'A' LEVEL SUBJECT PREFERENCE AND SEX IN RELATION TO MEDICAL SCHOOL EXAMINATION PERFORMANCE

N.M. Woolhouse and E.Q. Archampong

SUMMARY

The relative performance of students admitted to the Medical School with an A level pass in either biology or mathematics and of male and female students has been studied. The influence of the A level grade in chemistry on the subsequent performance in biochemistry has also been investigated. A significant difference ($p < 0.001$) was found in the distribution of examination results covering all subjects examined among mathematicians and biologists. In general, mathematicians performed significantly better overall than did biologists. In particular, mathematicians performed significantly better ($p < 0.01$) in anatomy. Whilst there is no significant difference between the performance of male and female students taken overall, females appear to perform significantly better ($p < 0.001$) than males in the clinical subject areas. The quality of the A level grade in chemistry has a major influence on performance in biochemistry at the MB II examination.

INTRODUCTION

The medical School admission requirements demand A level passes in chemistry and physics and a pass in either biology or mathematics with biology being the preferred subject. There is a belief firmly held in some quarters that students admitted to the Medical School with A level mathematics will be less well equipped as students of medicine than their counterparts admitted with an A level pass in biology. In particular, anatomy has been cited as an example of a discipline where a background in biology would be expected to confer an advantage. Some support for these ideas could be drawn from the results of a study by Huxham et al[1] who reported a significant negative correlation between numerical skills and performance in preclinical subjects in a cohort of Australian medical students. Will this also prove to be the case in the Ghana Medical School?

The present admissions policy is to allow a maximum of 20% of the available places each year to be taken by mathematicians who compete among themselves for these places. A further 20% of the available places are reserved for female students who again compete among themselves for these places. In consequence, since the number of female applicants with top grade A level aggregates is relatively low, a considerable proportion of the females are admitted for training with A level aggregates that would be most unlikely to secure them admission in open competition with male applicants. How well do our female students perform by comparison with their male peers?

Another pre-admission variable of interest as a possible predictor of performance is the quality of the A level pass in chemistry. The department of biochemistry has suspected for sometime that the students who fail in biochemistry at the MB II examination are generally those with a relatively poor pass in chemistry at A level. How far does this belief turn out to be true?

In order to address these questions, we have analyzed the data contained in records of students' performances in the various major examinations leading to the award of the MB, ChB degrees. Our data base was the transcripts of students admitted to the Medical School since 1976. This paper presents the results of these analyses.

MATERIALS AND METHODS

In analysing the A level data, the aggregates were categorised into four groups. A high performance group including individuals with A level aggregates from 3 to 5, two intermediate groups corresponding to aggregates 6 or 7 and 8 or 9 respectively and a low performance group corresponding to aggregates 10 and above. (It should be noted that currently, students with such low aggregates have virtually no chance of admission to the Medical School, but in the recent past a substantial number were able to gain admission).

The performances of students in any of the several examinations were classified into one of four groups according to their examination result, viz., pass with credit or distinction, pass, referred or failed. In some particular subject examination ie., in anatomy and biochemistry, the actual marks obtained were used to categorise the students into five groups, viz: group 1, a mark of 65 or better (credit or distinction), group 2, marks ranging from 60 to 64, group 3, marks ranging from 55 to 59 and group 4, a mark below 50 (failure).

The chi-square test was used to test the null hypotheses:

1. That there is no significant difference between the distribution of examination results among biologists and mathematicians,

2. That performance in the major medical school examination is independent of sex and

3. That the a level chemistry grade and performance in biochemistry are independent of each other.

RESULTS

The number of credits/distinctions and failures recorded in each of the major professional examinations written by candidates with either biology or mathematics, and the overall total number of credits/distinctions and failures in all examinations are given in Table 1. The values in this table represent the actual number of credits/distinctions or failures recorded subject by subject rather than the numbers of students obtaining such a result. The results obtained in the MB II examination in anatomy by 472 biologists, and 124 mathematicians are shown in Table 2. The total number of credits/distinctions gained and the number of failures recorded in all subjects by male and female candidates are given in Table 3 whilst Table 4 shows the relationship between the performance scores obtained in the MB II examination in biochemistry and the pre-admission A level chemistry grade attained. The various data sets tested and the chi-square values yielded from appropriate null hypothesis testing of these data are given in Table 5. The contingency table format used is shown and also, where appropriate, the major contribution(s) to the overall value of X^2.

DISCUSSION

Biology or Mathematics

That biologists in general fare better overall in medical school examinations than mathematicians and, in particular, also do better in the MB II anatomy examination are commonly held beliefs. However, when these beliefs are put to the test, neither assumption turns out, to be true.

Overall performance

The relative overall performance of biologists and mathematicians in each of the major examination hurdles to be overcome between admission to the medical school and eventual graduation, can be fairly judged by comparison of the numbers of credit/distinctions and failures recorded by each group (see Table 1). When the null hypothesis: that there is no difference in the distribution of examination results among biologists and mathematicians is tested, a highly significant value for chi-square is obtained ($X^2 = 29.185$, $p < 0.001$) which leads us to reject the hypothesis. What is the cause of this significant difference? This question is answered readily by

splitting of X^2. When this is done, the largest single contribution to the overall value of X^2 is seen to be due to the number of mathematicians obtaining credits and distinctions (71) which is well above the number expected (44; X2 = 16.4). This is really not so surprising since the proportion of students with the best A level results, i.e., those with aggregates of 3 to 5, is far higher among the mathematicians. For example, among the 126 mathematicians who wrote the MB II examination, 71 (56.3%) came into this top category compared with only 67 (13.9%) of the 482 biologists. It can be argued that since the number of medical school places available to the mathematicians is far fewer than for the biologists, the proportion with top grade A level aggregates inevitably should be higher. This of course is true and if one compares the relative performance of mathematicians and biologists with similar A level aggregates no significant difference is found. However, this is not the point at issue. The question addressed is whether medical students who have studied mathematics rather than biology before entry to the medical school are disadvantaged. The answer quite clearly is that they are not; the mathematicians appear to perform better overall than the biologists.

Anatomy

Does the superior performance of mathematicians over biologists in general hold true for anatomy in particular? When the results shown

TABLE 1
RELATIONSHIP BETWEEN THE MB II EXAMINATION RESULTS FOR 608 STUDENTS AND THEIR "A" LEVEL AGGREGATES

"A" Level Aggregate	No.	Credit or Distinction	Passed	Referred	Failed
3-5	139	48(34.5)*	77(55.4)	9 (6.5)	5 (3.6)
6-7	186	34 (18.2)	93 (50.0)	33 (17.7)	26 (14.0)
8-9	193	21 (10.9)	84 (43.5)	52 (26.9)	36 (18.7)
10+	90	8 (8.9)	39 (43.3)	25 (27.8)	18 (20.0)

* Percentages given in parentheses

TABLE 2: RESULT OBTAINED IN THE MB II EXAMINATION IN ANATOMY BY 472 MEDICAL STUDENT ADMITTED WITH "A" LEVEL BIOLOGY AND 124 STUDENTS ADMITTED WITH "A" LEVEL MATHEMATICS

	Performance in Anatomy				
"A"	1 (Credit or Distinction)	2 (60-64%)	3 (55-59%)	4 (50-54%)	5 (Failed)
Biology	31 (6.6)*	52 (11.1)	118 (25.1)	166 (35.3)	103 (21.9)
Mathematics	18 (14.5)	22 (17.7)	30 (24.2)	39 (31.5)	15 (8.1)

*Percentages given in parentheses.

TABLE 3: CREDITS OR DISTINCTIONS AND FAILURES RECORDED IN ALL SUBJECT EXAMINED AT THE MB II, MB III, FINAL PART I AND FINAL PART II EXAMINATIONS

		No. of Candidates		Credit or Distinction		Failed	
Examination	Subject	Male	Female	Male	Female	Male	Female
MB II	Anatomy Biochemistry Physiology	539	115	50 (9.3)* 66 (12.2) 37 (6.9)	8 (7.0) 6 (5. 2) 6 (5.2)	105 (19.5) 112 (20. 8) 72 (13.4)	27 (23.5) 36 (31.3) 22 (19.1)
MB III	Microbiology Pathology Pharmacology	348	74	34 (9.8) 36 (10.3)	6 (8.1) 3 (4.1) 3 (4.1)	32 (9.2) 31 (8.9) 57 (16.4)	4 (5.4) 4 (5.4) 12 (16.2)
Part I	Obstetrics/ Gynaecology Paediatrics	305	66	5 (1.6) 4 (1.3)	5 (7.6) 3 (4.5)	22 (7.2) 14 (4.6)	1 (1.5) 1 (1.5)
Part II	Medicine Surgery Community Health	233	47	1 (0.04) 1 (0.04) 2 (0.08)	0 (0.0) 1 (2.1) 1 (2.1)	19 (8.2) 19 (8.2) 16 (6.7)	3 (6.4) 0 (0.0) 2 (4.3)
*Percentages given in parentheses.							

TABLE 4: RELATIONSHIP BETWEEN THE PERFORMANCE SCORES OBTAINED BY 595 STUDENTS AT THE MB II EXAMINATION IN BIOCHEMISTRY AND THEIR "A" LEVEL CHEMISTRY GRADES

		Performance in Biochemistry				
"A" Level ChemistryGrade	No.	1	2	3	4	5
		(Creditor Distinc-tion)	(60-64%)	(55-59%)	(50-54%)	(Failed)
A	58	28 (39.7)	8(13.8)	11(18.9)	12(20.7)	4 (6.9)
B	309	33 (10.7)	37 (12.0)	70(22.7)	112(36.2)	57(18.4
C	149	9(6.0)	13(8.7)	30(20.1)	52(34.9)	45(30.2)
D/E	79	2(2.5)	4(5.1)	14(17.7)	31(39.2)	28 (35.4)
*Perecentage given in parentheses.						

TABLE 5: SUMMARY OF RESULTS OF CHI-SQUARE DATA ANALYSIS BY MEANS OF CONTINGENCY TABLES

Data Tested	Contingency Table	X^2	d.f	P
Overall examination results (Biologist V Mathematicians)	2 x 2	29. 185 (16.408)*	1	< 0.001
Anatomy examination results (Biologists v Mathematicians)	2 x 5	16.192 (5.905)	4	< 0.01
Overall examinations results (Males v Females)	2 x 2	2.629	1	NS
Pre- and paraclinical, clinical C/D (Males v Femalse	2 x 3	15.137 (12.896)	2	< 0.001
Pre- and paraclinical, clinical F (Males v Femalse	2 x 3	13.948 (5.645)	2	< 0.001
Biochemistry examintation results (Influence of chemistry grade)	4 x 5	77.759 (41.541)	12	<0.001

* Major single contribution to the overall X^2 value.
C - Pass with Credit
D - " " Distinction
F - Fail

in Table 2 are analysed the same story emerges. The X^2 value calculated from the anatomy examination data is 16.2, ($p < 0.01$), a significant result. Again, splitting the total X^2, we find that the largest contribution to the overall total comes from the greater than expected number of mathematicians obtaining a credit pass or better (18 observed, 10.1 expected; $X^2 = 5.9$). The next largest contribution stems from the smaller than expected number of mathematicians failing in anatomy (15 observed, 24.5 expected; $X^2 = 3.7$). Thus the mathematicians actually perform better in anatomy rather than worse when compared with the biologists. This finding is at variance with that of Huxham et al[1] who found a significant negative correlation between numerical skills and performance in preclinical subjects. They suggested that students with high numerical skills are frustrated with the more descriptive sciences. Perhaps the relatively greater attractiveness of a medical career, as compared to say engineering, in our present environment may lead to a higher degree of motivation in our highly numerate students.

Male or Female

The respective performance of males and females in medical school examination can be compared by referring to Table 3. The hypothesis that the total number of credits/distinctions gained and the number of failures recorded in all subject is independent of sex was tested in the form of a 2 x 2 contingency table. The chi-square value obtained was 2.6 which is not significant. In other words, there is no statistically significant difference between the overall performance of males and females. However, when the results are further analyzed by considering separately, performance in the preclinical (MB II), paraclinical (MB III) and clinical (Part I and Part II) examinations, a different picture emerges. Chi-square analysis of the number of credits/distinctions gained by each sex in these three different professional examinations was carried out using a 2 x 3 contingency table. A X^2 value of 15.1, ($p < 0.001$) was obtained. By far the largest contribution to the overall value of X^2 stems from the number of credit/distinctions (10) gained by the females in the clinical examinations, which is almost three times the expected number (3.5); $X^2 = 12.9$. When the numbers of failures were similarly analyzed, the X^2 value obtained was again highly significant ($X^2 = 13.9$. $p < 0.001$). Again, it is mainly due to the better performance of females in the clinical examinations. Among the females, the number of failures was only 9, less than half of the expected (19.5) $X^2 = 5.6$. Rather fewer females than expected failed the paraclinical examination subjects (observed = 20; expected = 25.7) whilst rather more than the expected number failed in the preclinical subjects (observed = 85; expected = 68.7).

Chemistry and Biochemistry

Biochemistry is a subject often disliked and frequently found difficult universally by medical students. The suspicion that the performance of students in biochemistry is related to the quality of the A level grade achieved in chemistry was tested by chi-square analysis of a 4 x 5 contingency table (Table 4). This analysis demonstrated quite conclusively that this is more than a mere suspicion ($X^2 = 77.8$, $p < 0.001$). By far the largest contribution to this X^2 value stems from the difference between the observed and expected numbers of students with A level aggregates from 3 to 5 who gain a credit or distinction in biochemistry ($X^2 = 41.5$).

There is a high degree of correlation between the A level grade in chemistry and the student's subsequent performance in biochemistry. Among 58 students with an A grade in chemistry, 23(39.7%) obtained at least credit pass whilst only 4(6.9%) failed. Conversely, among 79 students with grade D or E in chemistry, 28(35.4%) failed. Those with grade C fared little better. Among149 students in this category, 45 (30.2%) failed in biochemistry. Thus by far the greater number of failing students are those with grade C or worse in A level chemistry.

What conclusions could be drawn from these findings? A subject of present debate is whether the number of Ghana Medical School places allocated to mathematicians should be reduced and to what level? One fairly extreme view which has some support is that the number of places open to mathematicians should be cut back to 5% of the intake or even less. Our findings suggest that any such decision, if taken solely on academic grounds, would be difficult to justify. What should the policy with regard to the number of places available for females? The study we have undertaken was not designed to try to provide an answer to this kind of question. Judged by the availability evidence it would appear that, in academic terms, female students perform no better or worse than their male counterparts.

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