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DOI:

[10.1111/medu.13082](https://doi.org/10.1111/medu.13082)

[10.1111/medu.13082](https://doi.org/10.1111/medu.13082)

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Document Version

Peer reviewed version

Citation for published version (Harvard):

Mathers, J, Sitch, A & Parry, J 2016, 'Longitudinal assessment of the impact of the use of the UK clinical aptitude test for medical student selection', *Medical Education*, vol. 50, no. 10, pp. 1033-44.
<https://doi.org/10.1111/medu.13082>, <https://doi.org/10.1111/medu.13082>

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**LONGITUDINAL ASSESSMENT OF THE IMPACT OF THE USE OF THE UK
CLINICAL APTITUDE TEST FOR APPLICANT SELECTION.**

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ABSTRACT

Background: Medical schools are increasingly using novel tools to select applicants. The UK Clinical Aptitude Test (UKCAT) is one such tool and measures mental abilities, attitudes and professional behaviour conducive to being a doctor using constructs likely to be less affected by socio-demographic factors than traditional measures of potential. Universities are free to use UKCAT as they see fit but three broad modalities have been observed: 'borderline', 'factor' and 'threshold'. This paper aims to provide the first longitudinal analyses assessing the impact of the different uses of UKCAT on receiving an offer among applicants with different socio-demographic characteristics.

Methods: Multilevel regression was used to model the outcome of applications to U.K. medical schools during the period 2004-2011 (data obtained from UCAS), adjusted for sex, ethnicity, schooling, parental occupation, educational attainment, year of application, and UKCAT use (borderline, factor, and threshold).

Results: The three ways of using the UKCAT did not differ in their impact on making the selection process more equitable other than a marked reversal for female advantage when applied in a 'threshold' manner. Our attempt to model the longitudinal impact of the use of the UKCAT in its threshold format found again the reversal of female advantage, but did not demonstrate similar statistically significant reductions of the advantages associated with white ethnicity, higher social class and selective schooling.

Conclusion: Our findings demonstrate attenuation of the female advantage but no changes in admission rates based on white ethnicity, higher social class, and selective schooling. In view

of this, the utility of the UKCAT as a means to widen access to medical schools among non-White and less advantaged applicants remains unproven.

INTRODUCTION

Access to read medicine in the UK is not equal across different socio-demographic population sub-groups [1,2]. In part these differences reflect variation in application rates, but even among the applicant pool, the likelihood of receiving an offer from a university varies significantly by sex, ethnicity, parental occupation (a proxy for social class), and school type even when educational attainment is taken into account [3-6].

All applications to read medicine in the UK are made through the Universities and Colleges Admissions Service (UCAS) where the application will include details of academic attainment, a personal statement and references. The standard approach is to screen applications on the basis of academic attainment and then to invite selected applicants to interview. However the results of A-level examinations (the predominant examination taken by students in England and Wales on leaving school aged 18 years) have been the subject of 'grade inflation'; in 1996 the proportion of A-levels awarded the top grade (Grade A) was ~15% but with the Examination Boards moving from norm referencing to criterion referencing, this had increased steadily and substantially to ~27% by 2012 [7]. In consequence it has become more difficult for medical schools to differentiate the most academically able students to whom they wish to make offers. Further, at a time when there is increasing focus on ensuring fair access for all to professional careers, there have been calls to consider measures of intellectual ability other than A-levels; i.e. selection tools which cannot be 'coached for' or are dependent on quality of schooling received [8,9].

The UK Clinical Aptitude Test (UKCAT) is one such selection tool. Introduced in 2006, the test seeks to measure mental abilities, attitudes and professional behaviour conducive to being a medical practitioner, and to do so using constructs likely to be less affected by socio-

demographic factors than traditional measures of potential [10]. Applicants who wish to be considered for entry to universities using the UKCAT are required to register with the UKCAT Consortium in order to schedule an examination at one of the designated test centres across the country. Test fees at centres within the UK and the rest of the European Union (EU) are £80 (reduced to £65 for ‘early birds’) with bursaries covering the whole fee available for applicants in financial need [10]. Applicants are permitted only one attempt per admissions cycle.

Universities are free to use UKCAT as they see fit but three broad modalities have been observed: ‘borderline’, ‘factor’ and ‘threshold’ [11]. Borderline use is where the UKCAT score is used to offer borderline candidates (including as a ‘tie-breaker’ to separate students) an interview where otherwise their application would rate poorly. Tiffin has described this to be a ‘weak’ use of the test [12]. ‘Factor’ use occurs when the applicant’s UKCAT score is used alongside other information to determine whether an interview or offer is made (‘moderate’ use), and ‘threshold’ use refers to the UKCAT being used as a ‘screen’ whereby only applicants scoring above an agreed level move through to the next stage of the selection process (‘strong’ use).

Initial evaluations of the impact of UKCAT suggested that the inherent biases associated with A-level performance (students from White and professional social class backgrounds and attending independent or grammar schools tend to do best) also exist for UKCAT performance, albeit the biases may be reduced especially with regard to the role of schooling [13,14]. More promising insights have come from work by Tiffin using the 2009 applicant cohort [12]. Here, sub-groups analysis of the way in which the UKCAT was used suggested that the ‘stronger’ its role in the selection process – i.e. use as a threshold – the greater the

mitigation of disadvantage associated with demographic factors such that among students applying to institutions using the test as a ‘threshold’, only A-level grades and UKCAT score were significantly associated with receiving an offer. Tiffin and co-authors however urged caution in the interpretation of these results; the observations were made on a single cross-sectional dataset and use of the UKCAT as a ‘threshold’ in itself might be a marker of an institution’s willingness to address widening participation issues, that is, other unmeasured factors of the institution might be driving the observed association.

In this paper, we offer two separate but related longitudinal analyses of the impact of use of the UKCAT (borderline, factor and threshold) in changing the demographic profiles of medical student cohorts in the UK.

METHODS

Study Design

We undertook analyses of student applications and offers to study medicine at UK medical schools for the years 2004 to 2011 inclusive using data provided by the Universities and Colleges Admissions Service (UCAS), a UK-based charity which co-ordinated the application process for all UK medical schools during the study period [15].

Study Population

All individuals resident in the UK aged less than 21 years (‘school-leavers’) and applying to read medicine on the ‘traditional’ (5 year +/- intercalated degree) undergraduate programmes offered by any UK medical school during the study period. We limited our sample to this age-group, which comprises the substantial majority of applicants to these programmes, in

order to minimize the non-ascertainment of applicants' socio-economic status information which has shown to be associated with applicant age [16]

Study Variables and Data Preparation

Anonymised data were obtained from UCAS for the period 2004-2011. Appropriate data cleaning was undertaken and the sample restricted to home applicants (permanent address has a UK postcode) aged less than 21 years of age applying to traditional medical courses.

Self-declared information on gender, school type, ethnicity and parental occupation as made by the applicants in their UCAS application was recorded. Data was available on the number of General Certificate of Education Advanced Level ('A-Level') and of the Scottish Qualification Certificate Higher Grade ('Higher') examinations taken and the UCAS tariff achieved by each applicant [17]. The UCAS tariff is a means of allocating points to qualifications used for entry to higher education in the UK, developed to allow broad comparisons to be made about a wide range of qualifications used by Universities. A'levels are the predominant school-leaving educational qualification taken by 18-19 year old students in England, Wales and Northern Ireland, while Highers are the Scottish exit qualification.

For those with these qualification data, educational attainment was produced by calculating the maximum UCAS tariff obtainable (depending on the qualification type, year and number of qualifications) and converting the achieved UCAS tariff into a proportion of this.

Proportional attainment measures were then standardised by comparing this measure for each individual to the distribution of proportions, by qualification and year; Z-scores were generated by subtracting the mean and dividing by the standard deviation of the appropriate distribution of proportional attainment measures. A binary measure of attainment (good /

poor) was also generated. Tiffin et al classified good attainment as grades AAB in A'levels (or equivalent tariff) or above [12]. To approximate this measure of attainment, the proportional attainment for each student was compared to the proportion equivalent to AAB, depending on qualification type and year.

Data Subsets

The two subsets were chosen to specifically investigate the use of UKCAT and comprised:

- a) All applications made to the 24 schools using UKCAT in their admissions process in any way during the period 2006 to 2011.

- b) For the ten medical schools employing threshold use of UKCAT in their admissions process for a continuous period of two years or more, all applications submitted for the first two-year period of threshold UKCAT use and the two-year period immediately prior (these data include applications for the period 2004-2011).

Use of the UKCAT by Universities

The UKCAT consortium provided data after re-examination of their survey data on our behalf (and with permission of the medical schools concerned) to verify changes in UKCAT use, allowing the derivation of descriptions of the UKCAT use of participating institutions for the period 2006-2011. UKCAT use was categorised in the same way as used by Tiffin et al as borderline, factor and threshold [12].

Data Analysis

Characteristics of the applicants and applications by offer status were investigated. The application level data set was then further analysed using multilevel logistic (random-effects) regression modelling, with the outcome being the offer status of each application. Models allowed for the clustering of applications within applicant; however, we were unable to identify cases where applicants had applications in different years.

To investigate the impact of UKCAT use further, for the period 2006 to 2011 and for the institutions using UKCAT in their admissions process separate multilevel logistic regression models were fitted according to UKCAT use type adjusting for applicant characteristics (year, sex, ethnicity, parental occupation (pre-coded by UCAS using the simplified National Statistics Socio-Economic Classification based on the highest earning parent), school type and educational attainment). A model was fitted for all UKCAT use types including interaction terms for UKCAT use and each of the applicant characteristics to identify differences between use types. Institutions utilising threshold level UKCAT use were identified, and similar models were fitted to compare the two-year threshold UKCAT use period with the prior two-year period. All statistical analyses were carried out using Stata version 13. P-values < 0.05 were considered to be statistically significant.

RESULTS

There were 174,043 applications from 62,681 applicants to the 24 medical schools using UKCAT in their admissions process in the period 2006 to 2011. For the ten medical schools utilising UKCAT scores as a threshold for at least a two year period, for the period of the first two years of threshold use and the previous two years there were 55,542 applications from 43,144 applicants (see tables 1 and 2)

Models fitted separately for each of the UKCAT use categories appear to suggest the admissions process is more equitable in terms of sex for threshold use (OR=0.95; 95% CI 0.90 to 1.00; $p=0.067$) whereas for borderline and factor use the odds of an application being successful are greater for applications from female students. The odds of successful application were higher for White students, with higher managerial or professional (HMP) parental occupations, from grammar or independent schools, and with high educational attainment regardless of UKCAT use (see table 3).

When looking at modelling the interactions between UKCAT use category and application characteristics (see table 4), the type of UKCAT use does not appear to make the process fairer generally for applications from non-White students. For applications from Asian students the odds of success are reduced with stronger use of UKCAT in the admissions process compared with borderline use (for factor use OR=0.87; 95% CI 0.79 to 0.96; $p=0.003$; and for threshold use OR=0.78; 95% CI 0.60 to 1.01; $p=0.057$); however, for applications from Black students the results suggest the process is fairer when threshold UKCAT use is employed compared with borderline use (OR=1.21; 95% CI 1.11 to 1.33; $p<0.001$) but not for factor use compared with borderline use (OR=0.85; 95% CI 0.72 to 1.00; $p=0.047$). Type of UKCAT use appears to not alter the effect of parental background on the odds of an

application being successful. Applications from students from grammar and independent schools have increased odds of receiving an offer if factor UKCAT use is employed (OR=1.12; 95% CI 1.04 to 1.21; p=0.002) but decreased odds if threshold UKCAT is used compared with borderline UKCAT use (OR=0.92; 95% CI 0.85 to 0.99; p=0.027). There is a reduction in the odds of an application being successful for an increase in attainment score when UKCAT use is factor or threshold compared with borderline (for factor use OR=0.71; 95% CI 0.67 to 0.76; p<0.001; and for threshold use OR=0.77; 95% CI 0.73 to 0.82; p<0.001) but attainment is still a large factor for all UKCAT uses.

Analysis of the two-year period prior to threshold UKCAT use and two-year period of threshold UKCAT use (see tables 5 and 6) showed the process became more equitable in terms of sex (OR=0.88; 95% CI 0.79 to 0.99; p=0.017) and attainment (OR=0.88; 95% CI 0.81 to 0.96; p=0.005) but with no statistically significant differences for ethnicity, parental occupation and school type between the two periods.

Results of likelihood ratio tests showed including the random effect allowing for clustering of applications within applicants improved model fit.

DISCUSSION

Key Findings

In this paper we have explored the impact of differential uses of the UKCAT, and also the 'before and after' impact of the introduction of the test in its 'strongest' (threshold) format. The three ways of using the UKCAT did not appear to differ in their impact on making the selection process more equitable other than an attenuation of female advantage when applied

in a 'threshold' manner. Our attempt to model the longitudinal impact of the use of the UKCAT in its threshold format found again the attenuation of female advantage, but did not demonstrate similar statistically significant reductions of the advantages associated with white ethnicity, higher social class and selective schooling. The longitudinal analyses also suggest use of the UKCAT as a threshold reduces the impact of educational attainment, although this remains a large factor in the model.

Strengths and Limitations of Study

All applications to read medicine in the UK must be made through UCAS and thus using this dataset has ensured our coverage of the targeted study population should be complete. Our models allowed for the clustering of applications within applicant. We were unable to identify cases where applicants had applications in different years meaning our analyses do not take into account the correlation between applications when applicants had reapplied. Data from UCAS suggests that this may be as high as 20% [18]. This also means we have not been able to allow for or evaluate how students have changed between initial and subsequent applications, where they may potentially improve their examination grades, UKCAT score, undertake work experience etc. Further work exploring the changes 'unsuccessful' students make to the content of their applications, and the outcomes associated with re-application is required.

The data set available for use was large allowing thorough analyses to be performed. However, with such a large sample size it is likely that statistically significant results will be detected and thus it is critical the magnitude of detected differences be carefully considered.

Our ascertainment of data on sex, ethnicity, schooling and educational attainment was high and we constructed the latter variable using methods concordant with other researchers working in this field [12]. We used parental occupation as a proxy for socio-economic status, and this was pre-coded for us by UCAS using standard protocols. In our two data subsets 13.8% and 13.6% of applicants did not provide sufficient information on parental occupation to enable classification (Table 2). This is a much smaller proportion than that reported by Tiffin [12] and is likely to be due to our decision to limit our sample to those aged less than 21 years whereas Tiffin included both school-leavers and mature students in their analyses.

We categorised the use of UKCAT through discussion with the UKCAT Consortium.

Previous work by the Consortium has suggested a fourth way in which UKCAT may be used, termed ‘trade-off’ or ‘rescue’ whereby a relatively poor performance in one aspect of a candidate's application may be compensated by a high UKCAT score [11]. Following Tiffin, we have conceptualised this as a form of ‘borderline’ use and thus have grouped ‘trade off’ with ‘borderline’ as the weakest use of the test [12]. Some medical schools indicated to the UKCAT Consortium that use of the test may not be consistent with one modality each year; that it, the test might be used both as, say, ‘threshold and ‘factor’ in a single year. Where this occurred, we operated a rule whereby the ‘strongest’ use determined categorisation. Thus, medical schools with ‘factor’ and ‘borderline’ were categorised as ‘factor’ and any use of ‘threshold’ reported resulted in a medical school being categorised as ‘threshold’ for that year. This method means that it is possible that the impact of ‘threshold’ may be reduced by including medical schools in this category where the test was used in a weaker manner for some applicants. If this has occurred, we might anticipate reduced but quantifiably similar impacts on the advantages reported for sex, white ethnicity, higher social class and selective

schooling; however the impact on the socio-demographic factors varied (marked impact on sex; minimal impact on the others).

Interpretation of Findings

These findings suggest that the UKCAT test does reduce the advantage for female applicants over males in securing a place to read medicine. However, the test's impact on other socio-demographic variables associated with a disadvantage in traditional selection processes appears to be minimal, even when used in its 'strongest' format. The increasing use of UKCAT by medical schools is normalising its use in the selection process, and unsurprisingly there is a parallel growth in the 'how to pass the exam' industry [19]. Although it is argued that students cannot revise or be 'coached' to do well in the UKCAT, practice does improve performance [10]. It is probable that over time, schools and careers staff will get better at preparing candidates and more effective commercial courses and aids be developed; it might be speculated that this is likely to be to the advantage of students from more affluent families and those attending selective or independent schools [20].

Implications for Research and Practice

One driver for the development of the UKCAT was a desire to widen access to medicine from socio-demographic groups who are under-represented within the profession. These findings suggest that while the use of the test as a 'threshold' in the selection process does mitigate against female advantage, it has minimal impact on under-represented ethnic and socio-economic groups. The role of the test as a means to widen participation therefore remains unproven. These observations are in contrast to some conclusions drawn by other researchers

reporting findings from single year cross-sectional studies. We echo the call by Patterson and colleagues in their recent systematic review of selection methods that future research in this area needs both to make more use of longitudinal study design and to seek greater understanding of the impact of different selection methods on the widening access and student diversity [21]

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Diagrams, Tables and Figures

Table 1: Characteristics of Applications. Values are n (%).

	UKCAT 2006-2011 (24 Schools)			UKCAT 2-year threshold (10 Schools)		
	Successful application (n=41361)	Unsuccessful application (n=132682)	All applications (n=174043)	Successful application (n=12756)	Unsuccessful application (n=42786)	All applications (n=55542)
Year:						
2004	-	-	-	391 (3.1)	1013 (2.4)	1404 (2.5)
2005	-	-	-	2122 (16.6)	8063 (18.8)	10185 (18.3)
2006	6170 (14.9)	22023 (16.6)	28193 (16.2)	2652 (20.8)	8632 (20.2)	11284 (20.3)
2007	7286 (17.6)	23040 (17.4)	30326 (17.4)	2553 (20.0)	8559 (20.0)	11112 (20.0)
2008	7260 (17.6)	20750 (15.6)	28010 (16.1)	2910 (22.8)	8170 (19.1)	11080 (20.0)
2009	7127 (17.2)	19764 (14.9)	26891 (15.5)	1124 (8.8)	3562 (8.3)	4686 (8.4)
2010	7003 (16.9)	24135 (18.2)	31138 (17.9)	588 (4.6)	2940 (6.9)	3528 (6.4)
2011	6515 (15.8)	22970 (17.3)	29485 (16.9)	416 (3.3)	1847 (4.3)	2263 (4.1)

Table 2: Characteristics of Applicants. Values are n (%).

	UKCAT 2006-2011 (24 Medical Schools)			UKCAT 2-year threshold (10 Medical Schools)		
	Offered a place* (n=32555)	Not offered a place (n=30126)	All applicants (n=62681)	Offered a place* (n=22399)	Not offered a place (n=20745)	All applicants (43144)
Year:						
2004	-	-	-	622 (2.8)	782 (3.8)	1404 (3.3)
2005	-	-	-	3965 (17.7)	3933 (19.0)	7898 (18.3)
2006	5594 (17.2)	4980 (16.5)	10574 (16.9)	4311 (19.3)	3856 (18.6)	8167 (18.9)
2007	5529 (17.0)	4810 (16.0)	10339 (16.5)	4129 (18.4)	3736 (18.0)	7865 (18.2)
2008	5523 (17.0)	4662 (15.5)	10185 (16.3)	4402 (19.7)	3496 (16.9)	7898 (18.3)
2009	5392 (16.6)	4595 (15.3)	9987 (15.9)	2244 (10.0)	2024 (9.8)	4268 (9.9)
2010	5360 (16.5)	5379 (17.9)	10739 (17.1)	1643 (7.3)	1769 (8.5)	3412 (7.9)
2011	5157 (15.8)	5700 (18.9)	10857 (17.3)	1083 (4.8)	1149 (5.5)	2232 (5.2)
Sex:						
Male	14248 (43.8)	13826 (45.9)	28074 (44.8)	9721 (43.4)	9664 (46.6)	19385 (44.9)
Female	18307 (56.2)	16300 (54.1)	34607 (55.2)	12678 (56.6)	11081 (53.4)	23759 (55.1)
Ethnicity:						
White	22683 (69.7)	16130 (53.5)	38813 (61.9)	15509 (69.2)	11094 (53.5)	26603 (61.7)
Mixed	1220 (3.8)	1238 (4.1)	2458 (3.9)	783 (3.5)	832 (4.0)	1615 (3.7)
Other	577 (1.8)	882 (2.9)	1459 (2.3)	398 (1.8)	611 (3.0)	1009 (2.3)
Black Caribbean	76 (0.2)	169 (0.6)	245 (0.4)	48 (0.2)	116 (0.6)	164 (0.4)
Black African	611 (1.9)	1905 (6.3)	2516 (4.0)	451 (2.0)	1238 (6.0)	1689 (3.9)
Black Other	25 (0.1)	71 (0.2)	96 (0.2)	20 (0.1)	55 (0.3)	75 (0.2)
Pakistani	1407 (4.3)	2627 (8.7)	4034 (6.4)	960 (4.3)	1799 (8.7)	2759 (6.4)
Bangladeshi	292 (0.9)	705 (2.3)	997 (1.6)	217 (1.0)	449 (2.2)	666 (1.5)
Indian	3081 (9.5)	3227 (10.7)	6308 (10.1)	2147 (9.6)	2213 (10.7)	4360 (10.1)
Chinese	801 (2.5)	686 (2.3)	1487 (2.4)	540 (2.4)	517 (2.5)	1057 (2.5)
Other Asian	1320 (4.1)	1917 (6.4)	3237 (5.2)	985 (4.4)	1304 (6.3)	2289 (5.3)
Not known	462 (1.4)	569 (1.9)	1031 (1.6)	341 (1.5)	517 (2.5)	858 (2.0)
Parental Occupation:						
Higher managerial and professional	13649 (41.9)	9081 (30.1)	22730 (36.3)	9295 (41.5)	6299 (30.4)	15594 (36.1)
Lower managerial and professional	7816 (24.0)	7292 (24.2)	15108 (24.1)	5506 (24.6)	5035 (24.3)	10541 (24.4)
Intermediate occupations	3023 (9.3)	2817 (9.4)	5840 (9.3)	2135 (9.5)	2012 (9.7)	4147 (9.6)
Lower supervisory and technical	665 (2.0)	847 (2.8)	1512 (2.4)	451 (2.0)	548 (2.6)	999 (2.3)
Routine†	510 (1.6)	938 (3.1)	1448 (2.3)	343 (1.5)	594 (2.9)	937 (2.2)
Semi-routine‡	1804 (5.5)	2653 (8.8)	4457 (7.1)	1329 (5.9)	1786 (8.6)	3115 (7.2)
Small employers and own account	1223 (3.8)	1689 (5.6)	2912 (4.7)	906 (4.0)	1058 (5.1)	1964 (4.6)
Not stated	3865 (11.9)	4809 (16.0)	8674 (13.8)	2434 (10.9)	3413 (16.5)	5847 (13.6)
School Type:						
Grammar and Independent	17504 (53.8)	10870 (36.1)	28374 (45.3)	11531 (51.5)	7334 (35.4)	18865 (43.7)

Other	14829 (45.6)	18940 (62.9)	33769 (53.9)	10659 (47.6)	13006 (62.7)	23665 (54.9)
Not known	222 (0.7)	316 (1.1)	538 (0.9)	209 (0.9)	405 (2.0)	614 (1.4)
Attainment§:						
Good attainment	28625 (87.9)	16378 (54.4)	45003 (71.8)	19463 (86.9)	10580 (51.0)	30043 (69.6)
Poor attainment	2487 (7.6)	11805 (39.2)	14292 (22.8)	2128 (9.5)	8932 (43.1)	11060 (25.6)
Not known	1443 (4.4)	1943 (6.5)	3386 (5.4)	808 (3.6)	1233 (5.9)	2041 (4.7)

*Applicant has received at least one offer from any medical school application submitted to UCAS.

†Examples include HGV/van driver; cleaner bar staff.

‡Examples include postal worker; security guard; receptionist.

§Poor attainment is equivalent to obtaining ABB or below in A-level examinations.

Table 3: UKCAT analysis 2006-2011 for UKCAT Institutions.

UKCAT use; number of applications (applicants)	Borderline; 44916 (29344)			Factor; 48895 (32655)			Threshold; 43853 (31903)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Year†									
2007	1.11	(1.03, 1.21)	0.008	1.36	(1.23, 1.50)	<0.001	0.63	(0.52, 0.77)	<0.001
2008	0.86	(0.79, 0.94)	0.001	1.32	(1.20, 1.45)	<0.001	0.98	(0.81, 1.18)	0.811
2009	0.95	(0.86, 1.05)	0.339	1.22	(1.11, 1.34)	<0.001	1.06	(0.87, 1.28)	0.574
2010	1.07	(0.96, 1.19)	0.233	0.77	(0.70, 0.84)	<0.001	0.75	(0.62, 0.91)	0.003
2011	0.81	(0.72, 0.91)	0.001	0.75	(0.68, 0.82)	<0.001	0.78	(0.65, 0.94)	0.011
Sex‡									
Female	1.27	(1.20, 1.35)	<0.001	1.23	(1.17, 1.29)	<0.001	0.95	(0.90, 1.00)	0.067
Ethnicity¥			(<i><0.001</i>)			(<i><0.001</i>)			(<i><0.001</i>)
Asian	0.65	(0.61, 0.70)	<0.001	0.57	(0.54, 0.61)	<0.001	0.77	(0.72, 0.83)	<0.001
Black	0.52	(0.43, 0.64)	<0.001	0.40	(0.33, 0.49)	<0.001	0.52	(0.44, 0.62)	<0.001
Other	0.75	(0.66, 0.85)	<0.001	0.64	(0.57, 0.72)	<0.001	0.73	(0.65, 0.83)	<0.001
Parental Occupation§									
HMP	1.21	(1.14, 1.29)	<0.001	1.28	(1.21, 1.34)	<0.001	1.25	(1.18, 1.32)	<0.001
School type¶									
Grammar and Independent	1.27	(1.20, 1.35)	<0.001	1.41	(1.34, 1.48)	<0.001	1.19	(1.13, 1.26)	<0.001
Attainment									
Z-score	4.05	(3.82, 4.29)	<0.001	2.80	(2.68, 2.92)	<0.001	3.19	(3.04, 3.35)	<0.001

† Reference is 2006; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. (*Wald statistics*)

Table 4: Interactions between UKCAT use and application characteristics. Number of applications (applicants) is 137664 (49220).

		OR	95% CI	p-value	
Year†:				<i>(<0.001)</i>	
	2007	1.03	(0.97, 1.09)	0.341	
	2008	1.11	(1.04, 1.18)	0.001	
	2009	1.16	(1.09, 1.23)	<0.001	
	2010	0.86	(0.80, 0.91)	<0.001	
	2011	0.83	(0.78, 0.88)	<0.001	
Sex‡					
	Female	1.26	(1.19, 1.34)	<0.001	
Ethnicity¥				<i>(<0.001)</i>	
	Asian	0.65	(0.61, 0.70)	<0.001	
	Black	0.52	(0.43, 0.62)	<0.001	
	Other	0.76	(0.67, 0.86)	<0.001	
Parental Occupation§					
	HMP	1.23	(1.16, 1.31)	<0.001	
School Type¶					
	Grammar and Independent	1.28	(1.21, 1.36)	<0.001	
Attainment z-score		4.01	(3.81, 4.23)	<0.001	
UKCATⁿ				<i>(<0.001)</i>	
	Factor	1.36	(1.25, 1.48)	<0.001	
	Threshold	1.78	(1.64, 1.94)	<0.001	
Interactions:					
Sex‡		UKCAT useⁿ		<i>(<0.001)</i>	
	Female	Factor	0.98	(0.91, 1.05)	0.519
	Female	Threshold	0.75	(0.69, 0.81)	<0.001
Ethnicity¥				<i>(<0.001)</i>	
	Asian	Factor	0.87	(0.79, 0.96)	0.003
	Asian	Threshold	0.78	(0.60, 1.01)	0.057
	Black	Factor	0.85	(0.72, 1.00)	0.047
	Black	Threshold	1.21	(1.11, 1.33)	<0.001
	Other	Factor	1.05	(0.82, 1.34)	0.725
	Other	Threshold	0.98	(0.83, 1.15)	0.777
Parental Occupation§				<i>(0.654)</i>	
	HMP	Factor	1.03	(0.96, 1.11)	0.389
	HMP	Threshold	1.00	(0.93, 1.09)	0.829
School type¶				<i>(<0.001)</i>	
	Grammar and Independent	Factor	1.12	(1.04, 1.21)	0.002
	Grammar and Independent	Threshold	0.92	(0.85, 0.99)	0.027
Attainment				<i>(<0.001)</i>	
	Z-score	Factor	0.71	(0.67, 0.76)	<0.001
	Z-score	Threshold	0.77	(0.73, 0.82)	<0.001

¹ Reference is borderline use 1 † Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. (*Wald statistics*)

Table 5: UKCAT analysis for UKCAT Institutions comparing two-year threshold UKCAT use with prior two year period.

Period; number of applications (applicants)	Two-year period prior to Threshold UKCAT use; 14586 (12340)			Two-year period Threshold UKCAT use; 20127 (17488)		
	OR	95% CI	p-value	OR	95% CI	p-value
Sex ‡						
Female	1.16	(1.08, 1.24)	<0.001	1.02	(0.94, 1.11)	0.622
Ethnicity ¥			(<0.001)			(<0.001)
Asian	0.71	(0.65, 0.78)	<0.001	0.75	(0.68, 0.83)	<0.001
Black	0.65	(0.52, 0.81)	<0.001	0.56	(0.43, 0.71)	<0.001
Other	0.74	(0.63, 0.87)	<0.001	0.77	(0.65, 0.91)	0.003
Parental Occupation §						
HMP	1.14	(1.06, 1.22)	<0.001	1.30	(1.19, 1.41)	<0.001
School type ¶						
Grammar and Independent	1.08	(1.00, 1.16)	0.040	1.16	(1.07, 1.26)	<0.001
Attainment						
Z-score	3.36	(3.13, 3.62)	<0.001	3.19	(2.94, 3.46)	<0.001

‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent.
(Wald statistics)

Table 6: Interactions between two-year threshold UKCAT use with application characteristics. Number of applications (applicants) is 34713 (26645).

	OR	95% CI	p-value
Sex‡			
Female	1.16	(1.08, 1.25)	<0.001
Ethnicity¥			(<0.001)
Asian	0.70	(0.64, 0.77)	<0.001
Black	0.64	(0.51, 0.81)	<0.001
Other	0.73	(0.62, 0.87)	<0.001
Parental Occupation§			
HMP	1.15	(1.07, 1.24)	<0.001
School type¶			
Grammar and Independent	1.08	(1.00, 1.16)	0.041
Attainment			
Z-score	3.45	(3.23, 3.69)	<0.001
UKCAT use period[†]			
Two-year UKCAT use	1.12	(1.00, 1.26)	0.042
Interactions:			
Sex‡	UKCAT use[†]		
Female	Two-year UKCAT use	0.88	(0.79, 0.99) 0.017
Ethnicity¥			(<0.482)
Asian	Two-year UKCAT use	1.09	(0.96, 1.24) 0.185
Black	Two-year UKCAT use	0.90	(0.65, 1.26) 0.544
Other	Two-year UKCAT use	1.07	(0.85, 1.35) 0.573
Parental Occupation§			
HMP	Two-year UKCAT use	1.11	(1.00, 1.23) 0.057
School type¶			
Grammar and Independent	Two-year UKCAT use	1.07	(0.96, 1.19) 0.238
Attainment			
Z-score	Two-year UKCAT use	0.88	(0.81, 0.96) 0.005

[†] Reference is two-year period prior to threshold UKCAT use ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. (*Wald statistics*)

APPENDIX 1

Derivation of the original study sample from which the two sub-sets are drawn.

Study Design

We undertook analyses of student applications and offers to study medicine at UK medical schools for the years 1996 to 2012 inclusive using data provided by the Universities and Colleges Admissions Service (UCAS), a UK-based charity which co-ordinated the application process for all UK medical schools during the study period.

Study Sample

All individuals resident in the UK aged less than 21 years ('school-leavers') and applying to read medicine on the 'traditional' (5 year +/- intercalated degree) undergraduate programmes offered by any UK medical school during the study period. We limited our sample to this age-group, which comprises the substantial majority of applicants to these programmes, in order to minimize the non-ascertainment of applicants' socio-economic status information which has shown to be associated with applicant age.

Study Variables and Data Preparation

Anonymised data were obtained from UCAS for the period 1996-2012. Appropriate data cleaning was undertaken and the sample restricted to home applicants (permanent address has a UK postcode) aged less than 21 years of age applying to traditional medical courses.

Self-declared information on sex, school type, ethnicity and parental occupation as made by the applicants in their UCAS application was recorded. Data were available on the number of General Certificate of Education Advanced Level ('A-Level') and of the Scottish Qualification Certificate Higher Grade ('Higher') examinations taken and the UCAS tariff achieved by each applicant. The UCAS tariff is a means of allocating points to qualifications used for entry to higher education in the UK, developed to allow broad comparisons to be made about a wide range of qualifications used by Universities. A'levels are the predominant school-leaving educational qualification taken by 18-19 year old students in England, Wales and Northern Ireland, while Highers are the Scottish exit qualification.

For those with these qualification data, educational attainment was produced by calculating the maximum UCAS tariff obtainable (depending on the qualification type, year and number of qualifications) and converting the achieved UCAS tariff into a proportion of this. Proportional attainment measures were then standardised by comparing this measure for each individual to the distribution of proportions, by qualification and year; Z-scores were generated by subtracting the mean and dividing by the standard deviation of the appropriate distribution of proportional attainment measures. A binary measure of attainment (good / poor) was also generated. Tiffin et al classified good attainment as grades AAB in A'levels (or equivalent tariff) or above. To approximate this measure of attainment, the proportional attainment for each student was compared to the proportion equivalent to AAB, depending on qualification type and year.