp.121-127.

Maza, R.K. and Goodman, R.M. "A family with Dupuytren's contracture." Journal of Heredity, March-April, 1968;59(2): pp.155-156.

Me, W.H.; Hull, C.H.; Jenkins, J.G.; Steinbrenner, K. and Bent, D.H. SPSS: Statistical Package for The Social Sciences. New York: McGraw-Hill, Inc, (1975).

Meyers, C.E. and Dingman, H.F. "Factor analysis and structure of intellect applied to mental retardation." Mental Retardation Abstract, April-June, 1965;2(2): pp.119-130.

Mi, M.P. and Morton, N.E. "Blood factor association." Vox Sanguinis, July-August, 1966;20(7): pp.511-524.

Mikkelsen, O.A. "Dupuytren's disease and blood groups." Scandinavian Journal of Plastic Reconstructure Surgery ,1967;1(2): pp.148-149.

Mikkelsen, O.A. "The prevalence of Dupuytren's disease in Norway. A study in a representative population sample of the municipality of Haugesund." Acta Chiruriae Scandinavica, 1972;138(7): pp. 695-700.

Mikkelsen, O.A. "Dupuytren's disease-initial symptoms, age of onset and spontaneous course. Hand, February, 1977;9(1): pp. 11-15.

Mikkelsen, O.A. "Dupuytren's disease--a study of the pattern of distribution and stage of contracture in the hand." Hand, October, 1976; 8(3): pp. 265-271.

Mikkelsen, O.A. "Knuckle pads in Dupuyren's disease ."

Hand, October, 1977;9(3): pp.301-305.

Mikkelsen, O.A. "Dupuytren's disease--the influence of occupation and pevious hand injuries." Hand, February, 1978;21(3): pp. 943-944.

Miller, B.A.; Bentinck, C.A. and Pokorny, A.D. "Factor analysis of Psychiatric symptoms: alcholics compared with schizophrenics." Psychology Report, December, 1967;21(3): pp. 943-944.

Miller, D.G. "Preventive Medicine by risk factor analysis." JAMA--Journal of American Medical Association, October 16, 1978;46(6): pp.1340-1348.

Mishara, B.L. "Geriatric patients who improve in token economy and general milieu treatment programs: a multivariate analysis." Journal Consultant Clinical Psychology, December, 1978;46(6);pp. 1340-1348.

Moberg, E. "Three useful way to aviod amputation in advanced Dupuytren's contracture." Orthopic clinic of North America, October, 1973;4(4): pp.1001-1005.

Moore, B.J. "Measuring treatment and scale bias effects by linear regression in the analysis of OHI-S scores." Journal Dental Resource, May, 1977;56(5): pp. 460-464.

Morgan, J.N. and Messenger, R.C. Thaid: A Sequential Analysis Program for The Analysis of Nominal Scale Dependent Variables. Ann Arbor: Institute for Social Research, (1973).

Moss, A.J. "Profile of high risk in people known to have coronary heart disease: A review." Circulation, December, 1975;52(6 Supplimental): pp. 147-154.

Mukherjee, B.N. "Application of canonical correlational analysis to learining data." Psychology Bulletin, July, 1966;66(1): pp. 9-21.

Munster, A.M. "Letter: Depression of cellular immunity in pregnancy due to a serum factor." British Medical Journal, December 15, 1973;4(893): p. 675.

Mustakallio, K.K.; Lassus, A. and Putkonen, T. "Factor analysis in the evalution of criteria and variants of systemic lupus erythematosus." Methods Informational Medicine, October, 1966;33(1): pp. 69-72.

Nazari, B. "Duputren's contracture associated with liver disease." Journal Mt. Sinai Hospital New York, January-February, 1966;33(1): pp 69-72.

Newell, R.L. "Paget's disease, Duputytren's, contracture and phalangeal fracture." Hand, October, 1975;7(3): pp. 297-299.

Niederland, W.G. "Felix Platter and Dupuytren's contracture." Journal of American Medical Association, April 29, 1968;204(5);p. 405.

Noble, J. and Harrison, D.H. "Open palm technique for Dupuytren's contracture." Hand, October, 1976;8(3);pp. 272-278.

Noeva, K.; Karagantcheva, S. and Toshkov, A.S. "Antigamma-globulin factors and levels of IgG, IgA and IgM in sera of patients with Dupuytren's contracture." Acta Chirurgia Plasticae (Praha), 1977129(1): pp. 56-62.

Ogdon, C. "Dupuytren's contracture." Lancet, September 30, 1972;2(779);p. 715.

Onodera, K.; Sasaki, K.; Saito, M.; Kato, A.; Oikawa, M. and Oike, Y. "Factor analysis as to influence of systemic hypertension on bcg. (Biblical Cardiology) Biblical Cardiology, March-April, 1969;25; pp. 108-115.

Opmeer, C.H. "The information content of successive RR-interval times in the ECG. Preliminary results using factor analysis and frequency analysis." Ergonomics, January, 1973;16(1);pp.105-112.

Orlando, J.C.; Smith, J.W. and Goulian, D. "Dupuytren's contracture; a review of 100 patients." British Journal of Plastic Surgery, July, 1944;27(3);pp. 211-217.

Osiris, I.V. Ann Arbor, Michigan: Institute for Social Research, (198).

Parker, J.F. Jr. "The identification of performance dimensions through factor analysis." Psychology Bulletin , December, 1967;68(6);pp. 430-445.

Parker, R. and Boyd, J. "A comparison of a discriminant versus a clustering analysis of a partient classification for chronic disease care." Medical Care, 1974,12(11): pp. 944-957.

Patick, D.L. "Use of multivariate regression techniques to study the influence of selected clinical variables an apgar scores;" Alabama Journal of Medical Science, October, 1977;3(1): pp 436-467.

Peacock, E.E. Jr. "Dupuytren's disease: controversial aspects of management." Clinical Plastic Surgery, January, 1976;3(1): pp. 29-37.

Pierce, E.R. "F--Dupuytren's contractures in three successive generations." Birth Defects, 1974;10(5): pp. 104-105.

Pike, M.C.; Casagrande, J. and Smith, P.G. "Statistical analysis of individually matched case--control studies in epidemiology: factor under study a discrete variable taking multiple values." British Journal Preview of Social Medicine, September, 1975;29(3): pp. 196-201.

Pike, M.C. and Morrow, R.H. "Statistical anlysis of patient-control studies in epidemiology. Factor under investigation an all-or-none variable." British Journal Preview of Social Medicine, February, 1970;24(1).

Pipberger, H.V.; Klingeman, J.D. and Cosma, J. "Computer evaluation of statistical properites of clinical information in the diffential diagnosis of chest pain." Methods of Information in Medicine, 1968;1(1): pp. 79-92.

Podshadley, D.W.; Chen, M.K. and Shrock, J.G. "A factor analytic approach to prediction of student performance." Journal of Dental Education, March, 1969;33(1): pp. 105-111.

Pojer, J. and Jedli'ckov'a J. "Enzymatic pattern of liver injury in Dupytren's contracture." Acta Medical Scandinavian, January, February, 1970;187(1): pp. 101-104,

Pojer, J.; Radivojevic, M. and Williams, T.F. "Dupuytren's contracture of the hand and its surgical correction by limited fasciectomy. Acta Orthopaedica Belgica, March-April, 1972;38(2): pp. 190-203.

Posch, J.L. "Dupuytren's contracture". Surgery, July, 1962; 115: pp. 1-19.

Posch Jr., J.L. "Application of selected multivariate techniques to categorical and ordinal data: a specific problem with Carpal Tunnel Syndrome." Dissertation, 1976.

Poynter, F.N. "Doctors in The Human Comedy (Guillaume Dupuytren Jean Baptiste Bouillaud, Fran,cois Joseph Victor Broussais, Fran,cois Magendie). Journal American Medical Association, April 1, 1968;204(1): pp. 7-10.

Prentice, R. "Use of the logistic model in retrospective studies." Biometrics, September, 1976;32(3);pp. 599-606.

Prentice, R.L. and Gloeckler, L.A. "Regression analysis of grouped survival data with application to breast cancer data." Biometrics, March, 1978;34(1): pp. 57-67.

Quetglas, J. "Duputyren's disease. Comments on 80 cases operated on." Acta Chirurgiae Plasticae (Praha), 1972;14(4): pp. 244-254.

Rank, B.K. and Chang, L. "Surgery for Dupuytren's contracture: a long-term review." Australian and New Zeland Journal of Surgery, August, 1978;48 pp. 398-400.

Raso, A.M. and Raso, S.M. "Liquid-crystal therography in the diagnosis of Dupuytren's contracture." Panminerva Medical, April-June, 1978;20(2): pp. 113-116.

Ravid, M.;Dinai, Y. and Sohar, E. "Dupytren's disease in diabetes mellitus." Acta Diabetologica Latina, May-August, 1977;14(3-4); pp. 170-174.

Reumert, T and Zachariae, L. "Continued investigations into the effect of diuretics upon oedema of the hand following operation for Dupuytren's contracture: Bumetanide Leo." Acta Orthopaedica Scandinavica, 1973;44(4): pp.410-416.

Revach, M. and Cabilli, C. "Dupuytren's contracture and diabetes mellitus." Israel Journal of Medical Sciences, June, 1972;8(6): pp.774-775.

Richman, E.A.: Michel, M.E.; Schulter-Ellis F.P. and Corruccini, R.S. "Determination of sex by discrimant function analysis, of postchanial skeletal measurments." Journal of torensic Science, January, 1979;24(1): pp. 159-167.

Rhode, C.M. and Jennings, W.D. Jr. "Dupuytren's contracture." American Surgery, November, 1967;22(11): pp. 855-877.

Rhode, C.M. and Jennings, W.D. Jr. "Localized excision in Dupuytren's contracture." American Family Physician, April, 1971: 3(4): pp. 78-86.

Rodrigo, J.J.; Niebauer, J.J.; Brown, R.L. and Doyle, J.R. "Treatment of Dupuytren's contracture. Long-term results after fasciotomy and fascial excision." Scandinavain Journal of Urology and Nephrology, 1976;10(1): pp. 12-20.

Rosenberg, S.H. and Levy, P.S. "A characterization on misspecification in the general linear regressiom modetrics, December, 1972;28(4): pp. 1129-1133.

Rosencranz, H.A. and McNavin, T.E. "A factor analysis of attitudes toward the aged." Gerontologist, Spring, 1969;9(1): pp. 55-59.

Rostenberg, I.; Su'arez, P.E.; Ronces, R.F.; Gu'izar-V'azquez, J. and Pe'na-Aguilar, T. "Polynomial regression analysis of the precipitin reaction." Revista De Investigacion Clinca, January-March, 1975;27(1): pp. 7-10.

Sabiston, D.W. "Cataracts, Dupuytren's contracture." Bristol Medical Chirurgical Journal, October, 1972;87(324): p. 60.

Safrit, M.J. "Comparions of four factor models applied to measures of selected object-projection skills." Research Quarterly of American Association on Health and Physical Education, December, 1968: 39(4): pp. 1129-1132.

Sakellarides, H.T. "Dupuytren's contracture of the hand and its surgical correction by limited fasciectomy." Acta orthopaedica Belgica, March-April, 1972;38(2): pp. 190-203.

Salvi, V. "Personal experience with McCash's "open palm" technique of Dupuytren's contracture." Hand, June, 1973;5(2): pp. 161-164.

Saubermann, P. "Dupuytren's contracture (author's translation)." Zeithschrift Fur Orthopaedie Und Ihre Grenzgebiete, February, 1977;115(1): pp. 122-124.

Schepart, B.S.; Schwartz, R.A.; Southwick, G.J. and Ambrus, J.L. "Dupuytren's disease presenting as palmar pits." Journal of Medicine, 1987;9(4): pp.347-350.

Schildkraut, J.J.; Orsulak, P.J.; LaBrie, R.A.; Schatzberg, A.F.; Gudeman, J.E.; Cole, J.O. and Rhode, W.A. "Toward a biochemical classification of depressive disorders. II. Application of multivariate discriminant function analysis to data on urinary catecholamines and metabolites." Archives of General Psychiatry, December, 1978;35(12): pp. 1436-1439.

Schuman, S.H. and Polkowski, J. "Drug and risk perception on ninth-grade students; sex differences and similarities." Community Mental Health Journal, Summer, 1975: 11(2): pp. 184-194.

Schwarzbart, G. "Dupuytren's contracture: Tord Skoog's selective aponeurosectomy (a report of two cases)." West Vginia Medical Journal, November, 1978: 74(11): pp. 297-300.

Shaw, D.J. Factor analysis of the collegiate WAiS." Journal Consultant Psychology, April, 1967: 31(2): P. 217.

Shimomura, Y.: Doi, T.; Hukuda, S.: Akutagawa, H. and Mizuno, S. "A study on the pathogenesis of Dupuytren contracture. Preliminary report." Medical Journal Osaka University, September, 1976;18(1): pp. 105-119.

Siegel, A. and Pfeiffer, M.G. "Factor analysis of category and magnitude scales of a technical attribute." Journal of Applied Psychology, August, 1966;50(4): pp. 341-347.

Singer, E.; Cohen, S.M.; Garfinkel, R. and Srole, L. "Replicating psychiatric ratings through multiple regression analysis: The Midtown Manhattan Restudy." Journal Health and Social Behavior, December, 1976: 17(4): pp. 376-387.

Sive, P.H.; Medalie, J.H.; Kahn, H.A; Neufeld, H.N. and Riss, E. "Distribution and multiple regression analysis of blood pressure in 10,000 Israeli men." America Journal of Epidemiology, May, 1971;93(5): pp.317-327,

Skoog, T. "Dupuytren's contracture: pathogenesis and surgical treatment." Surgial Clinic of North-American, April, 1967;47(2): pp. 433-444.

Smart, R.C. "The changing composition of "intelligence": a replication of a factor analysis." Journal of Genetic Psychology, September, 1965;107(1): pp. 111-114.

Solursh, L.P. "Possible psychic factors in Dupuytren's contracture." Cancer Medical Association Journal, May966;94(21): p.1132.

Spiegel, D. and Keith-Spiegel, P. "Factor analysis of 78 variables from nine personality tests and scales." Journal Projective Techniques and Personality Assessment, April, 1969;33(2): pp. 160-167.

Spitzer, R.L.; Fleiss, J.L.; Endicott, J. and Cohen, J. "Mental status schedule. Properties of factor-analytically derived scales." Archives of General Psychiatry, April, 1967;16(4): pp. 479-493.

Sprague, R.L. and Quay, H.C. "A factor analytic study of the responses of mental retardates on the WAIS." American Journal of Mental Definciency, January, 1966;70(4); pp. 595-600.

Spring, M.; Fleck, H. and Cohen, B.D. "Dupuytren's contracture warning of diabetes?" New York State Journal of Medicine, May 1, 1970;70(9): pp. 1037-1041.

Stack, H.G. "The palmar fascia, and the development of deformities and displacements in Dupuytren's contracture." Annals of the Royal College of Surgeons of England, April, 1971;48(4): pp. 238-251.

Stanish, W.M.; Koch, G.G. and Landis, J.R. "A computer program for multivariate ratio analysis (MISCAT)." Computer Programs Biomedical, September, 1978;8(3-4): pp. 197-207.

Stech, E.L.; Curtiss, J.W.; Troesch, P.J. and Binnie, C. "Clients' reinforcement of speech clinicians: a factor analytic study." American SHA, June, 1973;15(6): pp. 287-289.

Sterling, T.D.; Glesser, M. and Pollack, S.V. "Robot data processing techniques of multivariate epidemiological predictions." Annals of the New York Academy of Sciences, August 6, 1965;126(2): pp. 779-794.

Stiles, J. "Ultrasonic therapy in Dupuytren's contracture." Journal of Bone and Joint Surgery, (British), August, 1966;48(3): pp.452-454.

Stoltze, K.: Tryde, G.; McMillan, D.R.; Morimoto, T.; Spanner, O. and Brill, N. "The linear model: a statistical tool applied to psychophysical research in dental prosthetics." Journal of Oral Rehabilitation, October, 1976;3(4): pp. 395-402

Su, C.K. and Patek, A.J. Jr. "Dupuytren's contracture. Its association with alcholism and cirrhosis." Archives of Internal Medicine, August, 1970;126(2); pp. 278-281.

Sutterer, J.R. and Rosecrans, C.J. "Factor analytic study of learning and perrperceptual and conceptual performance by a psychiatric outpatient population." Psychology Report, August, 1967;21(1): pp. 129-139.

Suzuki, T. and Kudo, A. "Recent application of quantification II in Japanese medical research." Environment and Health Cerspective, October, 1979;32: pp. 131-141.

Tatsuoka, M.M. Multivariate Analysis Techniques for Educational and Psychological Research. New York: John Wiley & Sons, Inc.,

Taylor, P.L.; Fulcomer, M. and Taylor, F.Z. "Daydreaming in the adolescent years: instrument development, factor analysis, and sex differences." Adolescence, Winter, 1978;13(52): pp. 735-750.

Tomlinson, A. and French, C.N. "The prediction of glaucoma from ocular biometrics data. Part 1. An application of multiple regression analysis." American Journal Optometry and Physiological Optics, December, 1975;52(12): pp. 807-816.

Tomlinson, A.; French, C.N. and Storey, J.K. "The prediction of glaucoma from ocular biometrics data. Part 2. An evaluation." American Journal of Optometry hand Physicological Optics, December, 1975;52(12): pp. 817-822.

Toogood, J.H.; Baskerville, J.; Errington, N.; Jennings, B; Chuang, L. and Lefcoe, N. "Determinants of the response to beclomethasone aerosol at various dosage levels: a multiple regression analysis to identify clinically useful predictors." Journal of Allergy and Clinical Immunology, December, 1977;60(6): pp. 367-376.

Truett, J.; Cornfield, J. and Kannel, W. "A multivariate analysis of the risk of coronary heart disease in Framingham." Journal of Chronic Disorders, July, 1967;20(7): pp. 511-524.

Tubiana, R.; Michon, J. and Thomine, J.M. "Scheme for the assessment of deformities in Dupuytren's disease." Su Clinic of North America, October, 196881968;48(5): pp. 979-984.

Tubiana, R.; Thomine, J.M. and Brown, S. "Complications in surgery of Dupuytren's contracture." Plastic Reconstructor Surgery, June, 1967;39(6): pp. 603-612.

Turner, M.E. Jr. "Allometry and multivariate growth." Growth, December, 1978; 42(4): pp. 434-450.

Tyrkk''o, J. and Viljanto, J. "Significance of histopathological findings in Dupuytren's contracture." Annales Chirurgiae Et Gynaecologiae Fenniae, 1975;64(5): pp. 288-291.

Ury, H.K. "Efficiency of case-control studies with multiple controls per case; continuous or dichotomous data." Biometrics, September, 1975;31(3); pp. 643-649.

Vacchiano, R.B. and Adrian, R.J. "A factor analytic study of the Picture Idenitification Test." Journal Clinical Psychology, July, 1966,22(3): pp. 320-323.

Vacchiano, R.B.; Schiffman, D.C. and Strauss, P.S. "Factor structure of the domatisdogmatism scale." Psychology Report, June, 1967;20(3): pp. 847-852.

Vandenberg, S.G. "A factor analysis of garment measures of Dutch women." Human Biology, September, 1968;40(3): pp. 295-313.

Vandenberg, S.G. and Price, R.A. "Replication of the factor sturture of the Comrey Personality Scales." Psychology Report, April, 1978;42(2): pp. 343-352.

Verstreken, J. "A new approach to the excision of Dupuytren contractures in the hand." Acta Orthopaedica Belgica, May-June, 1971: 37(3): pp. 290-293.

Vijanto, J.A. "Dupuytren's contracture: a review." Seminars In Arthristis and Rheumatism, 1973;3(2): pp. 155-176.

Viljanto, J.; Sepp''al''a, P.O and Lehtonen, A. "Chemical changes underlying Dupuytren's contracture." Annals of The Rheumatic Diseases, July, 1971;30(4): pp. 423-427.

Vupala, U. and Kaipainen, W.J. "DMOS in the treatment of Dupuytren's contracture. A therapeutic experiment." Acta Chirurgiae Plasticae (Praha), 1970;12(3): pp. 166-

172.

Wainer, H. "Piecewise regression: a simplified procedure." British Journal Of Mathematical And Statistical Psychology, May, 1971;24(1): pp. 83-92.

Wakker, P.J.; Hellendoorn, H.B.; Op de Weegh, G.J. and Heerspink, W. "Applications of statistics in clincal chemistry. A critical evaluation of regression lines." Clinica Chimica Acta, October 15, 1975;64(2): pp. 73-184.

Walker, P.M. and Johnston, K.W. "Prediction the success of A Sympathectomy: a prodicting study using discriminant function and multiple regression analysis." Surgery, February, 1980;87(2): pp. 215-221.

Wallace, A.F. "Dupuytren's contracture. The results of radial fasciectomy." British Journal of Plastic Surgery, October, 1965;18(4): pp. 385-386.

Walter, S.D. "Calculation of attributable risks from epedemiological data." International Journal Epidemiology, June, 1978;7(2); pp. 175-182.

Ward, C.M. "Oedema of the hand after fascietomy with or without toruniquet." Hand, June, 1976;8(2): pp. 179-185.

Webb-Jones, A. "Dupuytren's contracture. The results of radical fascietomy." British Journal of Plastic Surgery, October, 1965;18(4): pp. 377-384.

Westerkamp, M. "A case history of recurrent plantar fibromatosis (Dupuytren's contracture)." Journal of Foot Surgery, Summer, 1978;17(2): pp. 73-74.

Whitby, J.D. "Death during operation." British Journal Of

Anesthesia, March, 1975;47(3): pp. 408-411.

Wiener, A.S. "Blood group mythology; present status." Acta Paediatrica Academiae Scientiarum Hungaricae, 1977;18(1): pp. 1-15.

Wikoff, R.L. "Correlational and factor analysis of the peabody individual achievement test and the WISC-R." Journal Consultant Clinical Psychology, April, 1978;46(2): pp. 322-325.

Wilson, A. "Multivariate analysis: data reduction and treatment evaluation." British Journal Psychiatry, April, 1976;128: pp. 404-407.

Winkel, P. "Patterns and clusters--multivariate approach for interpreting clinical chemistry results." Clinical Chemistry, December, 1973;19(12): pp. 1329-1339.

Winkel, P.; Lyngbye, J. and J''orgensen, K. "The normal region--a multivariate problem." Scandinavian Journal Of Clinical And Laboratory Investigation, November, 1972;30(3): pp. 339-344.

Wooward, W.A. and Schucany, W.R. "Combination of a preference pattern with the triangle taste test." Biometrics, March, 1977;33(1): pp. 31-39.

Wray, J.B. "The recognition and treatment of Duputren's contracture." Journal Indiana State Medical Association, December, 1967;60(12): pp. 1658-1660.

Young, M.A. "Tutorial: application of regression analysis concepts to retrospective research in speech pathology." Journal Speech and Hearing Research, March, 1976;19(1):

pp. 5-18.

Zachariae, L. "Extensive versus limited fasciectomy for Dupuytren's contracture." Scandinavian Journal Of Plastic Reconstracture Surgery, 1967;1(2): pp. 150-153.

Zachariae, L. "Dupuytren's contracture. How limited should a limited fasciectmy be?" Scandinavian Journal Plastic Reconstracture Surgery, 1968;3(2): pp. 145-149.

Zachariae, L. "Operation for Dupuytren's contracture by the method of McCash." Acta Orthopaedica Scandinavica, 1970;41(4): pp. 433-438.

Zachariae, L. "Dupuytren's contracture. The aetiological role of trauma." Scandinavian Journal of Plastic Reconstracture Surgery, 1971;5(2): pp. 116-119.

Zachariae, L; Clemmesen, T.; Olesen, E. and Ulfeldt, M. "The effect of diuretic (Centyl, Leo) on the oedema of the hand following surgical treatment of Dupuytren's contracture." Acta Orthopaedica Scandinavica, 1970;41(4): pp. 411-418.

Zachariae, L; Dahlerup, J.V. and Olesen, E. "The electroencephalogram in patients with Dupuytren's contracture. Electroencephalographic and clinical neurological study of 78 Dupuytren patients." Scandinavian Journal Plastic Reconstracture Surgery, 1970;4(1): pp. 34-40.

Ziegler, D.K.; Hassanein, R. and Hassanein, K. "Headache syndromes suggested by factor analysis of symptom variables in a headache prone population." Journal

Chronic Disorders, July 1, 1972;25(6): pp. 353-363.

Zuedema, M.A. and Baugartner, T.A. "Second factor analysis study of physical fitness tests." Research Quarterly American Association On Health And Physical Education, October, 1974;45(3): pp. 247-256.

"Dupuytren's contracture." Lancet, September 16, 1972;2(7777): pp. 694-695.

"Dupuytren's contracture." Journal of American Medical Association, April 30, 1973;224 (Supplemental)5; pp. 751-752.

"Dupuytren's contracture contracture (editorial)." British Medical Journal, September 25, 1976;2(6038): p. 719.

"Dupuytren's disease." Cancer Medial Association Journal, September 9,1972;107(5): p. 389.

"The puzzle of Dupuytren's contracture." Lancet, July 22, 1972;2(769): pp. 170-171.

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