3: Bias in selection.

"Of those hundred and fifty students few were country lads like myself. The greater part came from the surrounding industrial region. They were nearly all middle-class folk, and a large number - between thirty and forty - sons of medical men ..."

Francis Brett Young,

Dr. Bradley Remembers, (1938; p.115).

"The Robbins committee ... heard evidence that a system of university admissions based chiefly on GCE grades was undesirable. This criticism came from both the schools and the universities..."

Choppin (1979; p.213).

Summary.

The effects of demographic, educational, family, and application factors upon success in admission to medical school are analysed in the St. Mary's Study. The inter-related processes of differential application, systematic selection, differential selection, and differential acceptance are analysed separately, for each of the variables of interest, in relation to admission to five groups of medical schools. A multiple logistic regression of the overall likelihood of selection showed that the most important overall determinant of success was A-level achievement. In addition O-level achievement, early application, and medical parents were independent predictors of success, although the effects of the latter variables were relatively small. Social class did not predict acceptance. Causal analyses of the determinants of educational achievement and early application are also presented.

Of the 10,810 people who applied through UCCA for admission to medical school in October 1981 only 3997 were admitted. 65.3% were rejected. Such a high rate of rejection raises public concern as to whether the selection process is fair. It is a common belief, for example, that medical schools tend to select preferentially those who are male, who have been educated at public school, or who are the children of doctors. In this chapter data from the St. Mary's Study is analysed in order to determine whether or not the selection process is 'fair', and by means of an appropriate statistical analysis of this sample of national applications conclusions will be drawn not only for St. Mary's alone, but for the system of selection as a whole.

The variables examined have been demographic (nationality, sex, age, social class and region of domicile), educational qualifications (O- and A-level results, pre- or post-A-level application, subjects taken), type of schooling (public or private sector, size of school, size of sixth form, number in sixth form going to university), family background (medical parents), and the manner in which the UCCA form has been completed (the number of choices for medicine, the number of London medical schools chosen, the use of bracketing in stating preferences, whether or not a previous application has been made to UCCA, and the date of receipt of the application at UCCA). The question of whether the selection process is biased towards candidates with particular personality, attitudes, cultural and other interests, or interests in particular aspects of medicine or particular medical careers is deferred until chapter 6.

Method.

The survey has been described in detail in chapter 2. 1361 applicants to St. Mary's were asked to complete a series of questionnaires, and were followed up to find their eventual destination. Of the 1183 UK nationals, 487 (41.2%) were admitted to medical school: 84 (17.3%) to St. Mary's, 225 (46.2%) to other London medical schools, 40 (8.2%) to Oxbridge, and 138 (28.3%) to other Non-London medical schools.

Academic qualifications.

Academic qualifications are of great importance in selection of students for university, both by voluntary choice on the part of the individual universities and colleges, and also in the legalistic sense that UCCA stipulates that no one may enter a university unless they have satisfied certain minimum matriculation standards. Table 3-1 summarises the O- and A-level qualifications of all applicants, these being divided into those who were successful and those who were unsuccessful. Many applicants had not taken A-levels at the time of application, or were resitting their exams. Results were obtained from examination boards for all exams taken after application (mostly in the summer of 1981) and Table 3-1 is based on actual results eventually obtained, resit candidates being credited with their best performance in a particular subject. In the case of mature applicants the grades quoted are both those taken a number of years earlier (often in Arts

subjects) and any that might be being taken at the time of application (usually in science subjects). Scores have been calculated on the basis of 5 points for an A grade, 4 points for a B, 3 for a C, 2 for a D, 1 for an E, and 0 for an O or F. At A-level most applicants offer sciences (usually physics, chemistry, biology and maths) with only a very few offering arts subjects (and then either a single subject in addition to science, or in the case of mature students, subjects taken a number of years earlier). On average each applicant offered 3.15 A-levels (excluding General Studies), with the vast majority taking three A-levels (81.8%), and a few offering only two A-levels (2.3%), four A-levels (13.8%), or more than four A-levels (2.1%). The grades of successful applicants in general are substantially higher than those of rejections, at both A and O level. On average each candidate at O-level had taken 4.2 science subjects and 5.0 non-science subjects, the vast majority having taken Physics, Chemistry, Biology and Maths, English literature and language, and French. The grades obtained by those accepted were significantly higher than those rejected except in art and music, and in a number of of subjects taken by only a few applicants.

Because of the inevitable correlations between grades in different subjects it is convenient to reduce Table 3-1 to a more compact set of four measures: the number of A-levels taken, the mean grade obtained (using the best grade in the case of resit subjects), the number of O-levels obtained, and the mean grade attained at O-level. Together these variables are referred to as educational qualifications (EQ). To a

large extent these measures encapsulate the essence of Table 3-1, although some subtleties may be lost.

In order to simplify interpretation of the findings, only UK nationals are analysed unless specific reference is made. Figure 3-1 shows the cumulative distributions of A-level achievement according to the six destination groups of the applicants. There is a sharp discrimination between the groups, as might be expected: Oxbridge scored higher than other acceptances ($F(1,485)=39.82, p<0.001$); there was no difference between St. Mary's, Other London and Non-London schools ($F(2,444)=1.50$, NS). Those accepted for non-medical courses had significantly higher grades than those rejected overall ($F(1,674)=25.42$, $p<0.001$). An A-level achievement threshold of 3.1 (i.e. an average grade between a B and a C; or the equivalent of between 9 and 10 points based on three subjects) correctly groups 83.9% of applicants into acceptances and rejections; only 8.4% of acceptances gained less and 22.1% of rejections surpassed it. Although the ability to achieve high A-level grades is clearly very important in selection, these figures show that it is not the only factor which determines selection, nor is there any overwhelming reason why it should be (Simpson, 1972), particularly given public doubts about the nature of the grading system in A-level exams (e.g. Anon, 1984b). Indeed an editorial in Medical Education commented that, "some disillusionment now exists with academic performance and with school credits in particular as the main basis for deciding who is suitable for medical education" (Anon, 1979a). Selection has therefore also been assessed without taking

A-level achievement into consideration, in order to determine the significance of other factors.

Univariate analsyses of non-academic factors.

It is not a simple matter to determine the effects of a single non-academic variable upon selection. This difficulty is clearly seen in respect to social class. From Table 3-2 it appears that those of higher social class are significantly more successful in their applications, while Table 3-3 appears to show no such bias as St. Mary's. Neither comparison is valid. Many St. Mary's rejects were accepted elsewhere, thus reducing the power of the statistics to detect true bias. More seriously, in Table 3-2, not all applicants have applied to the same medical schools, and the selection bias is therefore the aggregate of the individual biases of all schools. However if the applicants to different schools differ in their social class, as is likely, then even if each individual school were completely fair in its selection, the system as a whole could show an apparent bias. The corollary is also true. The system as a whole could be unbiased, but this could be due to exactly half of the schools being overtly discriminatory, and the other half being compensatory; to describe such a system as 'fair' would hardly be acceptable. Finally, it is likely that social class is itself correlated with success in O and A-level examinations because of different educational opportunities, and hence the differences of Table 3-2 could be entirely explicable in academic terms, and the apparent

fairness of table 3-3 may itself be illusory. The crude analyses of tables 3-2 and 3-3 have therefore been replaced with a more sophisticated multiple regression approach which allows answers to a number of closely related questions about four distinct aspects of selection, which are called differential application, systematic selection, differential selection, and differential acceptances. In so doing it is conceptually simpler to reverse the questions and ask if one may predict the social class of an applicant given a knowledge of other factors about the candidate. The NEW REGRESSION procedure of the SPSS statistical program (Nie et al, 1975; Hull and Nie, 1981) has been used for statistical analysis.

The following questions may be asked:-

i.) Are there differences between schools in their applicants? ('differential application'). The process of medical student selection by schools is complemented by the process of medical school selection by students (and often the crieria used by the latter are not those expected by the former - Roath et al, 1977). This second process I have called differential application, although in fact it has two distinct stages: i.) choosing five medical schools for the UCCA form, and ii). choosing from those schools who make offers. The two are necesarily combined in the analysis that follows.

From the St. Mary's data one may calculate for each medical school the mean social class (or any other parameter) of all those St.Mary's applicants who included that particular university on their UCCA form. Of course this will not produce an accurate estimate of the actual mean social class of all applicants to that school, but rather only of that subset that included St.Mary's on their UCCA form. Nevertheless such an analysis will allow us to estimate the relative pattern of social class differences between medical schools, and will be valid unless there are very unusual interaction patterns. For descriptive purposes one may combine these estimates into different types of school (the same groups as previously, except that Non-London has been further sub-divided into 'England and Wales' (E&W) and 'Scotland and Northern Ireland' (S&NI)), the scores of each school being weighted by the total number of applicants to that school.

It is not possible to calculate standard errors for such means since they are not combinations of independent estimates, some candidates applying to several universities within each group. The St. Mary's sample comprised 120 UK applications to Oxbridge, 3137 to other London schools, 1221 to English and Welsh schools, and 155 to Scottish and Northern Irish schools, and 1183 applicants to St. Mary's itself. In order to carry out statistical tests I have introduced into the multiple regression procedure a series of dummy variables, consisting of the number of universities applied to by each candidate in each medical school group. By entering these variables simultaneously into the

regression, after total number of UCCA applications and total medical school applications have already been entered, then a significant increase in the explained variance indicates the presence of differences between medical school groups. If overall differences are significant then the source of the difference is found by considering the confidence limits of the coefficients of each of the individual variables.

ii.) Is there any overall bias in the system? ('Systematic selection').

Having carried out the analysis in step i.) one may now find the statistical improvement obtained by adding in a variable indicating whether or not an applicant was accepted by any medical school. This tests whether overall there is a systematic trend in the selection system after differences in application pattern are taken into account; whether or not such trends are construed as bias will depend upon assessment of their relevance to the selection process.

iii.) Are there differences between schools in the way in which they select students from those who apply to them? ('Differential selection').

If after step ii.) one adds in extra variables which indicate acceptance by any one of the schools within each of the five groups, and obtains a significant improvement in the fit of the regression model, then there is evidence for heterogeneity in the selection methods of different medical

school groups. The source of the heterogeneity may be found by examining the standard errors of the regression coefficients of the additional variables. To my knowledge, only one study has ever explicitly considered such a possibility, Shuval (1980; p.60) finding differences between Israeli medical schools in their over-selection of the children of doctors.

iv.) Are there differences between medical schools in the individuals that they accept? ('Differential acceptance').

One may answer this question by fitting a series of variables as in iii.) above to just those applicants who are accepted for a medical school; a significant result indicates that medical students differ according to the particular medical school group that they are attending.

v.) Does the variable under consideration relate to O- and A-levels, and if so, can this relationship account for the results described in i to iv above?

Having obtained answers questions i.) to iv.) it should now be clear that any of these questions may be reassessed after entering EQ (or indeed any other variables or combinations of variables) into the multiple regression; the significance of that first step indicates whether the variable in question is related to educational qualifications, and subsequent steps analogous to i.) to iv.) above qualify the answer to these questions, by taking

differences in educational qualifications into account.

Each of the above questions may now be considered in relation to different sets of variables.

1.) Educational qualifications.

Figure 3-2 shows the O and A-level qualifications of applicants to and acceptances by the medical schools in the five groups.

Number of O-levels taken. Applicants differed: Oxbridge applicants took more, and S&NI applicants took fewer O-levels ($p<0.001$). Acceptances had significantly more O-levels than rejects ($p<0.001$.) There was no evidence that schools differed in the emphasis that they placed upon number of O-levels taken (i.e. no differential selection) and there was no evidence that acceptances by different schools differed in their number of O-levels (i.e. no differential acceptance).

Mean grade in O-levels. Applicants to schools differed in their average O-level grade ($p<0.001$), almost entirely because Oxbridge applicants had higher grades. Acceptances had significantly higher grades than rejections ($p<0.001$). There was no significant evidence of differential selection. Significant evidence of differential acceptance ($p<0.001$) was entirely attributable to Oxbridge acceptances having higher grades.

Mean number of A-levels taken. The only evidence of differential application ($p=0.051$) was that Oxbridge applicants had taken more A-levels. Overall there was no

evidence for systematic selection, and only marginally significant evidence ($p=0.064$) of differential selection, which was due to St.Mary's accepting applicants with higher numbers of A-levels. The differential acceptance ($p<0.001$), was attributable to both Oxbridge and St. Mary's entrants having more A-levels.

Mean grade in A-levels. The difference in average A-level grades between applicants and between entrants to different schools ($p<0.001$ for each), was almost entirely due to Oxbridge applicants having higher grades. Overall there was highly significant evidence for systematic selection in favour of high A-level grades. ($p<0.001$). There was no evidence for differential selection.

A-level maths taken. 39.2% of applicants and 43.7% of acceptances had taken A-level maths. Figure 3-2e shows that there is differential application ($p<0.001$), primarily due to more Oxbridge applicants having taken maths. Taking A-level maths did not relate to overall likelihood of acceptance, nor was there evidence of differential selection or differential acceptance. A-level maths related to EQ ($p<0.001$); those who took maths had taken more A-levels and achieved higher grades. Taking account of EQ reduced the significance of the differential application ($p<0.05$) but otherwise did not alter the above conclusions.

A-level biology taken. 78.3% of applicants and 74.4% of acceptances had taken A-level biology. Figure 3-2f shows no evidence for differential application, although there was a trend towards systematic selection ($p=0.054$) against biologists, but this was explained entirely by the lower mean

A-level grades of those including biology in their A-levels ($p<0.001$). There is no evidence for differential selection or differential acceptance.

2.) Demographic factors.

i.) Nationality. 178 (13.1%) of the applicants to St.Mary's were not of British nationality, as determined from their UCCA form. In contrast only 5.8% of acceptances were not British. There was marginally significant evidence of differential application ($p<.1$) (Figure 3-3a), highly significant evidence of systematic selection ($p<0.001$), and no evidence for differential acceptance. Being non-UK related significantly to lower EQ ($p<0.001$). Taking account of EQ increased the significance of the differential application ($p<0.05$), reduced the significance of the systematic selection ($p<0.05$), and did not alter any other conclusions.

In view of the educational and other differences between UK and non-UK applicants, the remaining analyses are confined to applicants of UK nationality.

ii.) Sex. 37.5% of applicants and 40.3% of acceptances were female. Figure 3-3b shows that any tendency to differential application is not significant. Nor is there evidence for systematic selection, differential selection or differential acceptance. Overall, sex related to EQ: women applicants had higher O-level grades but lower A-level grades, but the above conclusions were not altered when these differences

were taken into account.

iii.) Social class. This has already been discussed earlier. There was evidence for differential application (Figure 3-3c), because applicants to Oxbridge and London were from a higher social class background. After taking such differential application into account, acceptances were of higher social class than rejections ($p<0.05$). There was no evidence for differential selection, although there was significant evidence for differential acceptance ($p=.018$). The pattern of differences between schools is almost identical to that found by the Royal Commission on Medical Education (1968), for applicants entering medical school in 1961 and 1966, and for the more recent study of Donnan (1975). Class related significantly to EQ ($p<0.001$); those of higher social class had higher O-level achievement, but there were no significant differences in A-level achievement. When EQ was taken into account, the differential application was still significant, the systematic selection became non-significant, and the differential acceptance became more significant ($p=.008$).

iv.) Medical family. Candidates were classified as coming from a medical family if there was any evidence, either from the UCCA form or questionnaire Q1, that either parent was medically qualified. 17.1% of applicants and 19.9% of acceptances came from a medical family. Figure 3-3d shows that there are relatively small differences between the applicants to different medical schools ($p=.064$), with the majority of the differences being due to a higher application rate at Oxbridge. There was no significant evidence of

systematic selection (p=.102), or differential selection. St. Mary's and E&W had a lower proportion of individuals from medical families (p=0.035). Medical background related significantly to EQ (p=.016): those from medical families had taken more O-levels and fewer A-levels than other applicants, although average grades were similar. Taking EQ into account, applicants still differed between schools (p=.051), there was a trend towards systematic selection (p=.066) but no evidence of differential selection.

v.) Maturity of applicants. 'Mature' applicants were defined as those who would have reached the age of 21 by 30th September 1981 (i.e. the beginning of the 1981-1982 academic year). 14.8% of applicants and 8.3% of acceptances fitted into this category. Figure 3-3e shows a highly significant differential application (p<0.001) and differential acceptance (p<0.05) most of the effects being due to their lower application rate to Oxbridge. Mature students were less likely to be accepted (p<0.001) overall, although there was no evidence for differential selection. Mature applicants had significantly lower O- and A-level achievement (p<0.001). Taking these differences into account, schools still differed in their proportions of mature applicants (p<0.05), but there was now no evidence for systematic selection (p=.61), and still no evidence of differential selection.

vi.) Region of domicile. Applicants were divided into those from the north or south by means of a line drawn between the Mersey and the Humber, along the northern boundaries of Lincolnshire, Nottinghamshire, Derbyshire, Staffordshire,

Shropshire and Clwyd, and including Scotland and Northern Ireland. Not surprisingly S&NI schools received a higher proportion of northern applicants ($p<0.001$), and they were also more likely to accept northern applicants ($p=.027$) (Figure 3-3f). Applicants from the north had a slightly higher O-level achievement related to EQ ($p=.042$) but taking account of this did not affect the above conclusions.

3. Education.

i. Private versus Public Sector education. Applicants were classified according to whether they had received any education in the private sector (i.e. independent public schools, direct grant schools, private schools, or tutorial colleges); 47.5% of applicants and 51.1% of acceptances had had some private sector education. Figure 3-4a shows differential application ($p<0.05$), with Oxbridge having a higher proportion of private sector applicants. Taking application patterns into account there was no overall evidence of systematic selection ($p=.16$), differential selection, or differential acceptance. A private sector education correlated very significantly with EQ ($p<0.001$), a result almost entirely due to having taken more O-level subjects. Taking EQ into account produced no change in the above conclusions.

ii.) School size. Neither overall school size, size of sixth form, or number in sixth form going to university each year, affected the patterns of application or acceptance (figures 3-4b, 3-4c, and 3-4d). Applicants from large schools tended

to take more A-levels ($p<0.01$), applicants from larger sixth forms tended to have higher A-level grades ($p<0.1$) and applicants whose schools sent more students to university tended to have higher A-level grades ($p<0.1$.) Taking EQ into account did not alter any of the above conclusions.

4. The UCCA application.

i.) Oxbridge on the UCCA form. 10.3% of applicants and 20.3% of acceptances had included Oxford or Cambridge on their application form. Figure 3-5a shows the proportions of applicants to schools who had included Oxbridge on their UCCA form (Oxbridge itself being excluded since necessarily all applicants and acceptances had put it on the form). Although differential application was not significant, there was significant evidence for systematic selection ($p=0.01$), and a trend towards differential selection. Oxbridge application correlates highly with EQ ($p<0.001$), these applicants having taken more O and A levels, and gained better grades in those O and A levels. Taking EQ into account there was no evidence of differential application, and there remained only a trend towards systematic selection ($p=.086$).

ii.) The number of London schools on the UCCA form. Figure 3-5b shows the number of London schools included on the candidate's UCCA form. On average applicants had included 3.65 London schools (including St.Mary's) and acceptances had included 3.48 London schools. There was no evidence that it was an advantage to combine applications to London schools. Candidates applying to more London schools had lower O-level

achievement ($p<0.001$.) Taking this into account did not affect any of the above conclusions.

iii.) The use of bracketing on the UCCA form. Candidates may use one or two brackets around their five UCCA choices to indicate equal preference of choices. As a single measure of this the preferential position after taking account of bracketing of the choice that was actually in the fifth position on the UCCA form was used; thus if no brackets were used then the last choice was truly fifth in order of preference and a score of 5 was given, while if all five choices were bracketed together a score of 1 was given, since the last choice was actually first equal. On average applicants had a score of 4.06 and acceptances had a score of 4.20. Figure 3-5c shows that there are significant differences between applicants to different schools in their use of bracketing ($p<0.001$), applicants to Oxbridge using less bracketing (necessarily, by UCCA rules) and London applicants tending to use more bracketing. Overall there was a trend ($p<0.1$) towards acceptances using fewer brackets than rejections, and there was no evidence of differential selection or differential acceptance. Applicants using more brackets tended to have lower O- and A-level achievements. Taking EQ into account reduced the significance of the differential application ($p<0.01$), and removed any systematic disadvantage in selection ($p=.92$).

iv.) Post-A-level application. 36.6% of applicants and 39.0% of acceptances were post-A-level (defined as having already taken two or more A-levels at the time of the UCCA application). Differential application was highly

significant ($p<0.001$), with Oxbridge applicants being more likely, and E&W applicants less likely to be post-A-level. There was no evidence for systematic selection or differential selection. Differential acceptance ($p<0.05$), was almost entirely due to Oxbridge taking more post-A-level applicants. Post-A-level applicants had poorer O-level achievement but better A-level achievement ($p<0.001$). Taking account of EQ did not remove the differential application ($p<0.001$), or affect any other results.

v.) Previous UCCA application. 21.3% of applicants and 22.6% of acceptances had applied to UCCA previously. Figure 3-5e shows that schools differed in their proportion of previous UCCA applicants ($p<0.05$), due mainly to Oxbridge and E&W receiving fewer such applicants. There was no evidence of systematic selection, differential selection or differential acceptance. Previous UCCA applicants had lower O-level achievement but higher A-level achievement ($p<0.001$). Taking these differences into account did not affect any of the above findings.

vi.) Date of UCCA application. The mean date of receipt of applications at UCCA was October 24th, whilst the mean date of receipt of forms from acceptances was October 15th. Figure 3-5f shows that schools differed in the date of receipt of their applications ($p<0.001$), in part due to UCCA requiring that Oxbridge applications be submitted by October 15th. Overall successful applicants applied earlier ($p<0.001$). There was no evidence for differential selection. Acceptances showed differences between schools in their date of application ($p<0.001$), a result which is not entirely

accountable by earlier Oxbridge applications. Date of application correlated very significantly with EQ ($p<0.001$), early applicants having higher O- and A-level achievement, although these differences did not remove the differential application ($p<0.001$), or the systematic selection ($p<0.01$.)

Multivariate Analyses.

1.) UK applicants.

Univariate analyses have shown that a large number of factors show some of the four processes of differential application, systematic selection, differential selection or differential acceptance. However many of these variables are themselves inter-correlated (for instance being from social class I, having a medical parent and going to a private sector school are all positively inter-related). To determine which factors best discriminate between successful and unsuccessful applicants, one may use the multivariate technique of multiple logistic regression. The effects of 24 background variables were examined simultaneously. Table 3-4 shows the mean and SD (or percentage for binary variables) in UK applicants and rejects, and the result of a univariate significance test (unpaired t-test or chi-squared test) for differences between the two groups. The effect of the 24 background variables upon the likelihood of acceptance was analysed by a multiple logistic regression (McCullagh and Nelder, 1983), using the GLIM computer package (Baker and Nelder, 1978), the dependent variable being whether or not

the applicant was accepted at <u>any</u> medical school. Considering just the 946 UK applicants with complete data on all variables, the prediction equation based on all 24 variables was highly significant (Chi-squared = 601.5, 24df, $p<<0.001$). Table 3-4 shows for each variable the effect upon the relative likelihood of acceptance, the variables being ranked from most significant to least significant. Only the first six variables reach the conventional 5% level. Taken together the last 18 variables do not significantly improve the fit of the regression equation (Chi-squared = 12.4, 18df, NS). Table 3-4 shows 95% confidence limits of the relative likelihood for those variables which are statistically significant.

Four of the six significant predictors are concerned with educational qualifications, and these are dominated by the mean A-level grade, an applicant with one grade higher on average having increased his likelihood of acceptance by eight times. These educational qualifications are themselves determined by background variables and therefore factors predicting success at the educational qualifications have been examined. Of the other two predictors of success, the date of application to UCCA is also determined by many background factors, and will be analysed further below. The sixth predictor, coming from a medical family, did not seem capable of further breakdown in this manner.

ii). Non-UK applicants.

Thus far all of the analyses reported have been on those with United Kingdom nationality. A multiple logistic regression was carried out using the six significant predictors shown in table 3-4, and with the addition of UK nationality as a seventh predictor. After taking the six known predictors into account, UK nationals were 4.44 times as likely to be accepted as non-UK nationals ($p<.001$; 95% confidence limits 2.09x to 9.45x). There were no interactions between UK nationality and the other six predictors (Chi-squared = 7.2, 6df, NS).

Determinants of educational qualifications.

The average A-level grade obtained by applicants can be determined, in principle, by many factors; previous examination results, the particular mix and number of subjects being taken; the school size and type; and the family and other background variables. The method of causal modelling (Kenny, 1979) has been used to estimate the effects of factors which are felt to determine subsequent variables. Figure 3-6 shows the 13 variables. The method of analysis assumes that any variable to the left of a particular variable could be a cause of that variable, with precedence being given to those variables which are closest together. Estimates of effects were found by multiple regression (Kenny, 1979), using the NEW REGRESSION program of the SPSS package (Hull and Nie, 1981). Figure 3-6 shows all causal links which are significant at the 5% level.

From figure 3-6 it can be seen that the four measures of educational qualifications are all dependent upon background variables and upon each other. Private sector education ("Public schools") is more likely in those from social class I and those from medical families. Private sector schools are smaller, and have smaller sixth forms relative to overall school size. Sixth form size has no influence upon A-level results, but pupils at larger schools overall tend to take more A-levels (but not gain higher grades in them). The number of O-levels taken is higher at private sector schools, and those taking more O-levels also get higher grades at O-level. Grades attained at O-level determine whether maths or biology is taken at A-level, higher achievers taking maths rather than biology. The average grade at A-level is not related to the number of A-levels taken, but is higher in those taking maths and lower in those taking biology. Higher grades at O-level, and having taken more O-levels also predict subsequent A-level grades. The sexes differ in that females tend to obtain higher O-level grades but lower A-level grades (after taking O-level performance into account). Social class influences the type of schooling attended; those from social class I also tend to take more O-levels and to obtain higher grades in them. Those who come from a medical family tend to obtain lower O-level grades, and are more likely to take biology at A-level. Candidates from the north of Britain obtain higher O-level grades, but tend to take fewer A-level subjects.

From this analysis it can be seen that although A-level grades are the immediately proximate determinants of acceptance, they are themselves subject to many causal influences throughout the process of secondary education, and that background variables affect them in many ways. Of course the analysis of figure 3-6 considers only those individuals who actually applied to medical school. It is conceivable, although not likely, that the structural determinants of educational success are different in those who might apply to medical school, but in fact have not.

Determinants of date of UCCA application.

Causal modelling was not felt to be useful for analysing the date at which applicants applied to UCCA since no clear *a priori* ordering of variables could be determined. Results were therefore analysed by a forward entry multiple regression, variables being entered into the multiple regression equation such that at any step the variable entered had the greatest prediction of UCCA date from those variables not yet in the equation, taking account of the variables already in the equation. 19 variables were used, all of those mentioned earlier, with the exception of the four measures of O- and A-level achievement (which were not felt to be of direct interest since they already had an independent prediction of success at application).

Early UCCA application was predicted by five of the background variables (multiple R = 0.368, $p<<.001$) (see Figure 3-7). Oxbridge applicants applied 18.9 days earlier ($p<.001$) (due in large part to UCCA rules about Oxbridge applicants). The number of medical schools on the UCCA form related to date of application, each extra medical school on the form being associated with an application 11.4 days earlier ($p<.001$). Female applicants applied 6.8 days earlier ($p<.001$), and mature applicants applied 15.8 days later ($p<.001$), and applicants from the north of Britain applied 6.0 days later ($p<.005$). After taking all such effects into account, average O- and A-level grades also predicted date of application, each average grade at A-level being associated with a 2.9 day earlier application ($p<.001$), and each grade at O-level being associated with a 4.3 day earlier application ($p<.05$). Thus O- and A-levels have a double effect upon the likelihood of acceptance, directly, and indirectly via date of application. Oxbridge applicants tended to have significantly higher O- and A-level grades, to take more A-levels, and to be male. Mature applicants tended to have significantly lower O- and A-level grades, to have taken less O-levels, and more A-levels, and to have come from larger schools. The number of medical schools chosen on the UCCA form was significantly higher in applicants from medical families.

Figure 3-7 summarises the direct and indirect influences upon selection.

Discussion.

By far the most important factor determining selection is the grade at A-level. The widespread opinion that academic qualifications should be only a partial factor in selection (Bennett and Wakeford, 1982, 1983; Crisp, 1984; Linke et al, 1981; Parkhouse, 1979) may be to some extent justified by the generally poor predictive value of A-levels for subsequent university (Bagg, 1970; Entwistle and Wilson, 1977; Choppin et al, 1973), and medical school performance (Savage, 1972; Mawhinney, 1976; Tomlinson et al, 1977; Richardson, 1980), which rarely produce correlations accounting for more than 10% of the variance in medical school examinations (although as Guy (1984) has pointed out, that may in part be due to the inaccuracy of grade assignment at the very close boundaries between grades B,C and D, despite apparently very high correlations between markers (Murphy, 1978; 1982)). Similarly poor correlations have been found in America (Bloom, 1973; Rippey et al, 1981; Herman and Veloski, 1981; Jones and Thomae-Forgues, 1984), in Australia (Lipton et al, 1984), and in Israel in the so-called 'Beersheva experiment', in which a wide-ranging 'non-traditional' selection was used, and hence a wide-range of pre-entry examination results was found (Hobfoll and Benor, 1981). The fact that recent increases in A-level requirements for studying medicine (McManus, 1982a) means that a substantial proportion of those currently practicing medicine would not have been able to get into medical school at present, has also raised concern about the utility of selection by A-levels. Such doubts do not however

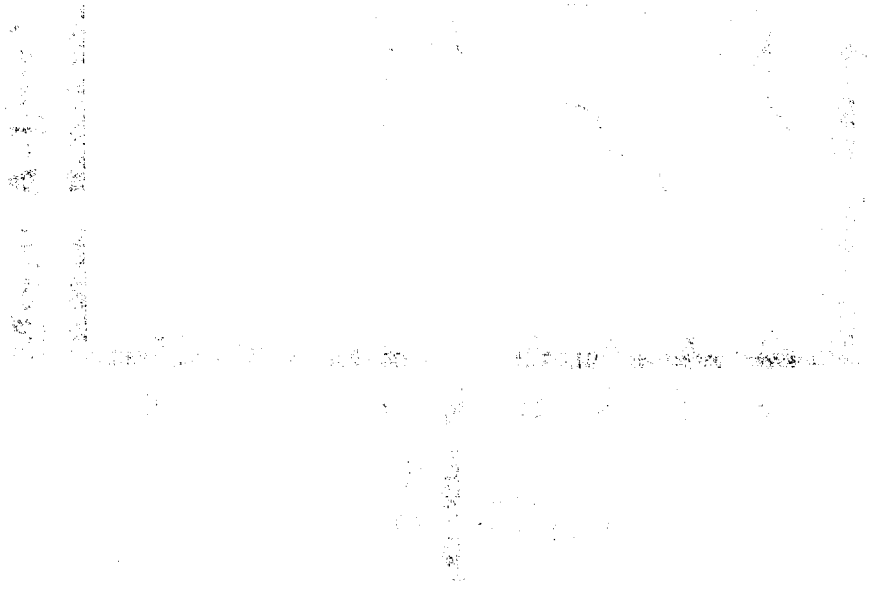
necessarily either mean that a proportion of those currently entering medical schools are unsuitable for medical practice, or that those individuals currently practicing are not as professionally competent as could be wished or obtained. The greatest practical advantage of selection based primarily on A-level grades, is that it is less likely to be biased by irrelevant social considerations.

Other factors predicting selection, in particular the type of school attended and the presence of a medical parent, are important in so far as they undermine public confidence in the fairness of the system, but their numerical effect appears to be relatively small. Of the other important factors, the inclusion of number and grade of O-levels is worrying in so far as the predictive value of O-levels for subsequent medical practice is likely to be minimal, and any effect due to their correlation with A-level success has already been taken into account in the analysis. The role of date of UCCA application needs careful thought since the implication is that a race is taking place in which some runners start before others, and thus an element of gamesmanship enters into the likelihood of successful application.

A number of background factors, such as type and size of school, sex, and social class, do not have direct effects upon selection, but have indirect effects via factors such as educational qualifications and date of application to UCCA, and therefore may confer indirect advantage upon some candidates. Of course such effects are outside the control

of medical schools. In interpreting these findings it must be remembered that there are many factors which this study does not consider. It looks only at biases arising after the UCCA form has been submitted. However a myriad of factors can bias that process of application, arising from school, home or peer group (Mortimore and Blackstone, 1982), and convincing some potential applicants that it not worthwhile either applying for admission, or even perhaps studying appropriate O- and A-level subjects. As a Lancet editorial put it, "When the student chooses which medical school he will apply to, only then do selectors begin to have any direct say" (Anon, 1974). That such bias is likely to be occurring can be inferred from the social class distribution of applicants, which is more exclusive than would be predicted if intellectual ability were the sole determinant of ability to study and practice medicine (McManus, 1982b), and on the basis of other studies of university admission in general (e.g. Halsey et al, 1980).

Figure 3-1: The cumulative distribution of mean A-level grade, according to the eventual destination of applicants.



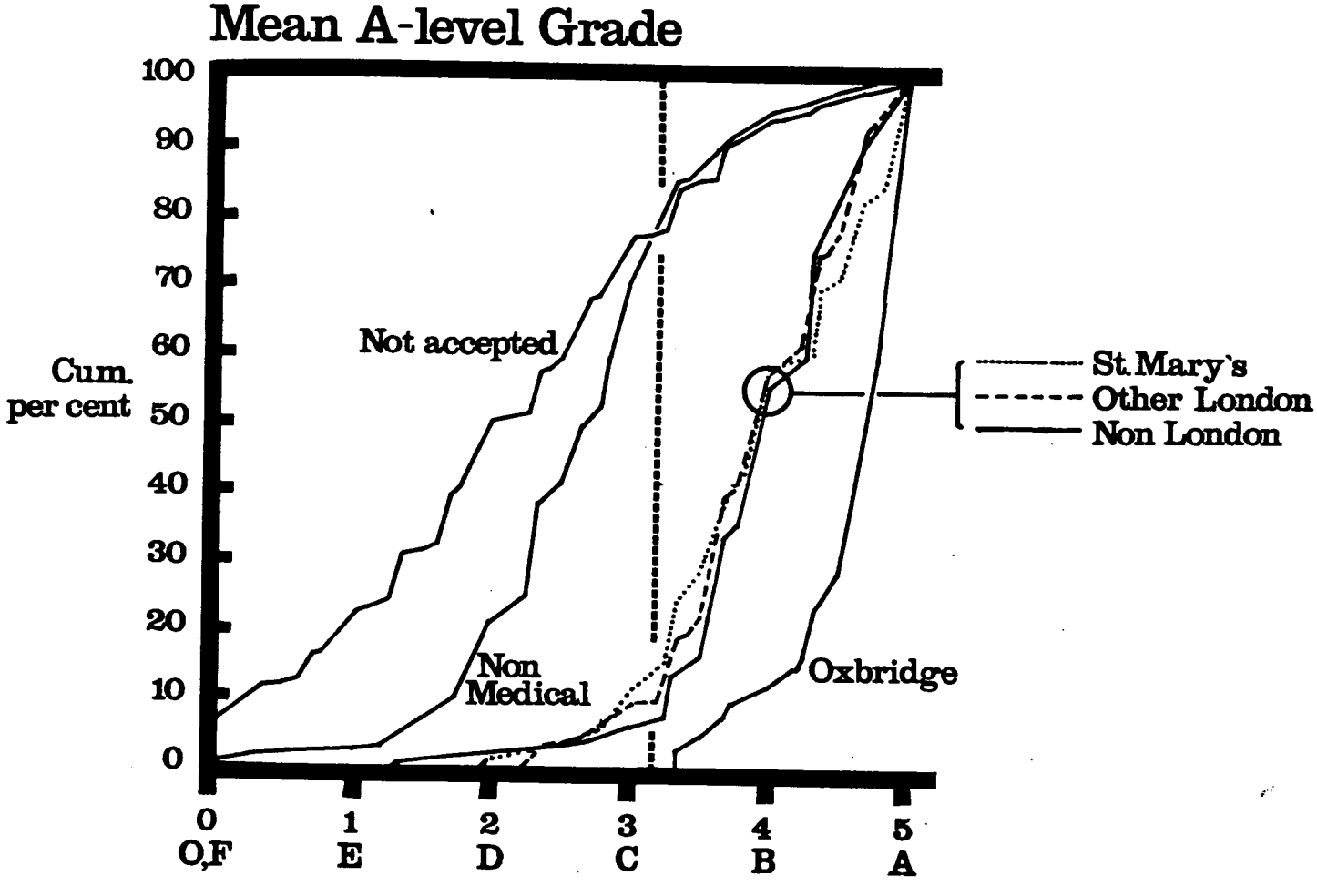

Mean A-level Grade
Cum. per cent
100
90
80
70
60
50
40
30
20
10
0
Not accepted
Non Medical
Oxbridge
St. Mary's
Other London
Non London
0 O,F
1 E
2 D
3 C
4 B
5 A

Figure 3-2: Shows the mean number of exams taken (top row) and average grades obtained (middle row), at O- and A-level, and the proportion (bottom row) taking A-level biology and A-level maths, by applicants (open triangles) and acceptances (solid triangles) to five medical school groups (OC: Oxford and Cambridge; SM: St. Mary's; L: Other London medical schools; EW: Other England and Wales medical schools; SNI: Scottish and Northern Ireland medical schools).

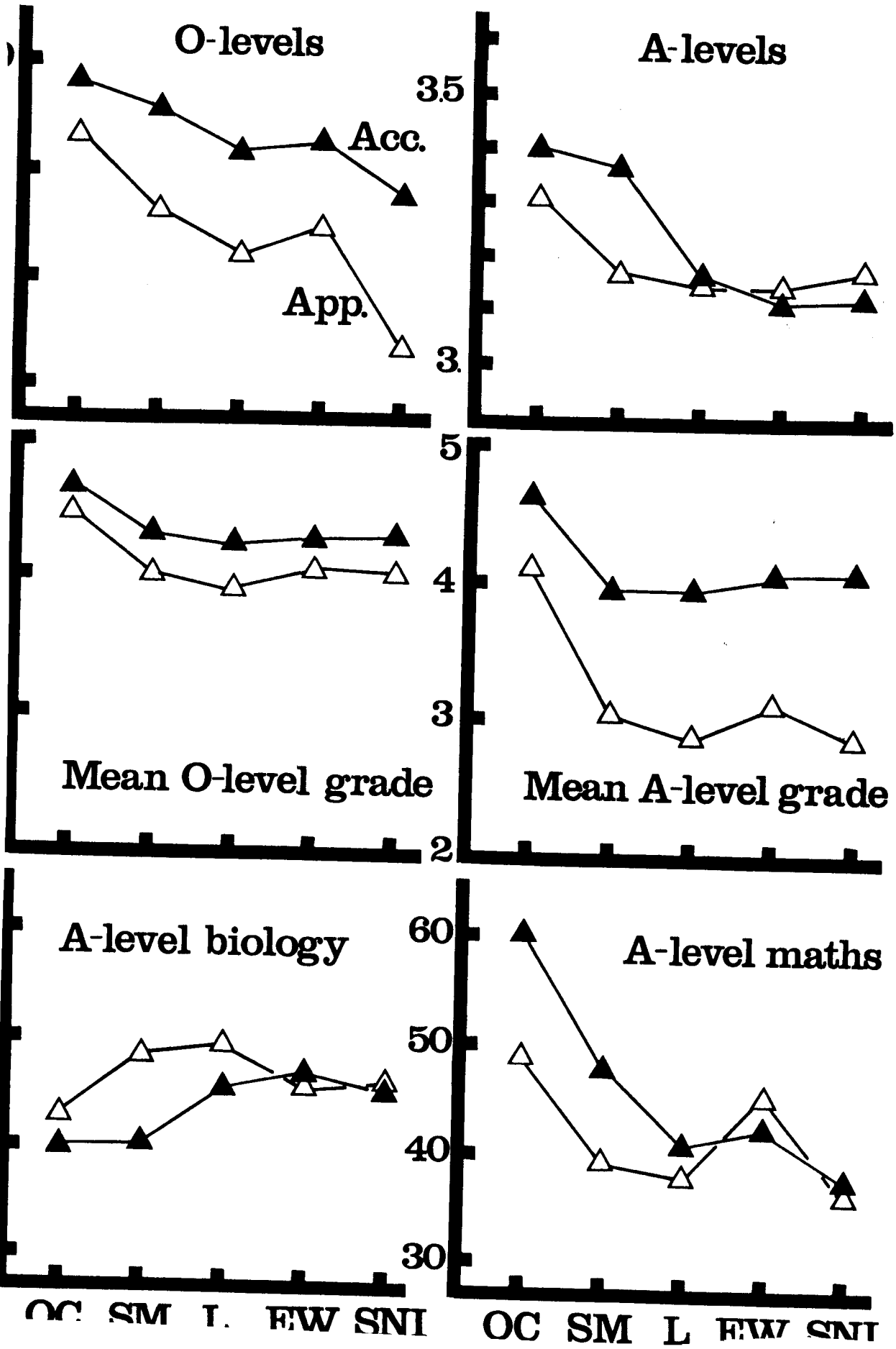

O-levels
Acc.
App.
A-levels
3.5
3
Mean O-level grade
5
4
3
2
Mean A-level grade
A-level biology
60
50
40
30
A-level maths
OC SM L EW SNI
OC SM L EW SNI

Figure 3-3: As for figure 3-2 except that the variables are the six demographic factors described in the text.

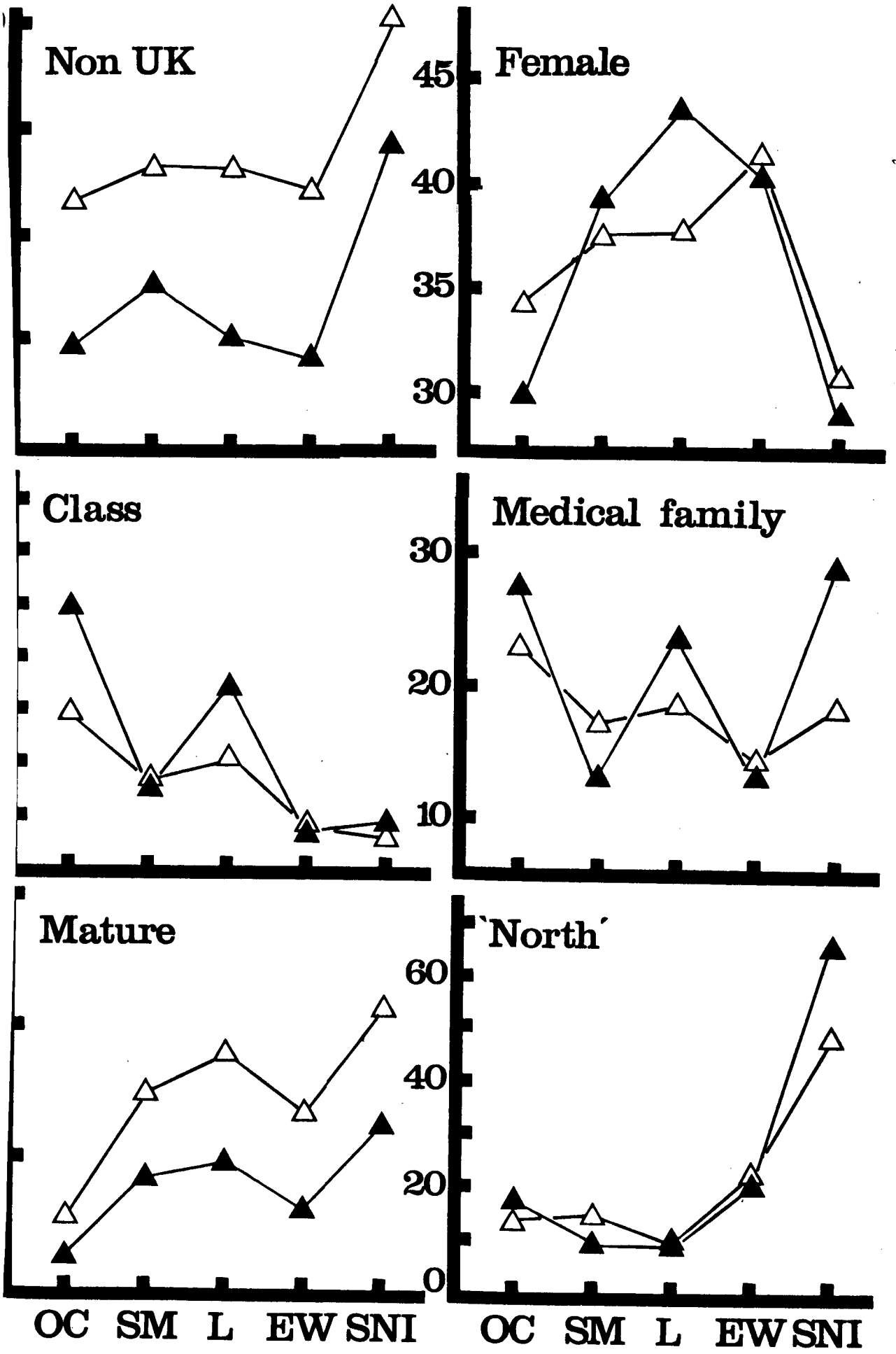

Non UK
Female
45
40
35
30
Class
Medical family
30
20
10
Mature
`North'
60
40
20
0
OC SM L EW SNI
OC SM L EW SNI

Figure 3-4: As for figure 3-2 except that the variables are the four descriptions of school type, as described in the text.

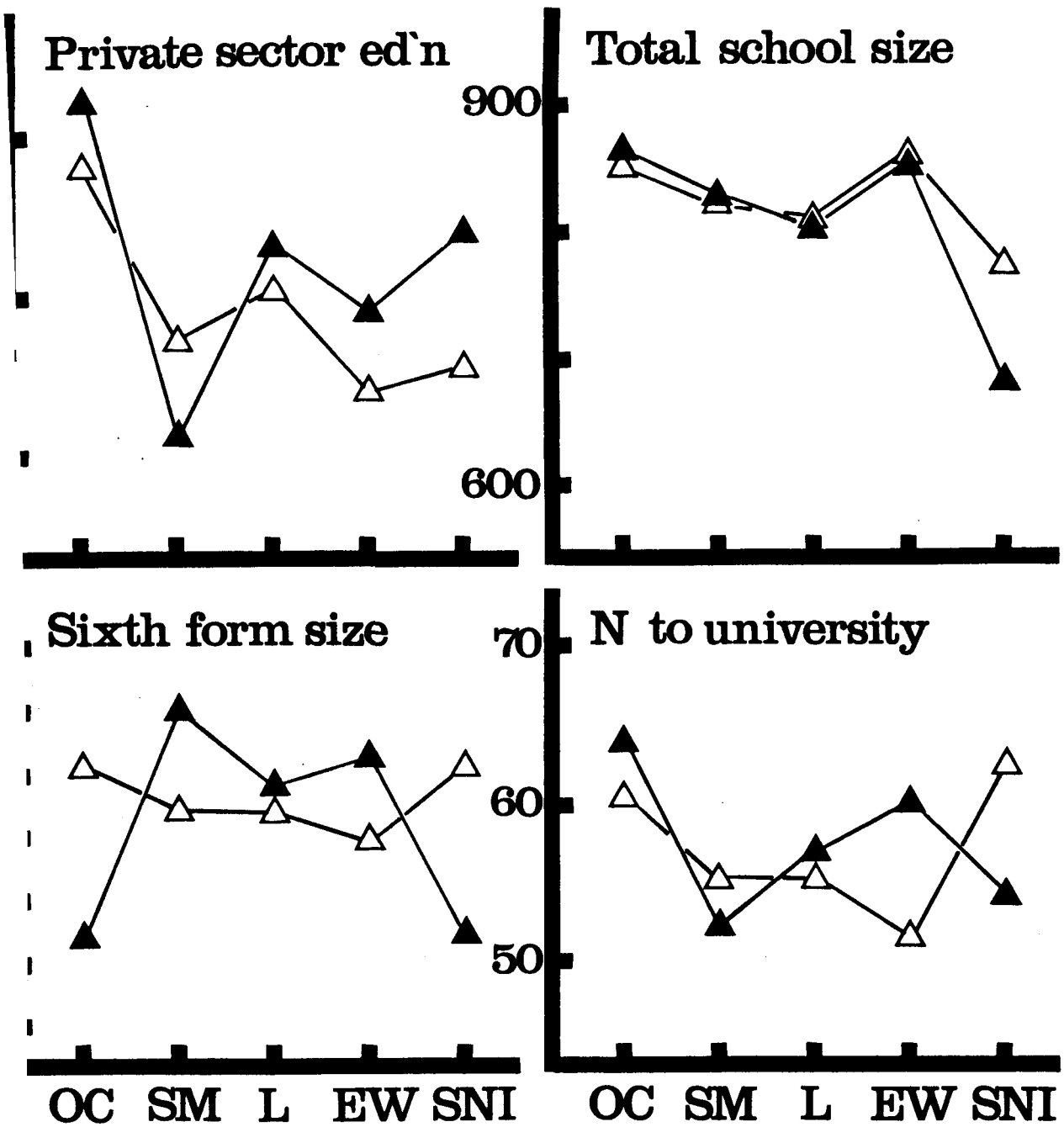

Private sector ed`n
Total school size
900
600
Sixth form size
N to university
70
60
50
OC SM L EW SNI
OC SM L EW SNI

Figure 3-5: As for figure 3-2 except that the variables are the six UCCA form variables as described in the text.

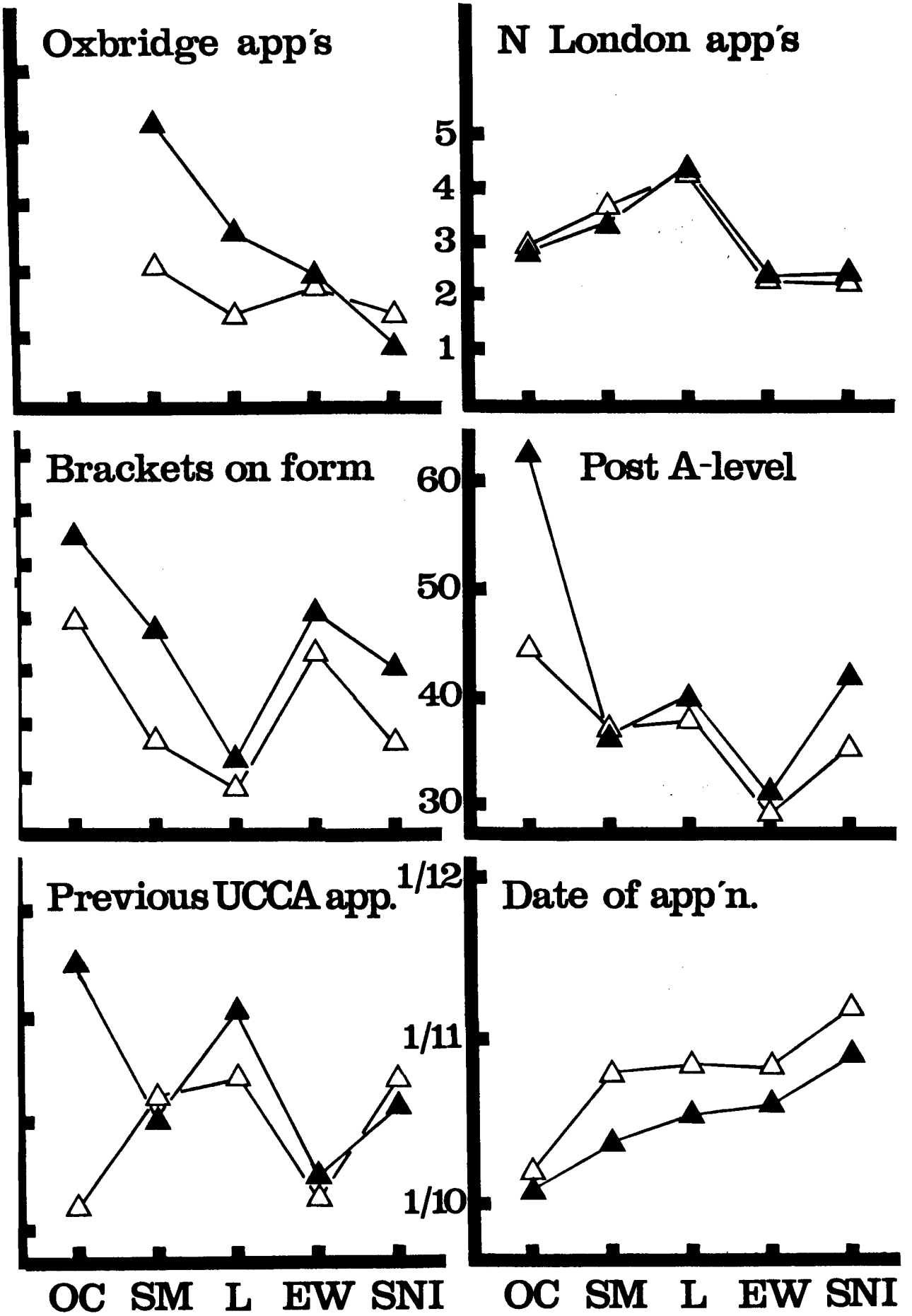

Oxbridge app's
N London app's
5
4
3
2
1
Brackets on form
60
50
40
30
Post A-level
Previous UCCA app.
1/12
1/11
1/10
Date of app'n.
OC SM L EW SNI
OC SM L EW SNI

Figure 3-6: Shows a causal model of influences upon O- and A-level achievement. Causal influences are presumed to act from left to right, and all links are shown which are significant at the 5% level. Values above the arrows indicate the standardised (beta) coefficients. Positive effects are indicated by solid lines, and negative effects by dashed lines. It should be noted that since in the Registrar-General's schema higher social classes are indicated by lower numbers, that the signs of class effects should be interpreted with care.

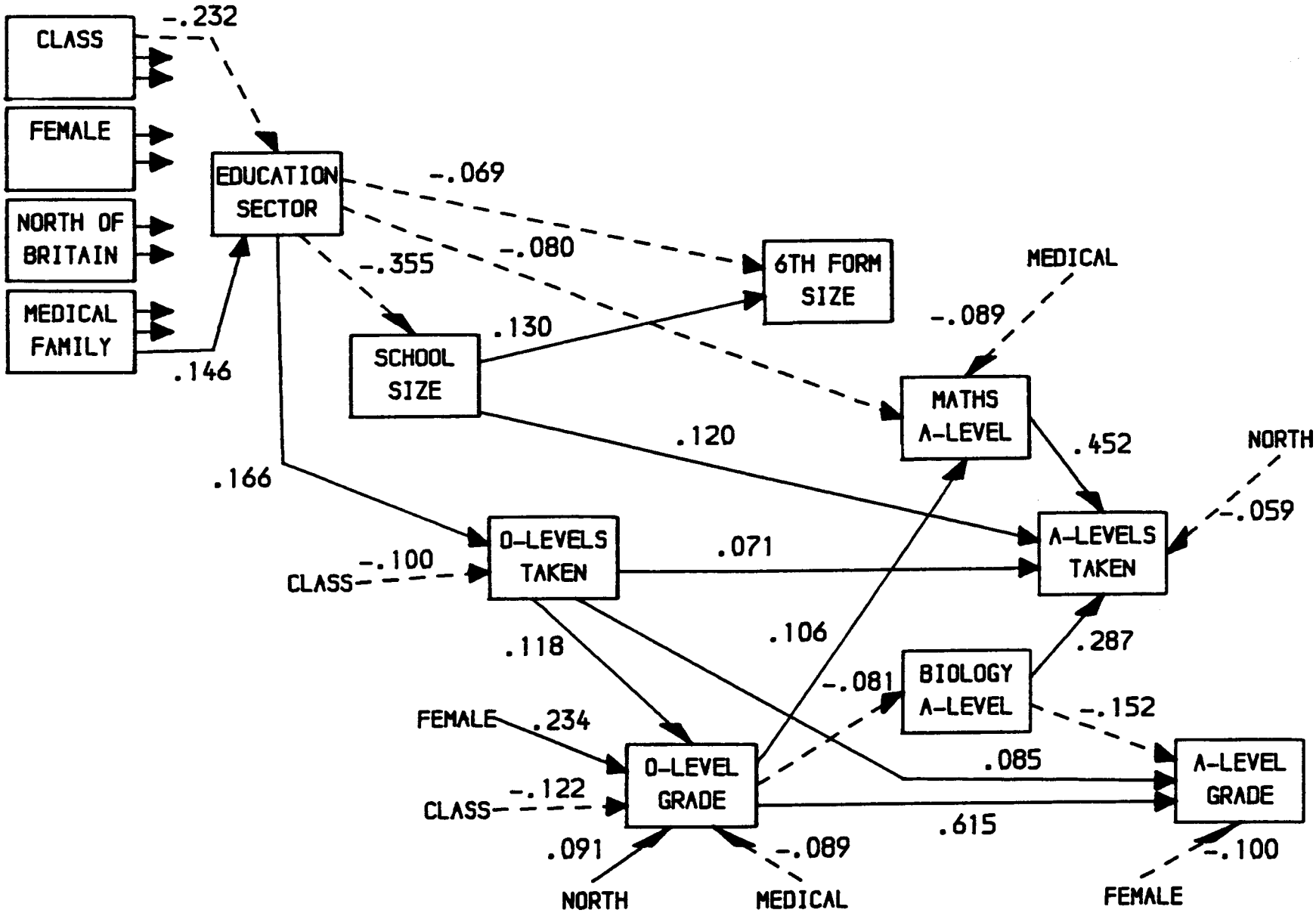

CLASS
FEMALE
NORTH OF BRITAIN
MEDICAL FAMILY
EDUCATION SECTOR
SCHOOL SIZE
6TH FORM SIZE
MATHS A-LEVEL
O-LEVELS TAKEN
A-LEVELS TAKEN
O-LEVEL GRADE
BIOLOGY A-LEVEL
A-LEVEL GRADE
-.232
-.069
-.080
-.355
.130
.146
.166
.120
.452
MEDICAL
-.089
NORTH
-.059
CLASS
-.100
.071
.118
.106
.287
-.081
FEMALE
.234
-.152
.085
CLASS
-.122
.615
.091
-.089
NORTH
MEDICAL
-.100
FEMALE

Figure 3-7: Shows the six significant proximate determinants of success at application. Significant determinants of the date of UCCA application are also shown, as are determinants of those factors. Determinants of academic achievement are shown in figure 3-6. Conventions are as for figure 3-6. Note that earlier UCCA applications are coded by smaller values, and hence negative influences indicate earlier application. Abbreviations: "N medical app'n"; Number of medical school applications on UCCA form: "Oxbridge app'n"; Oxbridge included on UCCA form: "Mature app't"; Mature applicant: "Date of app'n"; Date of application to UCCA.

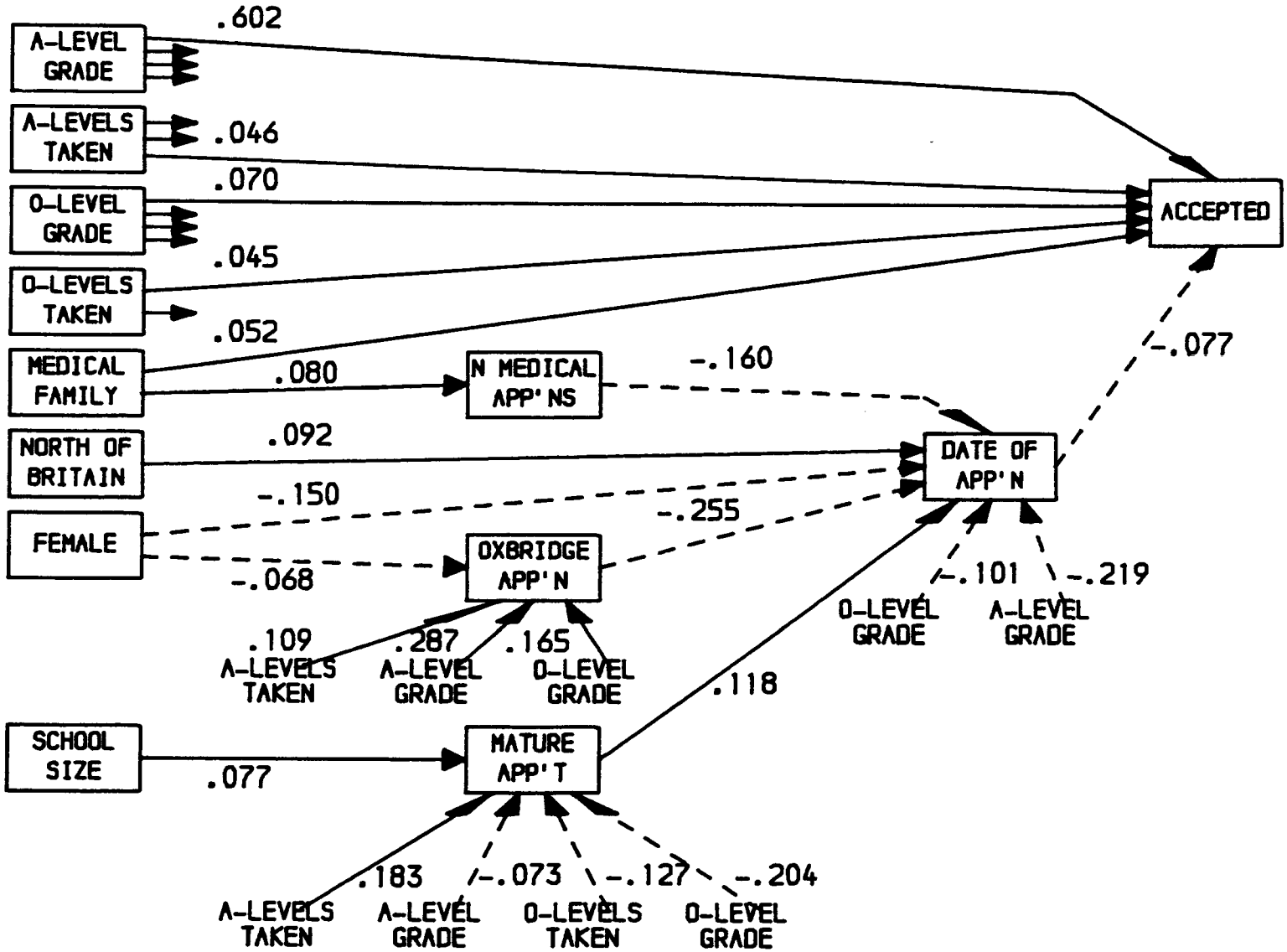

A-LEVEL GRADE
A-LEVELS TAKEN
O-LEVEL GRADE
O-LEVELS TAKEN
MEDICAL FAMILY
NORTH OF BRITAIN
FEMALE
SCHOOL SIZE
N MEDICAL APP'NS
OXBRIDGE APP'N
MATURE APP'T
DATE OF APP'N
ACCEPTED
.602
.046
.070
.045
.052
.080
.092
-.150
-.068
.109
.287
.165
.077
-.160
.255
.118
-.077
-.101
-.219
.183
-.073
-.127
-.204
A-LEVELS TAKEN
A-LEVEL GRADE
O-LEVEL GRADE
A-LEVELS TAKEN
A-LEVEL GRADE
O-LEVEL GRADE
O-LEVELS TAKEN
O-LEVEL GRADE

Table 5-1: O and A level grades of acceptees and rejects

	O-Levels							A-levels						
	Accept (n=517)			Reject (n=844)				Accept (n=517)			Reject (n=844)			
	n	%	mean grade	n	%	mean grade	sig diff	n	%	mean grade	n	%	mean grade	sig diff
Physics	469	90.7	4.57	690	81.8	3.91	***	464	89.7	3.72	678	80.3	1.85	***
Chemistry	454	87.8	4.57	671	79.5	3.94	***	502	97.1	4.21	782	92.7	2.30	***
Biology	460	89.0	4.58	667	79.0	4.10	***	353	68.3	4.36	611	72.4	2.70	***
Zoology	0	0	-	2	11.8	3.00	-	23	4.4	4.13	47	5.6	1.98	***
Botany	4	0.8	3.25	5	0.6	3.8	ns	5	1.0	3.80	5	0.6	2.60	ns
Maths	492	95.2	4.55	719	85.2	4.01	***	225	43.5	4.04	299	35.4	2.37	***
Add./Further maths	244	47.2	3.84	267	31.6	3.24	***	16	3.1	2.75	13	1.5	3.15	ns
Applied maths	1	0.2	5.00	3	0.4	2.33	ns	9	1.7	4.00	9	1.1	3.00	ns
English language	487	94.2	4.26	715	84.7	3.73	***	-	-	-	-	-	-	-
English literature	453	87.6	4.14	578	68.5	3.67	***	6	1.2	4.17	14	1.7	2.57	*
Latin	173	33.5	4.35	158	18.7	3.77	***	-	-	-	-	-	-	-
Greek	15	2.9	4.13	11	1.3	2.72	**	-	-	-	-	-	-	-
French	422	81.6	4.03	513	60.8	3.36	***	2	0.4	4.00	5	0.6	2.6	ns
German	120	23.2	3.87	127	15.0	3.53	***	3	0.6	1.66	-	-	-	-
Italian	4	0.8	3.25	6	0.7	3.67	ns	-	-	-	-	-	-	-
Spanish	7	1.4	4.29	11	1.3	3.00	+	-	-	-	1	0.1	5.0	-
Russian	2	0.4	4.00	7	0.8	4.00	ns	-	-	-	-	-	-	-
History	215	41.6	4.23	293	34.7	3.74	***	-	-	-	5	0.6	0.8	-
Geography	236	45.6	4.33	348	41.2	3.80	***	4	0.8	4.75	9	1.1	2.78	+
Economics	9	1.7	4.44	19	2.3	3.37	+	4	0.8	3.25	6	0.7	2.83	ns
Economic history	2	0.4	4.00	3	0.4	4.67	ns	-	-	-	2	0.2	4.00	-
Art	67	13.0	3.61	93	11.0	3.35	ns	7	1.4	2.43	9	1.1	2.33	ns
Music	44	8.5	3.75	47	5.6	3.55	ns	1	0.2	4.00	4	0.5	2.00	ns
Religious knowledge	98	19.0	4.01	174	20.6	3.74	+	2	0.4	1.00	1	0.1	4.00	ns
General studies	-	-	-	-	-	-	-	84	16.2	3.77	100	11.8	2.87	***
One or more others	162	31.3	-	321	38.0	-	-	21	4.1	28	3.3	-	-	-

Table 3-2: shows, for UK nationals only, the numbers who were accepted or rejected for medical school by social class.
Chi-squared=10.41, 4 df, p=.0341;
linear trend Chi-squared=7.844, 1df, p=.0051.

	Accepted	Rejected	%accepted
I	244	226	48.1%
II	206	138	40.1%
III	79	47	37.3%
IV	15	5	25.0%
V	10	7	41.2%

Table 3-3: shows, for UK nationals only, the numbers who were accepted or rejected for St. Mary's, by social class.
Chi-squared= 2.20, 4 df, p=.698;
linear trend Chi-squared=0.007, 1df, NS.

	Accepted	Rejected	%accepted
I	32	438	6.8%
II	27	317	7.8%
III	11	115	8.7%
IV	1	19	5.0%
V	0	17	0.0%

Table 5-4: Shows the significance in a [illegible] test (t test or chi-squared) of each of the 24 variables in predicting success at application to any medical school. The 24 variables are ordered in terms of their significance in the multiple logistic regression. Only the six variables above the dashed line are significant.

	Variable	Relative likelihood of acceptance	Multiple logistic Sig.	95% limits	Mean (SD) or percentage in Acceptances	Rejects	Univari Sig.
1	Mean A-level grade obtained	8.166x per mean grade	<<.001	6.13 - 11.55	4.04 (.65)	2.32 (1.13)	<.0(
2	Mean O-level grade obtained	2.229x per mean grade	<.005	1.30 - 3.82	4.30 (.46)	3.77 (.56)	<.0(
3	Date of UCCA application	1.442x per 28 days earlier	<.01	1.11 - 1.88	45.28 (21.6)	60.68 (25.3)	<.0(
4	Number of A-levels taken	1.774x per A-level	<.05	1.05 - 2.99	3.21 (.49)	3.13 (.52)	<.0!
5	Number of O-levels taken	1.168x per O-level	<.05	1.01 - 1.35	9.3 (2.2)	8.2 (3.2)	<.001
6	From a medical family	1.724x	<.05	1.01 - 2.96	19.9%	15.1%	<.05
7	Overall size of school	1.552x per 100 pupils less	NS	-	834.1 (461.3)	822.6 (357.6)	NS
8	Private sector education	1.405x if public sector	NS	-	51.1%	44.9%	<.05
9	Mature applicant	2.382x if not mature applicant	NS	-	8.3%	19.3%	<.001
10	Oxbridge on UCCA form	1.586x	NS	-	20.3%	3.3%	<.001
11	From north of Britain	1.304x	NS	-	15.6%	13.9%	NS
12	Maths A-level taken	1.292x if not taken	NS	-	43.7%	36.0%	<.01
13	Percentage of 6th form to university	1.039x per 10% increase	NS	-	26.5 (11.8)	25.6 (12.6)	NS
14	Previous UCCA application	1.325x if no prev. app'n.	NS	-	22.6%	20.4%	NS
15	Number of medical schools on the UCCA form	1.303x per medical school	NS	-	4.97 (.20)	4.94 (.35)	<.05
16	Post A-level application	1.235x	NS	-	39.0%	34.9%	NS
17	Number in 6th form	1.087x per 100 pupils less	NS	-	228.1 (154.4)	221.7 (142.2)	NS
18	Number from 6th form to university each year	1.039x per 10 pupils more	NS	-	57.1 (36.5)	53.9 (34.9)	NS
19	Use of brackets on UCCA form	1.021x for no bracketing versus all equal first	NS	-	4.20 (1.09)	3.97 (1.30)	<.005
20	Biology A-level taken	1.178x	NS	-	74.4%	81.0%	<.01
21	Female applicant	1.108x	NS	-	40.2%	35.7%	NS
22	Number of London medical schools on UCCA form	1.034x per school	NS	-	3.48 (1.34)	3.78 (1.31)	<.001
23	Total number of choices on UCCA form	1.073x per choice	NS	-	4.96 (.35)	4.98 (.13)	NS
24	Registrar-General's Social class	1.016x per class lower	NS	-	1.66 (.79)	1.80 (.81)	<.005