Medical Schools Council - Selecting for Excellence
Help and hindrance in widening participation: commissioned research report

Executive Summary

The research reported here was undertaken for two purposes: to provide evidence about the practical impact of different academic and ability selection criteria, and to explore how medical schools might converge in their selection processes. The results, in summary, were:-

1. Around half of UK secondary schools and colleges did not provide any applicants to medicine over the 3-year study period. A substantial majority (80%) of medicine applicants came from around only 20% of schools or colleges: these were more likely to be selective schools (grammar or independent) or large sixth form colleges.
2. Selection processes that employ cut-off scores (e.g. 3 As at A-level; threshold scores on UKCAT or GAMSAT) have an appreciable effect on the socio-demographic profile of applicants. In particular, applicants from disadvantaged backgrounds (neighbourhood, family, and schooling) and some minority ethnic communities are less likely to meet these thresholds.
3. The GAMSAT aptitude test, used mainly for graduate entry medicine, is sensitive to a number of neighbourhood socio-demographic factors. This pattern is similar to that seen also with A level tariffs and the UKCAT aptitude test and comprises poorer performance amongst applicants from deprived or disadvantaged neighbourhoods.
4. GAMSAT has incremental validity in predicting how well students do in a medicine programme i.e. higher scores on GAMSAT predict higher scores in medical school assessments over and above academic record. Again, this evidence is similar to published research on UKCAT.
5. Medicine applicant choices (each applicant may make 4) display systematic grouping. Seven groups of medical schools are more likely to have co-application within than between groups.
6. Medical schools use a wide variety of indicators for widening participation than their parent universities, in particular using school-based information as well as socio-economic status and neighbourhood indicators. Medical admissions currently uses multiple rather than single measures, but there is relatively little consistency in these measures between schools.

The implications of this evidence, combined with the published literature, are threefold.

First, there is considerable scope to encourage pupils from schools and colleges, that currently do not have applicants, to apply for medicine.

Secondly, the pattern of medicine choices amongst applicants suggests there may be groups of medical schools who could consider some degree of sharing or co-operation in selection processes.

Thirdly, most of the academic or aptitude threshold criteria currently in use for selection operate such that applicants from disadvantaged backgrounds are less likely to be successful. Most medical schools use a wide variety and multiple indicators of widening participation, but these may need to be combined with adjustment to cut-off thresholds to improve the success and representation of those applicants.

Contents

Acknowledgements

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The GAMSAT aptitude test

GAMSAT (Graduate Medical Schools Admissions Test) GAMSAT was developed by the Australian Council for Educational Research (ACER) to overcome the difficulties in distinguishing between the degree outcomes (GPAs) from a range of courses and a range of universities. It was first administered in 1995 for a consortium of Graduate-entry Medical Schools in Australia that now includes eleven Australian universities. GAMSAT seeks to provide a *level playing field* to select an intentionally heterogeneous cohort.

This aptitude test thus predates the two others employed for medicine in the UK – BMAT and UKCAT (introduced in 2003 & 2006 respectively). In 1999, ACER contracted with St George's, University of London for the provision of GAMSAT to aid in the selection of entrants to their new Graduate-entry Medicine Programme, and since then its use has spread in UK and Ireland, now involving twelve different universities. The first test administered in UK was in January 2000; in September 2014 over 3,000 applicants to seven different medicine courses sat the 14th GAMSAT UK.

GAMSAT is designed to assess the capacity to undertake high-level intellectual studies in a medical or dental course. The assessment includes the mastery and use of concepts in basic science, as well as more general skills in problem solving, critical thinking and writing. More information about the construct, structure and content of the test are available in the *Test Specification* and the *GAMSAT Information Booklet* (2014). It comprises three sections:

1. **Reasoning in Humanities and Social Sciences:** Tests skills in the interpretation and understanding of ideas in social and cultural contexts. Different kinds of text are used as stimuli, including passages of personal, imaginative, expository and argumentative writing. Although most of the stimuli materials in this section are in the form of written passages, some units may present ideas and information in visual and tabular form. Materials deal with a range of academic and public issues, with an emphasis on socio-cultural, personal and interpersonal topics.
2. **Written Communication**: Tests the ability to produce and develop ideas in writing. It involves two thirty-minute writing tasks. Each task offers a number of ideas relating to a common, general theme. The first task deals with socio-cultural issues while the second deals with more personal and social issues.
3. **Reasoning in biological and physical sciences**: This is made up of questions in Chemistry (40%), Biology (40%), and Physics (20%). Stimulus material is presented in a variety of formats including text, mathematical, graphs, tables and diagrams. In addition to testing reasoning and problem solving within a scientific context, this section examines the recall and understanding of basic science concepts. The skills assessed include the ability to identify knowledge in new contexts, analyse and interpret data, discover relationships, translate knowledge from one form to another, formulate and apply hypotheses and make generalisations, deduce consequences from models, follow and evaluate a line of reasoning, evaluate evidence, categorise and select information relevant to problems, generate and apply strategies to solve problems, make comparisons, extrapolate, interpolate, estimate and recognise limits in accuracy.

Section 3 (Reasoning in biological and physical sciences), which is double weighted in calculating the overall GAMSAT score, is useful in providing a guarantee of some competence in science across a variety of applicants' academic backgrounds.

There is a small amount of published research about GAMSAT, mostly in Australia (e.g. Coates, 2008; Puddey & Mercer, 2013; Wilkinson et al, 2014), and one study in the UK (Bodger et al, 2011), and a larger literature comprising internal reports from ACER (e.g. Pywell et al, 2013). In particular, the literature suggests that GAMSAT may have some modest predictive validity in terms of early years assessment results, but this is usually a weaker predictor than prior educational attainment (e.g. GPA). The present study provides additional evidence as to the predictive validity of GAMSAT.

More recently, research has examined the impact of socio-demographic factors and performance on medicine aptitude tests (e.g. Reiter et al, 2012; Tiffin et al, 2014; Puddey & Mercer, 2013) that suggests that many of these tests are affected by socioeconomic disadvantage and other demographic factors, such as gender. Since these tests are used for selection, it is likely that they have some impact on applicant success in gaining a place at medical school. There is little evidence about the impact of socioeconomic factors on GAMSAT and none in the UK. The present study provides initial evidence about this.

Impact on socio-demographics

Two, overlapping datasets were analysed to examine the relationships between a number of socio-economic, demographic and educational factors and performance on GAMSAT.

Dataset 1 comprised all candidates who sat GAMSAT UK in 2012 and 2013 who had a UK postcode (n=2265). Dataset 2 comprised all applicants to the University of Nottingham from 2003 to 2013 with a UK postcode (n=11703): clearly, Nottingham 2012 and 2013 applicants would also have been included in Dataset 1.

The approach was to examine the simple relationships between socioeconomic indicators, based on UK postcode, and GAMSAT performance (overall score, section scores, typical entry score{TES} – i.e. overall score>= selection criterion). Significant relationships were then examined further by controlling for a number of other variables (gender, age, ethnicity, degree class and subject). Finally, how the socioeconomic profile varies with the application of different TES values was investigated.

GAMSAT UK 2012-3

Applicants for GAMSAT register to take the test and self-report age, gender, ethnicity, field of study, class of degree, and highest degree. Applicant postcodes were used to derive a number of geographical indices of socioeconomic status, namely: Index of multiple deprivation (calculated as deciles separately for England, Wales, Scotland and Northern Ireland), POLAR 3 (quintiles – calculated as two separate indices – Young persons' participation rate in Higher Education – HE - {YPR}, and proportion of adults with HE qualifications {AHE}), and MOSAIC (calculated as deciles).

Elimination of invalid postcodes resulted in the loss of 273 individuals, leaving n= 1991 with full data.

Simple correlations between the different measures of deprivation and GAMSAT are shown in Table 1 below.

		S1	S2	S3	OA	IMD Decile	POLAR3 qYPR	POLAR3 qAHE	Mosaic Decile
GAMSAT S1	Pearson Correlation	1							
	Sig. (2-tailed)								
GAMSAT S2	Pearson Correlation	.499**	1						
	Sig. (2-tailed)	.000							
GAMSAT S3	Pearson Correlation	.593**	.288**	1					
	Sig. (2-tailed)	.000	.000						
GAMSAT OA	Pearson Correlation	.799**	.606**	.914**	1				
	Sig. (2-tailed)	.000	.000	.000					
IMD Decile	Pearson Correlation	.174**	.071**	.191**	.195**	1			
	Sig. (2-tailed)	.000	.001	.000	.000				
POLAR3 qYPR	Pearson Correlation	.074**	.081**	.086**	.099**	.347**	1		
	Sig. (2-tailed)	.001	.000	.000	.000	.000			
POLAR3 qAHE	Pearson Correlation	.104**	.114**	.071**	.105**	.144**	.715**	1	
	Sig. (2-tailed)	.000	.000	.002	.000	.000	.000		
Mosaic Decile	Pearson Correlation	.207**	.127**	.198**	.223**	.683**	.328**	.122**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	

Table 1

It can be seen that all the different measures of deprivation are inter-correlated significantly, with the strongest relationships between the two POLAR measures (r=0.715 - in part because they denote identical geographic areas) and between IMD and MOSAIC deciles (r=0.683). The different GAMSAT sections also correlate significantly with each other and with the overall score (Section 3 most strongly since it is double weighted in the calculation of the overall score).

Each of the deprivation measures is significantly associated with all of the GAMSAT scores (r_s ranging between 0.071 and 0.223), but the strongest relationships are between the MOSAIC decile and GAMSAT, with the weakest ones between the POLAR 3 measures and GAMSAT.

Figures 1 to 4 below show the relationships between the deprivation indices and GAMSAT overall performance.

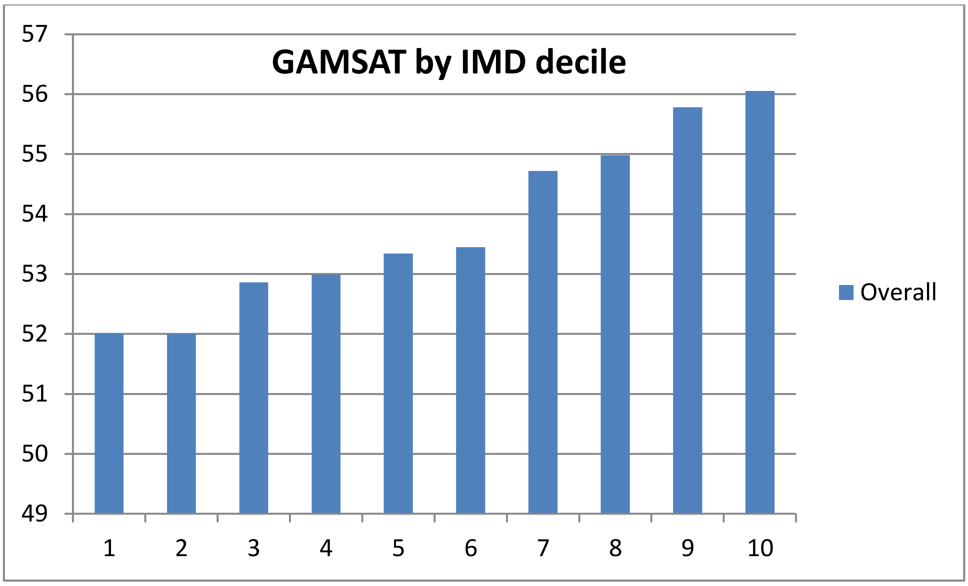


Figure 1

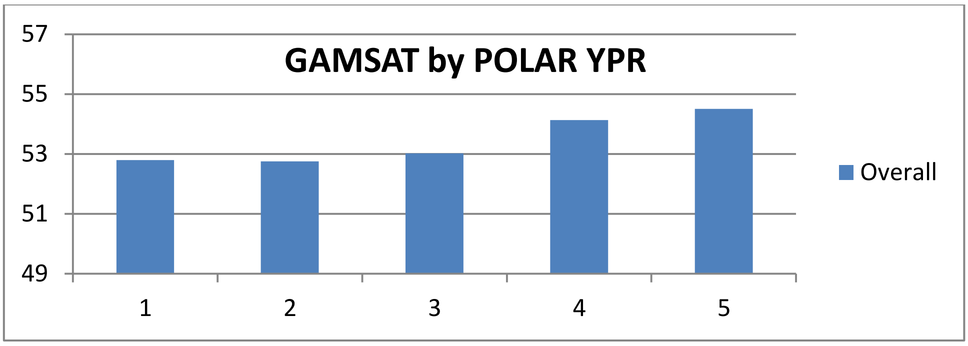
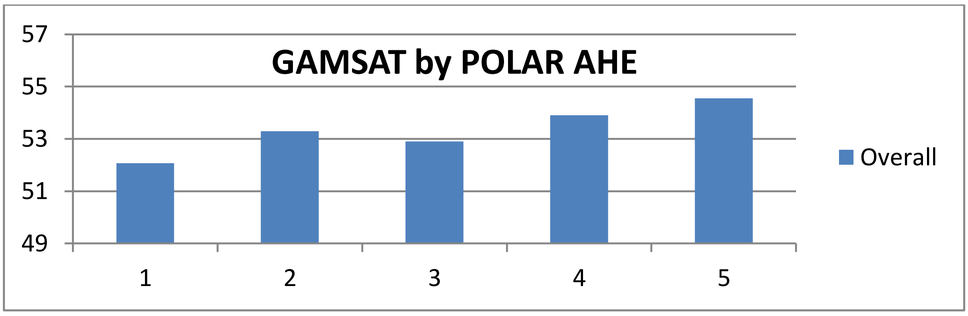


Figure 2



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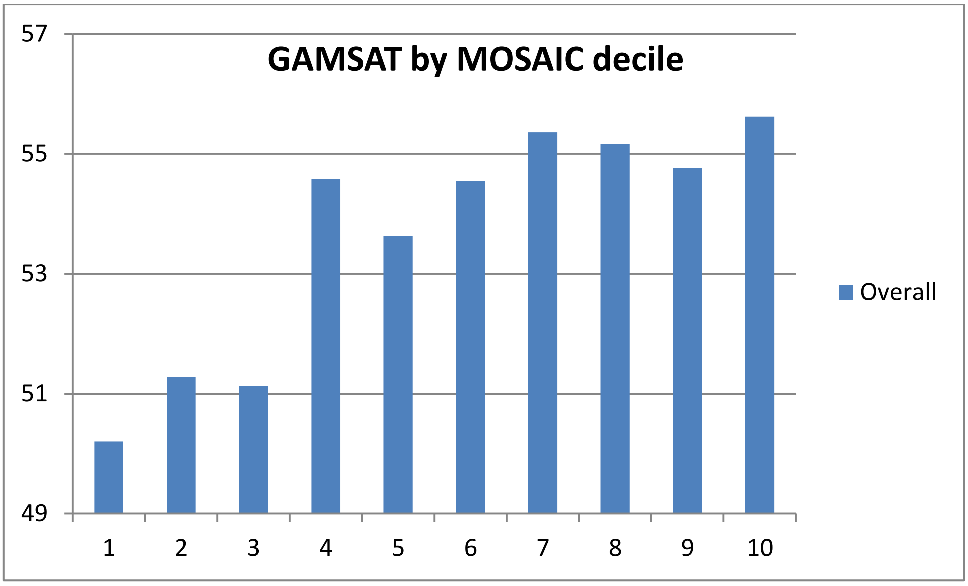

Figure 4

The relationships with GAMSAT overall scores are similar, but not simple linear ones: in the case of IMD and MOSAIC, the lowest two or three deciles are clearly performing worse than all the others. Figures 5-8 below break this down by the different GAMSAT sections and show that the relationships between the IMD and MOSAIC measures are strongest for Section 3. For the POLAR measures, relationships seem, by inspection, to be similar for all three GAMSAT sections.

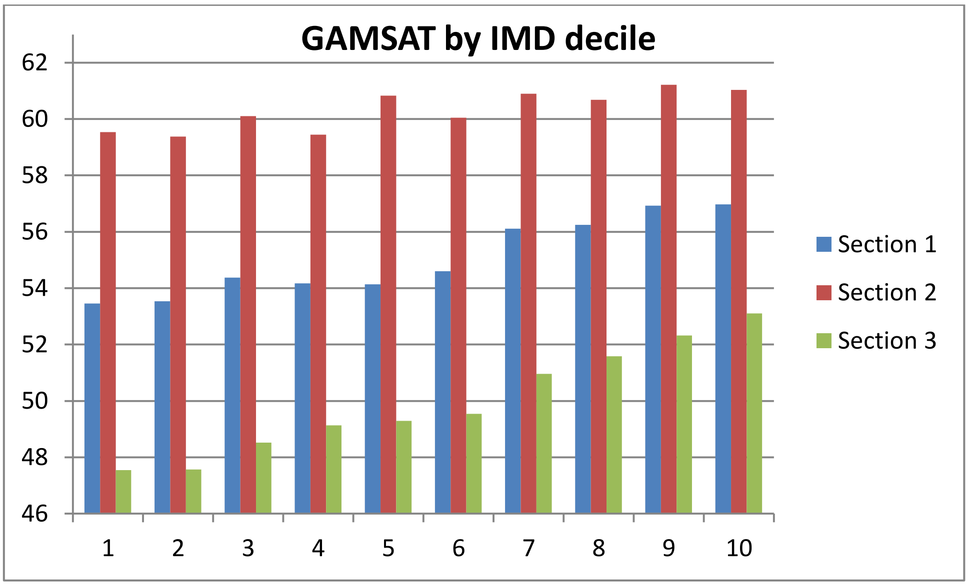

Figure 5

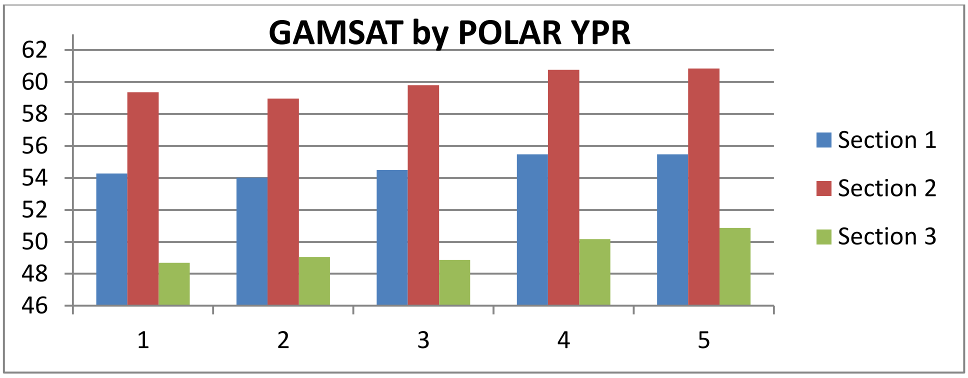

Figure 6

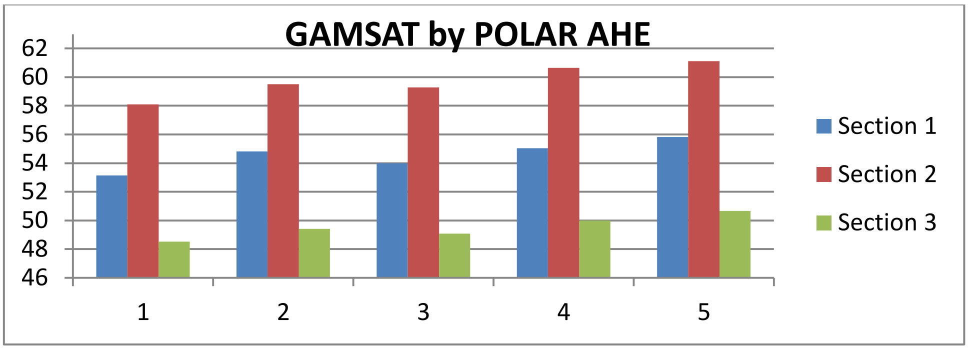

Figure 7

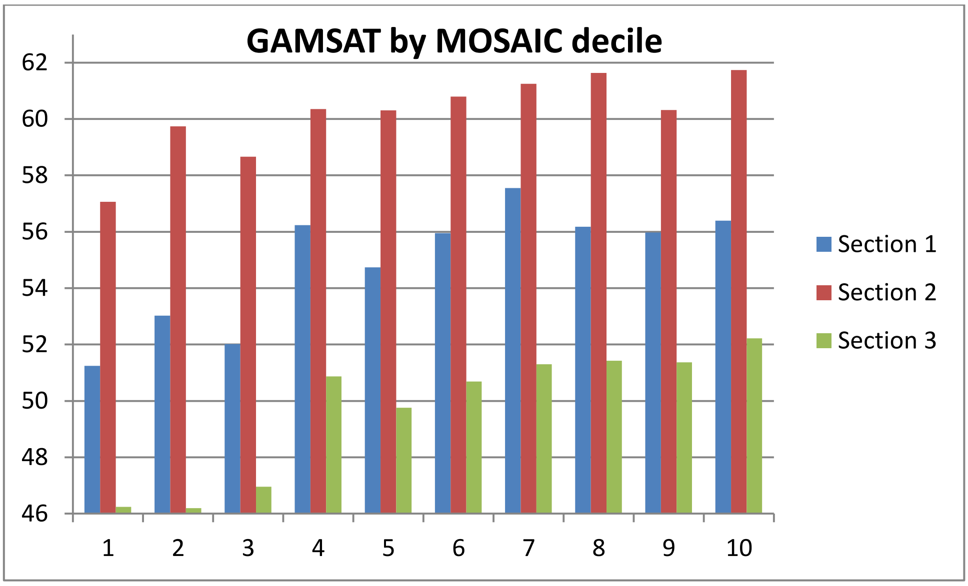

Figure 8

Simple univariate analyses of variance confirmed the separate, highly significant associations between all of the deprivation measures and all of the GAMSAT measures (sections 1, 2 & 3, and overall) with the exception of the Index of Multiple Deprivation and GAMSAT Section 2 (written communication; p>0.05).

- **Overall score**: IMD (F=9.1,df9&1982,p<0.001); POLAR YPR (F=5.48,df4&1986,p<0.001); POLAR AHE (F=6.27, df4&1986,p<0.001); MOSAIC (F=15.21,df9&1982,p<0.001).

- **Section 1**: IMD (F=7.6,df9&1982,p<0.001); POLAR YPR (F=3.33, df4&1986,p=0.01); POLAR AHE (F=6.98, df4&1986,p<0.004); MOSAIC (F=16.07,df9&1982,p<0.001).
- **Section 2**: IMD (F=1.56,df9&1982,p=0.121); POLAR YPR (F=3.81, df4&1986,p=0.004); POLAR AHE (F=7.12, df4&1986,p<0.001); MOSAIC (F=5.55,df9&1982,p<0.001).
- **Section 3**: IMD (F=8.61,df9&1982,p<0.001); POLAR YPR (F=4.28, df4&1986,p=0.002); POLAR AHE (F=2.82, df4&1986,p<0.024); MOSAIC (F=11.30,df9&1982,p<0.001).

However, multivariate analysis controlling for other independent variables (gender, age, ethnicity, highest level of qualifications, degree subject, and degree class) demonstrated much smaller independent associations between these indices of deprivation and the different GAMSAT scores. The remaining, statistically significant associations were:-

- **Overall score**: POLAR AHE (F=5.05, df1&1958,p=0.025); IMD, POLAR YPR & MOSAIC all p_s>0.05
- **Section 1**: POLAR AHE (F=5.57, df1&1958,p=0.018); MOSAIC (F=3.90, df1&1958,p=0.048); IMD, POLAR YPR all p_s>0.05
- **Section 2**: POLAR AHE (F=4.38, df1&1958,p=0.036); MOSAIC (F=7.05, df1&1958,p=0.008); IMD, POLAR YPR all p_s>0.05
- **Section 3**: IMD . POLAR YPR, POLAR AHE, & MOSAIC all p_s>0.05

In sum, GAMSAT scores (overall and sections) are sensitive to neighbourhood-based indices of deprivation, but when other demographic and educational factors are taken into account many of these become non-significant, leaving a small number of significant associations of Overall, section 1 & 2 scores (but not section 3 scores) with POLAR AHE and MOSAIC decile.

Analysis of typical entry scores (TES=60 GAMSAT overall score) discovered similar patterns of association with the deprivation measures. These are depicted in Figures 9-12 below.

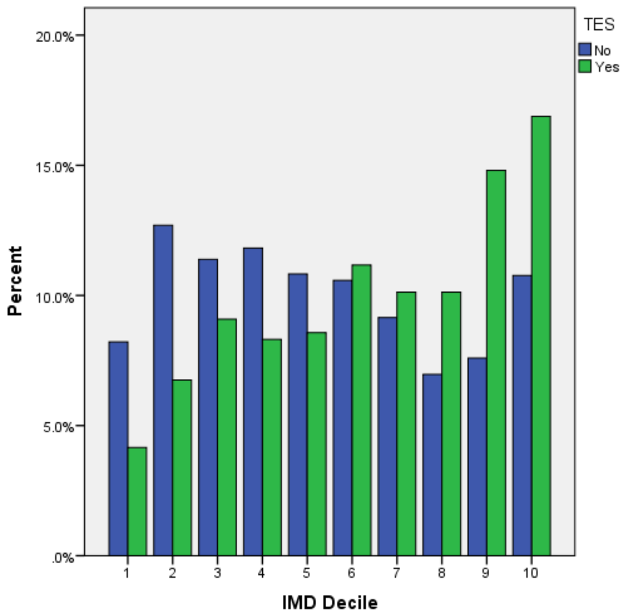

Figure 9

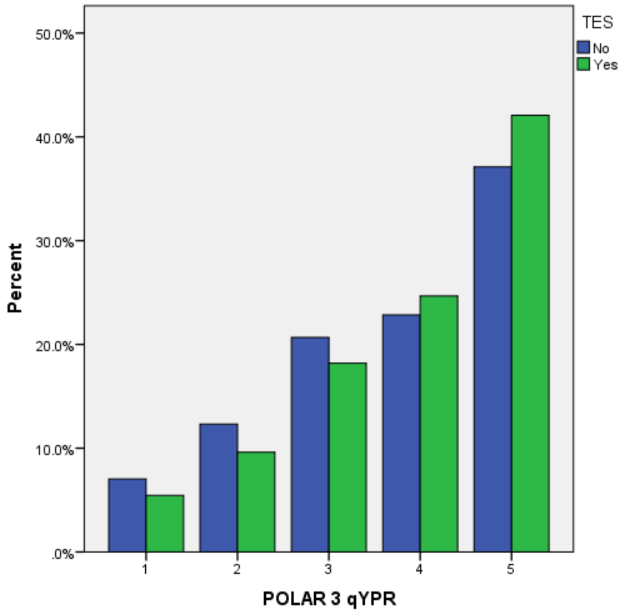

Figure 10

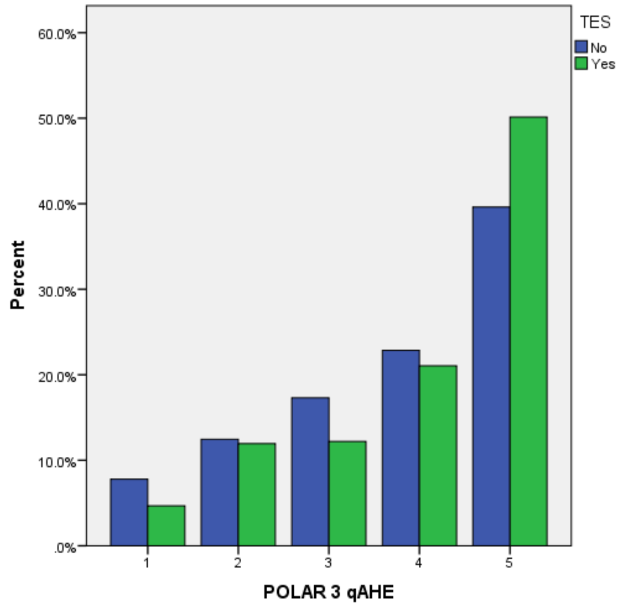

Figure 11

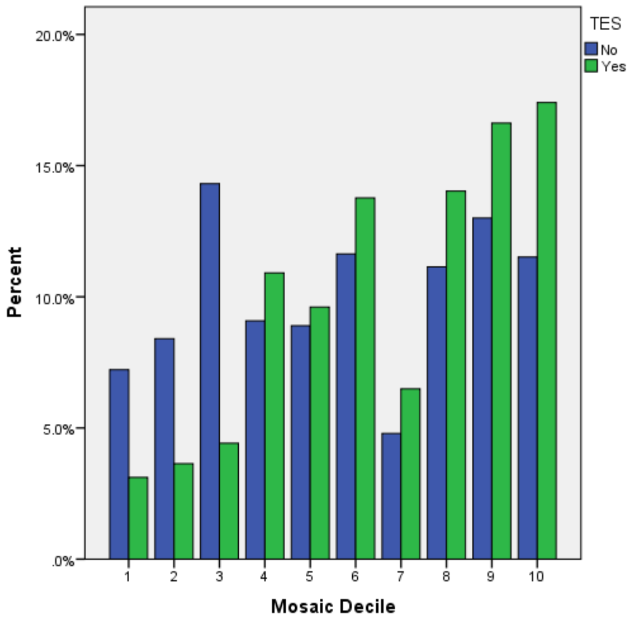

Figure 12

It can be seen that there are substantial differences in the likelihood of achieving a TES depending on deprivation. In particular, in the lowest five IMD deciles the majority fail to gain TES, but in the highest five deciles this reverses and the majority do gain a TES. In the lowest three MOSAIC deciles also the substantial majority do not gain TES, but the highest five have the reverse pattern with the majority gaining TES. POLAR YPR also displays a similar, but non-significant pattern with the lower three quintiles being less likely to gain TES and the upper two being more likely to gain TES. The POLAR AHE measure shows a somewhat different pattern, with only the highest quintile having a majority gaining TES but little difference in quintile 2.

- **TES=60**: IMD (F=6.26,df9&1982,p<0.001); POLAR AHE (F=4.51, df4&1986,p=0.001); MOSAIC (F=6.84,df9&1982,p<0.001); POLAR YPR non-significant (p>0.05)

Further exploration of how these profiles change with different overall GAMSAT cut-off scores are shown in Figures 13-16 below.

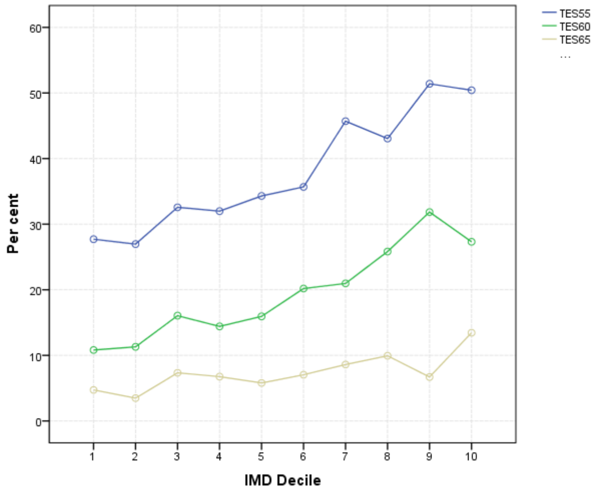

Figure 13

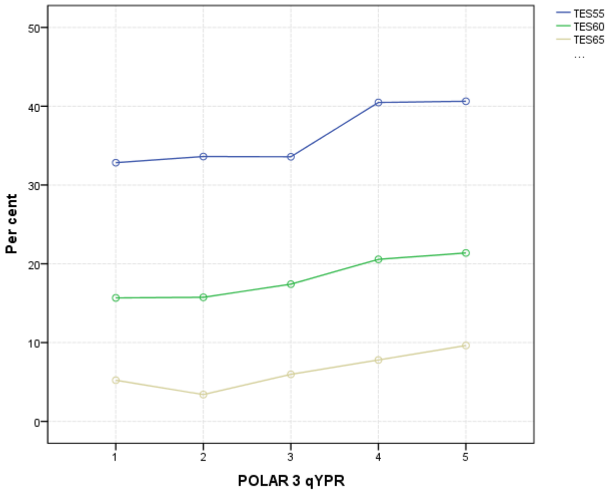

Figure 14

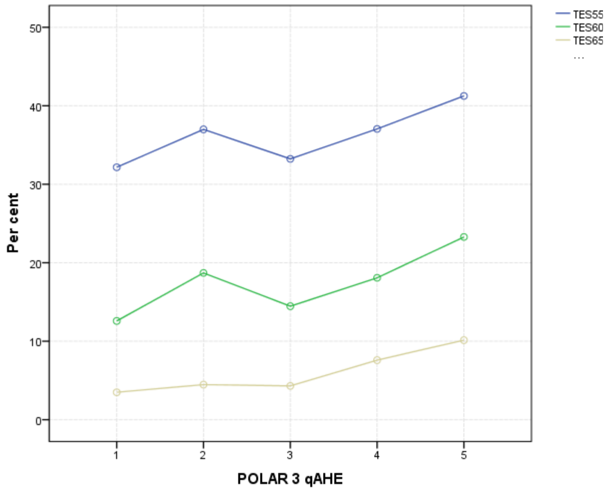

Figure 15

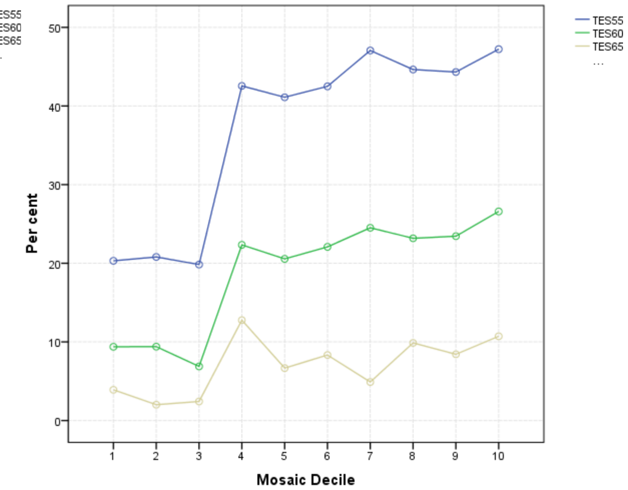

Figure 16

Inspection of the impact of different GAMSAT thresholds suggests that both MOSAIC and IMD measures have somewhat different associations with lower thresholds (TES=60 and TES=55) than the highest examined (TES=65), with more marked differences between (say) the lowest three deciles and the highest two. POLAR YPR does not seem to have a strong relationship with the different TES values (and is non-significant for TES=60); POLAR AHE seems to have a more complex relationship over these different TES values.

In summary, there are consistent, though modest associations between some of the neighbourhood-based indices of social deprivation and GAMSAT performance overall (especially POLAR AHE and MOSAIC). In addition, several indices appear linked to differential performance at a series of threshold values typically used for selection to medical school.[1]

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[1] TES values of 55 to 65 have been used by different medical schools in UK and Ireland for admission to graduate entry medicine programmes.

GAMSAT Nottingham 2003-13

Applications for the University of Nottingham GEM (graduate entry medicine) programme come via UCAS and self-report age, gender, degree subject(s), class of degree(s), and highest degree(s). (Though there is opportunity to record secondary educational qualifications, less than 30% do so and these were not considered further.) Applicant postcodes were used to derive a number of geographical indices of socioeconomic status, namely: Index of multiple deprivation (calculated as deciles separately for England, Wales, Scotland and Northern Ireland), POLAR 3 (quintiles – calculated as two separate indices – Young persons' participation rate in Higher Education – HE - {YPR}, and proportion of adults with HE qualifications {AHE}), and MOSAIC (calculated as deciles).

Elimination of invalid postcodes (mainly from EU and international applicants) resulted in the loss of 3095 individuals, leaving n=8608 with full data.

Table 2, below, shows the simple correlations between GAMSAT overall and section scores, and the four neighbourhood indices of social deprivation.

		S1	S2	S3	OA	IMD decile	POLAR3 qYPR	POLAR 3 qAHE	Mosaic decile
GAMSAT S1	Pearson Correlation	1							
	Sig. (2-tailed)								
GAMSAT S2	Pearson Correlation	.501**	1						
	Sig. (2-tailed)								
GAMSAT S3	Pearson Correlation	.605**	.269**	1					
	Sig. (2-tailed)	.000	.000						
GAMSAT mean OA	Pearson Correlation	.801**	.609**	.911**	1				
	Sig. (2-tailed)	.000	.000	.000					
IMD decile	Pearson Correlation	.175**	.104**	.193**	.205**	1			
	Sig. (2-tailed)	.000	.000	.000	.000				
POLAR 3 qYPR	Pearson Correlation	.095**	.091**	.087**	.110**	.364**	1		
	Sig. (2-tailed)	.000	.000	.000	.000	.000			
POLAR 3 qAHE	Pearson Correlation	.141**	.112**	.090**	.129**	.198**	.718**	1	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		
MOSAIC decile	Pearson Correlation	.178**	.110**	.209**	.219**	.687**	.346**	.171**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	

Table 2

Univariate analyses of variance showed that each measure of deprivation was significantly related to GAMSAT mean score: -

- IMD (F=45.53, df9&8597, p<0.001); POLAR YPR (F=21.45, df9&8597, p<0.001); POLAR AHE (F=37.61, df9&8597, p<0.001); MOSAIC (F=59.53, df9&8597, p<0.001)

In each case, candidates from the more deprived neighbourhoods scored on average lower on GAMSAT. Figures 17-20 below show the simple relationships of mean GAMSAT score with the Index of multiple deprivation decile (IMD), POLAR 3 quintile measures of Young people's participation rate (YPR) and Adults with HE qualifications (AHE), and the MOSAIC decile.

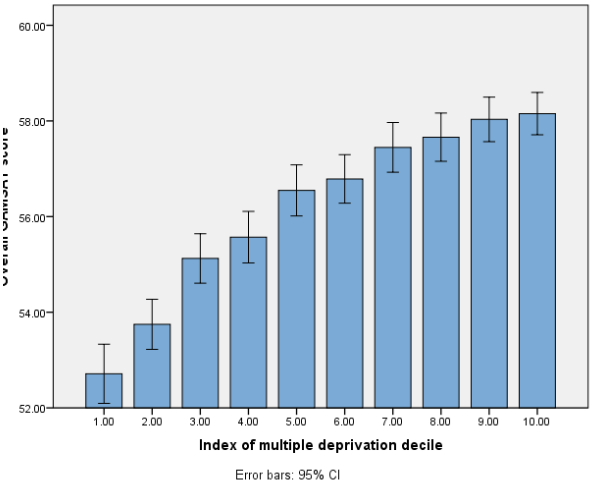


Figure 17

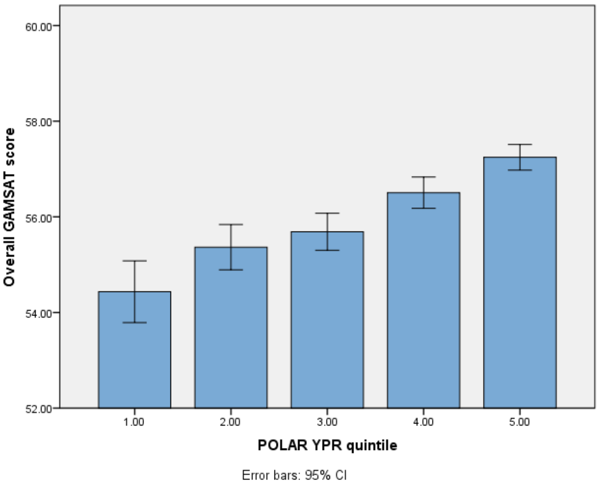


Figure 18

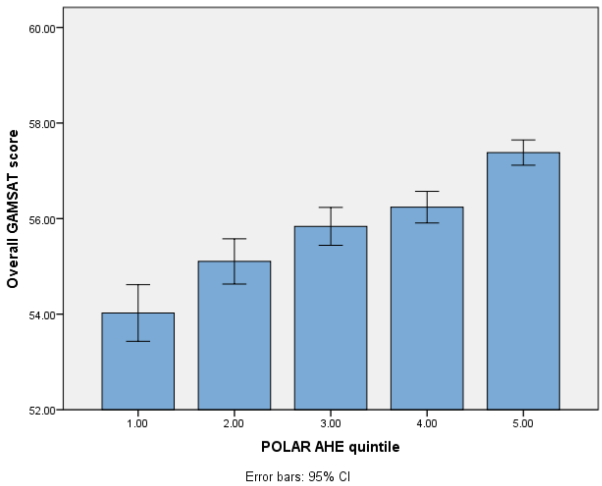


Figure 19

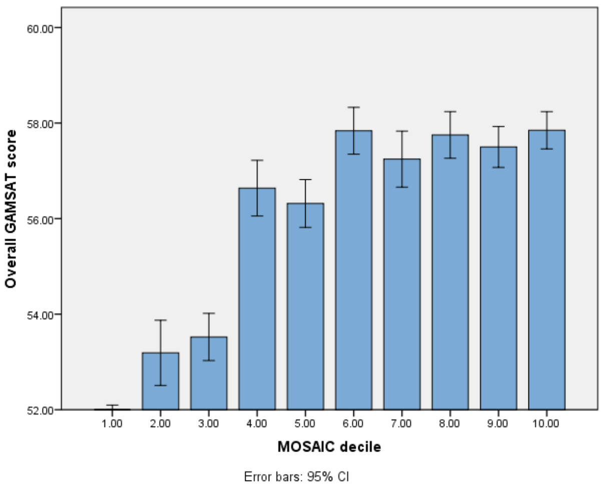


Figure 20

In summary, there are significant mean differences between candidate scores from the least and most deprived categories on each measure. In absolute terms the largest can be seen in the MOSAIC measure – circa 6 points range – a smaller difference in the Index of multiple deprivation (ca. 5 points), and smaller ones in the Polar3 measures (AHE – 3.5, YPR – 2.5); in terms of z-scores, the differences ranged from 0.78 to 0.32, moderate in size.

This overall pattern is clearly detectable in each section of GAMSAT as can be seen in the following figures 21-24.

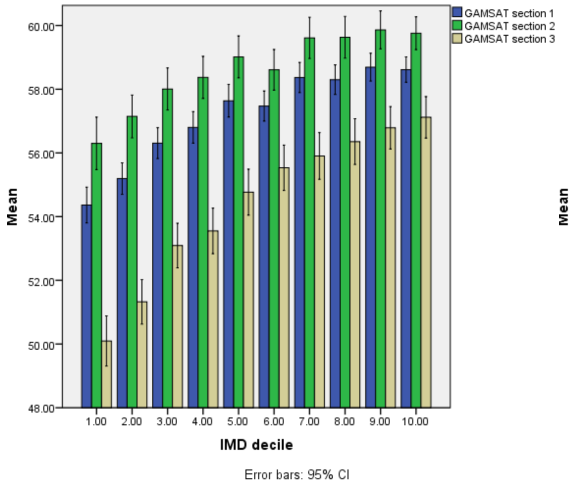


Figure 21

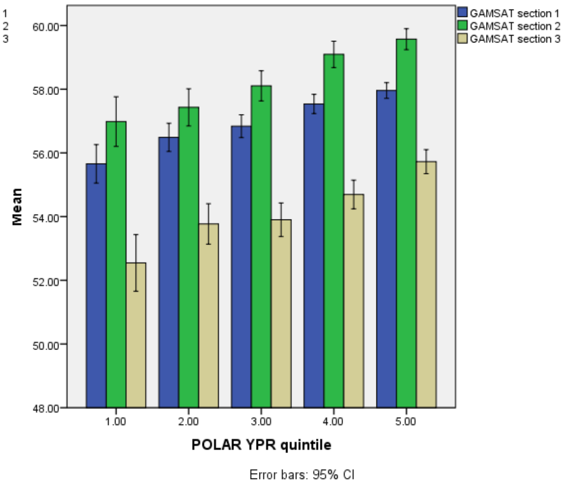


Figure 22

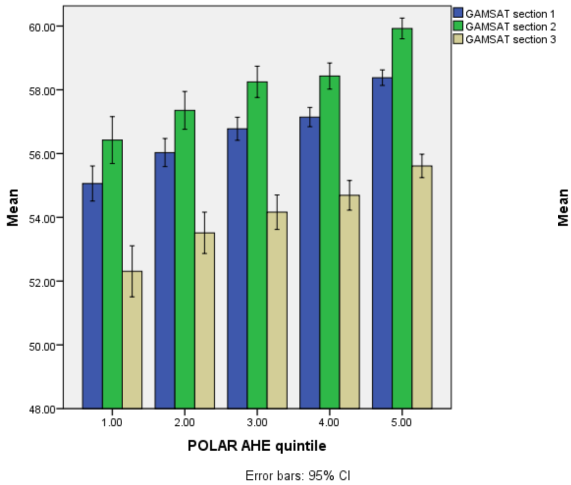


Figure 23

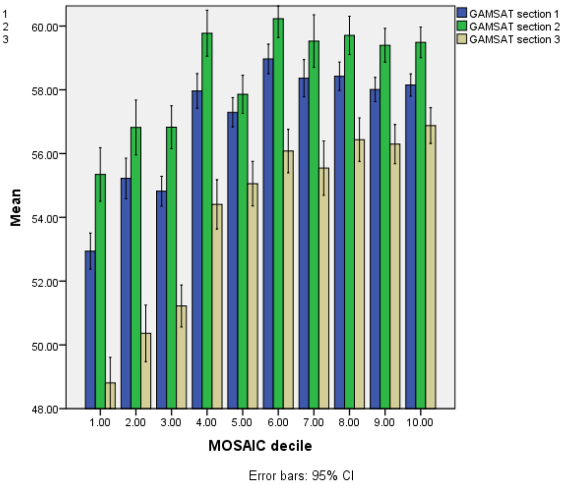


Figure 24

All GAMSAT section scores are significantly associated with the four deprivation indices (see statistics below). Inspection suggests that Section 3 scores are more sensitive to IMD and MOSAIC, applicants in the lowest two or three deciles respectively performing on average much worse than those in the most advantaged three deciles.

- **Section 1:** IMD (F=33.92, df9&8597, p<0.001); POLAR YPR (F=15.90, df4&8599, p<0.001); POLAR AHE (F=45.43, df4&8599, p<0.001); MOSAIC (F=49.50, df9&8597, p<0.001)
- **Section 2:** IMD (F=11.82, df9&8597, p<0.001); POLAR YPR (F=14.48, df4&8599, p<0.001); POLAR AHE (F=29.10, df4&8599, p<0.001); MOSAIC (F=19.32, df9&8597, p<0.001)
- **Section 3:** IMD (F=39.57, df9&8597, p<0.001); POLAR YPR (F=14.08, df4&8599, p<0.001); POLAR AHE (F=18.0, df4&8599, p<0.001); MOSAIC (F=48.79, df9&8597, p<0.001)

Finally, analysis of the relationship between each measure of deprivation and the overall GAMSAT score controlling for other demographic (gender, age) and educational (subject of degree, class of degree) was carried out.

- IMD (F=31.81, df9&7349, p<0.001); POLAR YPR (F=19.72, df4&7354, p<0.001); POLAR AHE (F=25.04, df4&7354, p<0.001); MOSAIC (F=41.99, df9&7349, p<0.001)

The above analyses showed that the relationships persisted for all four measures – greater levels of deprivation in applicant neighbourhoods associated significantly with overall GAMSAT score. Table 4 and Figure 25 below give the estimated means for each measure after controlling for the other demographic and educational variables.

	Decile									
Index	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
IMD	52.8	53.6	54.7	55.3	56.0	56.3	56.9	57.0	57.2	57.3
POLAR YPR	54.2	55.0	55.3	56.0	56.6					
POLAR AHE	53.8	54.5	55.5	55.8	56.5					
MOSAIC	51.7	53.4	53.6	55.8	56.1	56.9	56.2	56.8	57.0	57.0

Table 4

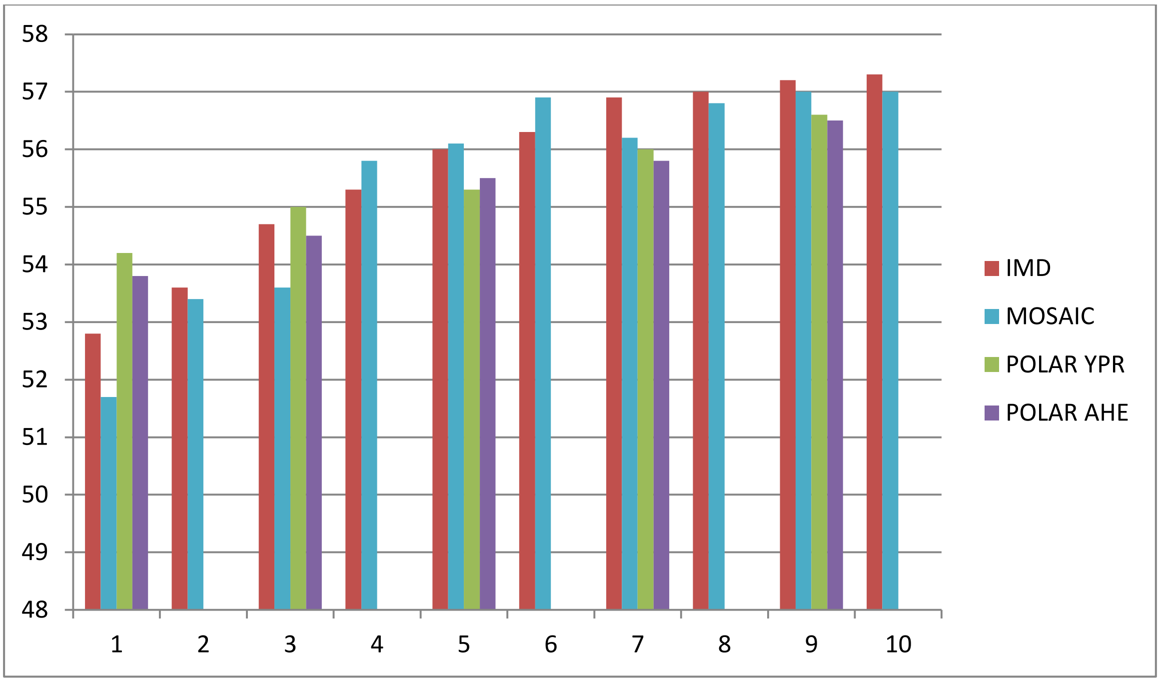


Figure 25

From Table 4 and Figure 25 above, it can be seen that the largest differences in overall GAMSAT score are found between the lowest and highest MOSAIC deciles (5.5 points), followed by IMD (4.5 points), AHE (2.7) and YPR (2.3). In terms of the standard deviation of GAMSAT scores, these are: 0.70, 0.57, 0.34 and 0.29

Typical Entry Scores

The last group of analyses explored how the profile of applicants might change depending on more stringent or lenient GAMSAT thresholds. The distribution of percentages who would be above cut-off scores set at 55, 60 and 65 are shown for the four deprivation indices in Figures 26-29 below.

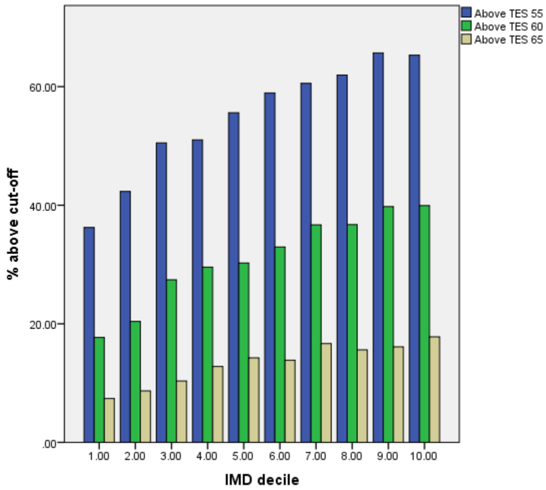


Figure 26

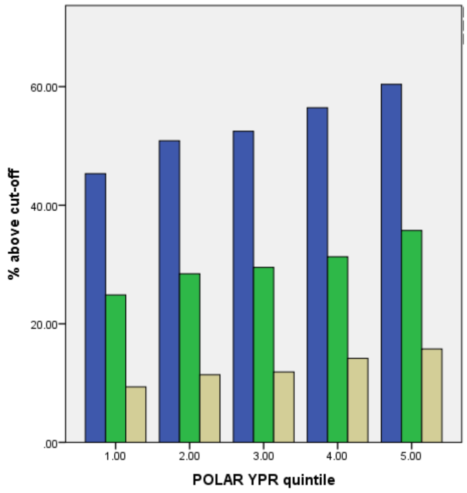


Figure 27

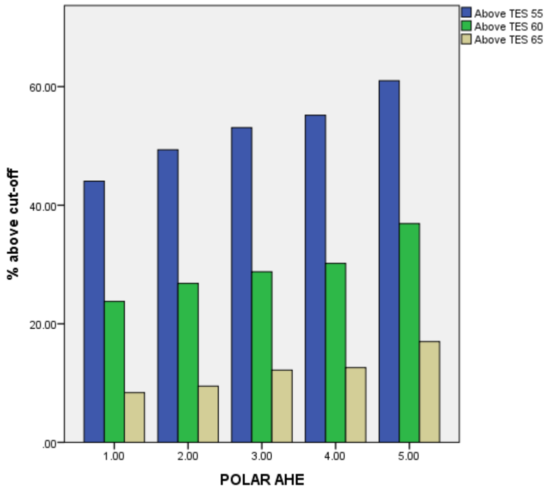


Figure 28

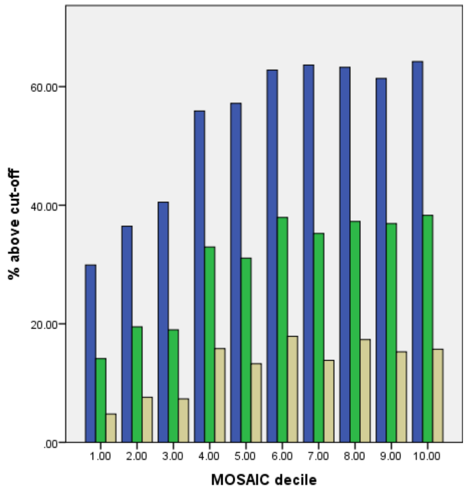


Figure 29

Inspection of Figures 26-29 above reveals that the shape of the profiles are similar across these different GAMSAT thresholds. Analysis using the Crosstabs function and Chi^2 statistic showed that all the separate profiles (i.e. IMD, POLAR YPR, POLAR AHE, MOSAIC) were highly significantly related to the numbers who would meet or fail to meet each of the three TES cut-off scores (55, 60 & 65) (all p_s <0.001).

Summary

The pattern of evidence from this second, partially overlapping dataset, confirms that GAMSAT scores are sensitive to neighbourhood-based indices of socioeconomic disadvantage, and this sensitivity persists after controlling for gender, age and first degree subject and class. The sensitivity can also be seen when examining the numbers and proportions of applicants who score above a variety of typical entry scores (GAMSAT cut-offs). The potential influence of ethnicity was not examined in this dataset and it is therefore possible that the strength of association between GAMSAT performance and the deprivation measures examined here would be different when ethnicity was controlled for.

Predictive validity

Four successive graduating cohorts (2007-2010) of students who all followed the same University of Nottingham GEM (graduate entry medicine) curriculum and took the same assessments were studied (n=347).

Predictor variables investigated were: age, gender, subject of first degree, class of first degree, possession of a higher degree (postgraduate masters or doctorate), GAMSAT (overall and section scores), and Interview grade (a 3-point interview rating: outstanding, very good, suitable[2]).[3]

Over the 4-year GEM programme, students took seventeen different graded summative assessments (8 knowledge-based, 6 skills-based, and 3 coursework-based).

In order to simplify the large number of potential relationships to analyse, all the assessment data was subjected to factor analysis to reduce the dimensions studied. The relationship of each assessment factor and GAMSAT was then explored via general linear modelling, starting by analysis of the simple relationship between GAMSAT and assessment factors, followed by controlling for the other demographic, educational, and selection factors. Details are reported later in this section.

Assessment factors

Principal component analysis with Varimax rotation was used to identify a small number of independent assessment factors. Four factors (Eigen value>1) were identified (see Table 5 below).

Table 5

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.952	35.015	35.015	5.952	35.015	35.015	4.640	27.295	27.295
2	1.489	8.761	43.776	1.489	8.761	43.776	1.987	11.690	38.985
3	1.317	7.746	51.522	1.317	7.746	51.522	1.646	9.682	48.667
4	1.054	6.201	57.724	1.054	6.201	57.724	1.540	9.057	57.724
5	.921	5.418	63.142						
6	.886	5.209	68.351						
7	.781	4.595	72.947						
8	.741	4.359	77.305						
9	.670	3.943	81.249						
10	.593	3.489	84.738						
11	.569	3.345	88.083						
12	.490	2.883	90.966						
13	.425	2.501	93.466						
14	.387	2.277	95.743						
15	.273	1.608	97.351						
16	.255	1.498	98.849						
17	.196	1.151	100.000						

[2] Interview grades of unsuitable, and completely unsuitable, only occurred amongst rejected applicants.
[3] Secondary educational qualifications were not available for the majority (ca. 70%) of this study population.

Extraction Method: Principal Component Analysis.

Examination of the factor loadings of the rotated solution showed the following patterns:-

- Factor 1: strong loadings from knowledge-based exams (e.g. MCQ exams in years 2, 3 & 4: 0.719 & 0.831, 0.755 & 0.753 & 0.645 & 0.675, 0.809) – hence termed *knowledge-based MCQ factor*
- Factor 2: the strongest loading from a modified essay exam and a coursework+presentation project (year 2; 0.630, 0.596) – termed *combined factor*
- Factor 3: the strongest loadings from OSLER skills-based exams (years 2, 3, 4; 0.725, 0.509, 0.592) with lower loadings from OSCE skills-based exams (0.372, 0.257, 0.345) – hence termed *skills-based factor*
- Factor 4: strong loadings from two course-work based assessments (years 1, 3; 0.709, 0.687) – termed *course-work factor*

Predictor analyses

The relationships between the different predictor variables and each independent assessment factor were examined using general linear modelling as follows. Simple, univariate analysis was used initially to establish which predictors were significantly related to assessment outcomes. Then, those factors with significant simple relationships were re-examined by adding each factor in turn (as fixed or random factors appropriately).

The predictor variables examined were constructed as follows:-

- GAMSAT: mean GAMSAT scores banded into five categories (<62.67, 62.67-65, 65-67.67, 67.67-75, >75); GAMSAT section scores used as continuous variables
- Age: banded into five categories (<23, 23-26, 26-30. 30-39, >39)
- Gender: male, female
- Degree class: 1st, 2.1, 2.2, 3rd or pass/unclassified/ordinary[4]
- Degree subject: this was coded initially using the UCAS JACS codes, then collapsed into four categories (biological or life sciences, health professional qualification, physical sciences inc. engineering IT & maths, arts humanities & social science)
- Highest degree: undergraduate bachelors or masters, postgraduate masters, postgraduate doctorate.
- Interview grade: excellent, very good, suitable

Knowledge-based MCQ factor

Three predictors had significant associations with this factor – GAMSAT mean score (F=17.0, df4&342, $p<0.001$), Ageband (F=2.6, df4&342, p=0.035), and Degree class (F=5.1, df3&342, p=0.001); all others being non-significant (all $p_s>0.05$). Analysis combining GAMSAT, Degree class and Ageband demonstrated a strong, independent effect of GAMSAT (F=15.5, df4&335, $p<0.001$), a weak additional effect of Ageband (F=2.54, df4&335, p=0.04) and a non-significant effect of Degree class ($p>0.05$). The general relationship – of higher GAMSAT scores with higher assessment factor 1 scores can be seen in Figure 30 below. There is a simple positive association between GAMSAT and Assessment factor 1; however, the relationship with age is more complicated, though marginal – the

[4] A small number of entrants had weak first degrees, but also postgraduate masters or doctoral degrees.

youngest age group doing slightly worse than the next age group, and the oldest group doing better than the next to oldest group.

In summary, higher GAMSAT scores are strongly related to better scores on the Knowledge-based MCQ factor. Roughly, one point increase in GAMSAT score would be related to a 0.5% increase in MCQ exam score.

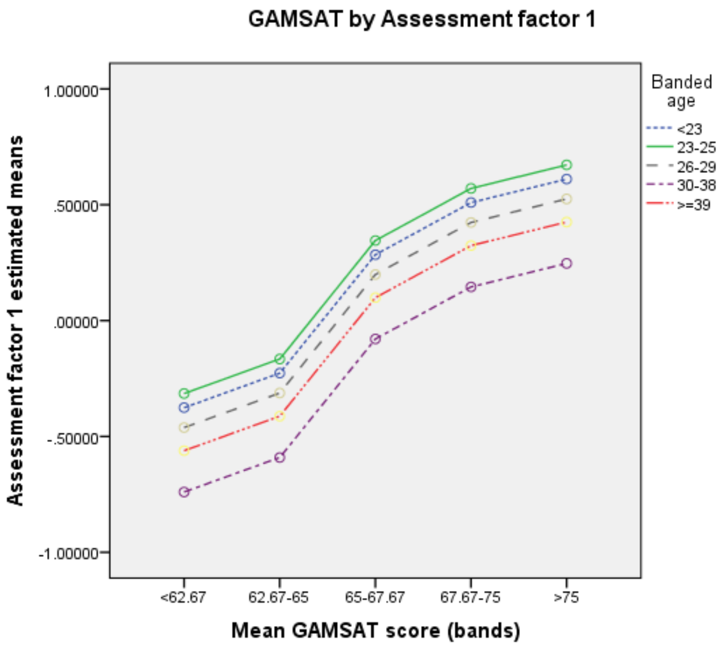


Figure 30

Combined assessment factor

Two predictors had significant associations with this factor – Gender - women scoring higher than men (F=11.5.0, df1&345, p=0.001), and Degree class – higher class of degree associated with higher scores (F=3.66, df3&343, p=0.013); all others being non-significant (all p_s>0.05). Analysis combining Gender and Degree class demonstrated a strong, independent effect of Gender (F=8.09, df1&342, p=0.005), and a non-significant effect of Degree class (p>0.05). The general relationship – of higher assessment factor 2 scores in women can be seen in Figure 31 below.

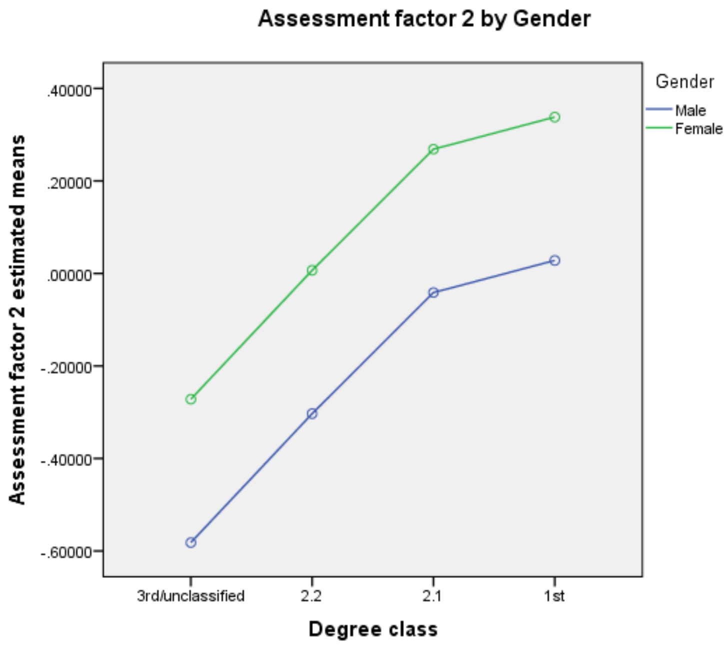


Figure 31

In summary, women scored higher on the Combined assessment factor – equating roughly to 1.7% in assessment marks.

Skills-based factor

Two predictors had significant associations with this factor – Gender (women scoring higher than men; F=13.7, df1&345, p<0.001),and Ageband (F=3.06, df4&342, p=0.017); all others being non-significant (all p_s>0.05). Analysis combining Gender and Ageband demonstrated a strong, independent effect of Gender (F=10.3, df1&341, p=0.001), and a non-significant effect of Ageband (p>0.05). The general form of these relationships can be seen in Figure 32 below.

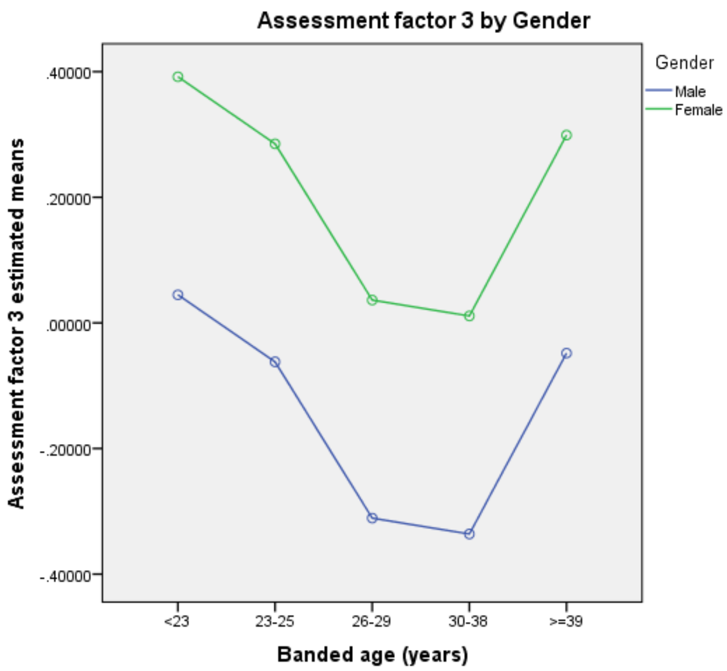


Figure 32

In summary, women scored higher on the Skills-based assessment factor – equating roughly to 3.3% in OSCE and OSLER marks.

Course-work assessment factor

Three predictors had significant associations with this factor –Ageband (F=2.59, df4&342, p=0.037), Degree class (F=3.10, df3&343, p=0.027), and Interview grade (F=8.30, df2&344, p<0.001); all others being non-significant (all p_s>0.05). Analysis combining Interview grade, Degree class and Ageband demonstrated a strong, independent effect of Interview grade (F=8.91, df2&337, p<0.001), a weak additional effect of Degree class (F=2.93, df3&337, p=0.034), and a non-significant effect of Ageband (p>0.05). The general relationship – of higher Interview grade and higher Degree class with higher assessment factor 4 scores can be seen in Figure 33 below.

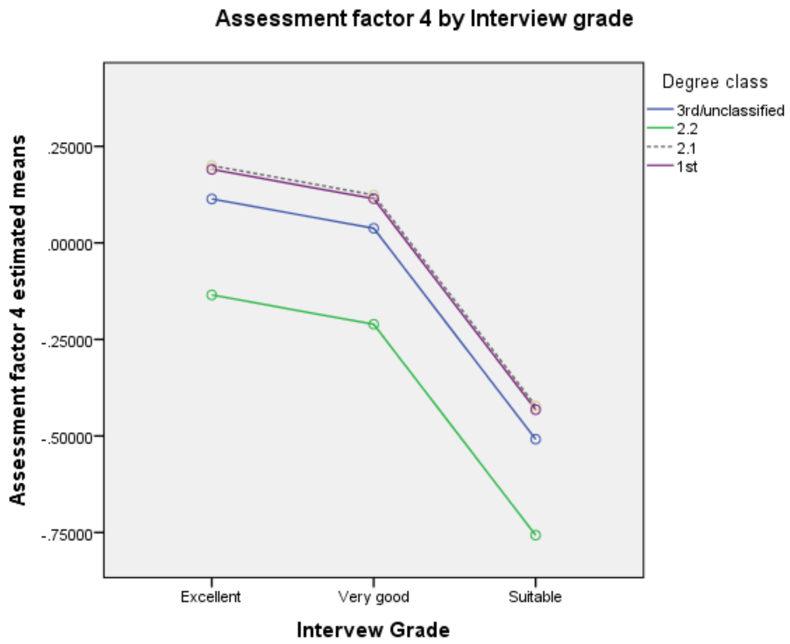


Figure 33

In summary, better Interview grades are strongly related to better scores on the Course-work assessment factor, and students with a 2.2 degree perform worse than those with 1st or 2.1 on the Course-work assessment factor. Roughly, being graded *Outstanding* rather than *Suitable* at interview would be related to a 3.4% increase in coursework marks.

Summary

GAMSAT is strongly predictive of student performance on an MCQ type knowledge-based exam factor, those scoring higher on GAMSAT also performing better in knowledge-based exams. This is the largest identifiable component of assessment, accounting for circa 30% of the variance in the factor analysis. Although class of first degree has a similar relationship, the association with GAMSAT is both stronger and independent of degree class. This is likely to be due to the coarse classification of degree class in the UK: past research on the predictive validity of GAMSAT in Australia, where degrees yield a GPA (grade point average), shows that GPA is typically also a good and independent predictor of medical school exam performance (Wilkinson et al, 2008; Coates, 2008). Secondary educational attainment might also be expected to predict assessment performance at medical school, although a recent study found a weaker relationship amongst graduates than amongst school-leavers in their first year of medical school (McManus et al, 2013). Unfortunately no secondary educational attainment data was available in the present study.

GAMSAT does not predict other assessment factors (accounting collectively for a further 30% of variance), in particular ones mainly reflective of clinical competency testing and written course work. Instead, these are predicted significantly by gender, with women performing better (Assessment factors 2 & 3), and interview grade (Assessment factor 4). Age had weak relationships with several assessment factors, taking the form of weaker performance with increasing age band, except for the oldest group (>39 years), though the number was smaller (n=531).

Discussion

The evidence about GAMSAT, both from the present study and published research, shows that GAMSAT has a degree of predictive validity that is incremental (i.e. over and above) or independent of attainment in first degree. The present study, demonstrates that this ability to predict performance at medical school is largely confined to knowledge-based exams, and that this effect can be seen throughout the four years of the programme. However, there is no research as yet that has controlled for the differences that must exist in secondary educational attainment amongst entrants to graduate medicine courses: since past and recent studies (e.g. McManus et al, 2013) have consistently demonstrated the strong relationship between secondary educational qualifications and performance at medical school, even if weaker amongst graduate entrants, the present results must be accompanied by an important proviso.

The other evidence presented here constitutes the first indication that GAMSAT performance (along with other aptitude tests and secondary educational attainment) varies consistently according to neighbourhood-based measures of socioeconomic advantage. Though these associations are highly significant statistically, the effect sizes are moderate. They do suggest, however, that applicants from more disadvantaged neighbourhoods are less likely to be successful in entering graduate entry medicine programmes. There is here also an important proviso: neighbourhood-based measures, though widely used in widening participation, may be a less valid indicator for graduate applicants to medicine than school leavers since graduates are less likely to be living in the parental home, and are more likely to be in the early years of their career, earning less than they will do later or, in some cases, still at university.

Patterns of medicine application

Applicants to medicine in the UK, must apply through UCAS (Universities and Colleges Admissions Service). Each individual may make up to four separate medicine applications and the majority of applicants do so. Candidates who have high academic attainment, score well on aptitude tests, and have strong personal statements are then likely to be invited for interview by several different universities.

In the past, small numbers of medical schools have collaborated over interviews or assessment centres. However, most carry out interviews independently. The feasibility of any shared interviews depends on the degree of co-application between medical schools, as well as agreement on the appropriate content and assessment involved. Thus the focus of this piece of work was to establish an initial picture of co-application across the thirty three UK universities offering medicine.

Method

Data was requested from UCAS for all applications to medicine programmes in the UK for entry in autumn 2013 in the following form: for each medical school (university), the number of applicants who also made an application to each of the other medical schools, thus resulting in a table of information showing the distribution of co-applications by medical school (index schools by other schools applied to). These figures are shown in Table 6 below.

These raw numbers were then converted into the proportion (percentage) of applicants for each index school who applied also to each other school, and the total number of applications to that index school converted into a proportion of 1 (100%). Table 7 below shows this information, together with shading that indicates how high the proportions of co-application are (heavier shading = higher proportion).

Year	Institution code	A20	B32	B74	B78	C05	C15	D65	E14	E56	E84	G28	H75	I50	K12	K60	L14
2013	A20	**2364**	128	159	232	75	161	1117	83	1030	55	870	73	43	210	117	19
2013	B32	128	**3304**	202	1384	369	349	54	106	236	73	60	67	451	170	495	66
2013	B74	159	202	**2528**	569	94	356	46	311	94	354	71	111	162	399	429	74
2013	B78	232	1384	569	**5218**	408	904	106	239	391	274	84	127	507	382	631	118
2013	C05	75	369	94	408	**2036**	99	51	35	288	35	46	30	678	40	447	11
2013	C15	161	349	356	904	99	**2627**	97	175	199	218	88	91	131	296	281	26
2013	D65	1117	54	46	106	51	97	**1929**	44	991	36	895	26	29	89	86	7
2013	E14	83	106	311	239	35	175	44	**1851**	38	188	38	183	58	353	342	79
2013	E56	1030	236	94	391	288	199	991	38	**2889**	70	871	51	264	51	341	10
2013	E84	55	73	354	274	35	218	36	188	70	**1783**	40	78	46	113	138	71
2013	G28	870	60	71	84	46	88	895	38	871	40	**1810**	45	42	58	103	8
2013	H75	73	67	111	127	30	91	26	183	51	78	45	**1103**	51	200	105	42
2013	I50	43	451	162	507	678	131	29	58	264	46	42	51	**3069**	68	1271	15
2013	K12	210	170	399	382	40	296	89	353	51	113	58	200	68	**2119**	156	140
2013	K60	117	495	429	631	447	281	86	342	341	138	103	105	1271	156	**5409**	17
2013	L14	19	66	74	118	11	26	7	79	10	71	8	42	15	140	17	**547**
2013	L23	288	372	410	722	145	458	117	225	293	146	110	263	146	445	343	76
2013	L34	165	375	380	429	140	281	75	201	104	148	65	149	197	371	514	40
2013	L41	203	912	422	1385	128	421	91	325	157	238	122	225	179	531	235	384
2013	M20	128	205	130	306	97	262	101	133	211	104	141	171	134	265	359	88
2013	N21	263	312	210	456	222	275	246	134	456	189	209	224	258	188	815	23
2013	N84	104	486	309	718	272	459	58	411	247	566	74	160	256	279	710	42
2013	O33	52	404	67	447	125	159	52	21	288	64	39	26	562	36	388	8
2013	P60	33	29	210	98	9	80	23	74	21	589	20	50	15	90	50	25
2013	Q50	99	285	312	408	228	236	67	198	176	116	74	107	877	150	1817	17
2013	Q75	275	67	83	152	41	173	231	56	222	41	177	41	26	75	66	12
2013	S18	161	320	250	563	135	416	128	168	242	114	105	223	133	301	296	46
2013	S27	151	380	675	814	211	472	83	535	158	416	120	123	369	319	1163	44
2013	S36	427	41	47	76	89	46	424	22	471	41	368	40	45	28	64	5
2013	S49	35	122	223	214	68	107	19	162	29	475	31	61	253	127	793	8
2013	S93	23	34	12	81	27	38	4	3	3	132	7	<3	7	29	38	3
2013	U80	55	434	140	536	641	123	29	43	278	43	23	46	1125	42	759	14
2013	W20	77	269	90	270	98	91	49	52	48	8	47	41	319	96	793	3

Table 6: Numbers of co-applicants by index medical school

Year	Institution	L23	L34	L41	M20	N21	N84	O33	P60	Q50	Q75	S18	S27	S36	S49	S93	U80	W20
2013	A20	288	165	203	128	263	104	52	33	99	275	161	151	427	35	23	55	77
2013	B32	372	375	912	205	312	486	404	29	285	67	320	380	41	122	34	434	269
2013	B74	410	380	422	130	210	309	67	210	312	83	250	675	47	223	12	140	90
2013	B78	722	429	1385	306	456	718	447	98	408	152	563	814	76	214	81	536	270
2013	C05	145	140	128	97	222	272	125	9	228	41	135	211	89	68	27	641	98
2013	C15	458	281	421	262	275	459	159	80	236	173	416	472	46	107	38	123	91
2013	D65	117	75	91	101	246	58	52	23	67	231	128	83	424	19	4	29	49
2013	E14	225	201	325	133	134	411	21	74	198	56	168	535	22	162	3	43	52
2013	E56	293	104	157	211	456	247	288	21	176	222	242	158	471	29	3	278	48
2013	E84	146	148	238	104	189	566	64	589	116	41	114	416	41	475	132	43	8
2013	G28	110	65	122	141	209	74	39	20	74	177	105	120	368	31	7	23	47
2013	H75	263	149	225	171	224	160	26	50	107	41	223	123	40	61	<3	46	41
2013	I50	146	197	179	134	258	256	562	15	877	26	133	369	45	253	7	1125	319
2013	K12	445	371	531	265	188	279	36	90	150	75	301	319	28	127	29	42	96
2013	K60	343	514	235	359	815	710	388	50	1817	66	296	1163	64	793	38	759	793
2013	L14	76	40	384	88	23	42	8	25	17	12	46	44	5	8	3	14	3
2013	L23	**3596**	673	622	590	783	744	169	68	225	93	933	509	60	109	13	155	126
2013	L34	673	**3068**	338	314	602	735	108	82	365	72	539	619	39	203	48	131	413
2013	L41	622	338	**3655**	513	319	375	118	104	212	212	404	351	47	150	38	204	128
2013	M20	590	314	513	**2503**	532	363	110	49	274	83	562	276	66	106	3	130	73
2013	N21	783	602	319	532	**4035**	598	227	65	497	179	720	737	118	162	50	140	837
2013	N84	744	735	375	363	598	**4526**	254	419	345	51	770	843	61	1049	497	232	260
2013	O33	169	108	118	110	227	254	**1802**	15	178	30	175	179	69	64	9	518	83
2013	P60	68	82	104	49	65	419	15	**1065**	53	29	46	200	16	415	108	17	9
2013	Q50	225	365	212	274	497	345	178	53	**3826**	62	264	900	47	605	23	483	763
2013	Q75	93	72	212	83	179	51	30	29	62	**1017**	83	104	57	24	7	21	31
2013	S18	933	539	404	562	720	770	175	46	264	83	**3043**	411	72	109	15	131	93
2013	S27	509	619	351	276	737	843	179	200	900	104	411	**4819**	56	358	121	146	998
2013	S36	60	39	47	66	118	61	69	16	47	57	72	56	**1065**	23	<3	41	6
2013	S49	109	203	150	106	162	1049	64	415	605	24	109	358	23	**2469**	427	159	178
2013	S93	13	48	38	3	50	497	9	108	23	7	15	121	<3	427	**679**	<3	133
2013	U80	155	131	204	130	140	232	518	17	483	21	131	146	41	159	<3	**2412**	12
2013	W20	126	413	128	73	837	260	83	9	763	31	93	998	6	178	133	12	**2221**

Table 6 cont.: Numbers of co-applicants by index medical school

	Aberdeen	Birmingham	Brighton & Sussex	Bristol	Cambridge	Cardiff	Dundee	East Anglia	Edinburgh	Exeter	Glasgow	Hull-York	Imperial	Keele	Kings	Lancaster
Aberdeen	1	0.054	0.067	0.098	0.032	0.068	0.473	0.035	0.436	0.023	0.368	0.031	0.018	0.089	0.049	0.008
Birmingham	0.039	1	0.061	0.419	0.112	0.106	0.016	0.032	0.071	0.022	0.018	0.02	0.137	0.051	0.15	0.02
Brighton & Sussex	0.063	0.08	1	0.225	0.037	0.141	0.018	0.123	0.037	0.14	0.028	0.044	0.064	0.158	0.17	0.029
Bristol	0.044	0.265	0.109	1	0.078	0.173	0.02	0.046	0.075	0.053	0.016	0.024	0.097	0.073	0.121	0.023
Cambridge	0.037	0.181	0.046	0.2	1	0.049	0.025	0.017	0.141	0.017	0.023	0.015	0.333	0.02	0.22	0.005
Cardiff	0.061	0.133	0.136	0.344	0.038	1	0.037	0.067	0.076	0.083	0.033	0.035	0.05	0.113	0.107	0.01
Dundee	0.579	0.028	0.024	0.055	0.026	0.05	1	0.023	0.514	0.019	0.464	0.013	0.015	0.046	0.045	0.004
East Anglia	0.045	0.057	0.168	0.129	0.019	0.095	0.024	1	0.021	0.102	0.021	0.099	0.031	0.191	0.185	0.043
Edinburgh	0.357	0.082	0.033	0.135	0.1	0.069	0.343	0.013	1	0.024	0.301	0.018	0.091	0.018	0.118	0.003
Exeter	0.031	0.041	0.199	0.154	0.02	0.122	0.02	0.105	0.039	1	0.022	0.044	0.026	0.063	0.077	0.04
Glasgow	0.481	0.033	0.039	0.046	0.025	0.049	0.494	0.021	0.481	0.022	1	0.025	0.023	0.032	0.057	0.004
Hull-York	0.066	0.061	0.101	0.115	0.027	0.083	0.024	0.166	0.046	0.071	0.041	1	0.046	0.181	0.095	0.038
Imperial	0.014	0.147	0.053	0.165	0.221	0.043	0.009	0.019	0.086	0.015	0.014	0.017	1	0.022	0.414	0.005
Keele	0.099	0.08	0.188	0.18	0.019	0.14	0.042	0.167	0.024	0.053	0.027	0.094	0.032	1	0.074	0.066
Kings College	0.022	0.092	0.079	0.117	0.083	0.052	0.016	0.063	0.063	0.026	0.019	0.019	0.235	0.029	1	0.003
Lancaster	0.035	0.121	0.135	0.216	0.02	0.048	0.013	0.144	0.018	0.13	0.015	0.077	0.027	0.256	0.031	1
Leeds	0.08	0.103	0.114	0.201	0.04	0.127	0.033	0.063	0.081	0.041	0.031	0.073	0.041	0.124	0.095	0.021
Leicester	0.054	0.122	0.124	0.14	0.046	0.092	0.024	0.066	0.034	0.048	0.021	0.049	0.064	0.121	0.168	0.013
Liverpool	0.056	0.25	0.115	0.379	0.035	0.115	0.025	0.089	0.043	0.065	0.033	0.062	0.049	0.145	0.064	0.105
Manchester	0.051	0.082	0.052	0.122	0.039	0.105	0.04	0.053	0.084	0.042	0.056	0.068	0.054	0.106	0.143	0.035
Newcastle	0.065	0.077	0.052	0.113	0.055	0.068	0.061	0.033	0.113	0.047	0.052	0.056	0.064	0.047	0.202	0.006
Nottingham	0.023	0.107	0.068	0.159	0.06	0.101	0.013	0.091	0.055	0.125	0.016	0.035	0.057	0.062	0.157	0.009
Oxford	0.029	0.224	0.037	0.248	0.069	0.088	0.029	0.012	0.16	0.036	0.022	0.014	0.312	0.02	0.215	0.004
Plymouth	0.031	0.027	0.197	0.092	0.008	0.075	0.022	0.069	0.02	0.553	0.019	0.047	0.014	0.085	0.047	0.023
Queen Mary	0.026	0.074	0.082	0.107	0.06	0.062	0.018	0.052	0.046	0.03	0.019	0.028	0.229	0.039	0.475	0.004
Queens Belfast	0.27	0.066	0.082	0.149	0.04	0.17	0.227	0.055	0.218	0.04	0.174	0.04	0.026	0.074	0.065	0.012
Sheffield	0.053	0.105	0.082	0.185	0.044	0.137	0.042	0.055	0.08	0.037	0.035	0.073	0.044	0.099	0.097	0.015
Southampton	0.031	0.079	0.14	0.169	0.044	0.098	0.017	0.111	0.033	0.086	0.025	0.026	0.077	0.066	0.241	0.009
St Andrews	0.401	0.038	0.044	0.071	0.084	0.043	0.398	0.021	0.442	0.038	0.346	0.038	0.042	0.026	0.06	0.005
St George's	0.014	0.049	0.09	0.087	0.028	0.043	0.008	0.066	0.012	0.192	0.013	0.025	0.102	0.051	0.321	0.003
Swansea	0.034	0.05	0.018	0.119	0.04	0.056	0.006	0.004	0.004	0.194	0.01	0.001	0.01	0.043	0.056	0.004
University College	0.023	0.18	0.058	0.222	0.266	0.051	0.012	0.018	0.115	0.018	0.01	0.019	0.466	0.017	0.315	0.006
Warwick	0.035	0.121	0.041	0.122	0.044	0.041	0.022	0.023	0.022	0.004	0.021	0.018	0.144	0.043	0.357	0.001

Table 7: Proportion of co-application by index medical school

	Leeds	Leicester	Liverpool	Manchester	Newcastle	Nottingham	Oxford	Plymouth	Queen Mary	Queens Belfast	Sheffield	Southampton	St Andrews	St George's	Swansea	University College	Warwick
Aberdeen	0.122	0.07	0.086	0.054	0.111	0.044	0.022	0.014	0.042	0.116	0.068	0.064	0.181	0.015	0.01	0.023	0.033
Birmingham	0.113	0.113	0.276	0.062	0.094	0.147	0.122	0.009	0.086	0.02	0.097	0.115	0.012	0.037	0.01	0.131	0.081
Brighton & Sussex	0.162	0.15	0.167	0.051	0.083	0.122	0.027	0.083	0.123	0.033	0.099	0.267	0.019	0.088	0.005	0.055	0.036
Bristol	0.138	0.082	0.265	0.059	0.087	0.138	0.086	0.019	0.078	0.029	0.108	0.156	0.015	0.041	0.016	0.103	0.052
Cambridge	0.071	0.069	0.063	0.048	0.109	0.134	0.061	0.004	0.112	0.02	0.066	0.104	0.044	0.033	0.013	0.315	0.048
Cardiff	0.174	0.107	0.16	0.1	0.105	0.175	0.061	0.03	0.09	0.066	0.158	0.18	0.018	0.041	0.014	0.047	0.035
Dundee	0.061	0.039	0.047	0.052	0.128	0.03	0.027	0.012	0.035	0.12	0.066	0.043	0.22	0.01	0.002	0.015	0.025
East Anglia	0.122	0.109	0.176	0.072	0.072	0.222	0.011	0.04	0.107	0.03	0.091	0.289	0.012	0.088	0.002	0.023	0.028
Edinburgh	0.101	0.036	0.054	0.073	0.158	0.085	0.1	0.007	0.061	0.077	0.084	0.055	0.163	0.01	0.001	0.096	0.017
Exeter	0.082	0.083	0.133	0.058	0.106	0.317	0.036	0.33	0.065	0.023	0.064	0.233	0.023	0.266	0.074	0.024	0.004
Glasgow	0.061	0.036	0.067	0.078	0.115	0.041	0.022	0.011	0.041	0.098	0.058	0.066	0.203	0.017	0.004	0.013	0.026
Hull-York	0.238	0.135	0.204	0.155	0.203	0.145	0.024	0.045	0.097	0.037	0.202	0.112	0.036	0.055	9E-04	0.042	0.037
Imperial	0.048	0.064	0.058	0.044	0.084	0.083	0.183	0.005	0.286	0.008	0.043	0.12	0.015	0.082	0.002	0.367	0.104
Keele	0.21	0.175	0.251	0.125	0.089	0.132	0.017	0.042	0.071	0.035	0.142	0.151	0.013	0.06	0.014	0.02	0.045
Kings College	0.063	0.095	0.043	0.066	0.151	0.131	0.072	0.009	0.336	0.012	0.055	0.215	0.012	0.147	0.007	0.14	0.147
Lancaster	0.139	0.073	0.702	0.161	0.042	0.077	0.015	0.046	0.031	0.022	0.084	0.08	0.009	0.015	0.005	0.026	0.005
Leeds	1	0.187	0.173	0.164	0.218	0.207	0.047	0.019	0.063	0.026	0.259	0.142	0.017	0.03	0.004	0.043	0.035
Leicester	0.219	1	0.11	0.102	0.196	0.24	0.035	0.027	0.119	0.023	0.176	0.202	0.013	0.066	0.016	0.043	0.135
Liverpool	0.17	0.092	1	0.14	0.087	0.103	0.032	0.028	0.058	0.058	0.111	0.096	0.013	0.041	0.01	0.056	0.035
Manchester	0.236	0.125	0.205	1	0.213	0.145	0.044	0.02	0.109	0.033	0.225	0.11	0.026	0.042	0.001	0.052	0.029
Newcastle	0.194	0.149	0.079	0.132	1	0.148	0.056	0.016	0.123	0.044	0.178	0.183	0.029	0.04	0.012	0.035	0.207
Nottingham	0.164	0.162	0.083	0.08	0.132	1	0.056	0.093	0.076	0.011	0.17	0.186	0.013	0.232	0.11	0.051	0.057
Oxford	0.094	0.06	0.065	0.061	0.126	0.141	1	0.008	0.099	0.017	0.097	0.099	0.038	0.036	0.005	0.287	0.046
Plymouth	0.064	0.077	0.098	0.046	0.061	0.393	0.014	1	0.05	0.027	0.043	0.188	0.015	0.39	0.101	0.016	0.008
Queen Mary	0.059	0.095	0.055	0.072	0.13	0.09	0.047	0.014	1	0.016	0.069	0.235	0.012	0.158	0.006	0.126	0.199
Queens Belfast	0.091	0.071	0.208	0.082	0.176	0.05	0.029	0.029	0.061	1	0.082	0.102	0.056	0.024	0.007	0.021	0.03
Sheffield	0.307	0.177	0.133	0.185	0.237	0.253	0.058	0.015	0.087	0.027	1	0.135	0.024	0.036	0.005	0.043	0.031
Southampton	0.106	0.128	0.073	0.057	0.153	0.175	0.037	0.042	0.187	0.022	0.085	1	0.012	0.074	0.025	0.03	0.207
St Andrews	0.056	0.037	0.044	0.062	0.111	0.057	0.065	0.015	0.044	0.054	0.068	0.053	1	0.022	9E-04	0.038	0.006
St George's	0.044	0.082	0.061	0.043	0.066	0.425	0.026	0.168	0.245	0.01	0.044	0.145	0.009	1	0.173	0.064	0.072
Swansea	0.019	0.071	0.056	0.004	0.074	0.732	0.013	0.159	0.034	0.01	0.022	0.178	0.001	0.629	1	0.001	0.196
University College	0.064	0.054	0.085	0.054	0.058	0.096	0.215	0.007	0.2	0.009	0.054	0.061	0.017	0.066	4E-04	1	0.005
Warwick	0.057	0.186	0.058	0.033	0.377	0.117	0.037	0.004	0.344	0.014	0.042	0.449	0.003	0.08	0.06	0.005	1

Table 7 cont.: Proportion of co-application by index medical school

Examination of Table 7 indicates that there are a number of high degrees of co-application (e.g. between B32 & B78, L14 & L41, and N84 & S93). It is not easy to discern how different universities group together in receiving applications from the same applicants (and one should note that school leavers are not allowed to apply to both Oxford and Cambridge), but some overlaps of application are evident.

The data in Table 7 was then investigated further by using simple, hierarchical cluster analysis as a technique to group different medical schools. A summary of the results is shown in Figure 34 below as a dendogram.

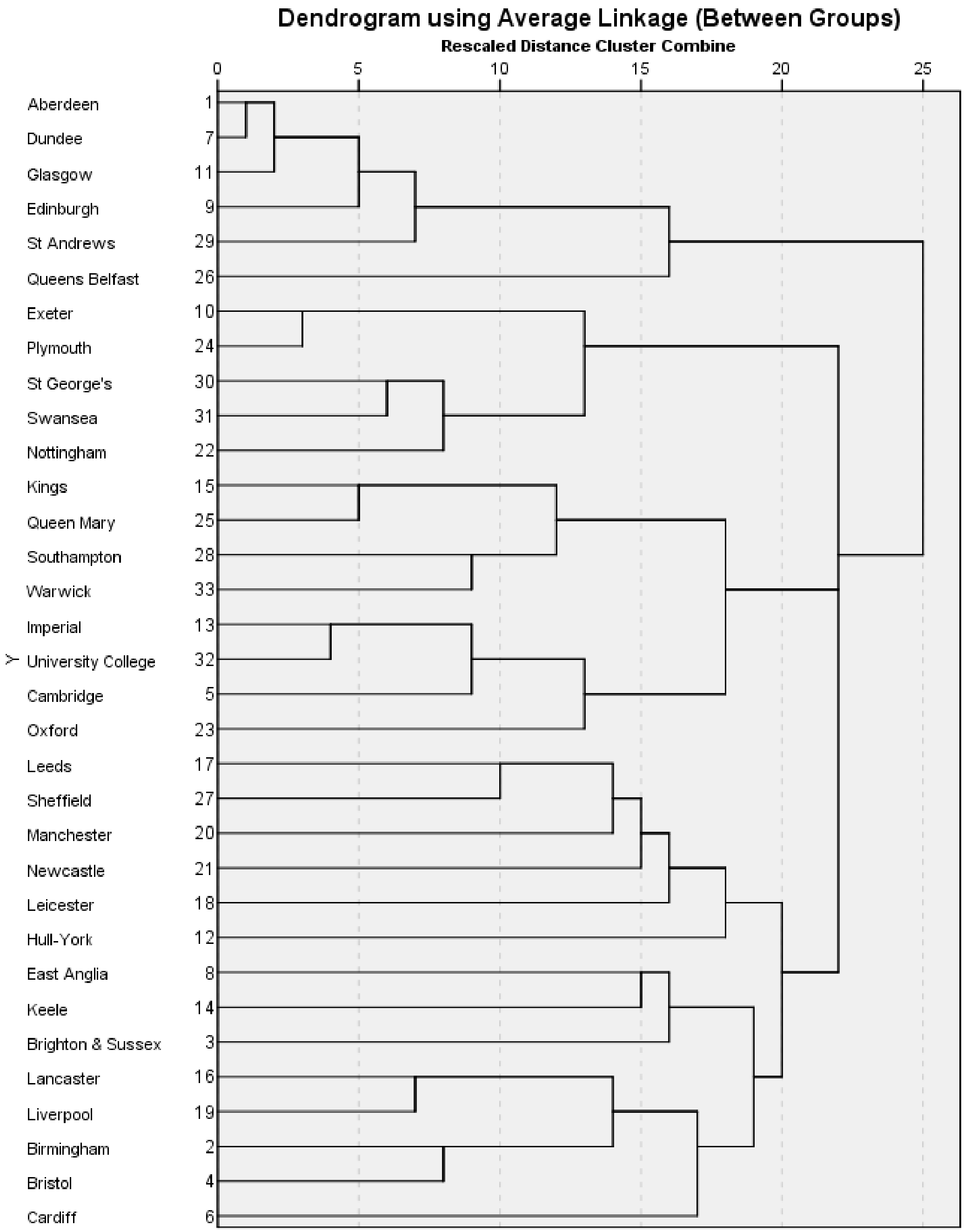


Figure 34: Clustering of medical schools by co-application

Figure 34 above depicts how different medical schools group together, and the strength of that relationship is indicated on the horizontal axis. Inspection shows a number of clear clusters, namely:-

- the Scottish schools of Aberdeen, Dundee, Edinburgh, Glasgow and (more weakly) St Andrews
- Exeter and Plymouth (constituents of the former Peninsula medical school), together with St. George's, Swansea and Nottingham
- Kings College and Queen Mary & Westfield, with Southampton and Warwick
- Imperial and University Colleges, London, together with Cambridge and Oxford (NB grouping between Oxford and Cambridge despite the artefactually low number of direct co-applications[5] {125 - presumably graduate applicants})
- Leeds, Sheffield, Manchester, Newcastle, Leicester, and Hull-York
- East Anglia, Keele and Brighton & Sussex
- Lancaster and Liverpool, Birmingham and Bristol, and Cardiff

There ae most probably several reasons for the clusters of co-application. The Scottish cluster is likely due to the pattern of home application that is marked in Scotland across higher education: Scottish applicants are also likely to have Scottish Highers qualifications rather than A levels. The second cluster comprises five schools who all use the GAMSAT aptitude test (although only for graduate applicants). The fourth cluster comprises probably the four HEIs with the highest academic requirements. The fifth cluster consists of established schools in the north of England primarily. The sixth group includes three of the five new medical schools, that are also not part if the Russell Group. The final cluster includes four HEIs that do not require applicants to take an aptitude test (BMAT, UKCAT or GAMSAT) at present.

This patterning suggest there is scope, at least, to explore some sharing of the interview/assessment centre component of selection for medicine.

[5] School leavers are not allowed to apply to both Oxford and Cambridge, but graduates may do so.

Widening participation indicators

It is not easy to define widening participation in terms of operational criteria. A recent report (Moore et al, 2013) reviewed some 22 different measures over the categories of Individual, Neighbourhood, School or College, coming to the conclusion that for most practical purposes admissions needs to focus on a small number of accessible indicators that can triangulate and effectively identify applicants who are disadvantaged.

This survey, therefore, set out to collate the different WP indicators currently used by UK medical schools for their different medicine programmes. It then compares the complexity (or absence in some cases) of WP indicators used in admissions with the measure(s) that each medical school's parent university employs with its agreement with the different statutory authorities – e.g. Office for Fair Access in England – a survey carried out by Medical Schools Council[6].

Indicators used for selection

Information was sought from the admissions deans and/or admissions officers at the thirty three UK medical schools, either in person or via online survey.

Informants were asked to indicate what types of WP markers were used for standard 5-6 year medicine programmes, graduate entry, foundation and access medicine programmes, and for outreach programmes.

Tables 8-11 below summarise the information collected.

[6] Burn, E. Office for Fair Access: Access Agreements Survey. Medical Schools Council, 2014.

School	History of LA Care	Low Income Household	Sole Carer	Receiving 16-19 bursary or similar	Disabled	NS-SEC 4-7	First to HE	Free School Meals	Targetted Outreach /In-reach	Deprived Neighbourhood	Neighbourhood with low HE participation	School serving deprived neighbourhood	School low academic performance	School progress to HE
Aberdeen									yes	yes		yes		yes
Birmingham	A2B	A2B <£42,600					A2B		A2B				YES	
Bristol	yes								yes				yes	yes
Dundee		yes	yes	yes	Yes	yes	yes		yes	yes		yes	yes	
East Anglia	Yes													
Edinburgh	yes	SIMD/EMA	yes		Yes		yes	EMA	yes	SIMD			Schools O/S Scotland	yes
Exeter	yes								yes					yes
Glasgow									yes				yes	
Hull York														
Imperial	yes	yes	yes	yes			yes	yes		yes		yes	yes	
Keele	yes								yes		yes		yes	
Lancaster														
Leeds									RO,ALL					
Leicester	yes	yes	yes		Yes	yes	yes		Yes	yes	yes	yes	YES	yes
Liverpool	yes				?				Scholars and Reps					
Manchester					yes	yes			yes		yes			yes
Newcastle	yes					yes	yes	yes	yes	yes	yes		yes	
Nottingham														
Oxford	yes		yes		yes				yes	yes	yes			
Plymouth														
St Andrews	yes								yes	SIMD			Scotland	Scotland
St George's	Yes								Yes				Yes	

Table 8: WP indicators used for standard entry 5-6 year medicine programmes

School	Programme	History of LA Care	Low Income Household	Sole Carer	Receiving 16-19 bursary or similar	Disabled	NS-SEC 4-7	First to HE	Free School Meals	Targetted Outreach /In-reach	Deprived Neighbourhood	Neighbourhood with low HE participation	School serving deprived neighbourhood	School low academic performance	School progress to HE
Bristol	Foundation Yearn (6 year)	yes								yes				yes	yes
East Anglia	Foundation Year (6 year)	yes	<35K											60% or less 5 A-C GCSE	
Keele	Foundation Yearn (6 year)	yes								yes		yes		yes	
King's	Foundation Yearn (6 year)	Yes								Yes				Yes	
Manchester	Foundation Year (6 year)					yes	yes			yes		yes		yes	yes
Nottingham	Foundation Year (6 year)	Yes	<35K	Yes											
Southampton	Foundation Year (6 year)	yes	C.Tax.W.Tax.I.S					yes	yes 10-13		yes/travelling family				
St Andrews	Foundation Year (6 year)	yes								yes	SIMD			yes	yes
Liverpool	Access Course (6 year)				Multiple individual indicators										
St Andrews	Access Course (6 year)	yes						yes		yes	yes				yes

Table 9: WP indicators used for foundation and access medicine programmes

School	Programme	History of LA Care	Low Income Household	Sole Carer	Receiving 16-19 bursary or similar	Disabled	NS-SEC 4-7	First to HE	Free School Meals	Targetted Outreach /In-reach	Deprived Neighbourhood	Neighbourhood with low HE participation	School serving deprived neighbourhood	School low academic performance	School progress to HE
Aberdeen	Outreach/in-reach programme									yes					
Bristol	Outreach/in-reach programme	yes						yes	yes			yes	yes	yes	yes
East Anglia	Outreach/in-reach programme	yes	<30k					yes							
Exeter	Outreach/in-reach programme	yes	yes		yes		yes	yes		yes	yes	yes	yes	yes	yes
Glasgow	Outreach/in-reach programme									yes					
Glasgow	Outreach/in-reach programme									yes					
Imperial	Outreach/in-reach programme							yes	yes		yes	yes	yes	yes	
Keele	Outreach/in-reach programme	yes						yes			yes	yes		yes	yes
Leeds	Outreach/in-reach programme	yes	yes		yes			yes	yes		yes	yes			yes
Leeds	Outreach/in-reach programme	yes	Yes	Yes	Yes							Yes		yes	
Leicester	Outreach/in-reach programme	yes	yes	yes	yes		yes	yes	yes			yes	yes	YES	
Manchester	Outreach/in-reach programme		yes		yes		yes	yes	yes			yes	yes	yes	yes
St Andrews	Outreach/in-reach programme	yes							yes	yes	simd			yes	yes

Table 10: WP indicators used for outreach and/or in-reach programmes in medical schools

School	Programme	History of LA Care	Low Income Household	Sole Carer	Receiving 16-19 bursary or similar	Disabled	NS-SEC 4-7	First to HE	Free School Meals	Targetted Outreach /In-reach	Deprived Neighbourhood	Neighbourhood with low HE participation	School serving deprived neighbourhood	School low academic performance	School progress to HE
Bristol	Graduate Entry(4 years)	yes								yes				yes	yes
Imperial	Graduate Entry(5 years)	yes	yes				yes	yes							
Leicester	Graduate Entry(4 years)	yes		yes		Yes								YES	
Newcastle	Graduate Entry(4 years)														
Nottingham	Graduate Entry(4 years)														

Table 11: WP indicators used for graduate entry medicine programme

The information contained in Tables 8-11 above demonstrates a number of common features, viz:

- The majority of medicine programmes utilise WP indicators
- WP indicators are diverse and include all the different categories of individual indicators (e.g. parental occupation, being in care, low income household, free school meals, etc), neighbourhood indicators (e.g. POLAR 2/3, MOSAIC, Scottish IMD), and educational indicators (e.g. low school academic achievement, low progress rate to HE)
- Most use multiple WP indicators for each type of medicine programme they provide
- Most medical programmes use participation in targeted outreach or in-reach programmes as one of their WP indicators
- A minority of programmes do not use WP indicators for specific courses (e.g. graduate entry)

Indicators used in university WP agreements

English universities wanting to charge higher tuition fees for Home / EU students are required to have an access agreement approved by the Office for Fair Access (OFFA). In the devolved administrations of Scotland, Wales and Northern Ireland there are similar agreements in place with the devolved government departments. WP agreements set out the access measures institutions will pursue and the targets for widening participation.

Table 12 below, taken from the MSC report (Burn, 2014) clearly shows that in England the National Statistics Socio-economic Classification (NS-SEC) and Low-Participation Neighbourhoods (LPN), defined using POLAR 2/3, and in Scotland the Scottish Index of Multiple Deprivation, are the most frequent measures of defining widening access. It is also clear that some institutions use measures of school performance, but how this is assessed varies.

Comparison of WP indicators used in medicine and institutionally

Comparison of these HEI institutional WP agreements with the diverse and multiple WP indicators used in admissions for medicine paints a simple, general picture: HEIs mostly use a single or dual WP measure, the commonest of which are NS-SEC or neighbourhood-based indicators (POLAR, SIMD), but medical school admissions mostly use multiple indicators that often include school-based measures as well as individual and neighbourhood ones.

The implication of this disparity between the medicine schools and their parent HEIs is that HEI policy may not always be a facilitating factor in medicine admissions; contrariwise, gains in and effective widening access by medical schools may not be reflected in their parent university measures. National agreement that provides some convergence and facilitate moves to common, shared indices would be helpful.

HEI Access agreement	WP indicators used by institution
Queen Mary	NS-SEC, LPN, care leavers
Birmingham	Low-income, outreach programme
Brighton and Sussex	NS-SEC, LPN, Care leavers
Bristol	NS-SEC 4-7, low achieving schools
Cambridge	LPN
Exeter	NS-SEC, LPN, care leavers, low achieving schools
Hull York	NS-SEC, LPN
Imperial	LPN
Keele	NS-SEC , LPN
Lancaster	NS-SEC 4,5,6, 7 , LPN
Leeds	NS SEC 4-7, low achieving schools
Leicester	NS-SEC
Liverpool	NS-SEC 4-7, LPN, Care leavers
Manchester	NS-SEC, LPN , low achieving schools
Newcastle	NS-SEC, LPN on a regional basis
East Anglia	NS-SEC, LPN, low income
Nottingham	Low-income background
Oxford	LPN, low achieving schools
Plymouth	NS-SEC 4-8, LPN, care leavers
Sheffield	NS-SEC 4-7, LPN, Care leavers
Southampton	NS-SEC 4-7, LPN, Care leavers
St George's	NS-SEC 4-7, LPN
University College	NS-SEC 4-8
Warwick	NS-SEC, LPN

Table 12: WP indicators used for English HEI OFFA agreements

Impact of academic thresholds

Data from three successive cohorts of UK applicants to medicine, from 2009-2011, were studied. They comprised all applicants who had taken the UKCAT test as part of their application process (n=33,103). This data was made available after application to the UKCAT Consortium and approval, by the Dundee University Health Informatics Centre via Safe Haven. Ethical approval was granted by the Nottingham Medical School Ethics Committee.

The data comprised socio-demographic information from self-report by applicants to medicine via UCAS or UKCAT (gender, age in September of UKCAT test year, NSSEC, Polar2 quintile, Index of Multiple Deprivation decile – computed separately for each devolved nation, Ethnic group, and School type). Secondary educational qualifications consisted of level 2 and level 3 qualifications, subjects and grades (i.e. Scottish Ordinary and Higher certificate; GCSEs and A-levels; International Baccaluareate) derived from UCAS supplied information. Lastly, UKCAT test data consisted of subtest and total scores: for a small proportion of candidates there were also multiple attempts (UKCAT can be taken once each year). It should be noted that the UKCAT test data and the UCAS data is married up in the Dundee Health Informatics Centre, who report that this has been achieved for approximately 92% of the applicants in 2009 and 2010.

Socio-demographic variables were constructed as follows:-

- Gender – coded male and female
- Age at September of test year – coded as bands <16 years, 16-20 years, >20 years (<16 applicants were not included in any analysis)
- Ethnic group – coded Asian, Black, Mixed, Other, White (these were reduced to Asian, Black, and White)
- NS-SEC (National Statistics Socio-economic classification – based on head of household occupation) coded in a simplified form as 1 = managerial and professional occupations, 2 = intermediate occupations, 3 = small employers and own account workers, 4 = lower supervisory and technical occupations and 5 = semi-routine and routine occupations
- IMD (Index of Multiple Deprivation) – coded as deciles (equal tenths) within each country, with 1=least deprived to 10=most deprived; based on applicant postcode
- POLAR2 – a measure of young people's participation rate in higher education (YPR); coded as quintiles, based on applicant postcode. 1=lowest YPR to 5=highest YPR
- School type – coded as comprehensive, further education college, grammar, independent, sixth form college, non-uk school, other school or unknown (the last three were excluded from analysis)
- Schools were also classified by their number of applicants to medicine. This was done by ordering them by number of applicants from each school, and then computing deciles where each decile contributed equal numbers of medicine applicants in total (i.e. deciles 1-10 each comprised schools that together contributed approximately 2,500 applicants over the 3-yr study period); decile 1 – schools with only 1-4 applicants over the study period, decile 10 – schools with multiple applicants over the study period (66-171).
- Highest educational qualifications – coded as higher education, information withheld, no formal qualifications, pre-higher education, school leaving qualifications, and unknown; only applicants with school leaving qualifications were included in analysis

Schools

In all, some 2,746 schools and colleges contributed approximately 25,000 applicants to medicine in this dataset from 2009-11, from the 5,250 secondary educational establishments that offer level 3 (e.g. A level, Scottish Highers, International Baccalaureate) qualifications. NB This omits applicants with higher educational qualifications (n=6,893) or with missing school information (n=965).

The number of applicants from different schools varied from a single applicant in many cases to a maximum over 170. An indication of this variation is shown in Figure 35 below, where a logarithmic scaled histogram has been used. It can be seen that just under half of UK schools did not have any applicant to medicine that took the UKCAT test, that similar numbers of schools had between a single and sixteen medicine applicants over the three year period, and that a small number of schools had larger numbers of applicants – from 17 to 171. Figure 36 below depicts this in a different way: schools have been grouped into deciles based on the number of applicants from each set of schools; thus each decile comprises all the schools who contributed approximately 2,500 applicants, ranging from decile 1 (all schools with between 1 and 4 medicine applicants) up to decile 10 (schools with 66-171 applicants), schools in each decile together aggregating 2,500 applicants). Figure 36 shows that a large number of schools contribute a minority of applicants, and that a small number of schools contribute the majority of medicine applicants – 19.3% of all UK schools and colleges being responsible (in these figures and this dataset) for 80% of all medicine applications[7].

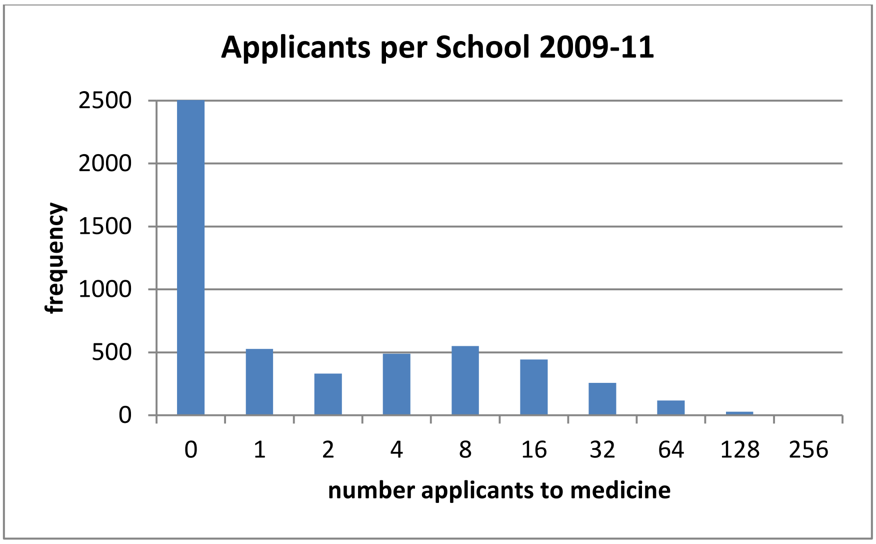


Figure 35

[7] This analysis was also computed solely for English secondary schools and colleges since the type and proportions of schools in Scotland, Wales and N. Ireland differ. Within England, the results are essentially very similar: from a total of 4,437 establishments, 51.7% contributed no applicants over this period, and 17.5% were responsible for 80% of all applicants.

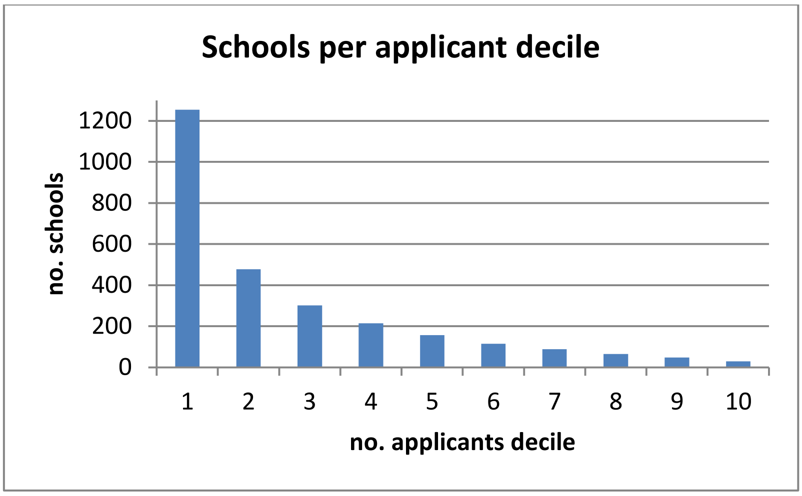


Figure 36

The distribution of applicants by school was examined further by looking at the socio-demographic characteristics of the applicants from these different deciles. That is shown in Figures 37-43 below.

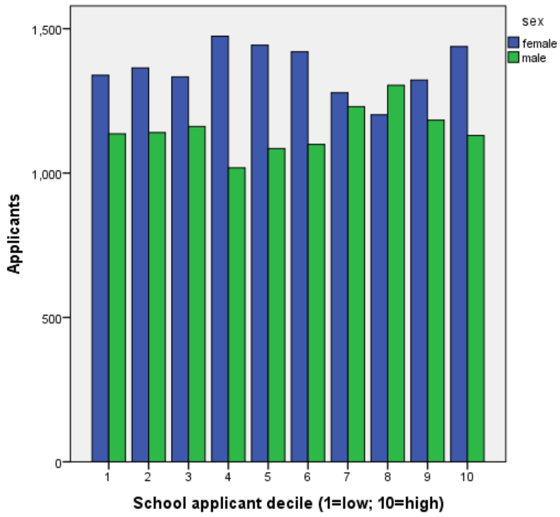


Figure 37

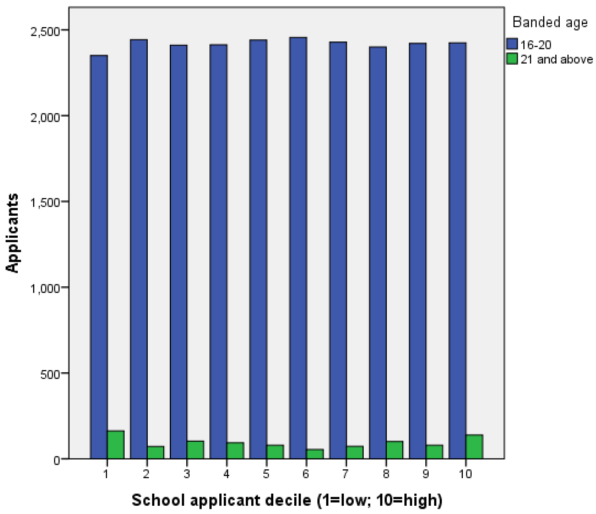


Figure 38

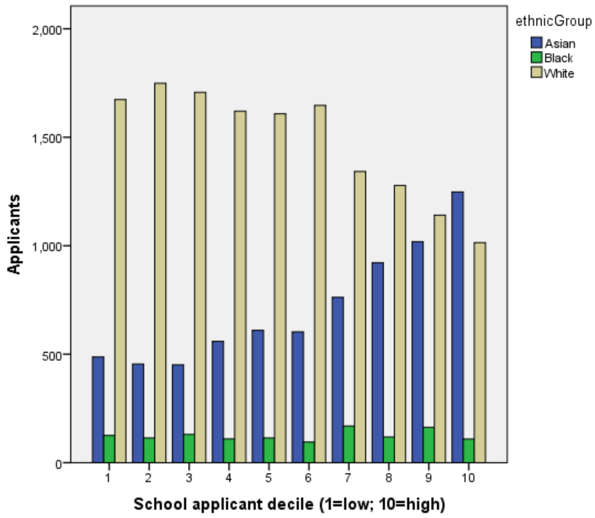


Figure 39

Age band, gender and ethnicity all differed significantly across applicant deciles (p<0.001).

The distribution of age (16-20 or >21) and gender differed less markedly by decile than ethnicity. Ethnicity demonstrated an interesting pattern, with smaller numbers of White applicants coming from higher deciles and progressively more Asian applicants, in contrast, coming from the higher deciles. The number of Black (and mixed and other) ethnicity applicants was small across all deciles.

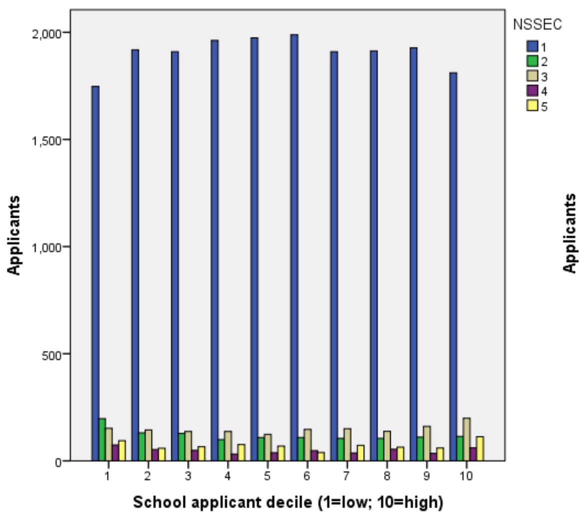


Figure 40

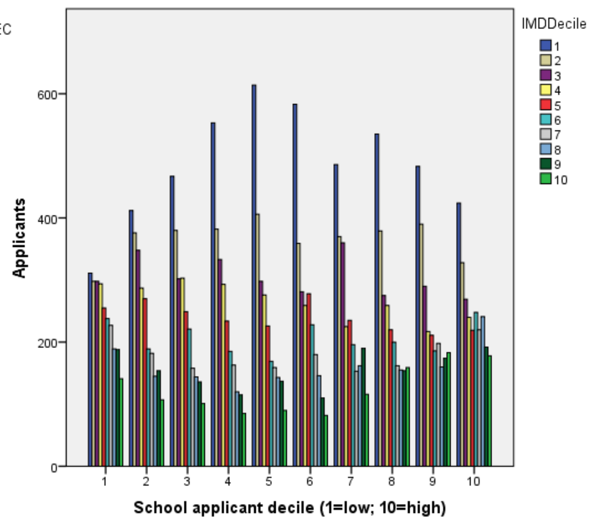


Figure 41

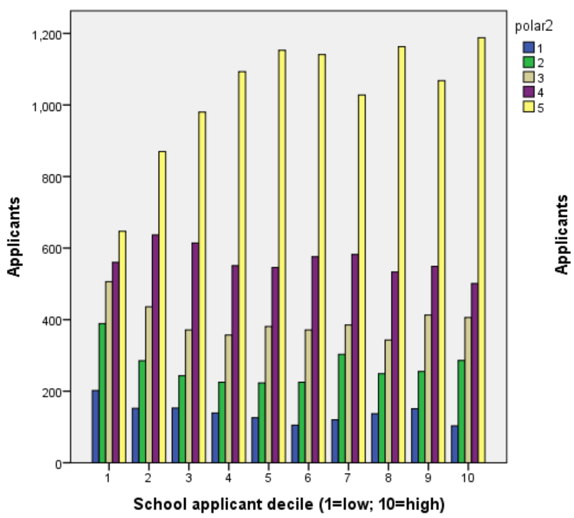


Figure 42

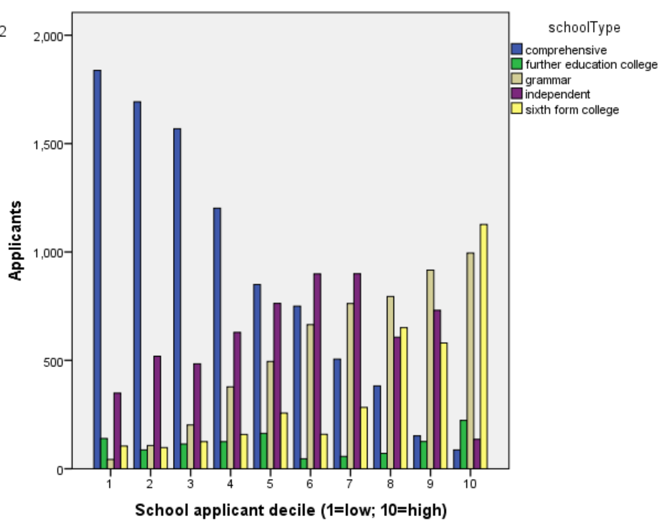


Figure 43

Again, each socio-demographic variable investigated differs significantly statistically by school decile (all p values<0.001).

First, it is clear that school type (Figure 43) varied markedly across deciles: Comprehensive schools contributing progressively less applicants from decile 1 to 10, grammar schools contributing progressively more, independent schools also contributing higher numbers in the higher deciles with the exception of decile 10, and sixth form colleges contributing more applicants in deciles 8, 9 and

10 particularly[8]. FE colleges did not differ so markedly across deciles. These differences in the type of schools are likely related to the socio-demographic differences discussed next, with the possible exception of 6th form colleges, that have much larger pupil numbers[8].

The different indicators of socioeconomic status or advantage (NS-SEC, POLAR2, IMD; Figures 41-43) all showed the strong social gradient that has been reported before, with the most advantaged applicants being in a substantial majority. In terms of the school deciles, there was somewhat less disparity in IMD and POLAR2 numbers of applicants in decile 1 than the other deciles, though even there the largest number of applicants still came from the most advantaged backgrounds.

GCE A levels

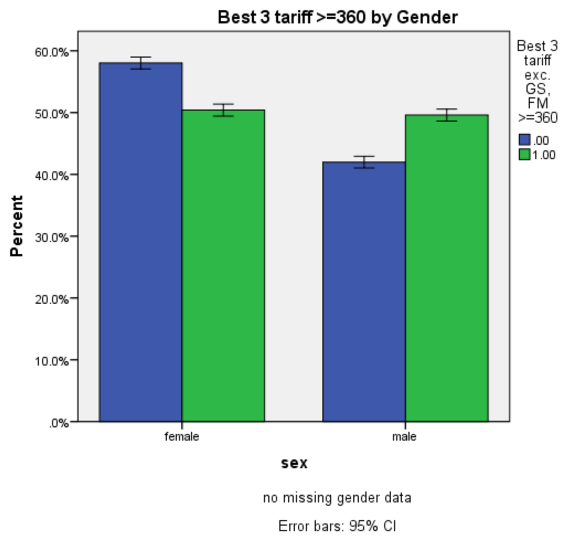
GCE A level data was handled following McManus et al (2012). In brief, duplicate data was eliminated, highest grade attained in each subject being retained. Variables were constructed to record each of biology, chemistry, maths and physics A levels taken (for Maths A levels, pure maths was included but further maths excluded since no applicant had taken further maths without also taking maths). Aggregate scores were then constructed for the Best 3 A level scores (excluding general studies and further maths), Best 3 A levels including chemistry (since many medical school require chemistry; and excluding general studies and further maths), Best 3 A levels including 2 of biology, chemistry, physics and maths (excluding general studies and further maths), total A level score (excluding general studies), and total A level score (including general studies).

New variables were constructed representing a range of cut-off A level scores from 300 (equivalent to three B grades) up to 420 (equivalent to three A* grades). Analysis compared the profiles of applicants meeting or failing to meet each cut-off using SPSS Crosstabs function and Chi square statistic.

From the initial 33,103 applicants in the dataset, A level information was available for 22,883; this excluded applicants with Scottish level 3 qualifications and those with International Baccalaureate. Only applicants reporting school leaving qualifications as their highest were included (n=20,709) in these analyses.

Each of the seven socio-demographic variables examined (gender, age band, ethnic group, NS-SEC, POLAR2, IMD decile, and school type) showed significant associations with the proportions of applicants meeting or failing to meet each cut-off score. Figures 44-57 below demonstrate the pattern of these effects by showing the proportion of each subgroup (e.g. men) who would meet the cut-off=360 (equivalent to three A grades – the typical medical school offer). The figures on the left show the percentages of all applicants so that one can see the relative proportions of applicants in different socio-demographic categories; the figures on the right show the impact of being in a different socio-demographic category using the proportions within each category who fail or pass the academic threshold.

[8] It should be noted that in England there were 94 sixth form colleges in 2010, but these establishments had large numbers of Key Stage 5 (i.e. pupils studying GCE AS and A levels) pupils – mean ≈ 1,600



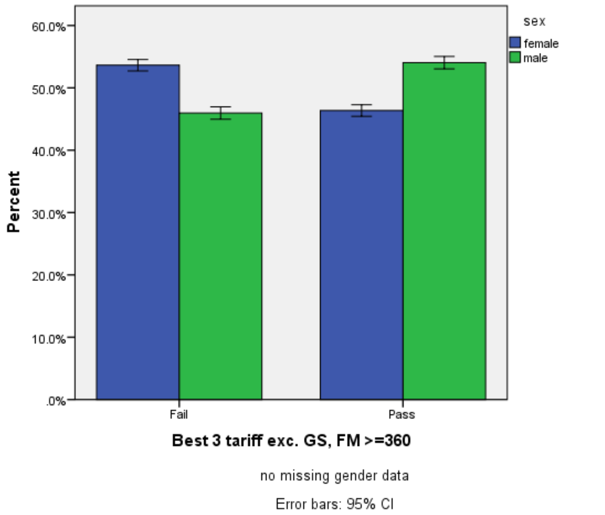
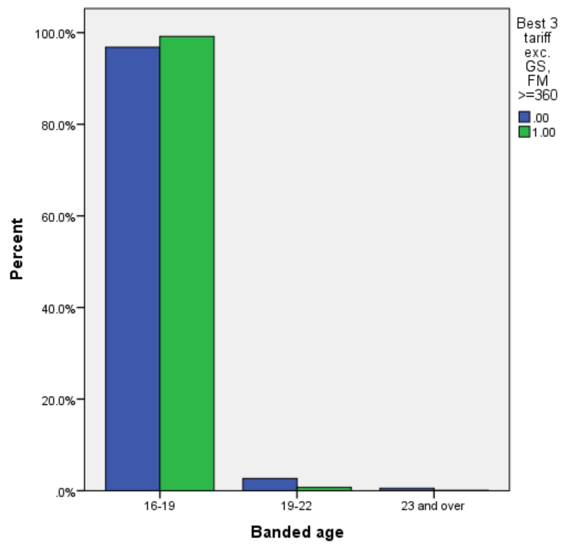


Figure 44 **Figure 45**

For gender by Best3-360, the cut-off clearly works to the benefit of males, even though the absolute numbers of male applicants is substantially less than female (around 45%)(Chi^2=121.2;df1,p<0.001).



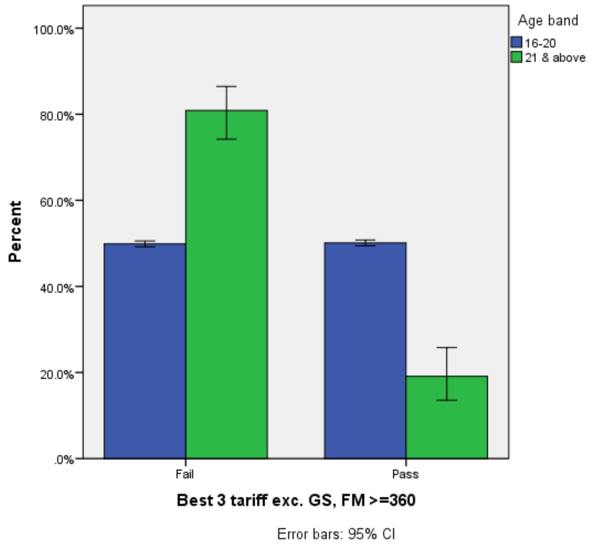


Figure 46 **Figure 47**

For age band, the younger group (16-20 years) are more successful in meeting this cut-off than the older groups (Chi^2=538.6;df2,p<0.001).

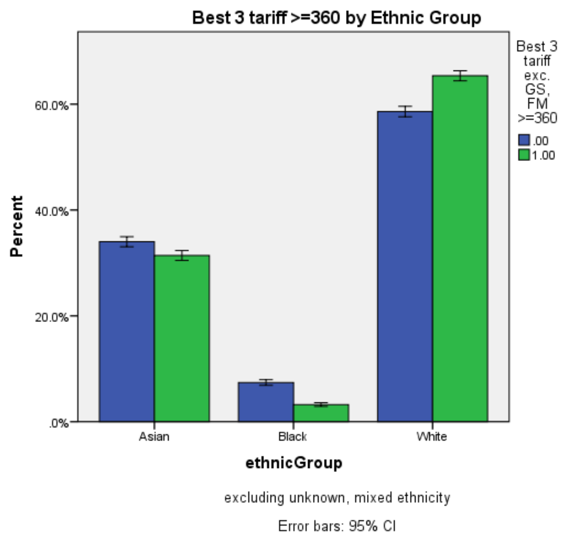


Figure 48

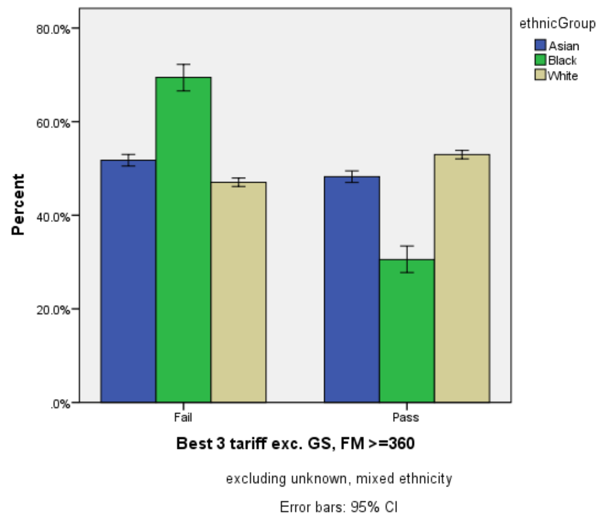


Figure 49

In terms of ethnicity, white applicants are more successful in meeting the 360 tariff than Asian, who in turn are more successful than black applicants (Chi^2=202.2;df2,p<0.001).

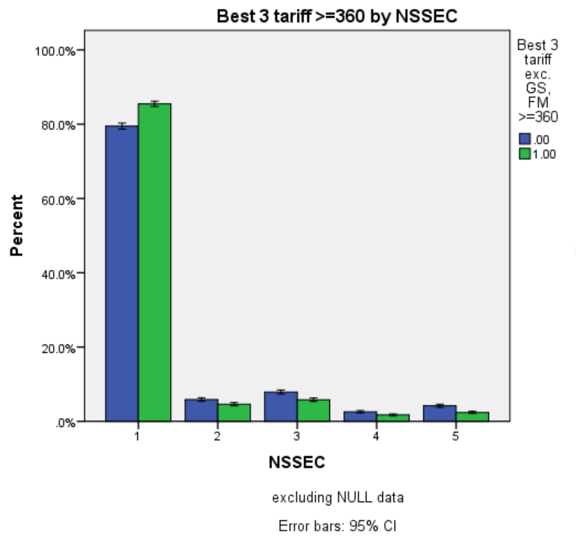


Figure 50

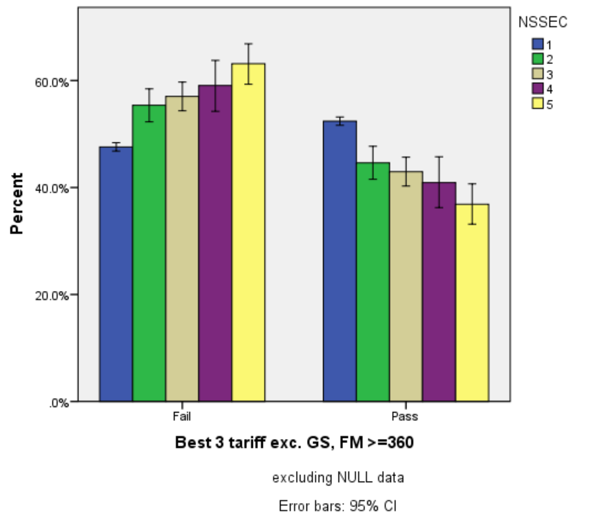


Figure 51

NS-SEC shows that applicants from group 1 (managerial and professional backgrounds) are somewhat more successful against the 360 tariff than all the other groups, who also contribute many fewer applicants overall (Chi^2=127.6;df4,p<0.001).

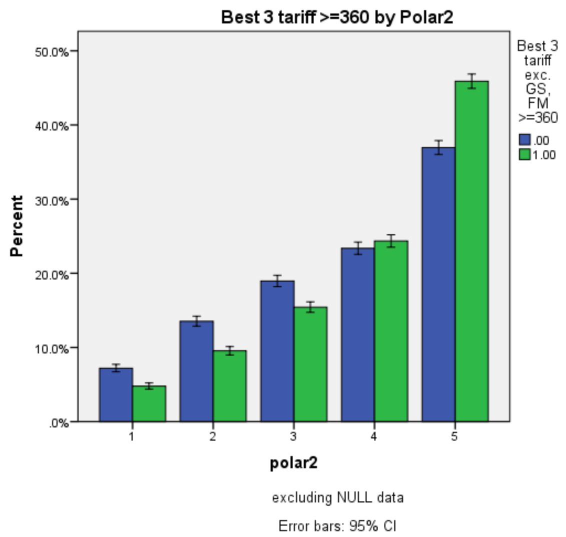


Figure 52

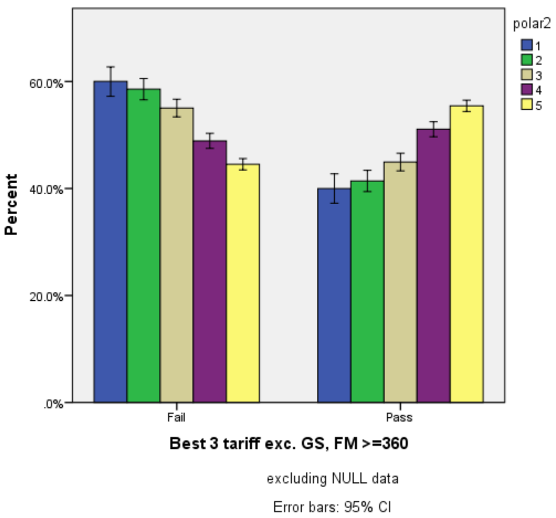


Figure 53

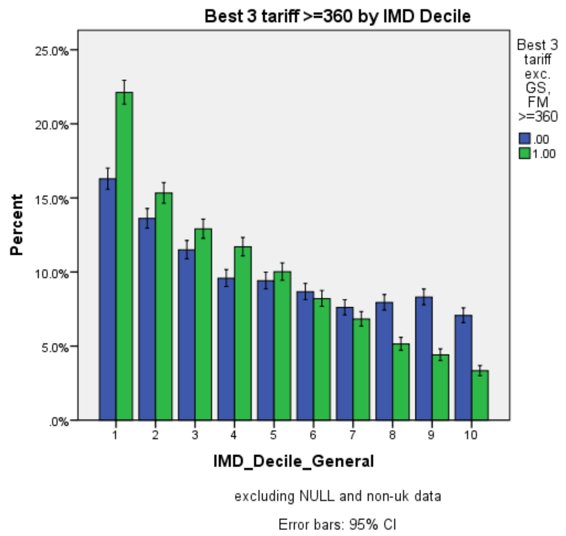


Figure 54

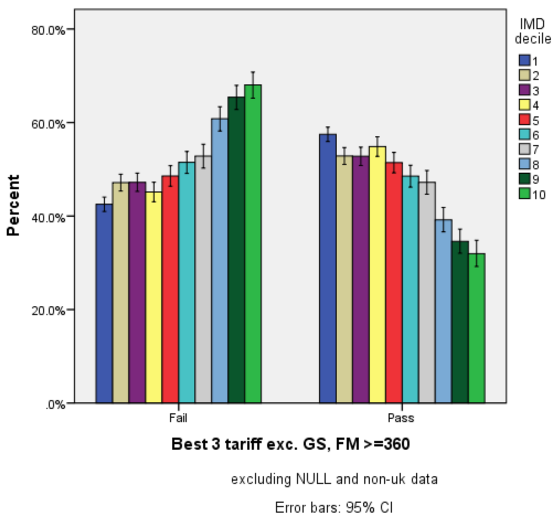


Figure 55

The two postcode-based neighbourhood indicators of deprivation and disadvantage demonstrate similar, highly significant associations with the 360 tariff: with POLAR2, the highest quintile shows a marked advantage in proportion of applicants achieving the 360 tariff compared to the others (Chi^2=256.8;df4,p<0.001); with IMD decile there is a considerable advantage for applicants from the most advantaged decile (1), that gradually reduces until the marked reverse effect for the three most disadvantaged deciles, 8-10 (Chi^2=459.4;df9,p<0.001). Again, one should note the different proportions of applicants from these different groups.

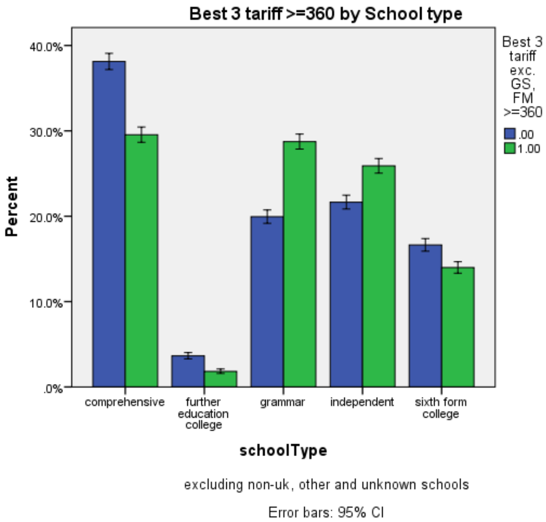


Figure 56

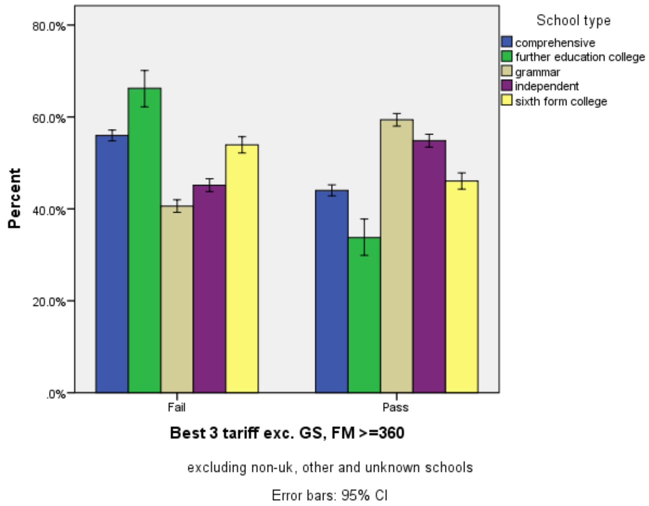


Figure 57

Lastly, type of school is strongly linked to the proportion of applicants meeting the 360 threshold (Chi^2=121.2;df1,p<0.001): selective schools (grammar and independent) showing a notable advantage and the non-selective schools (comprehensive, 6th form and FE colleges) showing the reverse in terms of proportion of applicants meeting this cut-off score.

Analyses of all the other thresholds, from 300 (3 B grades) to 420 tariff (3 A* grades), demonstrate the same, highly significant relationships (see Figures 60-66 below). In addition, analysis of two more restrictive tariff cut-offs – Best 3 A levels that include chemistry, and Best 3 A levels that include two sciences from biology, chemistry, maths and physics – show the same essential patterns. Two examples are shown below in Figures 58 & 59.

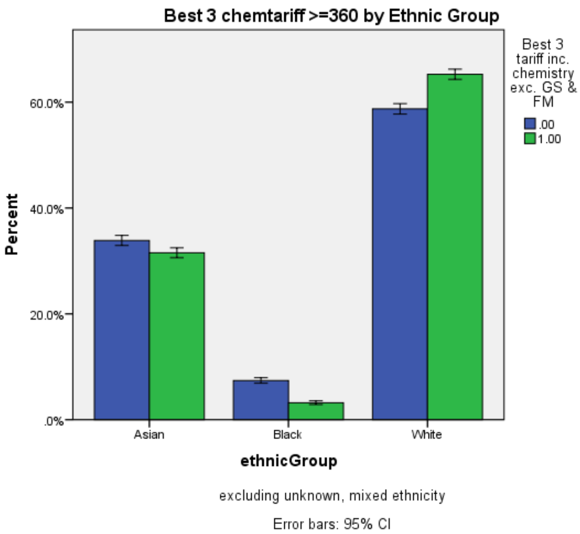


Figure 58

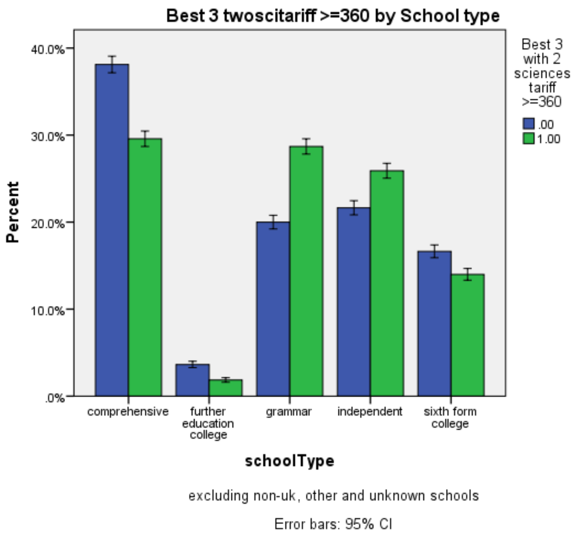


Figure 59

With ethnicity, again there is an advantage of white applicants over Asian, and for Asian over black applicants in terms of meeting the 360 inc. chemistry tariff (Chi^2=200.6;df2,p<0.001); and with type of school, selective schools clearly are markedly more successful in terms of the 360 tariff that includes two sciences (Chi^2=383.1;df4,p<0.001).

A pertinent question is to examine how setting different A level thresholds might change the socio-demographic profile of applicants who meet those thresholds. Figures 60-66 below display the profiles for Best 3 A level scores = 300, 320, 340, 360 and 380.

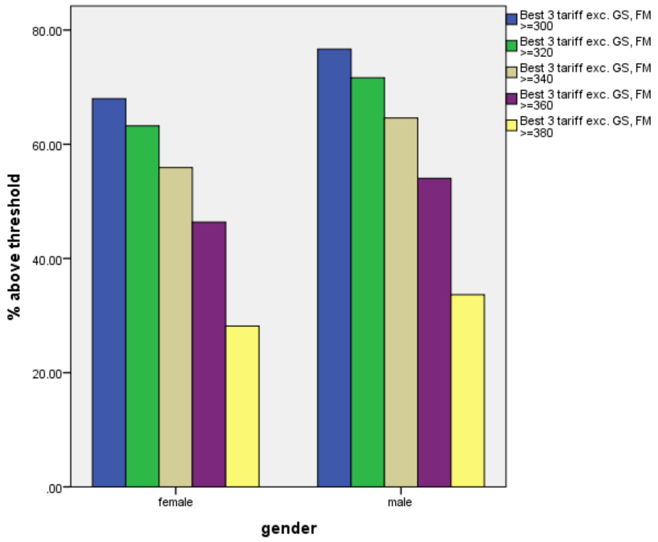


Figure 60

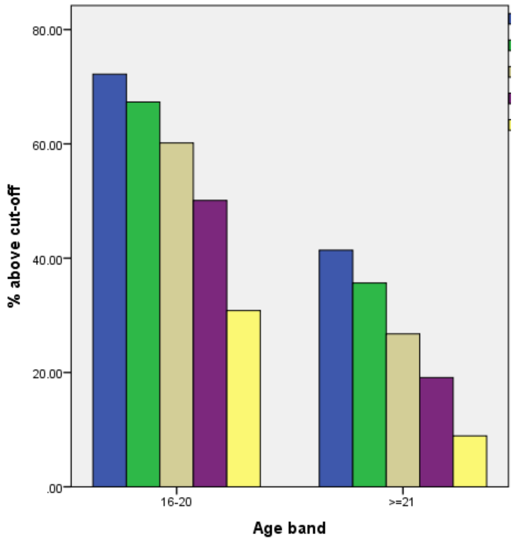


Figure 61

Clearly, the small male advantage and the considerable advantage of the younger age group (16-20) are preserved across all these thresholds, although, of course, higher proportions meet the lower thresholds.

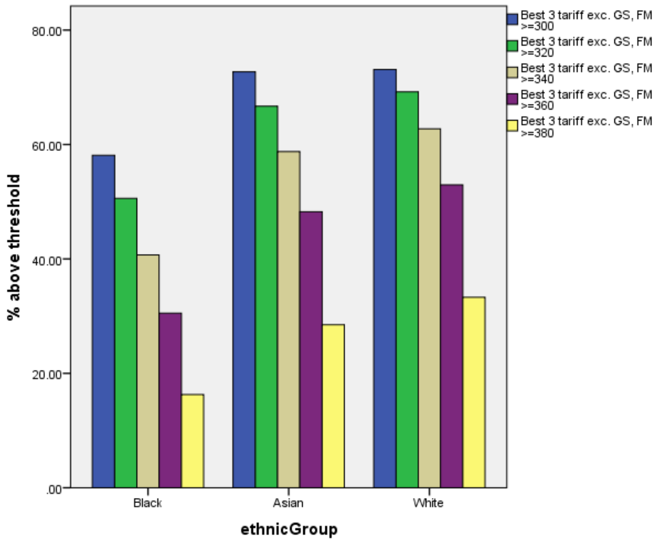


Figure 62

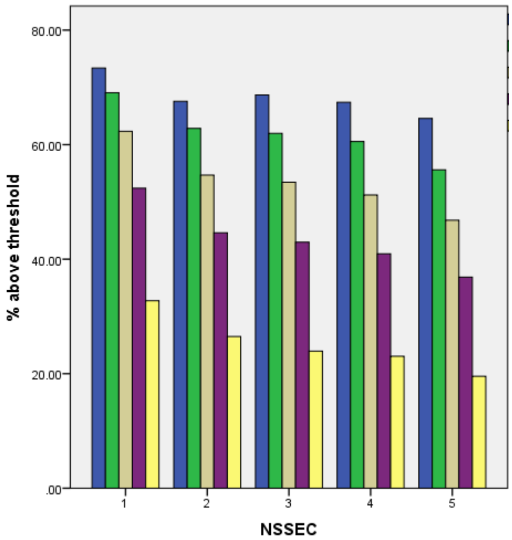


Figure 63

The effect of ethnicity varies with threshold: it can be seen that black applicants are consistently less likely to meet any threshold than Asian or white applicants; however, the advantage of white applicants over Asian is more evident at the higher thresholds.

In terms of parental occupation (NS-SEC), the advantage of applicants in category 1 (managerial and professional backgrounds) is present throughout, but larger with higher academic thresholds.

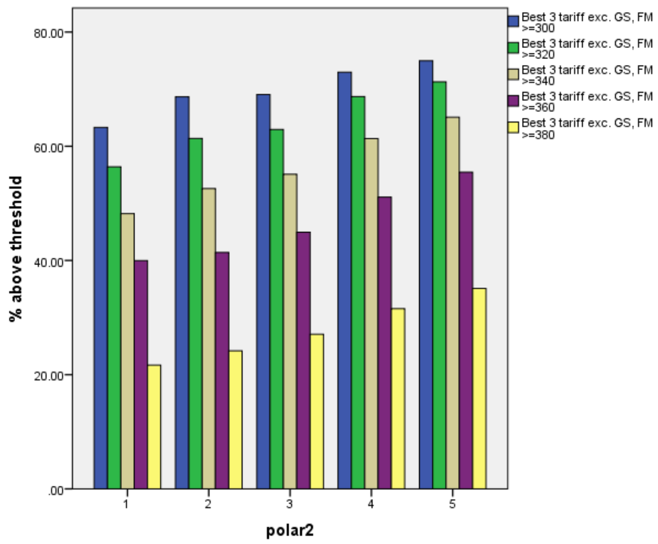


Figure 64

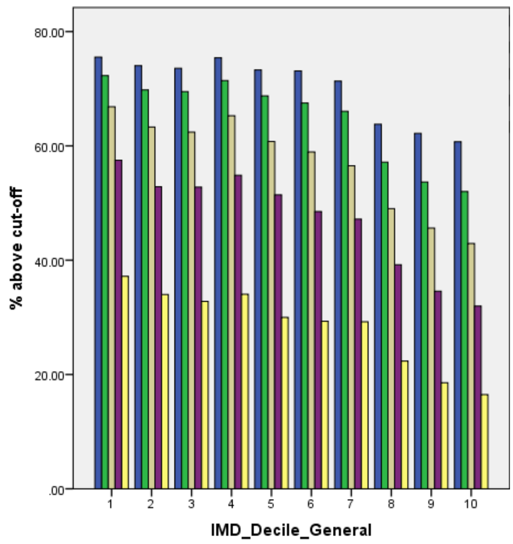


Figure 65

For both POLAR 2 and IMD decile, the proportions of applicants above threshold from more advantaged neighbourhoods are higher no matter what the academic threshold, and the lowest proportions are associated with the most disadvantaged neighbourhoods.

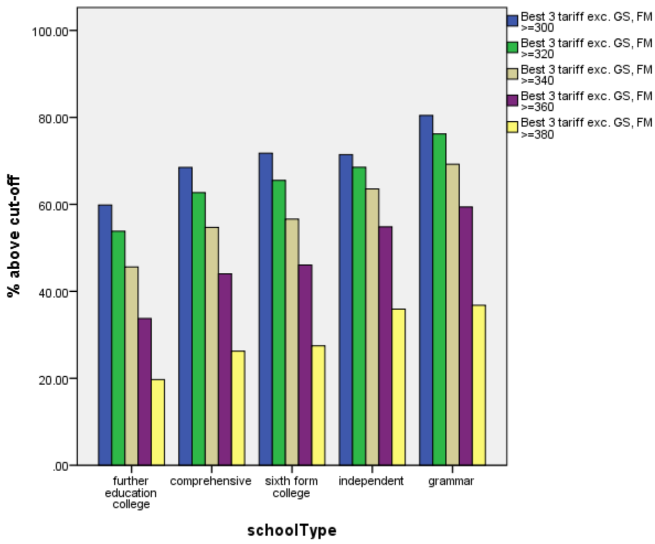


Figure 66

The relationship between type of school and chances of an applicant meeting different academic thresholds varies depending on threshold: lower thresholds are associated with marginally smaller, differences between selective and non-selective schools or colleges. In all cases, however, it is higher proportions of applicants from selective schools (grammar, independent) that meet the academic thresholds.

Adjusted A level tariffs

To make a rough assessment of the degree of adjustment that would be necessary to equate the proportion of less successful socio-demographic groups with that of the most successful the following calculations were made.

Taking the success rate for the best performing group at a tariff cut-off of 360 A level points, the interpolated value of an A-level points cut-off that would result in the same proportion of the least successful group in each case meeting that cut-off was computed from the values for the tariff cut-offs at 360 and 340 points. Table 13 below gives these interpolated values for each socio-demographic variable examined.

Variable	*Reference group*	*Comparison group*	*Interpolated A level tariff (difference)*	*Difference as z-score*
Gender	Male	female	344 (-16)	-0.22
Age	16-20 yrs	21 or over	Not computed – too few in comparison group	
Ethnicity	White	Black	316 (-44)	-0.59
NS-SEC	1 – managerial & professional	5 – routine & semi-routine	332 (-28)	-0.38
Polar 2	5 – highest YPR	1 – lowest YPR	323 (-37)	-0.50
IMD decile	1 – least deprived	10 – most deprived	316 (-44)	-0.59
School type	Grammar	Comprehensive	331 (-29)	-0.39

Table 13

Summary

In summary, A level tariff appears to be strongly sensitive to all the demographic variables examined and this pattern is preserved in nearly all cases even when the tariff is set lower or higher than the usual 360 A level points[9]. This degree of sensitivity to socio-demographic variables is consistent with recent research by Tiffin et al (2014), with the exception of gender, where that study reported no significant overall association between gender and Best 3 A level score; however the calculated adjustments above suggest that gender is the least influential variable examined here. The present study shows, in addition, that neighbourhood-based indices of social disadvantage (POLAR2, IMD) also are strongly related to A level achievement at the typical thresholds demanded for entry to medicine. It should be noted that these simple univariate analyses have not attempted to assess whether each socio-demographic factor has an effect independent of the others: two recent studies have used multiple regression to separate the influence of different factors (Tiffin et al, 2012, 2014), but nevertheless reported significant sensitivity of A level scores (3 best grades) to all the factors examined except gender.

[9] A minority of medical schools now ask for A*AA, equivalent to a tariff of 380.

UKCAT

For the UKCAT analyses, UKCAT total score was examined. UKCAT consists of five subtests, four of which test different cognitive abilities that were used in selection in the relevant years (2009-11).[10] The subtests comprise: verbal reasoning, quantitative reasoning, abstract reasoning, and decision analysis; the total score is the sum of each subtest. Where more than one attempt by a candidate was present (because they took UKCAT in several years), the highest combined (i.e. total) score and its subtests were used. More details about the UK Clinical Aptitude Test are available in the annual reports (e.g. UKCAT Technical Report, 2014).

Analysis was confined to applicants reporting school leaving qualifications as their highest: this produced a sample of 23,821 applicants, excluding, in particular, 6,893 reporting higher education qualifications. Of this sample (n=23,821) only 19,138 had complete information concerning all seven socio-demographic factors and, therefore, analysis was restricted to this sub-sample.

New variables were constructed representing a range of cut-off UKCAT Total scores from 2,300 (achieved by 90.2%) up to 3,000 (achieved by 4.3%). Analysis compared the profiles of applicants meeting or failing to meet each cut-off using SPSS Crosstabs function and Chi square statistic.

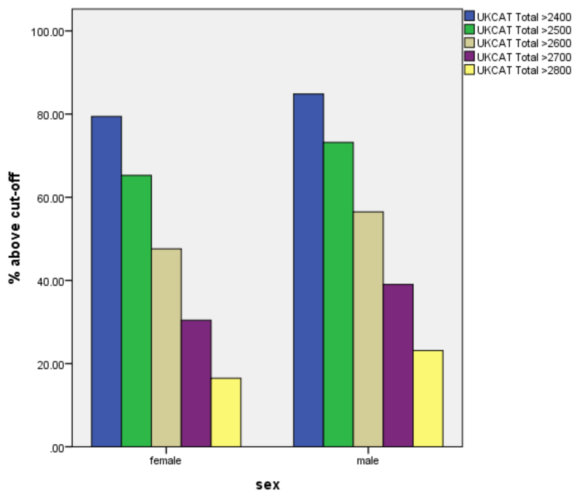


Figure 67

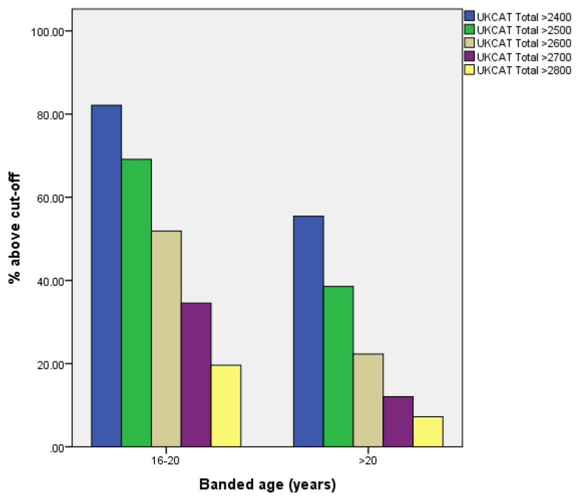


Figure 68

Analysis showed a significant association between the numbers meeting or failing each UKCAT cut-off score and gender: the nature of this can be seen above, where there is a clear male advantage at each threshold (e.g. UKCAT-2400 cut-off: Chi^2=93.3, df1, p<0.001). Comparing the two age bands, the younger group are markedly more successful in meeting each UKCAT threshold (e.g. UKCAT-2400 cut-off: Chi^2=71.6, df1, p<0.001).

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[10] The fifth UKCAT subtest – a non-cognitive test – was included in those years as part of the overall test; results were only used for research however, not selection.

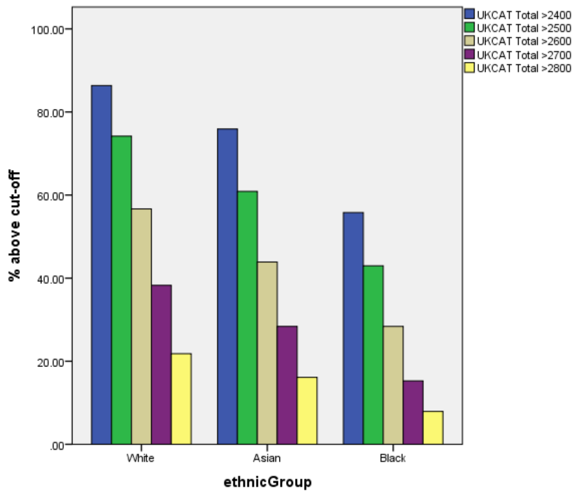

Figure 69

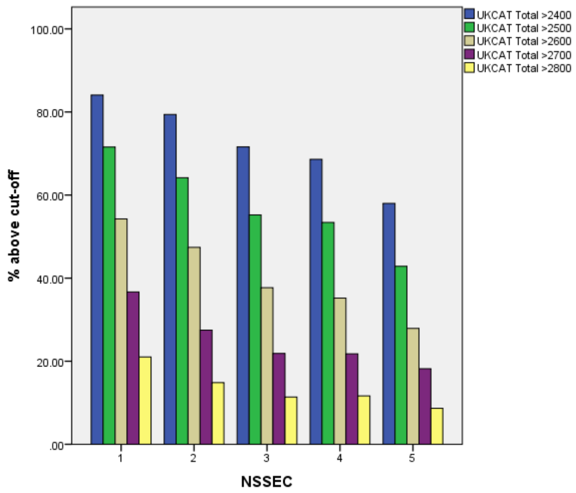

Figure 70

White applicants are more likely to meet the UKCAT thresholds examined than Asian applicants, who in turn are more successful than black applicants (e.g. UKCAT-2400 cut-off: Chi^2=717.7, df2, p<0.001). In terms of parental occupation, the NS-SEC category is also significantly associated with UKCAT threshold – applicants from managerial or professional backgrounds (NS-SEC 1) being most successful, followed in order by the other categories (e.g. UKCAT-2400 cut-off: Chi^2=417.0, df4, p<0.001).

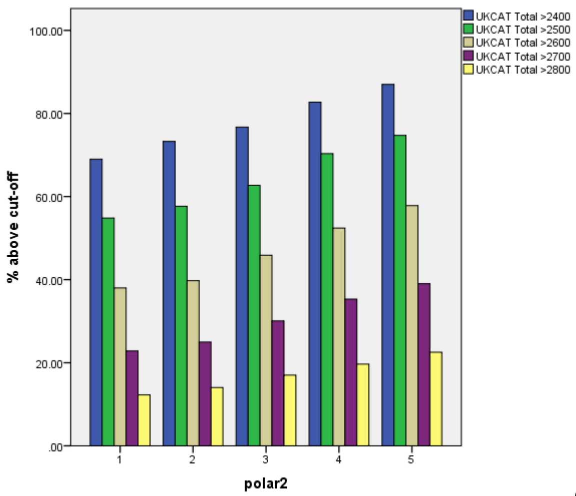

Figure 71

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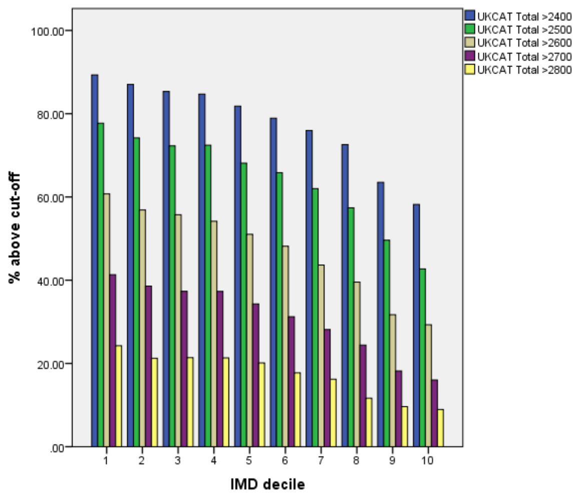

Figure 72

Both neighbourhood indices demonstrate similar significant associations with the proportion of applicants who meet different cut-offs (e.g. UKCAT-2400 cut-off: Chi^2=421.8, df4, p<0.001; UKCAT-2400 cut-off: Chi^2=857.4, df9, p<0.001 respectively for POLAR2 and IMD): applicants from the more advantaged neighbourhoods being consistently more successful than more disadvantaged neighbourhoods.

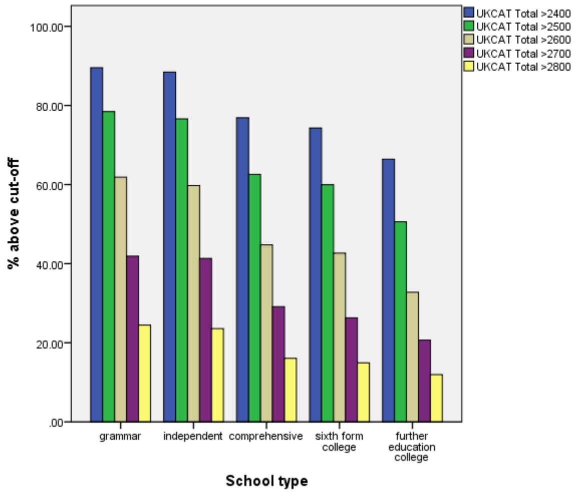

Figure 73

Lastly, the type of school is also strongly linked to an applicant's chances of meeting any UKCAT cut-off score (e.g. UKCAT-2400 cut-off: Chi^2=619.1, df4, p<0.001), applicants from grammar and independent schools being more likely to meet the threshold than those from comprehensives, sixth form colleges or FE colleges.

Adjusted UKCAT cut-offs

To make a rough assessment of the degree of adjustment that would be necessary to equate the proportion of less successful socio-demographic groups with that of the most successful the following calculations were made.

Taking the success rate for the best performing group at a total UKCAT score cut-off of 2600, the interpolated value of a UKCAT cut-off that would result in the same proportion of the least successful group in each case meeting that cut-off was computed from the values for the UKCAT cut-offs at 2600 and 2500. Table 14 below gives these interpolated values for each socio-demographic variable examined.

Variable	*Reference group*	*Comparison group*	*Interpolated UKCAT total score (difference)*	*Difference as z-score*
Gender	Male	female	2546 (-54)	-0.21
Age	16-20 yrs	21 or over	2518 (-82)	-0.32
Ethnicity	White	Black	2339 (-261)	-1.01
NS-SEC	1 – managerial & professional	5 – routine & semi-routine	2437 (-163)	-0.63
Polar 2	5 – highest YPR	1 – lowest YPR	2460 (-140)	-0.54
IMD decile	1 – least deprived	10 – most deprived	2338 (-262)	-1.02
School type	Grammar	Comprehensive	2495 (-105)	-0.41

Table 14

Summary

In summary, UKCAT total scores above thresholds typically applied for entry to medicine are sensitive to all the socio-demographic variables examined. This set of relationships is similar to those seen for A levels in previous research (e.g. Tiffin et al, 2014) as well as the present study, and, for a more limited set of variables, and for GAMSAT also in the present study.

The pattern of association between the seven socio-demographic factors and UKCAT total score is preserved in nearly all cases even when the tariff is set lower or higher than the usual minimum of 2400[11]. This degree of sensitivity to socio-demographic variables is consistent with recent research by Tiffin et al (2014) that reported significant associations of school, ethnicity, age, gender, non-professional background (NS-SEC) and English as an additional language. It should be noted, though, that Tiffin did not separate selective and non-selective state schools as in the current study, and the present study did not examine English as an additional language as a possible factor. The present study shows, in addition, that neighbourhood-based indices of social disadvantage (POLAR2, IMD) also are related to UKCAT total scores at the typical thresholds demanded for entry to medicine. It should be noted that these simple univariate analyses have not attempted to assess whether each socio-demographic factor has an effect independent of the others: two recent studies have used multiple regression to separate the influence of different factors (Tiffin et al, 2012, 2014), but nevertheless reported significant sensitivity of UKCAT scores (total and some sub-tests) to all the factors examined except gender for two sub-tests (abstract reasoning, decision analysis).

Discussion

One should begin with a note of caution: since these analyses do not include all medicine applicants; it is possible that different patterns may be present amongst applicants who did not take UKCAT, whose UCAS and UKCAT data could not be matched, or for whom the relevant data (e.g. school type) was missing. The analyses concern, almost wholly, younger applicants with only school leaving qualifications, who have taken the UK Clinical Aptitude Test. For comparison, in 2009 there were 53,871 applications to 5-year undergraduate medicine courses; since the majority of applicants make four applications, this amounts to roughly 13,500 applicants. Within the current dataset, there were approximately 11,000 applicants represented each year, approximately 82% of that total.

The school level analyses produced, in general, a picture that depicts medicine applications being dominated by a small proportion of UK secondary schools and colleges, typically selective, and with applicants who are very likely to come from professional or managerial family backgrounds, and neighbourhoods with high participation rates in HE and low indices of multiple deprivation. These schools and colleges are also associated with large numbers of Asian and White applicants and small numbers of Black applicants.

Two factors often suggested in the literature (e.g. Mathers et al, 2011; Woolf et al, 2011), that may be responsible for the differences observed in type of school, are aspiration and attainment. The pattern reported here is consistent with either . However, the analyses in the next section suggest that differential attainment is certainly one influential factor. For schools who contribute no applicants to medicine in this dataset it is impossible to decide.

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[11] Although 2400 is often reported as the lowest UKCAT cut-off, medical schools often vary this pragmatically to control the number of applicants then invited to interview or selection centre. More typical actual cut-offs are in the region of 2600. One school recently stated (personal communication) that all their entrants in one year had UKCAT scores of 3000 or above.

The evidence from this study of the impact of academic and aptitude thresholds on selection for medical school shows that both A-level cut-offs (e.g. 3 A grades) and UKCAT total cut-offs (e.g. 2400) are associated with differential chances of applicant success in meeting those thresholds depending on their background as indicated by parental occupation, type of school, and neighbourhood. In addition gender and ethnicity are also sensitive in the current study to the use of both types of threshold (academic attainment, aptitude), though published research suggests that gender may be more weakly related to UKCAT and non-significantly related to A level performance when one controls for a range of other demographic and social factors (Tiffin et al, 2012, 2014). Tiffin et al's work has also compared the degree of sensitivity of A levels and UKCAT total score to socio-demographic variables, reporting a number of differences: UKCAT in the 2014 study being less sensitive to schooling (state schooling associated with lower scores than independent/grammar), but more sensitive to gender (males scoring higher on UKCAT) and English as an additional language than A level tariff. In the current study Tables 13 & 14 suggest UKCAT total scores may be more sensitive to ethnicity (White vs. Black) and neighbourhood (IMD decile 1 vs. 10) than A level tariff, though the interpolated estimates have no confidence intervals and their variance is unknown. However, since several of these socio-demographic variables group together, the present evidence is unable to distinguish which of these factors may be the more influential.

The implications for selection are obvious: solely relying on single measures of educational attainment or aptitude test performance is likely to disadvantage applicants from socially disadvantaged backgrounds, or from minority ethnic communities – especially Black African or Caribbean applicants. Since application to medicine is heavily self-selected one cannot assume that applicants from differing backgrounds are comparable in terms of their capacity to be successful at medical school and to make good practitioners – indeed it seems likely that aspiration varies considerably in different communities (see, for example, Seyan et al, 2004; Garrud, 2011; who report on the different proportions of medicine applicants from ethnic minority communities in the UK). Nevertheless, this examination of the impact of academic and aptitude cut-offs does suggest that selection may well require both the use of contextual data and A level grades or UKCAT scores that are lower for applicants from disadvantaged and under-represented backgrounds.

UK medical schools in the twenty first century have a very different student profile compared to the post-WW2 period. Women are in the majority and students from many UK ethnic minority communities are well represented. Widening participation initiatives, therefore, have been focussed on the substantial under-representation of young people from socio-economically and educationally disadvantaged backgrounds. Much of the work required to change that will have to address the limited range of schools and colleges that supply applicants currently; other work should address the question of using contextual background information about applicants along with academic record and aptitude test performance in choosing between applicants.

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