DOCUMENT RESUME

ED 121 191 HE 007 636

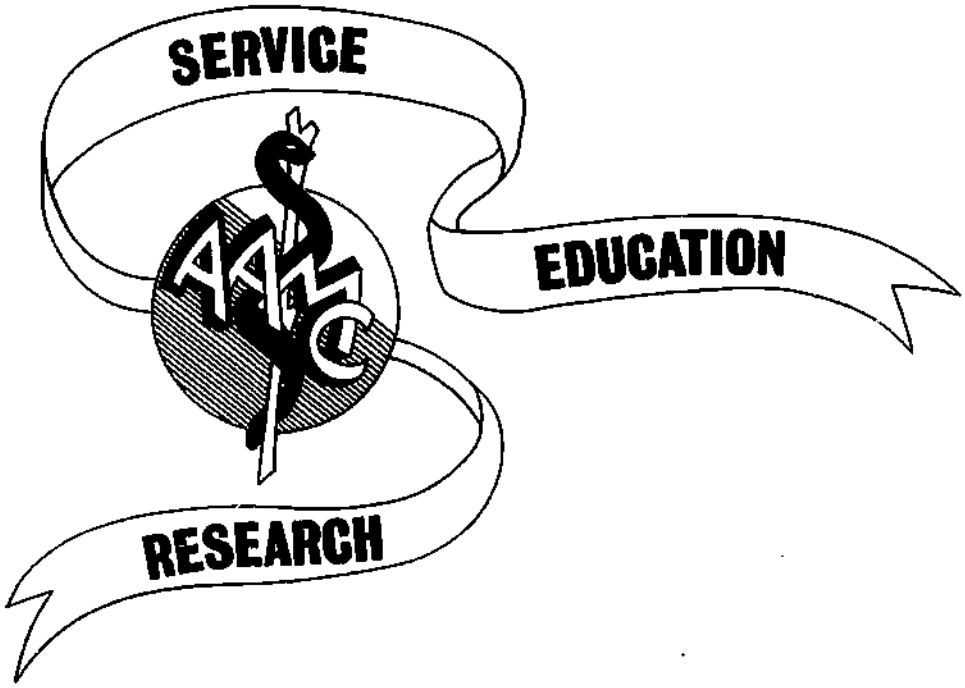
AUTHOR Sherman, Charles
TITLE Study of Medical Education: Interrelationships Between Component Variables.
INSTITUTION Association of American Medical Colleges, Washington, D. C.
SPONS AGENCY Health Resources Administration (DHEW/PHS), Bethesda, Md. Bureau of Health Manpower.
PUB DATE Dec 75
NOTE 81p.; Prepared by Division of Operational Studies
AVAILABLE FROM Association of American Medical Colleges, division of Operational Studies, One Dupont Circle, N.W., Washington, D.C. 20036

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage
DESCRIPTORS Health Occupations; *Higher Education; *Medical Education; *Medical Research; Medical Students; Methods Research; Preventive Medicine; *Research Criteria; Research Methodology; Research Proposals; School Surveys; *Statistical Analysis

ABSTRACT

AAMC data describing medical education institutions were analyzed in order to raise researchable questions for subsequent examination. A suitable multivariate method was selected and its applicability tested. The method chosen was multiple factor analysis, which analyzes the pattern of correlations among large sets of variables. Variables were organized into categorical subsets to describe four conceptual components of medical education: faculty, curriculum, student, institution. Factor analysis was performed on each of the four sets and used to select descriptive variables that are representative of the dimensions of institutional variation in each educational component. The relationships of variables within components were discussed. The representative variables from the four educational components were merged and analyzed as one set. Apparent relationships among variables from separate components were described. Questions of potential interest were presented which address substantive issues, the quality of the data and possible effects of the method on the results. These questions or hypotheses may serve to guide the selection and design of focused research studies. (Author/LBH)

STUDY OF MEDICAL EDUCATION:
INTERRELATIONSHIPS BETWEEN COMPONENT VARIABLES



PREPARED BY:

CHARLES SHERMAN, PH.D.
STAFF ASSOCIATE

ASSOCIATION OF AMERICAN MEDICAL COLLEGES
DIVISION OF OPERATIONAL STUDIES
ONE DUPONT CIRCLE, N.W.
WASHINGTON, D.C. 20036

DECEMBER 1975

Study of Medical Education:

Interrelationships Between Component Variables

The work upon which this publication is based was supported in part by the Bureau of Health Manpower, Department of Health, Education and Welfare pursuant to contract number 231-75-0007. However, any conclusions and/or recommendations expressed herein do not necessarily represent the views of the supporting agency.

CONTENTS

EXECUTIVE SUMMARY

An analysis was performed on the AAMC data, maintained for ready access, that describe medical education institutions. The analysis was exploratory in nature. It was not designed to test specific hypotheses, but was conducted, rather, to let the data "speak for themselves" and perhaps raise researchable questions for subsequent examination. The analysis proceded in stages:

1) A suitable multivariate method was selected and its applicability tested (a replication of an earlier study was performed). The method chosen was multiple factor analysis, which analyzes the pattern of correlations among large sets of variables.

2) Interesting variables were selected or computed and organized into categorical subsets to describe four conceptual components of medical education (faculty, curriculum, student, institution).

3) Factor analysis was performed on each of the four sets and used to select descriptive variables that are representative of the dimensions of institutional variation in each educational component. The relationships of variables within components were discussed.

4) The representative variables from the four educational

components were merged and analyzed as one set. Apparent relationships among variables from separate components were described.

5) Questions of potential interest, raised by knowledgeable persons giving close attention to the descriptive summaries of apparent relationships within and between the four educational components, were presented. The questions raised address substantive issues, the quality of the data and possible effects of the method on the results. These questions or hypotheses may now serve to guide the selection and design of focused research studies.

Chapter I

INTRODUCTION

Background

With the stated common belief that the "illumination of alternatives for the further development of public policy relating to medical education" will be enhanced by the development of a "comprehensive and systematic body of information concerning medical education and academic medical centers"[1], the Bureau of Health Manpower (BHM) contracted with the Association of American Medical Colleges (AAMC) to collect, maintain and analyze such information. It was envisioned that relationships may exist between several distinguishable categories of medical education data. Possible data categories include the faculty, curriculum, student, and institution. It was felt that the pattern of such relationships could be exposed through data analysis and, once understood, contribute to rational public policy formation. This is a report of the conduct and findings of a series of initial exploratory analyses of relationships witnin and between various categories of data available as of June 1975.

Overview

A search of the literature of descriptive studies of academic medical centers, experimentation with several alternative data analytic tools, and consultation with experts in multivariate data analysis led to the selection of factor analysis as the method to be used in the present exploratory work. Successful replication of the results of a previous study served to enhance

[1] Quotation from Article I, contract no. 231-75-0007.

confidence in both the method and the data. Four sets of descriptive variables were selected from four descriptive categories of medical education. Each set was analyzed separately in order to select sub-sets of variables that are both broadly representative of the independent dimensions within each domain and most likely to reveal interesting and meaningful interrelationships. The four sub-sets were then merged and analyzed as one set. The resulting pattern of correlations among variables from the several components of medical education, finally, was interpreted and used to raise questions and suggest several hypotheses for confirmatory observation and testing.

The remainder of this chapter describes the objectives of this effort, the rationale for the selection of a particular method to meet the objectives, and, briefly, the objectives of similar studies reported in the literature.

Exploratory Objectives

The goal of the present study is not to answer specific research questions by empirically testing formal hypotheses. The goal is, rather, to explore the available data for evidence of possible relationships that may exist among the categories of data descriptive of medical education. To do this one might consider examining the correlation coefficients describing each relationship between all pairs of variables. Given the large number of variables at hand (over 3000 when this study was begun), the problem of examining all such possible pairwise relationships is prohibitive. Assuming, however, that some form of structure exists among the complete set of intercorrela-

tions of variables, and that the proper variables have been adequately measured, the task may be seen as a proper application for exploratory factor analysis. In the words of one of the pioneers of this method:

> When a particular domain is to be investigated by means of individual [for our purposes, "institutional"] differences, one can proceed in one of two ways. One can invent a hypothesis regarding the processes that underlie the individual ["institutional"] differences, and one can then set up a factorial experiment or a more direct laboratory experiment, to test the hypothesis. If no promising hypothesis is available, one can represent the domain as adequately as possible in terms of a set of measurements of numerical indices and proceed with a factorial experiment. The analysis might reveal an underlying order which would be of great assistance in formulating the scientific concepts covering the particular domain. In the first case we start with a hypothesis that determines the nature of the measurements that enter into the factorial analysis. In the second case we start with no hypothesis, but we proceed, instead, with a set of measurements or indices that cover the domain, hoping to discover in the factorial analysis the nature of the underlying order. It is this latter application of the factorial methods that is sometimes referred to as an attempt to lift ourselves by our own boot straps, because the underlying order in a domain cannot be discovered without first postulating it in the form of a hypothesis. This is probably the characteristic of factor analysis that gives it some interest as general scientific method (Thurstone, 1947, p.55).

Henrysson (1960) adds that "explorative factor analysis is to be used primarily in the mapping of a field about which we have little knowledge or developed theories. The results of such analysis can then be used for formation of more rigorous hypotheses and in planning experiments" (p. 92). Mulaik (1972) also cites the value of exploratory factor analysis in generating hypotheses but acknowledges its limitations as a source of theory:

> Factor analysis can ultimately only provisionally establish

> its common factors as causal mechanisms accounting for the relationships among variables. Here factor analysis must give ground to experimental or observational techniques in which the researcher has direct control or observation of the crucial independent variables. Still one can think of many situations in the behavioral, social, and economic sciences in which direct control and observation of the crucial parameters are and will continue to be highly difficult to achieve, and it is in such situations that we expect factor analysis will continue to make valuable contributions (p. 362).

Principal components analysis, the primary form of factor analysis performed in the present study, is essentially a way of grouping variables that tend to correlate with one another. The number of patterns of correlations within and among groups of variables is smaller and more manageable for examination, interpretation, and possible hypothesis generation than would be the full correlation matrix. As such it is ideally suited to overcoming the problem of "too much data" and meeting the present exploratory objectives.

The present use of exploratory techniques is not intended to imply that nothing is known about medical education. The present study serves to supplement other more focused "special studies" also performed by AAMC for the Bureau of Health Manpower.

Previous Studies

A search of the literature of higher education has uncovered a small number of previous studies, utilizing similar methods,

but usually with different objectives.

Several published studies have employed factor analysis for the empirical characterization of higher educational institutions. Astin (1962) factored 33 major variables (financial, typical, faculty, student, miscellaneous) in an effort to "(a) provide researchers with a more limited set of empirical dimensions which account for the major variations among institutions; and (b) provide evidence regarding the structure of higher educational institutions, particularly with regard to the interrelationships of such variables as the college's financial resources, the college 'environment', and the characteristics of the faculty and student body." (p.224) He factored data separately for each of five subgroups of 335 accredited 4-year degree granting colleges and universities. The validity of the assumption of the applicability of a factor structure model was supported by the reappearance of essentially the same factors for each of the five subgroups.

Four factor analytic studies have involved only medical colleges. Richards, et al. (1968) factored an assortment of variables, all taken from public records. They were selected to correspond closely with variables used in studies of four-year colleges and included no measures related to faculty characteristics. As such, the value of the study was severly limited. Rogers and Elton (1974) analyzed only fourteen variables, none

of which was descriptive of faculty. On the basis of their limited analysis, however, they did manage to raise some interesting questions (e.g. "Why do private medical schools have a higher ratio of applicants for admission to positions available?") and to speculate about their answers. Keeler, et al. at RAND (1972) factored a set of 31 variables, more uniformly selected from the several descriptive categories of medical education, as a first step toward an empirical clustering of medical schools for purposes of subsequent institutional sampling. Thus, their purpose was not to speculate on the meanings of possible interrelationships among variables. Otis, et al. (1975) also employed a strategy involving several multivariate analyses of medical school characteristics to develop a general purpose typology of U.S. medical schools. The intent of their study was to relate the observed institutional "types" to "external" variables (in particular, production rates of various specialists) for purposes of hypothesis generation.

The advantage of the present study over the previous studies is in the comprehensiveness and currency of the data base from which variables were extracted. Many institutional measures available to AAMC are not published in non-aggregated form, but are here made available for correlational analyses. There is, in comparison to other studies cited above, a much greater likelihood that meaningful relationships, if they exist, will be found.

Chapter II

METHOD

The general method used to investigate the interrelationships among variables that describe the components of medical education at the institutional level may be organized into three steps: preparation of the data, the factor extraction and rotation (factor analysis), and the examination of the resulting factor pattern matrix for hypothesis producing insight. Each of these steps will be described with a minimum of technical detail in this chapter.

The results of six applications of factor analysis are presented in this report, one in this chapter, four in Chapter III, and one in Chapter IV. The application presented in this chapter serves two purposes: (1) to support the validity of the method for use with institutional data; (2) to present an example of the interpretation of a resultant factor pattern matrix and so obviate such methodological repetitions in subsequent chapters devoted to substantive results.

Preparation of the Data

The AAMC routinely collects very substantial amounts of data from its constituent institutions about themselves and their faculties for specific purposes including accreditation, management improvement, policy studies, self studies and comparative studies

for its members, and occasional focused studies of trends and changes in the characteristics of medical education. Studies are conducted for AAMC and its members, as well as for sponsoring agencies. In the course of processing student applications for admission to medical schools, data concerning applicants and admitted students are also collected, some of which are summarized for individual institutions.

The data from the several sources, collected for diverse purposes, are continually being stored for efficient retrieval by the computer implemented Institutional Profile System (IPS). The capability now exists to quickly provide member institutions with selected information by which they may compare themselves with all other medical schools or with any subset of schools that meet some purposive selection criterion. The capability also exists to readily extract data for a modest number of variables and prepare them in a form suitable for specific analyses using statistical programs available as an adjunct to the system. An individual with an hypothesis concerning a specific relationship among some of the stored variables, a research design that calls for institutional measures, an understanding of statistics and the measurement qualities of the data at hand, some understanding of the dynamics of medical education, and access to IPS may readily test the hypothesis.

The present study was not designed to test a specific hypothesis and required steps beyond present IPS capabilities. The requirements of the present study and several other studies[1] presented a new problem: the need to re-organize and explore selected but large segments of the IPS data base. Preparation of the data into a mode suitable for analysis required several tasks:

(1) Selection of Variables Already Stored in IPS. This entailed generating and going through a list of variable descriptors to select variables, for the most recent year available, that were judged useful to discriminate one institution from another in some potentially meaningful way. Much of the process was subjective but necessary to reduce the mass of the information and concentrate on variables that are applicable to the largest number of schools. For example, while the "number of faculty in anatomy departments" (or any single department) may not have been deemed useful and therefore not selected, the "number in all basic science departments" was selected.

(2) Creation of a Researchable Data Base. Data extracted from IPS and other sources were combined and stored in a

[1]Specifically, Richard Nunn, "The Classification of Medical Schools", and William Sedlacek, "Variables Related to Increase in Medical School Class Size" both supported by BHM under contract no. 231-75-0007.

separate data file amenable to computational transformations and logical reorganization and other subsequent stages of preparation for analysis.

(3) Preparation of New Variables from Existing Variables. Many routinely stored variables represent counts of some subset of students, faculty or dollars received or expended. As such they are most closely related to overall "size" of the institution and not directly meaningful in comparisons of schools of different size. In some cases, therefore, a new variable was created by forming a ratio of extant variables. For example, the information value of the number of full-professors on the faculty may be limited, but, dividing by the total number of faculty of all ranks the result would be the proportion of faculty having full-professor rank which may give information more useful in the comparison of institutions. Such new variables were judged more likely to be related to other variables in the study in insight-giving ways. Therefore it was necessary to again peruse the list of variable descriptors to create as many new variables as were potentially interesting. Some new variables that describe growth or other change over time were also created by taking differences between variables that measure the same thing in two different years dividing the result by the datum for the earlier year.

Variables computed in this or similar manners included changes in NIH research funding levels and projected enrollments growth rates.[2]

(4) Data Transformation. Some of the data had to be recoded or numerically transformed prior to analysis to enhance the meaningfulness of linear correlational procedures. A preliminary analysis revealed that the arcsine transformation of proportion data, while theoretically applicable, did not have an appreciable effect on the magnitude of the correlations or the interpretation of the results. It was therefore not used in the analyses reported here.

(5) Organization of Researchable Data Base. A system for the organization of selected old and all newly created variables was devised. Variables were labeled using standardized abbreviations and sorted into groups according to the classification of their content. The result was a comprehensible list of variable descriptors that served to facilitate the selection of variables for various analyses.[3]

---

[2]While it was anticipated by contract negotiators that this study would lag behind other "Profile" studies conducted under the BHM contract in order that the findings from particular domains of medical education could facilitate the identification of pertinent variables for inclusion in this study of interrelationships, the time lag was not sufficient to permit this. AAMC colleagues conducting those studies were solicited to aid in variable identification. It is probable, however, that, at that time some otherwise available indicators of institutional change may have gone unrecognized.

[3]The list is available from AAMC: "Variables List for Classification of Medical Institutions Study and Interrelationship Study", Lindy Lain, October 2, 1975.

Selection of Variables for Analysis

Approximately 350 variables comprised the researchable data base resulting from the steps outlined in the previous section. The four component areas of medical education were unevenly represented by numbers of variables in the data base. There were about 50 faculty, 40 curriculum, 160 student and 100 institution measures. There was no reason to believe that the aggregated variables presented a balanced representation of the possible dimensions by which institutions differ from one another. Furthermore, 350 are too many variables to factor simultaneously given existing computer programs and machine limitations. Factor analysis was therefore used in two stages to examine the interrelationships of variables from component domains of medical education.

At the first stage four factor analyses were used to examine separately the four component domains. Four mutually exclusive sets of variables were selected from the prepared data base to cover the probable range of variation within each domain. In the subjective process of selection an attempt was made to avoid obvious linear dependencies. For example, the selection did not include all three counts of basic science faculty, clinical science faculty and total faculty since "total" is always the sum of the other two. Such perfect dependencies would adversely affect the factor analytic process. Each of the four pre-selected sets was then factored and used to select representative variables of maximum interest and minimum redundancy. These four analyses are reported in Chapter III.

At the second stage, the representative variables from each set were merged into one. The merged set was then factor analyzed and examined for evidence of possible interrelationships among the representative component variables, hence the component domains of medical education.

Factor Analysis

Factor analysis is a general term referring to a number of specific procedures. Most of the procedures accept, as input, the entire matrix of $\underline{N} \times \underline{N}$ correlation coefficients between all pairings of $\underline{N}$ variables being analyzed, and produce, as output, a smaller matrix "factor loadings". The matrix of factor loadings, commonly called the "factor pattern matrix", may be used to see which variables are related to one another and how many such groupings there are.

The proper mode of interpretation of the loadings depends on the particular procedure that was used to create them. In "Common Factor Analysis" the groups may be thought to be related to some common process or "factor", and the numerical "loading" of each variable on a factor indicates to what degree that particular variable is related to the common factor. "Principal Components Analysis", on the other hand, seeks to identify the main components

of variation between the objects of study, here schools. A single variable does not have to be related to some process in common with another variable in order to be recognizable as a principal component if it does serve to account for differences between schools. Still, related variables are grouped together as a result of the procedure.

In the end, with either procedure, it is easier to try to make sense of patterns in the factor pattern matrix than in the larger original correlation matrix. For reasons given in the following chapter, both types of factoring procedures were employed in the present study.

The data used in the present study were not complete. For some variables there were recorded values for all 117 American medical schools for which data are maintained by the AAMC. For some variables, recorded values were not available for all schools: some were not reported, some were not applicable. In the computation of the correlation matrices used in the present study, only recorded and applicable pairwise observations were used. Individual correlation coefficients, therefore, are based on maximum but varying numbers of actual observations. No school's data were deleted from the study.

Applicablility of Factor Analysis to Institutional Data: A Replication.

Correlation coefficients, the input to factor analysis, are

measures of the extent to which two variables have a straight line relationship to one another. In the present exploratory work the assumption of linearity could not be made with any confidence. If relationships were best represented by a curved line, correlations could then possibly have been enhanced through non-linear data transformations, but it was believed that this would not be necessary. The application of the arcsine transformation to percentage data in a preliminary analysis for example, was found to have some effect on the correlation coefficients but, little effect on the results of factoring.

Another assumption of the factor analytic model is that there is some "structure", or pattern, in the data that can be found in spite of minimal random variation. There were several sources of variation in the institutional data at hand that were not known to be minimal or random and that may be considered to limit the legitimate interpretation of the eventual results. These sources include the fluctuations in values over time, the process of selection of particular variables, and imperfect comparability between data reported by different schools.

The applicability of the technique to the data at hand was supported to some extent, however, by the successful replication of the results of a previous study, using data from a more recent year, a different (although overlapping) set of schools, and somewhat different variables.

An attempt was made to re-assemble, as closely as possible, the set of variables used in a factor analysis reported by Keeler, et.al. (1972) of the RAND Corporation. Twenty-three of RAND's 31 variables were produced or approximated. Some variables (e.g. priority scores) available to RAND were not availabe to AAMC. Table 1 presents the variables used in the two studies.

A list of variables comprising each of the six outcome factors in the RAND study is presented in Table 2.

A "common factor" analysis of the 23 AAMC variables, with six factors rotated to an equimax criterion (the specific procedure used by RAND) resulted in the factor pattern matrix presented in Table 3. The groupings of variables in Table 3 may be compared to the groupings of variables in Table 2.

In spite of the data differences mentioned, the results are strikingly similar and subject to equivalent interpretations. It appears that there are six independent factors that distinquish medical schools: (1) size of graduate medical education program; (2) level of federal research involvement; (3) size of undergraduate medical program; (4)public versus private ownership; (5) reliance on non-full-time faculty, and (6) size of non-medical education programs.[4] There may, of course, be other

[4]Varimax and Equimax rotations of a principal components analysis of the same data led to differently ordered but otherwise identical sets of factors. An interpretation of the meaning of these factors is given in Keeler, et al. (1972), pp. 9-10. Of the eight variables not included in the replication, six had not been found highly related in the original RAND analysis.

TABLE 1

Variables Used in Replicated Factor Analyses

RAND (1972)	AAMC'S REPLICATION (1975)
1. Medical Students	1. Medical Students (73-74)
2. Interns in Major Teaching Hospitals	2. Total Interns Instructed by MC Faculty (72-73)
3. Residents in Major Teaching Hospitals	3. Residents Instructed by MC Faculty (73-74)
4. State or Private School Status	4. Public or Private Control(73-74)
5. Unrestricted Endowment (decile)	5. Tot MC Rev from Unrestricted Endowments (72-73)
6. MCAT Science Scores (decile)	6. MCAT Science Scores of 1st Yr Med Student(73-74
7. Percent Faculty Salary from Fed $ (decile)	7. Percent Sponsored Fac Sal from Eed $ (72-73)
8. State Medicaid Program	
9. Percent NIH Research Applications Approved	
10. Average Priority Score	
11. Population SMSA/Total Medical Students SMSA	8. SMSA Population per Medical Student (73-74)
12. NIH Research and Training Grant $ (FY 1971)	9. NIH Awards - Research Grants $ (73-74)
13. Total Students	10. Tot of All Students Instructed at MC (73-74)
14. Percent of Medical Students from Home State	11. Percent of Medical Students from Home State73-4
15. Special Project $/Total Students	12. Special Project $ per MD Students (72-73)
16. Log (1972 - year organized)	13. Age. Log (1974 - year organized)
17. Percent of Total Beds in University Hospital	
18. Percent of Total Beds in VA Hospital	
19. Part-time Faculty/Full-time Faculty	14. Part-time Faculty/Full-time Faculty
20. Volunteer Faculty/Full-time Faculty	15. Volunteer Faculty/Full-time Faculty
21. Full-time Faculty/Total Students	16. Full-time Faculty/Total Students (73-74)
22. Sponsored Program Expenditures/Full-time Faculty	17. Sponsored Program Expenditures/Full-time Fac72-3
23. Regular Operating Expenditures/Total Students	18. Regular Operating Costs per MD Student 72-73
24. Total Expenditures/Total Students	19. Total Expenditures/Total Students (73-74)
25. Sponsored Program Expenditures/Total Expenditures	20. Sponsored Program Expenditures/Total Expend.72-3
26. (Interns & Residents)/Medical Students	21. (Interns & Residents)/Medical Students 73-74
27. (Masters & Doc. in Basic Sci)/Medical Students	22. (Masters & Doc. in Basic Sci)/Med Students(73-4)
28. Financial Distress $/Regular Operating Expenditures	
29. $ Weighted Priority Score - Priority Score	
30. $ Weighted Fraction Approved - Fraction Approved	
31. Other Student Equivalents/Medical Students	23. Medical Student Equivalents/Medical Stud.(73-74)

Table 2

Six Factors from RAND Analysis
(Keeler, et al., 1972)

Factor 1 - Graduate Medical Education Program

Residents in Major Teaching Hospitals
Interns in Major Teaching Hospitals
(Interns & Residents)/Medical Students
Total Students
MCAT Science Scores (decile)

Factor 2 - State School/Private School

Percent of Medical Students from Home State
(-) Percent Faculty Salary from Federal Dollars (decile)
State (1) or Private (0) School Status
(-) Financial Distress $/Regular Operating Expenditures
(-) Unrestricted Endowment (decile)
(-) Special Project $/Total Students
(-) Sponsored Program Expenditures/Total Expenditures

Factor 3 - Non-MD Education Programs

Other Student Equivalents/Medical Students
(Masters & Doc. in Basic Sci)/Medical Students

Factor 4 - Reliance on Non-Full-time Faculty

Volunteer Faculty/Full-time Faculty
Part-time Faculty/Full-time Faculty
(-) Full-time Faculty/Total Students

Factor 5 - Federal Research Involvement

NIH Research and Training Grant $ (FY 1971)
Percent NIH Research Applications Approved
Sponsored Program Expenditures/Full-time Faculty
Total Expenditures/Total Students
Average Priority Score**

Factor 6 - MD Education Programs

Medical Students
Log (1972 - year organized)
Total Students
(-) Full-time Faculty/Total Students
(-) Population SMSA/Total Medical Students SMSA
(-) Regular Operating Expenditures/Total Students

*Variables under each factor are listed in the order of their loading on that factor. All variables listed have loadings of 0.5 or higher.

**Lower scores are better.

TABLE 3

Factor Pattern Matrix from Analysis of
RAND Study Variables (Using New AAMC Data)
By Method of Common Factors and Equimax Rotation

VARIABLES	RAND FACTOR LABELS	VARIABLE LABELS	FACTOR (VARIABLE GROUPS) 1	2	3	4	5	6
V6310		TOT RESDNTS INSTR BY MD FAC 73-74	.86	.22	.28	-.03	.07	-.03
V6330	Graduate Medical Education	TOT INTERNS INSTR BY MD FAC 72-73	.80	.19	.21	-.02	.05	-.00
V6080	Programs	ENROL RATIO-INTERNS & RESDNTS TO MD STU	.64	-.10	-.29	.09	.11	.22
V6010		TOT STUDENTS...ALL...INSTRUCTED AT MC	.61	.38*	.60	-.17	-.12	.21
V3350		SPONS PROG EXPD PER FT FAC	.10	.86	.19	-.00	.11	.09
V3345		MC EXPD-REG OP COSTS PER MD STUDENT	.24	.61	-.19	.50	.09	.17
V2830	Federal Reaearch Involvement	MC EXPD-PCT SPONS PROG EXPD OF TOT	.04	.67	.25	-.06	.34*	.12
V2940		NIH AWARDS RESRCH GRANTS $1000 73-74	.42*	.58	.06	.35*	.30	.36*
V7200		MEAN MCAT SCORE SCI-1ST YR MD STUDENTS	.38*	.41	.00	.09	.23	.30
V2820		PCT SPONS FAC SALARY FROM FED $ 72-73	-.14	-.32	-.12	.02	-.20	.26
V6020	U.G. Med. Educ.	ENROLL-TOT MD STUDENTS 73-74	.30	.22	.85	-.08	.02	-.11
V1045	Programs	AGE OF INSTITUTION	.08	.08	.74	-.07	.29	.04
V1140		SMSA POP PER MD STUDENT	.17	.06	-.33	.11	-.05	-.27
V5025	Reliance on Non-Full-Time	RATIO FT FAC TO TOTAL STUDENTS	-.11	-.02	-.29	.76	.05	.04
V2750	Faculty	TOT MC EXPD PER TOTAL STUDENTS	-.19	.52	-.12	.81	.06	-.07
V5040		RATIO VOL FAC TO FT FAC	.05	.02	-.45*	-.41	-.16	-.37
V2740		SPECIAL PROJ $ PER MD STUDENT 72-73	-.20	.11	-.11	-.34	-.00	.01
V1030		CONTROL TYPE (1=PRIVATE, 0=PUBLIC)	.10	.05	.01	.07	.78	-.10
V6230	Control: Public Vs. Private	PCT MD STUDENT FROM HOME STATE	.11	-.20	-.24	.16	-.58	-.09
V2110		MC REV-TOT UNRESTR ENDOW & GIFTS	.14	.17	.06	.29	.56	.11
V6050		ENROLL RATIO-MD STUDENT EQUIV TO MD STU	.08	.12	.16	.24	-.29	.64
V6140	Non-M.D. Educ. Programs	ENROLL RATIO-MAS & DOC BAS SCI TO MD STU	.17	.16	.00	.07	.07	.52
V5030		RATIO PT FAC TO FT FAC	.03	.01	.03	-.30	-.20	-.43

dimensions of difference described by variables not used in these analyses.

Some of the differences between the original analysis and the replication may be due to real changes over time in the functioning of academic medical centers, or they may be artifactual as discussed below. The fact that the same general "structure" or interpretable pattern was found serves to enhance confidence in the method and in the data for the purposes of both the RAND analysis (the basis for subsequent sampling of schools) and the present analysis (hypothesis generation).

Interpretation of the Factor Pattern Matrix

An understanding of the interpretation of the numerical "loadings" that comprise the factor pattern matrix facilitates the assessment of the results not only of the factor analysis replication presented here, but, more particularly, the five exploratory analyses in subsequent chapters.

The numbers in Table 3, the "factor loadings", are measures of strength of association between the variables and the derived "factors". Like correlation coefficients representing the relationship between pairs of simple variables, they range in value from +1.0 to -1.0. Values near zero represent "no relationship"; values near +1.0 or near -1.0 represent strong positive and strong negative relationships. The first row

shows that the first variable is highly related to factor 1 (the loading is +.90) and weakly related, at best, to the other factors. If it is assumed that variables related to the same factor are likely to be related to each other, it is seen that the first four variables and possibly the 8th and 9th are somehow related to one another. (This gives grounds for speculation.) For ease of examination, the variables in the table are ordered according to their highest factor loadings. The predominant loading (or loadings) for each variable are highlighted with a "box" (for high values) or an "asterisk" (for moderately high values). The grouping of variables means that they may be related to one another, that is, their values vary the same way across institutions. At any given school, high standardized values of one variable tend to be matched with high values of the other, low with low, if the relationship is positive, that is, if the signs on the loadings are the same (both "plus" or both "minus"). If the signs of two variables' loadings are different (one "plus" and one "minus") the relationship is probably negative, that is, high standardized values of one variable are matched with low values on the other. Because the factors are numerically independent of one another (due to the rotational procedure used), it is also likely that the variables in one group have low correlation with variables in another group. Exceptional variables are readily seen.

By way of additional guidance in the interpretation of the factor pattern matrices presented in this report, two additional rules of thumb may be useful. First, factor loadings with value

less than about .50 (in absolute value) should not be given as much attention as larger numerical loadings. Second, variable groupings that are lower on a given variable list may be less accurate indicators of potential relationships than groupings near the top of the list of variables. Therefore, speculations based on the first several groupings are more likely to be substantiated by a closer inspection of the data than are speculations based on later groupings.

Some apparent differences in the variable groupings resulting from the two analyses presented in this chapter can be explained by examination of the matrix of factor loadings. Whereas the named "factors" may be conceptually independent and most variables related only to one, some individual variables may be found to be related to more than one. This may be more easily understood through a simple analogy. If, instead of medical schools, rectangles were the unit of study, among the measured variables might be height, width, and area. As a result of analysis, height and width may be found in a common factor with area, but, since height and width are independent of each other, one or both may also be found in additional factors. So it is found, in the replication of the RAND study, that "Total medical center expenditures per total students" is related to both "federal research involvement" (factor 2) and "reliance on non-full-time faculty" (factor 4). That is seen by its sizeable loadings on <u>both</u> factors (.52 and .81). This is an example of the need to examine the factor loadings in addition to the grouped variable names, for an enhanced assessment of interrelationships among variables.

Chapter III

ANALYSIS OF FOUR SETS OF VARIABLES

Four sets of descriptive variables were selected, by the procedure described in Chapter II, from four functional categories of data descriptive of medical education:

Faculty

Curriculum

Student

Institutional
(Primarily Financial)

Each set was analyzed[1] separately to select sub-sets of variables that are both broadly representative of the independent dimensions within each domain and most likely to reveal interesting relationships with other domains. This chapter presents the results of the four analyses and variable selections. In each case several observations are made based on the factor loadings and occasionally on the first-order correlations from the input matrix. All observations must be viewed as tentative and not as proven conclusions.

Faculty

Twenty-three faculty variables were submitted to both princi-

[1] Principal components analyses are reported for the student and institution data, common factor analyses are reported for the faculty and curriculum data; in all analyses the factors were rotated to the orthogonal varimax criterion. The number of factors rotated was the number of factors with eigenvalues larger than 1.0.

pal components analysis and common factor analysis. The variable groupings resulting from the common factor analysis appeared to make more intuitive sense and therefore better facilitated the judgemental process of representative variable selection.

The names of the 23 variables and the resulting matrix of factor loadings[2] are presented in Table 4. The following are some observations based on the pattern of factor loadings:

1. Clinical science faculty salary scales of the several ranks tend to be more related to one another than to basic science faculty scales, although some correspondence between major field scales is seen. Stated another way, while the average salary of assistant professors (for example) of the basic sciences is associated with the average salary of clinical assistant professors at a given school, the salaries of clinical faculty at full, associate or instructor rank are all more strongly associated with assistant clinical faculty salaries.

2. While clinical and basic science salary scales appear here to be somewhat independent of one another, they both also appear to be independent of other factors: the numbers and percentages of faculty vacancies, the distribution of faculty members across the ranks, the ratio of part-time to full-time faculty members,

[2]See Chapter II for a discussion of the interpretation of factor loadings.

TABLE 4

Factor Pattern Matrix from Analysis of
Faculty Data by Method of Common Factors and Varimax Rotation

	VARIABLES	LABELS	VARIABLE GROUPS (FACTORS) 1	2	3	4	5	6	7	8
1.	V5520	AV TOT SALARY-ASST PROF-CLIN SCI 74-75	.91	.01	-.02	.23	.00	-.03	-.08	.01
	V5510	AV TOT SALARY-ASSOC PROF-CLIN SCI 74-75	.91	.00	.10	.27	.01	-.09	.01	.14
	V5500	AV TOT SALARY-PROF-CLIN SCI 74-75	.86	-.03	.08	.15	.01	-.09	.02	.01
	V5530	AV TOT SALARY-INSTR-CLIN SCI 74-75	.62	-.10	-.27	.30	.16	.22	-.08	-.02
2.	V5205	FT CLIN SCI FAC-PCT PROF	-.01	.80	-.26	-.06	.05	.01	-.04	-.04
	V5170	RATIO BAS SCI FAC TO CLIN SCI FAC	-.05	.75	.04	-.07	-.13	.10	-.21	-.02
	V5320	PCT BUDGETED VACANCIES-CLIN SCI	-.05	.75	.23	.08	.54	.00	.20	-.05
	V5040	RATIO VOL FAC TO FT FAC	.08	.57	-.03	.04	-.03	.29	.37*	-.08
	V5225	FT CLIN SCI FAC-PCT ASST PROF	-.01	-.48	.14	.02	.09	-.15	.15	-.11
	V5010	FT FAC-TOT ALL DEPT	.25	-.47	-.15	.20	.06	-.28	-.38*	.05
3.	V5265	FT BAS SCI FAC-PCT ASST PROF	-.01	.00	.84	-.08	.10	-.01	.16	-.40*
	V5245	FT BAS SCI FAC-PCT PROF	-.06	.23	.81	-.15	-.09	-.02	.21	-.07
4.	V5420	AV TOT SALARY-ASST PROF-BAS SCI 74-75	.34*	-.01	.01	.86	.05	-.09	.07	-.01
	V5410	AV TOT SALARY-ASSOC PROF-BAS SCI 74-75	.36*	.00	.12	.83	.03	-.09	-.00	.02
	V5400	AV TOT SALARY-PROF-BAS SCI 74-75	.43*	.00	.11	.77	-.02	-.22	-.12	.05
	V5430	AV TOT SALARY-INSTR-BAS SCI 74-75	.05	-.14	-.16	.52	.27	.05	.09	-.18
	V5025	RATIO FT FAC TO TOTAL STUDENTS	-.02	-.01	.35*	.45	.07	-.49*	-.23	.26
5.	V5300	VACANCIES-FT FAC-CLIN SCI	.10	-.01	.07	.05	.88	-.10	.04	.11
	V5310	VACANCIES-FT FAC-BAS SCI	.00	-.04	.04	.09	.72	.04	.01	-.10
6.	V5020	RATIO-FT FAC TO MD STUDENTS	-.06	.20	-.08	-.38*	-.14	.70	.01	.11
	V5030	RATIO PT FAC TO FT FAC	-.05	.23	.09	.03	.06	.67	-.09	.08
7.	V5215	FT CLIN SCI FAC-PCT ASSOC PROF	-.07	-.18	-.09	.05	.10	-.10	.70	.25
8.	V5255	FT BAS SCI FAC-PCT ASSOC PROF	.10	-.02	-.13	-.06	-.02	.09	.17	.62

and the size of the program as reflected by the total number of full-time faculty.

3. The FT faculty/MD student ratio appears to be independent of both major field salary scales. The FT faculty/total student ratio, however appears to be positively related to the basic science faculty salary scale: the higher the average salary, the fewer students per full-time faculty.

4. The FT faculty/MD student ratio apparently is related (r = .49) to the ratio of PT faculty to FT faculty. Holding the number of FT faculty constant, one might therefore expect to see an inverse relationship between the number of MD students and the number of PT faculty: the fewer part-timers, the more MD students.

5. At any school the total of the percentages of FT faculty at each of the four ranks (full professor, associate professor, assistant professor, and instructor) is, of course, 100%. Such numbers are obviously related since an increase in one percentage is always balanced by a decrease in one or more of the others. For technical reasons, the percentage of faculty at the instructor rank was not included in this analysis and the observations of the others must be tentative. However, for both clinical and basic science faculties, while the percentage of full professors appears to be inversely related to that of assistant professors,

there is indication that the percentage of associate professors (at least in the clinical sciences) is somewhat independent of the other percentages. (The single proportion of faculty holding tenured positions was not used as a variable in this study.)

6. It appears that the "smaller" schools (i.e., fewer FT faculty) have larger than usual proportions of the full-time clinical faculty ranked as associate professors (or conversely that "larger" schools have fewer) and larger ratios of volunteer to paid faculty members. The latter relationship may be apparent simply because "smaller" schools have larger ratios of volunteer to full-time faculty ($r = -.44$). The former relationship does not appear to hold for the basic sciences*.

7. Schools with clinical faculties staffed with a greater than average percentage of professors having full rank tend also to have a larger ratio of volunteer to full-time staff. Their staffs also tend to be more heavily (relative to the average institution) oriented toward the basic sciences. They are also "smaller" schools (having fewer full-time faculty), and have the highest percentages of budgeted clinical faculty vacancies.

On the basis of this preliminary examination it would seem

*Based on data reported in 1975 "Medical Education" supplement to JAMA, it may be observed that, while 29% of paid full-time faculty are in the basic sciences (including pathology), only 6% of volunteer are in the basic sciences.

reasonable to suggest that in any study involving faculty salary scales, those for clinical and basic science be examined separately. In any study of medical school faculties, the percentage of faculty of associate rank (or perhaps all "tenured" ranks) could be partitioned and used as a blocking variable or otherwise given special attention. The two faculty/student ratios behave differently and are probably not interchangeable for all descriptive and research purposes.

The following faculty variables were selected to be merged with variables from other domains of medical education for the analysis reported in Chapter IV:

V5510	AV TOT SALARY-ASSOC PROF-CLIN SCI 74-75
V5170	BAS SCI FAC TO CLIN SCI FAC
V5040	RATIO VOL FAC TO FT FAC
V5010	FT FAC-TOT ALL DEPT
V5410	AV TOT SALARY-ASSOC PROF-BAS SCI 74-75
V5300	VACANCIES-FT FAC-CLIN SCI
V5025	RATIO-FT FAC TO TOTAL STUDENTS
V5020	RATIO-FT FAC TO MD STUDENT
V5215	FT CLIN SCI FAC-PCT ASSOC PROF
V5255	FT BAS SCI FAC-PCT ASSOC PROF

Curriculum

Very few of the correlation coefficients computed between pairs of the 33 curriculum variables were high[3]. Common factor

[3]Thirty-one of the variables are binary: "yes" or "no" represented by 1's and 0's. One variable is a continuous measure in months. One variable is a percentage measure, grouped into 5 ordinal (approximately linear) categories. The factor analysis, therefore, is based on correlations which are mostly tetrachoric.

analysis was, therefore, employed to group variables. The names of the variables and their loadings on 12 rotated factors are presented in Table 5. The following are some observations based on the pattern of factor loadings:

1. The first grouping (or "factor") consists mostly of variables pertaining to electives. With few possible exceptions it does not appear that the availability of particular (subject area) electives distinguishes among schools, only the presence or absence of the elective system. Assuming that the term "elective" is used in a comparable way for all courses at all schools, a weighted average of these variables based on factor score coefficients to minimize variability, may serve as an index of elective utilization.

2. The availability of a combined MD-PhD program appears to be more likely in schools that do not offer electives.

3. There is an indication in factor two of a possible relationship between the minimum number of months of instruction required to earn an MD degree and the liklihood that a medical undergraduate would gain experience in ambulatory care. The shorter the program, the less likely that ambulatory care experience would be part of it ($r = .36$). It may be found in subsequent studies that educational programs are shorter at institutions that have no facilities for ambulatory care experience and that

TABLE 5

Factor Pattern Matrix from Analysis of
Curriculum Data by Method of Common Factors and Varimax Rotation

	VARIABLES	LABELS	VARIABLE GROUPS (FACTORS) 1	2	3	4	5	6	7	8	9	10	11	12
	V4200	CURR ELECTIVES-ALCOHOLIMS 74-75	.78	.01	.03	.17	.00	.07	-.08	.05	-.04	-.40*	.09	.04
	V4190	CURR ELECTIVES-DRUG ABUSE 74-75	.71	.12	.10	.23	.07	.12	-.04	-.01	-.14	-.40*	-.02	.12
	V4140	CURR ELECTIVES-HUMAN SEXUALITY 74-75	.62	-.13	-.08	.04	.12	.01	-.14	.06	.09	.03	-.06	-.01
	V4220	CURR ELECTIVES-ETHICAL PROBLEMS 74-75	.60	-.01	.00	.02	.07	-.37*	.09	-.07	-.09	.09	.13	.30*
1.	V4160	CURR ELECTIVES-NUTRITION 74-75	.57	.00	-.02	-.02	-.01	-.02	.20	-.02	-.11	.00	.04	.00
	V4150	CURR ELECTIVES-MD JURISPRUDENCE 74-75	.52	.00	-.06	-.04	.04	-.03	-.11	-.03	-.01	.08	-.12	.02
	V4230	CURR ELECTIVES-HLTH CARE DELIVERY	.51	.15	-.01	.05	-.03	-.18	.39*	-.30	-.03	-.19	-.18	.29
	V4000	OFFER COMBINED DOC+MD PROG 74-75	-.37	-.02	.25	-.16	.01	.24*	.31*	.01	.25	-.13	-.21	-.18
	V4300	CURR-PCT UNDERGRAD EXPERIENCE AMBUL CARE 73	.02	.90	-.13	.07	.07	-.07	-.04	.12	-.11	.13	.04	.03
2.	V4290	CURR-REQUIRED AMBUL CARE EXPERIENCE 73	-.02	.85	.04	-.01	.09	.04	-.11	.13	.20	.15	-.09	-.08
	V4030	MINIMUM MONTHS INSTR FOR MD DEGREE	-.01	.41	-.18	-.07	-.24	.13	.11	-.02	-.07	-.11	-.17	.19
	V4120	CURR INNOVATN-CLIN APPL COMPUTERS 74-75	-.05	-.03	.89	.12	-.10	.06	-.01	.19	.10	.16	.02	.04
3.	V4130	CURR INNOVATN-COMPUTER ASSTD INSTR 74-75	-.04	-.16	.64	.02	.10	.10	.16	-.11	-.08	.01	.16	-.14
	V4360	STATMNT OF BEHAV OBJS PUBLSHD	-.17	.06	.36	.23	-.14	-.17	.02	.20	-.18	-.34*	.32*	.21
	V4240	CURR-FAMILY MD PROG 74-75	.11	-.07	.12	.61	.00	-.13	.30	-.27	.06	.01	.05	-.14
4.	V4250	CURR-FAMILY MD GRAD PROG 73	.02	-.01	.12	.61	.00	.13	.02	-.07	.06	-.02	.04	.05
	V4310	CURR-PRIM CARE DEPT ENCOURAGE GENERALIST	.15	.09	-.10	.61	-.08	.00	-.07	.28	-.08	.11	.05	-.06
5.	V4170	CURR ELECTIVES-NON-WESTRN MEDICINE 74-75	.20	.08	-.02	-.05	.94	-.02	-.01	.03	.09	.05	.03	.20
6.	V4340	CURR-PATIENT CARE PROG-ALCOHOLISM OR DRUG	-.01	.00	.13	.12	-.05	.76	.07	.00	-.03	.15	.04	.12
7.	V4100	CURR INNOVATN-AMBUL PRIM CARE PROG 74-75	-.10	-.10	.11	.17	-.01	.10	.62	.25	.01	-.04	.06	-.03
	V4260	CURR-PRIMARY CARE PROG 74-75	.03	.12	.05	-.06	-.01	.01	.11	.52	-.02	-.10	.02	-.08
8.	V4110	CURR INNOVATN-SPECLTY TRACKS 74-75	-.11	.13	.07	.28	.20	-.03	.12	.33	.18	.10	-.21	-.08
	V4180	CURR ELECTIVES-POP DYNAMICS 74-75	.29	-.10	-.06	-.13	.30	-.12	.27	-.30	-.22	-.20	.06	-.22
9.	V4325	CURR-HLTH CARE MANGMT PROG 73	-.11	.01	.00	.04	.06	-.01	.01	.00	.75	.05	.09	-.02
10.	V4330	CURR-EMERGENCY CARE PROG 73	-.06	.13	-.03	.18	-.19	.13	.13	.07	.12	.38	.11	.13
	V4350	CURR-HLTH CARE MANAGMT PROG 73	.04	.07	.12	.04	.07	.06	-.04	-.06	-.02	.37	-.02	-.02
11.	V4280	CURR-RESRCH & DEV OF EDUC PROCESS 74-75	-.03	-.08	.09	.06	.03	.05	.03	-.01	.09	-.03	.66	-.07
	V4210	CURR ELECTIVES-MD HYPNOSIS 74-75	.13	.10	.00	-.03	.04	-.02	.04	-.09	-.05	.03	-.08	.33*
12.	V4270	CURR-ACCLRTD PROG-MD DEGREE < 6 YRS	-.02	-.15	-.07	-.05	.09	.12	.00	.01	.05	.05	.05	.27
	V4040	MC PERMITS PASS-FAIL GRADING	-.19	.06	-.04	-.17	.03	.28*	.02	.06	.11	.27	.13	-.21

rely on their students to elect post graduate residencies for such experience. On the other hand, there may be evidence here that in recent efforts to produce more primary care physicians more quickly by shortening the curriculum, ambulatory care training was considered more expendable than other parts of the curriculum.

4. The third factor indicates that schools which utilize computers in clinical applications also are more likely to utilize them for computer-aided-instruction.

5. Schools which utilize computers are also more likely to publish statements of the behavioral objectives of the medical curriculum. These may be joint outcomes of careful planning, since the publications of such a statement is also seen to be moderately related to the presence of efforts for research and development of the educational process (factor 11). Sedlacek (1975) found these practices to be more characteristic of newer schools than of older schools. (Age of the school was not among the variables used in the present study.)

6. Factor 4 represents the presence of undergraduate and graduate programs in family practice and the encouragement of general practice. It is of interest to note that the presence of such programs tends to be independent of student experience in ambulatory care, and both are independent of the presence of

primary care programs. One may conclude that the practical distictions drawn by Dr. R. E. Reynolds in JME (September, 1975) between primary care, ambulatory care, and family medicine also distinguish the learning experiences at different medical schools.

7. Factors 5, 6, and 7 each consists of only one variable. For each, over 80% of the schools indicate these programs are available: an elective in non-western medicine, an alcohol and drug abuse patient care program, and an ambulatory primary care program. It is of interest to note the lack of correspondence ($r = -.08$) between schools that indicated availability of undergraduate ambulatory care experience in a 1973 survey and schools that listed such experience in the 1974-75 curriculum directory. This may evidence either a rapid change in medical curricula or inconsistencies in information given by the schools to different audiences.

8. The presence of a program to train non-MD health practitioners does not appear to be related to any other curriculum characteristic examined. It may, of course, be related to institution and student measures not included here.

9. There does not appear to be any consistent pattern of relationship between the use of pass-fail grading or the option for accelerated programs to other curriculum characteristics.

Over all, the available data reveal few distinguishing characteristics of medical school curricula: There may or may not be electives, computer utilization, ambulatory care experience, family practice programs, primary care programs. No data were available to reflect possible differences within the basic science portion of the curricula. Some inconsistencies in data describing the availability of ambulatory care experience were noted.

For further analyses with variables from other components of medical education, the following variables were selected or computed:

V4135	INDEX OF ELECTIVE UTILIZATION[4]
V4000	OFFER COMBINED DOC+MD PROG 74-75
V4300	CURR-PCT UNDERGRAD EXPERIENCE AMBUL CARE 73
V4030	MINIMUM MONTHS INSTR FOR MD DEGREE
V4120	CURR INNOVATN-CL APPL COMPUTERS 74-75
V4240	CURR-FAMILY MD PROG 74-75
V4100	CURR INNOVATN-AMBUL PRIM CARE PROG 74-75

Student

Student and institutional (chiefly financial) variables predominate the available researchable data base. Most of the

[4]The coefficients of the Index of elective utilization are factor score coefficients. V4135 = .344 x V4200 + .277 x V4190 + .104 x V4140 + .177 x V4220 + .122 x V4160 + .110 x V4150 + .117 x V4230.

TABLE 6

Labels for Student Variables

GROUP	VARIABLE	LABEL
1.	V6020	ENROLL-TOT MD STUDENTS 73-74
	V7700	NEED AID-TOT MD STUDENTS
	V6200	ENROLL-TOT IN-STATE MD STUDENTS
	V6310	TOT RESDNTS INSTR BY MD FAC 73-74
	V6160	ENROLL RATIO MAS + DOC CONFRD TO TOT ENROLL
	V6330	TOT INTERNS INSTR BY MD FAC 72-73
2.	V7210	MEAN MCAT SCORE VER-1ST YR MD STUDENTS
	V7200	MEAN MCAT SCORE SCI-1ST YR MD STUDENTS
	V7220	MEAN MCAT SCORE GEN-1ST YR MD STUDENTS
	V7230	MEAN MCAT SCORE QUAN-1ST MD STUDENTS
3.	V7505	REQST+RECVD AID-PCT MD STUDENTS
	V7515	REQST+RECVD AID-PCT 1STYR MD STUDENTS
	V7715	NEED+RECVD AID-PCT 1ST YR MD STUDENTS
	V7545	REQST+RECVD AID-PCT FINAL YR MD STUDENTS
	V7745	NEED+RECVD AID-PCT FINAL YR MD STUDENTS
	V7835	RECVD AID-SCHLSHIP-PCT MD STUDENTS
4.	V7900	TUIT+EXPEN PER IN-STATE MD STUDENTS
	V7950	TUIT+EXPEN RATIO-IN-STATE TO OUT-STATE
	V7910	TUIT+EXPEN PER OUT-STATE MD STUDENT
5.	V6605	ENROLL-PCT FEMALE 1ST YR MD STUDENT
	V6635	ENROLL-PCT FEMALE MD STUDENT
	V8115	APPL-PCT MALE TO TOT
6.	V6705	FOREIGN STD ENROL-PCT MD STUDENTS
	V6735	FOREIGN STD ENROL-PCT FINAL YEAR STDS
	V7135	PRE MD GPA LESS THAN 2.6-PCT 1ST MD STUD
	V6805	UNDERREP MINORITY-PCT MD STUDENTS
7.	V7025	WITHDRL-PCT MID YR-ALL REASONS
	V7000	WITHDRL-TOT MD STUDENTS-ALL REASONS
8.	V6050	ENROLL RATIO-MD STUDENT EQUIV TO MD STUD
	V6040	ENROLL-TOT MD STUDENTS EQUIV INSTR BY MD
	V6110	ENROLL-TOT GRAD STUDENTS-MAS & DOC CAND
	V6130	ENROLL-TOT GRAD STUDENTS-NON-DEGREE CAND
9.	V7616	AV AID PER RECIPIENT MD STUDENT
	V7801	TOT AID PER TOT MD STUDENTS
	V7635	AV AMT AID TO 1ST YR MD STUDENTS
	V7695	AV AMT AID TO FINAL YR MD STUDENTS
10.	V8150	RATIO-APPL TO ENTERING
	V8140	RATIO-FEMALE APPL TO ENTERING
	V8130	RATIO-MALE APPL TO ENTERING
11.	V8081	ENRL RATIO INTERNS + RESDNTS TO MD STDS
12.	V8300	HLTH MANPOWER REV CAREER CHOICE WITHIN 5 YRS
	V8340	CAREER INTENT AFFECTS ADMISS DECISION
13.	V8330	ADVIS PROG-STUDENT RETENTION 74-75
	V7330	1ST YR MD STUDENTS-PCT ADV DEGREE
	V7035	WITHDRL-PCT FINAL YR-ALL REASONS
14.	V6900	REPEATERS-PCT 1ST YR MD STUDENTS
	V7815	RECVD AID-LOANS-PCT MD STUDENTS
	V6220	ENROLL RATIO-IN-STATE TO OUT-STATE MD STUDENTS
15.	V7100	UNDERGRAD GPA-ENTERING 1ST YR MD STUDENT
	V7115	PRE MD GPA 3.6 to 4.0-PCT 1ST YR MD STUD
16.	V7015	WITHDRL-PCT 1ST YR-ALL REASONS
	V7305	BACH DEG-PCT 1ST YR MD STUDENTS

(Cont.)

TABLE 6

Factor Pattern Matrix from Analysis of
Student Data by Method of Principal Components and Varimax Rotation

VARIABLES	VARIABLE GROUPS (FACTORS)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
V6020	.89	.07	.08	.14	-.04	-.04	-.03	.16	-.02	-.21	-.11	-.01	.08	-.01	.06	.04
V7700	.84	.00	.05	.22	.06	.20	.04	.14	.13	-.18	.06	.12	.04	-.01	.05	.03
V6200	.74	-.04	-.02	-.12	-.03	-.14	-.06	.17	-.11	-.41*	.01	.08	.08	.08	.06	-.11
V6310	.67	.32*	-.02	.02	.00	.02	.00	.05	.15	.02	.57	-.03	-.01	-.09	-.02	.01
V6160	-.62	.07	.03	-.02	.14	.00	.30*	.02	.00	-.24	.30	.20	.16	-.10	-.08	.01
V6330	.58	.29	-.02	-.03	.00	.01	-.03	.02	.25	.02	.53	.04	.00	-.12	-.11	.07
V7210	.03	.91	.05	.08	.17	-.04	.02	.07	.13	.13	.01	.03	-.05	-.08	-.04	-.10
V7200	.11	.88	.03	.12	-.05	-.02	.04	.14	.13	.08	.12	.06	.03	.09	.24	.03
V7220	.08	.87	.07	.08	.12	-.09	-.03	.06	.07	.10	.06	-.02	-.09	-.05	-.04	-.12
V7230	.00	.84	-.02	.23	-.04	-.11	.00	.04	.09	.08	.07	.03	.07	.13	.16	.02
V7505	-.03	.01	.92	.06	-.04	-.01	.16	-.04	-.07	-.05	-.01	.07	.04	.11	.00	.02
V7515	-.05	.00	.89	.04	-.04	-.04	.21	.02	-.10	-.01	.07	-.01	-.01	.06	-.03	-.01
V7715	.05	.13	.86	-.11	.05	-.01	-.04	.13	-.05	.00	-.07	-.03	-.01	-.03	-.05	-.06
V7545	.43*	.04	.59	-.08	.08	.09	-.37*	-.09	.23	-.04	-.25	-.01	.16	.07	.05	.10
V7745	.45*	.05	.57	-.15	.10	.10	-.41*	-.05	.20	-.03	-.29	-.04	.13	.02	.05	.09
V7825	-.05	-.26	.47	.16	.00	.10	.09	-.18	.06	.23	.20	.20	-.12	-.33*	.23	.10
V7900	.07	.20	-.02	.86	.10	.05	-.01	-.12	.23	.24	-.03	-.03	-.02	-.01	-.05	-.01
V7950	.06	.06	.03	.81	.13	.15	-.03	-.16	.19	.21	-.01	-.02	-.08	-.07	-.08	.16
V7910	.11	.23	-.05	.73	.05	-.05	-.01	-.01	.16	.14	.00	-.10	.10	.04	.03	-.22
V6605	-.04	-.01	.01	.04	.97	.02	.00	.00	.02	.08	-.04	-.09	.00	.00	-.04	.00
V6635	-.07	.00	.01	.05	.96	.00	.03	-.03	-.02	.10	-.03	-.03	.03	.04	-.05	-.02
V8115	-.10	-.29	.01	-.14	-.76	-.09	.06	-.02	-.15	-.07	-.09	-.02	-.06	.19	.05	.04
V6705	.06	-.04	.01	.11	.05	.90	-.04	.01	.20	.00	.02	.06	-.17	.11	-.02	-.04
V6735	.11	-.12	-.04	.11	.10	.69	.04	.14	.03	.16	.03	-.01	-.09	-.10	-.09	.40*
V7135	-.05	-.40*	.03	-.04	.00	.66	.03	.16	-.09	.11	-.14	-.11	.09	-.17	-.23	.05
V6805	-.04	.20	-.01	-.18	-.04	.52	.02	-.11	.45*	-.15	-.02	.18	.20	.18	.02	-.41*
V7025	-.13	-.02	.12	-.06	.00	-.01	.88	-.04	.01	-.03	-.04	.07	.00	.05	-.01	-.03
V7000	.32*	.09	.16	.01	.02	.09	.73	.10	.11	-.10	-.11	-.07	.09	.01	.02	.26
V6050	-.03	.08	-.03	-.14	-.03	.15	.02	.86	.01	-.20	.06	.05	.15	.05	.04	.06
V6040	.32*	.06	-.04	-.07	.01	.06	.01	.85	.03	-.15	.00	.13	.11	.05	.04	.04
V6110	.45*	.16	.15	.08	-.03	-.07	-.01	.55	.22	-.08	-.09	-.10	.01	.01	.08	-.17
V6130	.10	.34	.12	-.17	.03	-.03	.02	.50	.45*	.06	.18	.01	-.10	.02	.15	-.03
V7616	.12	.21	-.18	.29	.02	.06	.04	.11	.80	.09	.03	-.14	.06	-.01	.08	-.07
V7801	-.09	.04	.08	.20	.18	.18	.10	.06	.73	.11	.17	.12	-.11	-.09	.04	-.08
V7635	.11	.13	-.11	.36*	-.02	-.08	.03	.04	.70	.12	.06	-.30*	.04	.00	.00	.07
V7695	.48*	.14	-.03	.00	.01	.16	-.17	.04	.61	.04	-.22	-.09	.11	-.04	.06	-.07
V9150	-.17	.12	-.01	.21	.12	.05	-.06	-.12	.10	.90	.08	.03	-.01	.02	-.02	-.06
V8140	-.14	.18	-.04	.18	-.08	.02	-.03	-.15	.10	.86	.08	.06	.13	.04	.05	-.05
V8130	-.17	.08	.00	.19	.42*	.04	-.04	-.11	.08	.81	.05	.01	-.01	.04	-.03	-.06
V6081	-.16	.08	-.07	-.02	.00	.03	-.08	.04	.04	.15	.78	.03	-.04	.06	.07	-.05
V8300	-.01	.07	.08	.06	-.08	-.09	-.09	.10	-.11	-.06	.01	.83	-.01	-.04	.03	-.11
V9340	.05	.03	-.06	-.28	-.03	.15	.17	.02	-.07	.18	.04	.65	.09	-.02	-.01	.02
V9330	-.04	.07	-.07	.02	-.04	.09	-.04	-.19	-.05	-.08	.05	.04	-.78	.07	.20	-.06
V7330	-.20	.02	-.07	-.32*	.03	.12	.02	.11	.16	.04	-.31*	.06	-.42	-.26	-.38*	-.03
V7035	.21	.01	-.08	-.10	.16	-.21	-.04	.21	.09	.04	-.12	.15	.36	.25	-.04	.12
V6900	.06	-.16	-.08	.00	.07	-.09	-.07	-.11	.04	-.11	-.08	.06	.02	-.63	-.17	.01
V7815	.08	-.27	.27	.15	.02	-.16	.03	.00	-.24	.05	-.21	-.10	-.19	.51	-.33*	.00
V6220	.09	-.23	-.02	-.39*	-.08	-.21	-.10	-.09	.11	-.32*	.00	.10	.13	.46	-.04	.04
V7100	.07	.16	-.04	-.06	-.08	-.12	.01	.10	.07	-.01	-.02	.01	-.12	.03	.78	-.05
V7115	.19	.20	.05	-.05	-.16	-.28	.00	.16	.28	.09	.07	.03	-.21	.17	.49	.26
V7015	-.04	-.14	.03	-.09	-.08	.20	.15	-.02	-.19	-.20	-.03	-.16	.23	.00	.06	.70
V7305	.01	.27	.09	.12	.05	.17	.00	.00	-.14	.32*	.14	-.28	.36*	-.22	.27	-.42

information about students describes their numbers in the several classes and programs and the average levels and extent of financial aid they receive from the schools. Little or no information was available, at the time of this exploratory analysis, concerning the students' personal backgrounds (other than race, grades and admission test scores), personality, or specialized career goals. Fifty-two variables were submitted to a principal components analysis, resulting in 16 variable groups, or "independent factors". As in the replication of the RAND study reported in the preceding chapter, there were some variables found to be related to each of several groups. Table 6 presents the names of the 52 student variables and the matrix of factor loadings. The following are some observations based on the pattern of factor loadings and occasional referal to the input correlations.

1. Most of the variables that load heavily on the first factor (i.e. the first group of variables found to be related to one another more than to other variables) are measures of the "size" of the institution in terms of the number of students (undergraduates, graduate students, interns, and residents).

2. While the number of Master's and Ph.D. students at the medical school is directly related to other enrollment counts, the ratio of the number of these students to total enrollment

is inversely related to simple enrollment measures. This may indicate only that in larger schools, Master's and Ph.D. programs are a smaller proportion of the overall educational program.

3. Several variables that describe financial concerns of final year medical undergraduates are seen to be related to program size (numbers of medical students). The larger the number of students, the larger the number and the percentage of final year students needing, requesting, and receiving financial aid. Furthermore, the average amount of aid given to these students is larger at these schools. These less salient loadings on factor one (as well as other loadings on other factors) are highlighted with an asterisk on the matrix. The pattern appears to apply to final year and not to first year students. (Data for students in intermediate years were not included in this exploratory analysis). Studies currently in progress (for BHM) by AAMC's Division of Student Studies on "How Medical Students Finance Their Education", based on "individual" and not "institutional" data, do not show overall differences between extent of aid received by first, middle, and final year students generally.

4. The mean MCAT scores for the several components of the exam (verbal, science, general, quantitative) are highly correlated with one another across institutions and are not related to other

selected descriptors of medical school student bodies. It would therefore seem justifiable to select any one mean to represent all four as an institutional attribute. (It should be noted, in passing, that MCAT component scores for individual (unaggregated) students are not highly correlated.)

5. The percentage of each of several aggregations of students who need, request and receive aid are related to one another. This is indicated by factor 3. This does not necessarily contradict observation 3, that aid to final year students is related to school size while aid to first year students is not so related.

6. Factor 4 suggests that costs incurred by the in-state student (expenses and tuition) are highly related to costs incurred by the out-of-state student. If the sum is high for in-state students (relative to the in-state mean for all schools), it is high for out-of-state students (relative to the out-of-state mean). This does not indicate the cost to in-state students are equal to costs to out-of-state students. The ratio of in-state costs to out-of-state costs is seen to correlate with both in-state costs and out-state costs, indicating the higher the overall costs to the students (generally), the higher the disparity between in-state and out-of-state rates.

7. As may be expected, the enrollment ratio of in-state to out-of-state students is inversely related to the ratio of the costs (expenses + tuition) by in-state versus out-of-state students: the greater the disparity in costs, the smaller the proportion of out-of-state students.

8. Apparently, the greater the in-state to out-of-state student cost ratio, the greater the average amount of aid received by first year students. Since public schools are probably more likely to have different rates for in- and out-of-state students, we may therefore also expect average aid to first year students to be found in subsequent analyses, to correlate with public/ private control.

9. The fifth factor describes the representation of women among enrolled students and is generally independent of other included student variables, save one: the ratio of male applicants to entrants. The factor is not related to the applicant/entrant ratio for women. Higher women's representation is related to the rejection of men. The mean ratios for men and women are little different, 27:1 (applications per entrant) for men versus 23:1 for women, but the effect on enrollment is statistically noticeable.

10. The representation of foreign students is positively related to the representation of underrepresented (non-Oriental) minorities

(Afro-Americans, American Indians, Mexican Americans, mainland Puerto Ricans). One might suspect that many of the minorities counted are foreigners. Some schools may be more liberally oriented toward both groups. Some distinction is apparent, however, in the relation of these percentages to the percentage of first year students with low (less than 2.6) G.P.A.'s. The latter correlates .47 with the representation of foreign students, but not at all (r = .07) with the representation of traditionally underrepresented minorities.

11. The total rate of student withdrawal from school does not appear to be related to any other student variables (other than number of withdrawals).

12. Except for the ratio of M.A. and Ph.D.'s conferred to total enrollment, discussed in observation 2 above, the several measures of the extent of non-M.D. training programs do not appear to be related to other student variables.

13. Several measures of total and average student aid are found to be related to one another. Average aid is found to be higher in schools where the representation of traditionally under-represented minorities is also high. This is consistent with preliminary findings of the study in progress by the AAMC's Division of

Student Studies showing that such persons are reported to require and receive greater financial aid.

14. Several applicant/entrant ratios appear to be related to one another. They are all inversely related to the ratio of in-state to out-of-state enrollments. The more "selective" schools have relatively more out-of-state students. While it is true that state-supported schools limit the number (or proportion) of out-of-state students they accept, more selective (more highly renowned?) schools may simply receive greater number of applications from all over. This relationship has been observed in previous studies reported in the literature. One author suggested it may reflect a student's admission strategy of applying to the home state state-supported school, with a high subjective probability of success, and to several prestigious schools as a gamble.

15. The ratio of interns and residents taught by the medical school faculty to undergraduate medical students does not appear to be related to other student factors. This may be an artifact of differences in reporting numbers of house staff.

16. Schools that acknowledge considering an applicant's career intention in the admission decision (about one-half of all schools) tend to be the schools that review their graduates' career choices within five years of graduation.

17. Examination of the pair-wise correlation coefficients show the relationships within the several of the remaining variable groups to be weak. The variables that comprise these groups do, however, correlate with some variables from other groups.

- Schools with higher percentages of new students holding bachelor's degrees have higher applicant/entrant ratios.
- Entrant's mean GPA's (in all courses and in pre-med courses only) correlate with mean MCAT science scores more strongly than with other mean MCAT component scores. Admissions committees may primarily select students with both high GPA's and MCAT science scores.

On the basis of these observations the following variables were selected for analysis with variables from other components of medical education:

V6020	ENROLL-TOT MD STUDENTS 73-74
V6310	TOT RESDNTS INSTR BY MD FAC 73-74
V7200	MEAN MCAT SCORE SCI-1ST YEAR MD STUDENTS
V7505	REQST+RECVD AID-PCT MD STUDENTS
V7745	NEED+RECVD AID-PCT OF FINAL YR MD STUDENTS
V7950	TUIT+EXPEN RATIO-IN ST TO OUT ST
V6605	ENROLL-PCT FEMALE 1ST YR MD STUDENT
V6705	FOREIGN STD ENROL-PCT MD STUDENTS
V6805	UNDERREP MINORITY-PCT OF MD STUDENTS
V7025	WITHDRL-PCT MID YR-ALL REASONS
V6050	ENROLL RATIO-MD STUDENT EQUIV TO MD STUD
V7616	AV AID PER RECIPIENT MD STUDENT
V7635	AV AMT AID TO 1ST YR MED STUDENTS
V7695	AV AMT AID TO FINAL YR MD STUDENTS
V8150	RATIO-APPL TO ENTERING
V8130	RATIO-MALE APPL TO ENTERING
V6081	ENRL RATIO INTERNS + RESDNTS TO MD STDS
V8300	HLTH MANPOWER REV CAREER CHOICE WITHIN 5 YRS
V6220	ENROLL RATIO -IN ST TO OUT ST MD STUDENTS
V7115	PRE MD GPA 3.6 TO 4.0-PCT 1ST YR MD STUD

Institution

Most of the information stored in the data base, descriptive of institutional characteristics other than faculty, students and curricula, consists of variable measures of the dollars received and expended by the academic medical center. A few variables describe geographic, ownership, and enrollment growth characteristics.

Fifty-one variables were analyzed by the principal components method, resulting in 15 groupings of variables. The variables and the matrix of factor loadings are presented in Table 7. The following are observations based on the variable groupings and the pattern of factor loadings:

1. Fifteen variables "load" on the first factor, that is, they tend to be related to one another in some common way by which they are not related to the other 36 variables. Each of the other 14 factors has at most 4 constituent variables (i.e., ones with predominant loadings). This means there is primarily one area of empirical redundancy in the institutional data.

2. Seven of the fifteen variables in the first factor are dollar figures probably relating to the size of the institution and/or its research involvement. These variables include total revenue, revenue from federally sponsored programs, NIH research grants, NIH program and project and center grants, recovered indirect

TABLE 7

Labels for Institutional Variables

GROUP	VARIABLE	LABEL
	V2940	NIH AWARDS-RESRCH GRTS TOT $ 73-74
	V2300	MC REV-TOT FED SPONS PROG
	V2000	MC REV-TOT ALL SOURCES
	V2900	NIH AWARDS-PROG+PROJ & CENTER GRTS $1000
	V2220	MC REV-INDIRECT COSTS RECOVERY FED PROG
	V3345	TOT MC EXPD PER MD STUDENT
	V2430	MC REV-TOT NON-GOVT SPONS RESRCH
1.	V3330	MC EXPEN-SPONS TCH-TRN PER MD STUDENT
	V3350	SPONS PROG EXPD PER FT FAC
	V3321	MD EXPD-SPONS RES PER FT FAC
	V2405	PCT OF TOT MC REV FOR SPONS RESRCH
	V2750	TOT MC EXPD PER TOTAL STUDENTS
	V2830	MC EXPD-PCT SPONS PROG EXPD OF TOT
	V2110	MC REV-TOT UNRESTR ENDOW & GIFTS
	V2017	PCT MC REV-FED SPONS+IND CST RCVY
	V2515	PCT OF TOT SPONS TCH-TRN FROM FED
2.	V2535	PCT OF TOT SPONS TCH-TRN FROM NON-GOVT
	V2530	MC REV-TOT NON-GOVT SPONS TCH-TRN
	V1085	RATIO HOSPS BENDS PER MD STUDENT
3.	V1060	ACCREDITATION
	V1140	SMSA POP PER MD STUDENT
	V3310	MC LIBRARIES-BUDGET,BOOKS,PERIODICALS
4.	V2635	PCT MC EXPD FOR INSTR & DEPT RES
	V2125	PCT REV FROM STUDENT TUITION
	V1030	CONTROL TYPE 1=PRIVATE, 0=PUBLIC)
	V1072	MC HAS UNIV OR OTHER AFFIL HOSP
5.	V1071	MC HAS UNIV AFFIL HOSP
	V2155	PCT MC REV FROM UNRESTR GIFTS-FNDTNS
	V2435	PCT OF TOT SPONS RESRCH FROM NON-GOVT
	V2415	PCT OF TOT SPONS RESRCH FROM FED
6.	V2820	PCT SPONS FAC SALARY FROM FED $ 72-73
	V3025	PCT OF TOT CONSTR FUNDS FROM PRIV GIFTS
7.	V2505	PCT OF TOT MC REV FROM SPONS TCH-TRN
	V2740	SPECIAL PROJ $ PER MD STUDENT 72-73
8.	V2951	NIH RES $ PCT CHG 67-9 TO 72-4
	V2731	MC EXPD-TOT UNRSTR PER FT FAC
9.	V2640	MC EXPD-TOT UNRESTR PUBLIC SERV
	V3300	PROFESSIONAL FEES RECVD PER CL SCI FAC
	V1080	TOT BEDS AFFIL HOSPS
10.	V1120	MC LOCATION-IMMEDIATE LOCATION POP-DENSI
	V1130	MC LOCATION-SMSA POP-PCT NON-WHITE
	V2140	MC REV-TOT UNRESTR GIFTS-BUSINESS & INDU
11.	V2160	MC REV-TOT UNRESTR GIFTS-ALUMNI
	V2145	PCT MC REV FROM UNRESTR GIFTS-BUSINESS
12.	V1090	NUMBER OF DEANS APPNTD 60-74
	V2625	PCT OF TOT MC EXPD FOR ACADM SAL
13.	V3005	PCT OF TOT CONSTR FUNDS FROM FED
	V3000	CONSTR FUNDS-TOT FED
14.	V2165	PCT MD REV FROM UNRESTR GIFTS-ALUMNI
15.	V2615	PCT OF TOT MC EXPD FOR ADMN & GEN
	V6491	PROJTD ANNUAL GROWTH RATE 74-78

(Cont.)

TABLE 7

Factor Pattern Matrix from Analysis of
Institutional Data by Method of Principal Components
and Varimax Rotation

VARIABLES	VARIABLE GROUPS (FACTORS)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
V2940	.94	-.03	-.05	-.07	-.01	.07	.02	.00	.05	.04	.11	-.01	.05	-.05	.02
V2300	.94	.01	-.15	.00	.12	.09	.00	-.06	.07	.07	.06	-.03	.02	.03	.00
V2000	.91	.12	-.08	.02	.12	.01	-.14	.03	.05	.25	-.01	.01	-.02	.03	.05
V2900	.88	.00	.01	-.13	-.10	-.11	.05	-.14	.02	-.09	.05	.17	-.02	.05	.11
V2220	.87	-.04	-.11	.01	.04	.08	.00	-.08	.11	.06	.17	-.18	-.03	.08	-.03
V3345	.80	.03	.35*	.08	-.01	.08	-.17	.29	.02	-.03	.00	.04	.05	-.03	-.02
V2430	.80	.26	-.07	.05	.01	-.14	-.14	-.06	-.05	.12	.12	.01	.14	.02	.04
V3330	.73	.25	.18	.16	.10	-.03	.36*	.02	.11	-.11	-.07	-.01	.10	-.06	-.11
V3350	.70	.12	-.20	.27	.25	.05	.03	.17	-.24	-.02	-.05	.30	-.12	-.10	.16
V3321	.69	-.04	-.32	-.06	.19	.11	-.15	.19	-.19	.19	.20	.12	.07	-.15	-.07
V2405	.67	.02	-.43*	.10	.01	.31*	-.08	-.06	-.02	-.12	.20	.01	.23	.11	-.05
V2750	.62	-.11	.37*	.02	.05	-.05	-.21	.20	.05	-.19	.05	.07	-.20	.24	.06
V2830	.58	.16	-.18	.54	.08	.08	.36*	-.07	-.09	.04	-.03	.20	.04	.03	.16
V2110	.56	-.23	-.12	.07	-.20	.07	-.07	-.06	-.05	.07	.14	-.48	.03	.03	-.13
V2017	.52	-.11	-.40*	.26	.10	.36*	.43	-.14	.07	-.17	.11	.06	.11	.07	-.06
V2515	-.04	-.91	.09	.06	.05	.09	-.06	.02	.00	.04	.01	.03	-.10	-.03	.04
V2535	-.05	.88	-.03	.06	-.12	-.08	.03	.11	.06	-.02	.03	-.06	.07	.15	-.13
V2530	.26	.84	-.04	.04	.12	-.08	.03	-.11	.06	.01	.07	-.03	.26	-.01	.02
V1085	-.25	-.16	.79	-.08	-.13	.02	.17	.01	.01	.02	.07	-.08	.11	-.13	-.15
V1060	-.21	-.25	.65	-.20	-.01	-.30*	-.03	-.18	-.08	-.28	.01	-.08	.05	-.07	-.17
V1140	.05	.08	.60	-.16	-.22	.22	-.21	-.22	-.19	.05	.05	.06	.01	.06	.21
V3310	.27	.10	.06	-.72	.00	.15	.00	.03	-.10	.27	-.10	.12	.00	-.11	.22
V2635	-.47*	-.27	.15	-.61	.00	-.03	-.19	.04	-.07	-.16	.04	-.13	-.03	-.04	.25
V2125	-.05	.03	-.24	.54	-.14	.11	.24	-.34*	-.19	.17	.14	.07	.29	.17	.00
V1030	.29	-.14	-.13	.49	-.34	.00	-.02	-.16	-.05	.13	.23	-.26	.08	.26	-.16
V1072	.06	-.06	-.12	.02	.89	.14	.01	-.03	.01	.15	.06	.01	.07	.01	.05
V1071	.14	-.03	-.12	-.08	.86	.13	.06	-.06	.09	.01	.13	.02	.12	.00	.05
V2155	-.07	-.14	-.17	.04	-.37	.08	-.09	.08	.02	.16	.21	-.28	-.23	-.37*	.20
V2435	-.11	.13	-.05	.02	-.15	-.84	.02	.05	.00	.05	-.02	.01	.02	.02	.06
V2415	.17	-.07	-.14	.01	.12	.82	-.33*	.10	.02	.07	.05	.00	.02	.04	.11
V2820	-.25	-.33*	.10	-.33*	.06	.49	-.32*	.06	.20	-.25	-.03	-.08	-.02	-.13	-.08
V3025	.23	.04	-.08	.04	.07	-.45	-.22	-.16	-.08	-.01	.31*	-.21	.06	-.21	.08
V2505	-.06	.83	.05	.19	.11	-.16	.80	-.30	-.04	-.07	-.08	.04	.05	-.03	-.06
V2740	-.09	-.04	-.04	-.02	-.01	-.06	.72	.22	-.15	.10	.02	-.04	-.15	-.01	.21
V2951	-.06	.01	-.17	-.15	-.15	.09	.04	.77	.06	-.04	.05	.06	.07	-.06	.02
V2731	.31	-.04	.01	-.11	.36*	-.03	-.29	.47	-.27	-.14	.03	.19	-.06	-.29	-.04
V2640	.00	.11	-.02	.07	-.03	-.03	-.12	-.12	.73	.07	.02	.19	-.05	-.15	-.04
V3300	.21	.00	-.11	-.11	.16	.14	-.03	.26	.68	-.07	-.06	-.04	-.07	.08	.16
V1080	-.05	-.03	.00	-.11	.15	.01	.08	-.06	.08	.87	.07	.08	.01	-.08	-.01
V1120	.35*	.09	.03	.36*	-.17	-.08	-.20	-.07	-.29	.58	-.01	.06	.11	.20	.03
V1130	.05	.17	-.13	.06	.07	-.1	-.03	.00	.12	.52	-.12	-.08	.34	.42*	-.01
V2140	.29	.01	.10	.05	.17	.07	.01	.16	.00	-.04	.82	.06	-.04	-.04	.03
V2160	.23	.16	-.05	.10	-.02	-.04	-.04	-.13	-.12	.13	.65	.06	.01	.49*	.02
V2145	.00	.05	.36	.27	.05	.02	-.06	.45*	.07	-.05	.45	-.04	.34*	-.19	-.03
V1090	.09	-.17	-.08	.03	.02	.03	-.03	.08	.15	.10	.08	.78	-.03	.13	.03
V2625	-.30*	.03	.19	.09	.03	-.20	-.02	.12	.15	-.07	-.30*	-.37	-.22	.12	.30
V3005	.02	.15	-.05	-.01	.12	.01	-.03	-.05	-.08	.05	.04	.03	.75	.10	.03
V3000	.12	.23	.17	.12	.06	-.05	-.04	.17	-.01	.07	-.03	-.05	.74	-.01	.07
V2165	.02	.14	-.08	.15	-.01	.08	-.03	-.09	-.07	.02	.05	.08	.05	.79	-.04
V2615	-.18	.12	.19	-.13	-.16	-.13	-.19	-.06	-.08	.01	-.02	-.08	-.06	.14	-.78
V6491	-.11	-.30*	.18	-.14	-.13	-.35*	-.06	-.15	.01	.04	-.01	-.06	.23	.10	.50

costs from the federal government, non-governmentally sponsored research revenue, and unrestricted endowment and gifts.

Related to these overall size-of-budget measures are five "dollars-per-person" variables: $/med student, $/total students, sponsored training $/med student, sponsored research $/FT (full-time) faculty, sponsored program $/FT faculty.

Also related to the above are three percentage figures: % of revenue for sponsored research, % of revenue from federal sponsored programs including the amount received to recover indirect costs, % of revenue for all sponsored programs from all sources.

This group of variables seems to describe size of the research program which, in turn, appears to correspond with relatively high levels of funding for faculty and higher costs per student trained.

Type of control (public vs. private) appears to be unrelated to this major factor.

Change over the last five years in level of NIH research funding also appears to be unrelated to this factor.

Projected annual enrollment growth rate appears to be unrelated to the factor.

Percent of expenditures for "instruction and departmental

research", while primarily related to variables in factor 4, is inversely correlated with all of the variables in factor 1 (save endowment and gift income to which it is unrelated). This may be a symptom of medical schools heavy dependence on sponsored sources of support.

Percent of expenditures for academic salaries is moderately inversely related to all variables in factor 1: The larger the research budget, the smaller the proportion of expenditures for salaries alone.

3. The proportion of revenues for sponsored teaching and training that comes from federal sources is inversely related ($r = -.78$) to the level (dollars) of funding for sponsored training from non-governmental sources: The less money received from non-governmental sources for sponsored teaching, the greater the proportional reliance on federal funding for this purpose.

4. Accreditation status appears to be related to the number of hospital beds per undergraduate medical student: provisionally accredited (mostly new) schools tend to have a smaller total number of beds in hospitals affiliated with the school.

5. Private schools tend to report greater proportions of their total revenue coming from tuition:

6. Public schools tend to report greater proportions of their total expenditures going for "instruction and departmental research." This may result from state pressures to devote their energies in this direction.

7. Whether or not a medical school is affiliated with a hospital (as distinct from a clinic), on campus or not, appears to be independent of other institutional variables. The meaning and quality of the affiliation variable is not certain.

8. The sixth factor suggests that the percentage of faculty salary revenue that is derived from federal sources is related to the extent to which research is sponsored by the federal government. This seems reasonable since sponsored research probably contributes to salaries regardless of source.

9. The amount of special project revenue received per medical student is positively related ($r = .43$) to the percentage of all medical center revenues that are received for sponsored teaching and training. Schools placing relative emphasis on graduate level (Ph.D.) training tend to be schools that receive more support per student for "special projects". The meaning of this is unclear.

10. The percentage of all revenues from sponsored teaching and training appears to be inversely proportional to the percentage of sponsored research revenues received from federal sources ($r = -.49$): the more federally sponsored research, the

smaller the proportion of all revenues received for sponsored teaching (primarily at the Ph.D. level). This may be evidence of a ceiling effect on the benefit to students of increasing levels of research activity.

11. Change in levels of NIH research funding between the two-year periods 67-69 and 72-74 is not highly correlated with any other institutional variable. It is only moderately related to expenditures per faculty ($r = .27$) and to percentage of all revenues from business gifts ($r = .26$).

12. Among the set of 51 selected variables, expenditures for "extension and public service" is only related (directly) to professional fees received per clinical science faculty member ($r = .32$).

13. Total beds at all affiliated hospitals, local population density, and percent non-white in the local SMSA population are understandably found to be interrelated. They are apparently not, however, related to other institutional variables.

14. Schools that receive larger than average donations from alumni are also schools that receive larger gifts from business and industry. Some schools apparently have effective fund raising offices.

15. The positive relation between alumni giving and private control ($r = .36$) is somewhat stronger than the relation between business giving and private control ($r = .16$).

16. The amount of revenue received from non-governmentally funded research is more strongly related to alumni giving (r = .41) than to business giving (r = .28). This is an interesting parallel that suggests the possibility of indirect alumni aid.

17. The number of deans (excluding acting-deans) appointed between 1960 and 1974 is not strongly related to any single variable in the set. As seen in the joint loading on a common factor, however, turnover in deanships may be indirectly (and inversely) related to endowment and gift receipts.

18. Neither the level of federal funding of construction at the medical school nor the proportional federal contribution of all construction appears to be related to other institutional variables.

19. The percentage of all unrestricted monetary gifts received from alumni is weakly related only to the variables suggesting private control.

20. The annual growth rate computed from schools' enrollment projections is related only to the percentage of expenditures for "instruction and departmental" research. Growth rate may be related, however, to variables describing the other three broad components of medical education.

With the exception of many "research funding" indicators, the institutional variables selected and/or computed do not appear to be highly interrelated. Selection of institutional variables to intercorrelate with variables from other components of medical education is not greatly facilitated by the present analysis. The selected variables, judged to be representative and potentially most interesting are:

V2000	MC REV-TOT FED SPONS PROG
V3345	TOT MC EXPD PER MD STUDENT
V3350	SPONS PROG EXPD PER FT FAC
V2405	PCT OF TOT MC REV FOR SPONS RESRCH
V2515	PCT OF TOT SPONS TECH-TRN FROM FED
V2635	PCT MC EXPD FOR INSTR & DEPT RES
V1030	CONTROL TYPE (1=PRIVATE, 0=PUBLIC)
V1072	MC HAS UNIV OR OTHER AFFIL HOSP
V2415	PCT OF TOT SPONS RESRCH FROM FED
V2505	PCT OF TOT MC REV FROM SPONS TCH-TRN
V2951	NIH RES $ PCT CHG 67-9 TO 72-4
V2731	MC EXPD-TOT UNRESTR PER FT FAC
V3300	PROFESSIONAL FEES RECVD PER CLIN SCI FAC
V1090	NUMBER OF DEANS APPNTD 60-74
V6491	PROJTD ANNUAL GROWTH RATE 74-78

Chapter IV

INTERRELATIONSHIPS BETWEEN VARIABLES FROM FOUR CATEGORIES

Variable Selection

The process of selection of variables for the present analysis has been detailed in Chapters II and III. The aim was to select a sub-set of all available variables that adequately represent the major dimensions of variation in the four component areas of medical education. The variables are listed in Table 8. For the faculty data, ten variables were selected from a pre-selection set of 23; curriculum, 7 out of 33; student, 20 out of 52; institution, 15 out of 51.

Interpretation of the Factor Pattern Matrix

Table 8 presents the matrix of factor loadings of the selected variables on each of 18 "factors" indicating the strength of the association of each within each group of variables. A more complete description of the proper interpretation of this type of presentation is given in Chapter II.

Since the relationships among variables within each descriptive category have already been discussed, the emphasis here will be placed on apparent relationships between variables selected from separate categories.[1]

---

[1]The consideration of possible interrelations between the several categorical domains is the principal task requested under section I.B.3.j. of the AAMC-BHM contract.

TABLE 8

Labels for Interrelationships Variables

GROUP	VARIABLE	LABEL
	V2000	MC REV-TOT ALL SOURCES
	V5010	FT FAC-TOT ALL DEPT
	V2405	PCT OF TOT MC REV FOR SPONS RESRCH
	V2635	PCT MC EXPD FOR INSTR & DEPT RES
	V3350	SPONS PROG EXPD PER FT FAC
	V7695	AV AMT AID TO FINAL YR MD STUDENTS
	V7616	AV AID PER RECIPIENT MD STUDENT
	V6310	TOT RESDNTS INSTR BY MD FAC 73-74
1.	V7635	AV AMT AID TO 1ST YR MD STUDENTS
	V7200	MEAN MCAT SCORE SCI-1ST YR MD STUDENTS
	V6020	ENROLL-TOT MD STUDENTS 73-74
	V3345	TOT MC EXPD PER MD STUDENT
	V4135	INDEX OF ELECTIVE UTILIZATION
	V4000	OFFER COMBINED DOC+MD PROG 74-75
	V4240	CURR-FAMILY MD PROG 74-75
	V5040	RATIO VOL FAC TO FT FAC
	V8130	RATIO-MALE APPL TO ENTERING
	V8150	RATIO-APPL TO ENTERING
2.	V6605	ENROLL-PCT FEMALE 1ST YR MD STUDENT
	V7950	TUIT+EXPEN RATIO-IN-STATE TO OUT-STATE
	V1030	CONTROL TYPE
	V7025	WITHDRL-PCT MID YR-ALL REASONS
3.	V5170	BAS SCI FAC PER CLIN SCI FAC
	V2505	PCT OF TOT MC REV FROM SPONS TCH-TRN
	V2415	PCT OF TOT SPONS RESRCH FROM FED
	V5410	AV TOT SALARY-ASSOC PROF-BAS SCI 74-75
4.	V6081	ENRL RATIO INTERNS + RESDNTS TO MD STDS
	V5510	AV TOT SALARY-ASSOC PROF-CLIN SCI 74-75
5.	V2731	MC EXPD-TOT UNRSTR PER FT FAC
	V8300	HLTH MANPOWER REV CAREER CHOICE WITHIN 5 YRS
6.	V4120	CURR INNOVATN-CL APPL COMPUTERS 74-75
	V4100	CURR INNOVATN-AMBUL PRIM CARE PROG 74-75
7.	V5025	RATIO FT FAC TO TOTAL STUDENTS
	V5020	RATIO-FT FAC TO MD STUDENTS
8.	V6705	FOREIGN STD ENROL-PCT MD STUDENTS
	V6805	MD STUDENTS-PCT UNDERREP MINORITY
9.	V4300	CURR-PCT UNDERGRAD EXPERIENCE AMBUL CARE
	V4030	MINIMUM MONTHS INSTR FOR MD DEGREE
10.	V7505	REQST+RECVD AID-PCT MD STUDENTS
	V7745	NEED+RECVD AID-PCT FINAL YR MD STUDENTS
11.	V5300	VACANCIES-FT FAC-CLIN SCI
12.	V1072	MC HAS UNIV OR OTHER AFFIL HOSP
13.	V6050	ENROLL RATIO-MD STUDENT EQUIV TO MD STUD
14.	V2951	NIH RES $ PCT CHG 67-9 TO 72-4
15.	V3300	PROFESSIONAL FEES RECVD PER CLIN SCI FAC
	V7115	PRE MD GPA 3.6 TO 4.0-PCT 1ST YR MD STUD
16.	V6491	PROJTD ANNUAL GROWTH RATE 74-78
	V2515	PCT OF TOT SPONS TCH-TRN FROM FED
	V1090	NUMBER OF DEANS APPNTD 60-74
17.	V5215	FT CLIN SCI FAC-PCT ASSOC PROF
	V6210	ENROLL RATIO-IN-STATE TO OUT-STATE MD STUDENTS
18.	V5255	FT BAS SCI FAC-PCT ASSOC PROF

(Cont.)

TABLE 8

Factor Pattern Matrix from Analysis of
Faculty, Curriculum, Student and Institutional Data

VARIABLES	VARIABLE GROUPS (FACTORS)																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
V2000	.86	-.13	.08	.10	.27	.00	-.10	-.01	.08	.04	.12	.05	.08	.06	.15	-.01	.03	.01
V5010	.80	-.12	.09	.28	-.17	.03	-.25	.00	.06	.03	.09	.13	.08	-.05	.12	-.02	.00	-.04
V2405	.72	.16	.19	-.21	.09	.23	-.02	-.06	.18	.12	-.13	-.07	.17	.06	.06	.23	-.01	-.03
V2635	-.68	-.09	.24	-.11	.09	.02	.02	.03	-.02	-.10	.19	-.18	.17	.06	.13	-.31*	.08	.02
V3350	.64	-.05	-.17	-.01	.57	.03	.05	.12	-.01	.15	-.12	.16	-.05	.03	.01	.09	.09	.07
V7695	.63	.00	.23	-.08	.12	-.21	.09	.29	.02	-.24	.20	.15	-.10	.06	.08	.15	.15	.07
V7616	.63	.21	.12	-.10	.02	-.10	-.05	.24	.25	-.36*	-.04	-.18	.02	-.12	.07	.16	-.03	-.15
V6310	.57	-.07	.11	.50	.04	.13	.27	.01	.19	-.01	.00	.06	.14	-.15	-.02	.00	.06	.09
V7635	.57	.23	.08	-.07	-.21	-.12	.00	.16	.32*	-.28	-.04	-.23	-.10	-.18	.15	.04	-.04	-.12
V7200	.57	.11	.04	.19	.29	.04	.01	-.09	-.02	.14	-.18	-.17	.32*	-.03	.19	-.03	-.15	.07
V6020	.56	-.28	.12	-.02	-.13	.12	.46*	-.05	.04	.04	.18	.41*	-.05	-.10	-.02	.00	.09	.09
V3345	.55	.18	.04	.16	.45*	-.19	-.45*	-.07	.02	-.03	.11	-.07	.04	-.07	.19	.02	.08	-.02
V4135	-.50	-.17	.15	.09	-.16	-.15	-.05	.19	.12	-.10	-.16	-.15	-.10	-.45	.13	.17	-.01	-.05
V4000	.45	.20	.05	-.25	-.09	.22	.03	-.29	-.08	-.11	.02	.16	.36*	.02	.10	.03	.37*	.10
V4240	-.40	-.13	.14	-.04	-.05	.26	-.07	-.03	.20	-.38*	-.26	.23	-.06	.20	.08	.12	.28	-.04
V5040	-.39	.22	-.32*	.12	.28	.16	.39*	.00	.10	.03	.07	-.34*	-.04	-.05	-.12	-.17	.12	.02
V8130	-.04	.95	.02	.14	.02	-.01	-.08	.02	-.03	-.02	-.02	-.01	-.05	.02	.00	-.01	-.02	-.02
V8150	.03	.87	.01	.12	.05	.10	-.10	.05	-.11	-.05	-.06	-.14	-.11	-.05	.09	-.07	-.02	-.01
V6605	-.08	.54	.05	.16	-.04	-.33*	.00	-.03	.22	.07	.05	.36*	.14	.20	-.29	.13	.04	-.07
V7950	.39*	.52	.06	-.18	-.25	-.12	.09	.14	.07	.05	-.04	-.07	-.26	-.19	.17	-.10	-.28	.10
V1030	.50*	.50	.09	.00	-.26	.04	-.03	-.09	.01	.03	-.13	-.16	-.35*	.02	-.14	-.10	-.33*	.05
V7025	.01	-.01	-.92	-.10	.02	-.07	.08	-.01	.01	.07	-.05	-.10	.03	.10	.05	.04	-.04	.04
V5170	-.19	-.02	-.90	-.09	.08	-.02	.05	-.01	.04	.09	.00	-.15	-.03	.01	-.05	.00	-.07	-.04
V2505	.02	-.07	-.70	.17	-.30*	.18	.04	.26	-.14	.04	-.06	.24	.04	-.24	-.10	.12	-.06	.07
V2415	.19	.08	.48	-.36*	.30	-.06	.12	-.30	.29	.07	.01	.05	.12	.03	.13	.28	-.14	.10
V5410	.06	.32*	.01	.74	.01	-.20	-.27	-.05	.00	-.12	.23	.06	-.03	.07	.04	-.02	.11	-.10
V6031	.06	.04	.01	.72	-.23	.18	-.23	.04	-.11	-.04	-.31*	-.18	.06	-.06	-.04	-.01	-.02	-.03
V5510	.11	.14	.05	.72	.17	-.02	-.09	.03	.13	-.08	.15	-.03	-.20	.17	.03	.07	-.22	.18
V2731	.10	-.04	.08	-.05	.85	.11	.02	.11	-.07	-.06	.02	.14	-.02	.17	.06	.00	.01	-.10
V8300	-.09	.00	-.03	-.05	.21	.71	.00	-.01	-.04	.09	.25	-.06	.07	-.10	-.15	.04	.00	.07
V4120	.10	-.00	.09	.11	-.02	.69	-.06	-.03	-.14	.06	-.08	.24	.09	-.00	.23	.07	-.12	-.04
V4100	.12	.04	-.09	-.11	-.17	.50	.10	.20	.05	-.35*	.06	-.12	-.04	.31*	.20	-.20	.16	.10
V5025	.00	.09	-.03	.17	-.05	-.07	-.86	-.10	.02	-.10	.10	.00	-.19	-.04	.00	-.05	-.03	.04
V5020	-.14	-.11	-.26	-.21	.00	-.02	.75	-.12	-.03	.02	.08	.21	-.21	.00	-.07	.05	-.03	.16
V6705	-.01	.11	-.11	.02	.05	-.07	.00	.98	.02	.01	-.03	.10	.10	-.09	-.04	-.08	-.01	.02
V6805	.19	-.03	.04	-.02	.46*	.13	.08	.62	.05	.02	-.08	-.28	.05	.25	-.09	.33*	.04	-.04
V4300	-.19	.00	.04	-.08	.06	-.01	-.06	.00	-.80	.02	.04	.05	-.08	.03	-.07	-.06	-.15	-.12
V4030	-.09	.15	-.07	.04	-.01	-.16	.14	-.05	-.66	-.03	.13	-.18	.08	.06	.08	.36*	.10	.18
V7505	.02	-.01	-.14	-.14	-.03	.06	.09	.02	.03	.84	-.04	-.02	-.05	-.02	.08	.05	.05	-.04
V7745	.33*	-.01	.32*	-.16	-.03	.02	.13	.14	.01	.44	.21	.31*	-.15	.18	.21	.09	.37*	.11
V5300	.00	-.10	.12	.05	.00	.14	-.16	-.06	.03	-.01	.79	.00	.06	-.03	-.04	-.14	-.03	.06
V1072	.11	-.09	.11	-.07	.18	.09	.15	.02	.03	.00	-.02	.74	.07	-.09	.13	.02	.06	.04
V6050	.13	-.24	.01	-.08	-.03	.10	.03	.12	.05	-.06	.06	.06	.82	.12	.01	.00	-.08	.01
V2951	-.08	-.04	.03	.10	.16	-.07	.01	-.01	-.05	.00	-.06	-.09	.09	.79	.13	.07	.02	-.08
V3300	.08	-.02	.04	-.05	.03	.03	-.13	-.02	.12	.07	.02	.11	.02	.22	.81	.04	.04	.15
V7115	.36*	-.04	.03	.14	.11	.13	.10	-.13	-.19	.01	.14	.04	.04	-.15	.57	.00	-.06	-.22
V6491	-.18	.09	.01	.06	-.08	-.03	.02	.00	.03	-.04	.19	-.08	-.02	-.02	-.01	-.71	.01	-.10
V2515	-.14	.04	.18	-.23	.13	-.08	-.23	-.07	.19	.00	-.35 *	.11	.07	-.01	-.07	-.53	-.06	.27
V1090	.18	-.17	.13	-.10	.05	-.23	-.10	.03	.27	.13	-.19	.11	-.17	-.01	-.07	-.07	.59	-.04
V5215	-.10	.16	.39*	-.02	-.02	.18	.05	.16	-.05	.05	.11	-.18	.08	.15	-.15	-.15	.48	.37
V6220	-.21	.38*	-.01	.08	.10	-.03	.19	-.13	-.01	-.05	.06	.02	-.01	-.02	.17	.29	.47	-.11
V5255	.02	-.03	-.01	.05	-.07	.03	.07	.00	.01	-.03	.04	.05	.01	-.08	.06	.05	-.01	.92

The following paragraphs present interpretations of what the data "seem to say." Some are obviously true and relatively uninteresting, but their manifestation is an indication of the integrity of the data and the analysis method. Some interpretations are less obvious and may lead to thought and speculation. The observations are presented here. Questions raised by these observations are presented in the next chapter.

1. As was found to be the case with institution data alone, there appears to be one predominant dimension along which institutions differ. In addition, there are several other distinct but less salient dimensions. Only 7 of the 18 groups contained variables from two or more of the four categories.

2. Institutional "size" is the most salient characteristic of the primary dimension, but several disparate variables appear to be related to it. Total revenues, total full-time faculty, total undergraduate medical students, and total residents are among the variables in this group that justify the descriptive term "size". The percentage of revenue for sponsored research is positively related; the percentage of expenditures for "instruction and departmental research" is inversely related.

Students at larger schools appear to receive more financial aid (through the school) on the average than do students-in-need at smaller schools. The different characteristics of aid to final

year students, observed in the analysis of student variables alone, is not apparent here.

Mean MCAT science scores appear to be higher at larger schools. These schools are also more likely to offer combined MD-PhD programs. Institution expenditures are higher per undergraduate medical student at larger schools. There also appears to be a lower proportion of volunteer (unpaid) faculty. It appears that large schools, with an apparent research (vs. practice) emphasis, tend to enroll students with higher test scores and rely less on volunteer (probably clinical) faculty. It may be that small schools, having less sponsored support, are somewhat dependent on volunteer faculty.

The research-over-practice emphasis apparent in larger schools is further reflected by two curriculum variables. The large research schools are less likely to offer programs in family medicine and less likely to offer electives in alcoholism, drug abuse, human sexuality, ethical problems, nutrition, medical jurisprudence and health care delivery.

3. Public versus private ownership is related to the "size" factor (public schools tending to be less research oriented), but it is also related to several other variables not seen to be associated with size:

Private schools receive more applications per opening in

the entering class. They also tend to have higher representations of women among their first year students.

In-state to out-of-state tuition plus expenses ratios are related to public/private control. Tuition and expenses are notably less for in-state than for out-of-state students in public schools.

4. The third grouping of variables suggests that schools may further be distinguished by the predominance of either academic or clinical medicine. The percentage of all revenues received for sponsored teaching and training is higher at schools with a higher ratio of basic science faculty to clinical science faculty. (Clinical science faculty may still dominate in absolute numbers.) These schools appear to have a higher drop-out and transfer-out rate for students in the middle years of the program. Perhaps it is expected that some students in schools with a basic science emphasis will transfer to schools having a clinical emphasis. Perhaps academic programs are "tougher" or in some way "less desirable" to students, causing them to be dissatisfied and leave.

Schools with a relative faculty emphasis on basic sciences also tend to receive a smaller percentage of their sponsored research revenues from federal sources.

It may be interesting to note that, as in the RAND study

replication and in the analysis of institution variables, research emphasis and teaching emphasis emerge as separate factors, that is, they discriminate among schools in different ways.

5. While clinical science faculty receive about 50% higher reported salaries than do basic science faculty, the scales appear to be correlated with one another (r = .60) across institutions. Also positively related to both salary scales is the enrollment ratio of interns and residents to medical students: the more residents, the higher the faculty salary scales.

The basic science faculty salary scale is positively correlated with the percentage of women among new students (r = .40). The clinical (reported) salary scale is not as highly correlated (r = .18). The former correlation may be spurious (due to chance) or it may require a search for an intervening variable to assist explanation.

6. Schools also appear to differ along a dimension that indicates an awareness of current issues and methods[2]. Schools recording an ambulatory and primary care program in the curriculum directory also tend to be schools that report the use of computers in the curriculum, and that review the career choices of their graduates

[2]The statistical frailty of this dimension is indicated by its disappearance when 10 instead of 18 factors were rotated.

within five years of graduation.

7. Each of variable groups 7 through 14, 15, and 18 consists of variables (or a variable) from a single component of medical education. The relationships of variables within these groups, therefore, have been discussed in other sections of this report. It is important to note that these variables do not here evidence any interrelationships between the four component domains of medical education. These independent characteristics include: faculty/student ratios, the representation of minorities and foreigners among students, duration of the program, percentage of students requiring aid, clinical science faculty vacancies, hospital affiliation, relative numbers of medical and non-medical student equivalents, five-year percentage change in NIH research funding levels, projected enrollment growth rate, and the percentage of basic science faculty at the associate rank. Most of these variables were found to be related to some variables within their same component domain, but their independence here is evidence of the complexity of the medical education enterprise.

8. Variables within groups 15 and 17 are from several component domains but the first-order correlations are low and interpretations obtuse. There may be no meaning in the observation that, for example, the professional fees received per clinical science faculty is correlated ($r = .34$) with the percentage of first year

students with high pre-med GPA's (between 3.6 and 4.0).

9. Some of the first-order correlations that were not accentuated by the principal components analysis may nevertheless also be interesting or suggestive:

- Private schools are more likely to have out-of-state students.
- The greater the proportion of clinical science faculty at the associate rank, the greater the withdrawal rate of middle-years students.
- The larger the undergraduate medical enrollment, the more likely it is that the school is affiliated with a hospital.
- The greater the expenditures per medical student, the greater the faculty/MD student ratio, but the lower the faculty/total student ratio.
- The greater the number of undergraduate medical students, the <u>greater</u> the faculty/MD student ratio ($r = .38$). This apparent paradox may occur because the number of faculty increases more sharply than the size of the undergraduate medical program with increased support from sponsored research.

CHAPTER IV

Conclusion

Caveat

This study is an attempt to let available data speak for themselves through the medium of multivariate analytic methods. These methods are predominantly objective but also somewhat restrictive in their assumptions and subjective in their application. Several possible conditions, therefore, may influence the recognition and accurate interpretation of the results of the analyses. These possible conditions include:

1. The degree to which the data are missing, inaccurate, or otherwise not strictly comparable between schools.

2. The degree to which the measures of selected variables do not meet the mathematical assumptions of the analytic methods.

3. The effect of the particular selection of variables on the resultant variable groupings.

These possible conditions were recognized at the outset as permissible in exploratory analysis. Hypotheses for subsequent consideration, not hard conclusions, were the projected outcome. In view of these conditions, any conclusions based on the analytic results must be considered tentative and best expressed as questions or hypotheses about medical education institutions and, occasionally, about the data collected to monitor their operations.

Questions Raised

The following questions are raised by the data used in this exploratory study. Many of them were suggested by members of the AAMC staff who read earlier drafts of this report. Some questions address substantive issues, some ask for more complete descriptions of particular relationships between refined variables based upon current data, some suggest the need for an assessment of the integrity of particular variables. It is likely that AAMC data may be useable in subsequent, focused efforts to address these issues.

Some questions go beyond the data now at hand. Some AAMC reviewers clearly let the present observations stimulate more creative, less directed thinking.

Their queries indentify attributes of medical education that are not currently measured or reflected adequately in data routinely collected.

A few additional questions are directed at methodological concerns.

The substance of individual questions necessarily cross the artificial descriptive categories used in the execution of the study. The four categories are used below, however, to organize the questions according to their dominant theme.

A. FACULTY

1. What are the characteristics of schools that utilize volunteer faculty (besides their accepting students having lower mean MCAT scores)? Are these parameters of fiscal efficiency or quality of instruction? Do they merely reflect newness of an institution?

2. Does the presence of higher proportions of full-time paid clinicians on a faculty lead to higher salaries for basic science faculty?

3. It was observed that the number of faculty vacancies appear not to be related to the institution's position on the scale of average salaries. Are vacancies primarily a departmental problem? When vacancies occur at a given school, do most of them tend to be in a few departments, or are they uniformly distributed across departments? To what extent are the "vacancies" reported budgetary hedges and not staff deficiencies?

4. Can we define and identify those medical schools with an abnormal pattern of widespread and continuous vacancies? What are the characteristics of these high-vacancy schools with regard to: age of school, age of faculty, recent expansion, neighboring competetive medical schools, turnover in deanship and chairmanship, salary scales, basic science vs. clinical science orientation, full-time faculty ratio, student faculty ratio, sources of financial support?

5. What are the common characteristics of schools that have higher-than-average proportions of tenured faculty?

6. What are the characteristics of medical schools that pay lower faculty salaries (after adjustment for local cost-of-living)?

7. Does a school with a low emphasis on tenure compensate by paying higher salaries?

8. Is it possible, using available data, to construct a single faculty/student ratio that is sensitive to the medical teaching load of the faculty and student opportunity for personal attention by faculty members?

9. What is the reason for the observation that medical schools with the highest faculty salaries have a lower ratio of students per faculty member?

B. CURRICULUM

1. What are the principal ways medical schools differ in the process of MD production?

2. Can we identify those medical schools which are "out front" in social curricula such as primary care, ambulatory care, nutrition, etc.? What are the characteristics of these schools?

3. What are the distinguishing characteristics of schools and programs that include ambulatory care experience as part of the undergraduate medical curriculum? Can the apparent relation between such experience and the duration of the medical curriculum be verified? Which schools have recently added or deleted such experience from the curriculum? Why?

4. What are the common but distinguishing characteristics of institutions that 1) produce the most MD's who eventually become providers of primary care, 2) produce higher-than-average proportions of primary care oriented graduates, 3) have been

most readily responsive to recent increased demand for more primary care doctors?

5. Currently available curriculum data do not satisfactorily describe basic differences between schools. What institutional data could be compiled to reflect categorical (or continuous) differences in philosophy of medical education in strategy of basic science teaching? Are there such differences that are believed to affect medical learning or subsequent practice? If so, how would these measures relate to other institutional measures?

6. How are schools distributed on a plane whose two axes are "research emphasis" and "health care delivery emphasis?"

7. What is the nature of the discrepancy between the two available indicators of the availability of ambulatory care training in the curriculum? What accounts for the observed discrepancy: poor definition? error in reporting? error in recording? actual change in curricula?

8. Would "percentage of students in 36 month programs" be a better variable than "minimum months required to earn the MD" to represent an institution's usual program duration?

9. Are there identifiable institutional characteristics for medical schools conducting inter-disciplinary undergraduate medical education programs?

10. Is there a relationship between the institutional level of interdisciplinary research awards and the presence and/or initiation of inter-disciplinary undergraduate medical education courses/programs?

11. Is there a relationship between the quantity of non-tenured faculty positions and the degree of curricular innovation? What are the descriptors of "curricular innovation"?

12. Is there a relationship between the quantity of preclinical laboratory experiences and the clinical elective choice pattern?

C. STUDENT

1. Can the apparent better representation of women among students at private schools be verified upon closer inspection of the data? Is the difference in representation, presumably in a state of flux, seen to be increasing or decr decreasing in recent years?

2. Is there really no relation between faculty/student ratio and applicant/entrant ratios? Is there any relation between a refined expenditures/per student measure and the applicant/entrant ratio? Are student applications directed on the basis of program preference, geographic preference, or probability of acceptance?

3. As private schools are co-opted by state support to give preference to in-state applicants, can the in-state to out-of-state applicant ratio be observed to increase?

4. Do schools using more volunteer faculty, students and community members on admissions committees put less emphasis on MCAT scores (and, by implication, more emphasis on noncognitive factors) than schools with admissions committees made up of full-time faculty and weighted with basic scientists?

5. Do admissions committees at larger medical schools tend to over-emphasize MCAT scores because of the magnitude of the admissions job? Is there a relation between man-hours per applicant and MCAT average?

6. Do public or private schools place more emphasis on career intent in their admissions decisions?

7. Why do students at larger schools receive more financial aid than students at smaller schools? Is this related to more full-time financial aid officers at larger schools? to cost of living near larger schools?

8. Does alumni giving (percentage of living alumni who give or mean gift per living alumnus) reflect student-faculty relations. Does current alumni giving reflect former student retention rates?

9. Is number of years between accreditation reviews numerically related to applicant/entrant ratio (or any other possible indicator of program selectivity or quality)?

10. How diverse are the standards and practices used to define and assess student financial need?

11. Are (and if so why are) final year students more willing to incur debt in medical school? Given an honest appraisal of their eventual earning power, could/would needy middle-year and first-year medical students bear greater levels of debt than they are presently want to do?

12. Do average financial aid measures reflect the costs-of-living in the medical schools' locales?

13. Do larger schools expend greater effort to find financial aid for their students?

14. Since the rates of admission of women into medical school are currently in flux, can the observed correlation between representation of women and the applicant/entrant ratio for

men be replicated with data for a newer year?

D. INSTITUTION

1. Is there an institutional dependence of sponsored research for general educational program support?

2. Which variables or new measures would reflect an institution's health? How are these variables interrelated?

3. Is there a ceiling effect on the degree to which increased research activity in the medical school contributes to the substance or quality of undergraduate medical education?

4. Is federally sponsored research more likely than non-federally sponsored research to contribute to faculty salaries? If so, why?

5. Why or how are reported expenditures for "extension and public service" (LCME Part I, line 60) related to reported receipt of professional fees per clinical science faculty member?

6. Is alumni giving a potential source of financial assistance for public medical schools?

7. Why or how is non-governmentally funded research income related to alumni giving?

8. The percentage of all revenues from sponsored teaching and training was found to be inversely related to the percentage of research revenues received from federal sources. Contrary to expectation, this suggests that schools having the strongest dependence on the federal government for research support have the least overall emphasis on PhD level training. Can this apparent relationship be verified, better described, and explained?

9. To what extent are the apparent relationships observed in this study due to the heterogeneity of institutions? Would the same relationships appear if developing schools were excluded and the analysis conducted using data only from established schools?

Methodological Observations

The major focus of the present study was on the inter-dependence of variables. While many interesting patterns and sizeable correlations among the available variables were observed, a large number of variables and minor factors (small variable groups) were observed to be mutually independent. The number of "factors" required to explain a sizeable portion of the overall variability was large. This is evidence of the high complexity of the medical educational enterprise and of the likely diversity of medical education institutions. It is therefore important, in efforts to group or to select representative schools, to carefully consider and select the particular dimensions (factors, ways, variables) along which schools are to be sorted.

The objective grouping of variables (based on their inter-correlations) that leads to subjective speculation depends, naturally, on the availability of the variables that form interesting relationships. With a given set of 31 variables, RAND (Keeler, et al., 1972) observed a certain pattern of correlations. With 23 of the 31 variables, the present study was able to observe a similar pattern. In another study, Richards, et al. (1968) included seven variables describing pre-med course requirements for admission and observed a pattern of differences between schools related to other school characteristics. Information on pre-med course requirements was not available for this study, hence no comparable relationships could be observed. Notably lacking in the present study were variables describing the basic curriculum, educational philosophy, and learning atmosphere. Measures of students' personal characteristics at several stages of medical learning were also absent. Since the present study was begun, however, several new (as well as updated) sets of variables have been added to the AAMC's IPS data base:

- Information derived from the Faculty Roster such as numbers of females and FMG's on the faculty, number of graduates who teach at other schools and/or at the same school.

- Information from the recently published AMA Medical School Alumni such as numbers of living alumni, number who are in various specialties, board members, and inactive.

- Longitudinal annual (1959-1974) information selected from earlier LCME questionnaires such as enrollments, mean MCAT scores, withdrawal rates, faculty size, faculty vacancies.

- Information derived from the Student Profile data base about applicants' and students' backgrounds (parent education level. etc.) aggregated into institutional measures.

From these data new measures may be constructed, such as percentage of graduates who become board certified, change in student test scores and withdrawal rates, change in enrollments and faculty size, change in tuition, difference characteristics between applicants and entrants, and others. The analysis of these data together with previously available measures may lead to additional variable groupings and enhance further speculation and hypothesis generation. Questions raised by exploratory work may suggest the need to examine some relationships more closely and carefully, while paying stricter attention to the quality of the measures and possible need to make fine adjustments (e.g., numerical transformation). Particular relationships among specific measures may then be examined, using data from several years (if available), for their stability or possible trends of change.

Finally, the value of this type of exploratory analysis must be assessed. It is certainly valuable to persons who use the data base to understand the quality and limitations of the data and to be able to anticipate relationships that may exist among the variables. Such studies may uncover error and lead to improvement of the data base. If the questions raised by this type of effort also lead to

useful focused studies that serve to inform educators and policy makers, then the exploratory studies are worthwhile.

BIBLIOGRAPHY

Astin, A.W. "An Empirical Characterization of Higher Educational institutions". Journal of Educational Psychology,53: 224-235, 1962.

Henrysson, S. Applicability of Factor Analysis in the Behavioral Sciences: A Methodological Study. Stockholm: Almqvist & Wiksell, 1960.

Keeler, E., Koehler, J. E., Lee, C. and Williams, A.P., Jr. Finding Representative Academic Health Centers. A Working Note prepared for NIH/HEW. Santa Monica, CA: RAND Corp., 1972.

Mulaik, S. A. The Foundations of Factor Analysis. New York: McGraw-Hill, 1972.

Nunn, R. S. "Classification of Medical Education Institutions". Washington, D.C.: AAMC, 1975.

Otis, G. D., Graham, J. R., and Thacher, L. "Typological Analysis of U.S. Medical Schools." Journal of Medical Education, 50: 328-338, 1975.

Reynolds, R.E. "Primary Care, Ambulatory Care, and Family Medicine: Overlapping but Not Synonymous." Journal of Medical Education, 50: 893-895, 1975.

Richards, J.M., Rand, L.M., and Rand, L.P. "A Description of Medical College Environments." American Educational Research Journal. 5: 647-658, 1968.

Rodgers, S. A. and Elton, C. F. "An Analysis of the Environment of Medical Schools." Research in Higher Education. 2: 239-249, 1974.

Sedlacek, W. E. "Variables Related to Increase in Medical School Class Size". Washington, D.C.: AAMC 1975.

Thurstone, L. L. Multiple-Factor Analysis: A Development and Expansion of the Vectors of the Mind. Chicago: University of Chicago Press, 1947.

Studies in Medical Education

Anderson, P. Descriptive Study of Salaried Medical School Faculty. December, 1975.

Johnson, D.G. and Dube, W.F. Descriptive Study of Medical School Applicants, 1974-75. December, 1975.

Lambdin, J.A. Survey of How Medical Students Finance Their Education, 1974-75. December, 1975.

Nunn, R. and Lain, L. Classification of Medical Education Institutions. December, 1975.

Rosenthal, J. Medical School Programs, Resources and Financing.

Sedlacek, W.E. Variables Related to Increases in Medical School Class Size. December, 1975.

Sherman, C. Study of Medical Education: Interrelationships Between Component Variables. December, 1975.

Additional copies of these publications may be obtained from:

Association of American Medical Colleges
Attention: Membership and Subscriptions
1 Dupont Circle N.W.
Washington, D.C. 20036