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POPULATION-BASED LONGITUDINAL ANALYSES OF OFFER LIKELIHOODS IN U.K. MEDICAL SCHOOLS: 1996-2012.

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ABSTRACT

Background: The challenge of ensuring 'fair selection' processes is one facing medical schools across the globe. In the U.K., historical analyses suggest applicants who are male, non-white, from less advantaged socioeconomic and school backgrounds have been less likely to be offered a place at medical school. In this paper we provide a contemporary population-based longitudinal analysis of the likelihood of receiving an offer to read medicine in the U.K. stratified by key socio-demographic characteristics.

Methods: We calculated the likelihood of receiving an offer among applicants to U.K. medical schools during the period 1996-2012, adjusted for sex, ethnicity, schooling, parental occupation, educational attainment and year of application. To investigate differences across time, models were fitted with interactions between application year and each of the other explanatory variables.

Findings – There were 154,957 applicants, with more females (n=86,361; 55.7%) than males (n=68,596; 44.3%). The majority of applicants were of white ethnicity (n=94,519; 61.0%). The commonest parental occupation category was Higher Managerial and Professional (HMP) (n=60,167; 38.8%) with 68,313 (44.1%) applicants from grammar and independent schools. The likelihood of receiving an offer to study medicine varied 3-fold across the study period, peaking in 2001 against the 1996 baseline (OR 2.94; 95% CI 2.78 to 3.11; p<0.001). Throughout the study period, applicants who were female (OR 1.21; 95% CI 1.19 to 1.24; p<0.001), from more advantaged family backgrounds (OR 1.26; 95% CI 1.24 to 1.29 p<0.001) and who attended independent or grammar schools (OR 1.25; 95% CI 1.23 to 1.28; p<0.001)

were more likely to receive an offer. Compared to Asian, Black and Other Ethnic Groups, Whites applicants had a greater likelihood of receiving an offer (1.56 (1.54, 1.610; 2.33 (2.17, 2.50) and 1.45 (1.39, 1.51)) respectively. Differences in the odds between white and non-white applicants were reduced slightly during the study period but the overall advantage for white applicants persisted. The advantage for female applicants diminished markedly from 2007 onward. There was no clear trend in the advantage for students from HMP families but from 2005 onwards the odds of success for applicants with grammar and independent schooling background increased.

Interpretation: Despite efforts to make the selection processes more equitable, our findings suggest that a persistent advantage remains for some demographic factors.

BACKGROUND AND RATIONALE FOR THE STUDY

The need to ensure access to medicine is fair is a recurring issue but distinguishing our future doctors from a large pool of potentially capable candidates is no easy task and one facing medical schools around the globe [1-6]. It demands that medical schools make choices between applicants, many of whom will meet the minimum threshold for academic attainment. These choices must identify candidates who will withstand the rigours of intense medical training, that have the potential to become good doctors, and do so in a way which is as transparent, valid and 'fair' as possible.

Fairness as a term has been used widely in UK policy literature but it remains a rather a slippery and ill-defined concept. The Oxford English dictionary defines fairness as the "impartial and just treatment or behaviour without favouritism or discrimination" [7]. Thus, in the context of selecting students to become doctors, a 'fair' system would result in all applicants to medical school having an equal chance of receiving an offer provided they were of equal ability to become a 'good doctor'. The problem comes in knowing what a 'good doctor' looks like and the factors which predict this. In regard to the latter, the UK system has historically heavily based its prediction on educational attainment at aged 18 years. However, within the UK context, pioneering work by McManus and colleagues in the 1980s and 1990s demonstrated that certain demographic and social characteristics were associated with the likelihood of receipt of an offer to study medicine [8-11]. Analysis of data from 1996/97 showed that age, gender, ethnicity, socio-economic background and schooling were associated with offer likelihood [11]. Specifically, applicants who were older, male, non-white, from less advantaged socioeconomic and school backgrounds were at a disadvantage even when adjustment was made for other factors such as educational

attainment. If these factors in themselves are not thought to be important in determining whether a person has the potential to be a 'good doctor', then it is 'unfair' that they give applicants in possession of them more opportunity to read medicine than equally capable applicants who are not e.g. non-White or less affluent applicants.

The consequences of 'unfair' selection are two-fold: First is the issue of social justice with existing selection processes seemingly limiting social mobility and opportunity [12-14]. Second, there is some evidence that students educated in demographically-diverse medical schools are better able to provide healthcare to patients with backgrounds different to their own [14, 15]. UK medical schools have thus made substantial effort to improve selection procedures [16, 17]. These include aptitude tests; situational judgement tests; personality assessments, and multiple mini-interviews with recent years witnessing a tranche of publications reporting greater equity as a result of these processes [for example, 18-22]. However, the generalizability of this emerging 'evidence-base' is compromised by the observation that many published studies use data only from a single medical school or from a single year or limited time period. Further, the interpretation of the findings from UK studies conducted during the last 15 years is complicated by macro changes in medical education provision. The major expansion in the number of English medical school places during the period 1999-2005 resulted in an additional 2,280 new places, a 68% expansion above the 1998 baseline of 3,316 places [23], which for a period of time fundamentally changed the applicants-per-place ratio for undergraduate programmes in England.

In this paper we explore whether the socio-economic and educational factors identified historically as conferring advantage on applicants, have remained independent predictors of

selection by medical schools over recent years. In doing so we have examined whether macro-policy changes such as the 'expansion period' coincide with shifts in key predictors of offers to study medicine. To achieve this, we present an analysis of the likelihood of applicants receiving an offer to read medicine adjusted for a range of demographic, social and educational characteristics for a 17 year period from 1996 to 2012.

METHODS

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 [24].

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 (see Discussion for further detail).

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 (see Figure 1).

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 [25]. 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 [22]. 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 Analysis

Characteristics of the applicants and applications by offer status were investigated. The application level data set was then further analysed using multilevel logistic 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. Unadjusted and adjusted odds ratios were produced for the explanatory variables: 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. To further investigate differences across time, models were fitted with interactions between application year and each of the other explanatory variables and plots derived from the results of these models.

Patient and Public Involvement.

Applicants, medical school admissions staff and members of the general public were not involved in the design, analysis or interpretation of this study.

RESULTS

General trends

From 1996 to 2012 there were 584,741 recorded UCAS applications to traditional medical courses from 154,957 home school-leaver applicants (Table 1). The characteristics of the applicants can be seen in Table 1: The number of applicants increased over the time period from 8,027 in 1996 to 10,647 in 2012 (32.6% increase on the 1996 baseline) and the number of offers from 4,337 to 5,468 (26.1% increase).

Over the whole study period, there were more female applicants (n=86,361; 55.7%) than male applicants (n=68,596; 44.3%) and the majority of applicants were of White ethnicity (n=94,519; 61.0%). The most common parental occupation category was Higher Managerial and Professional (HMP) (n=60,167; 38.8%). There were 68,313 (44.1%) applicants from grammar and independent schools and 91,995 (59.4%) achieved 'good attainment'.

Modelling of offer status

Multilevel modelling adjusted for year and applicant characteristics can be seen in Table 2. The odds of an application resulting in an offer were increased if the application was from a female candidate (OR=1.21; 95% CI 1.19 to 1.24; p<0.001), an applicant having their parental occupation in the Higher Managerial and Professional category (OR=1.26; 95% CI 1.24 to 1.29; p<0.001), those with grammar and independent schooling (OR=1.25; 95% CI 1.23 to 1.28; p<0.001), and applicants with higher educational attainment z-scores (OR=2.40; 95% CI 2.37 to 2.43; p<0.001). Compared with applications from White applicants the odds of an application receiving an offer were decreased for Asian applicants (OR=0.64;

95% CI 0.62 to 0.65; p<0.001), Black applicants (OR=0.43; 95% CI 0.40 to 0.46; p<0.001) and applicants of Other Ethnicity (OR=0.69; 95% CI 0.66 to 0.72; p<0.001).

The adjusted odds of a successful application by year, compared with 1996, are displayed in Figure 2). What is striking is that during the period 1998-2004 the odds of receiving an offer were increased (peaking in 2001; OR=2.94; 95% CI 2.78 to 3.11; p<0.001) compared to 1996, while the odds of a successful application were decreased compared to 1996 at both the beginning (1997) and the end (2005-12) of the study period. For the last three years of the study period (2010-12), the odds of a successful offer fall to a significantly lower level than baseline.

Figures 3-7 show the results of modelling with interaction terms between each characteristic and year to show differences through time (further results from these models can be seen in supplementary materials). When looking at the differences between applications from male and female applicants the results show applications from females have better odds of being successful from 1996 to 2006; from 2007, the trend appears to change with the difference in odds of success between applications from males and females significantly reducing. Differences in the odds between ethnicities over time show that whilst a gap between white and non-white students persists, that the gap for Asian candidates is reduced in the period 1999-2012. Similarly, for black students the difference in odds compared with white students are significantly decreased in 2002, 2004, 2005, 2008 and 2012 compared with 1996. For other ethnicities, although there is a trend toward better odds of an offer, a significant difference is only seen in 2012.

There are no clear longitudinal trends in the difference in odds of success for applications based on socio-economic status, although the advantage for students from HMP occupational backgrounds was significantly increased in 2001 and 2007 compared with 1996. However, when examining schooling there appears to have been a trend toward a reduced difference in odds of success for applications from students with grammar and independent schooling background compared with others from 1998 through 2003, with significant decreases in 1999, 2001 and 2002 compared to 1996. From 2005 onwards this reverses with the difference in odds of success between applications from grammar and independent schools and others being increased compared to the reference period. This increase is significant from 2005 other than for 2010 and 2012.

Analysis of educational attainment over time shows the difference in odds of successful application for those with attainment z-score of 1 compared with attainment z-score of 0 is significantly reduced for the years 1997-2001 but then significantly increased for 2002-2012, compared with 1996.

DISCUSSION

Key Results

During the period 1992-2012 the likelihood of university applicants receiving an offer to read medicine varied 3-fold, peaking in 2001. Throughout the study period, applicants who were female, White, from more advantaged family backgrounds and who attended independent or grammar schools were more likely to receive an offer. Although differences in the odds between white and non-white applicants were reduced slightly during the study

period, the overall advantage for white applicants persisted. In contrast, the advantage for female applicants diminished markedly from 2007 onward. There was no clear trend in the advantage for students from HMP occupational backgrounds but from 2005 onwards the odds of success for applications from students with grammar and independent schooling background increased.

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 for the period 1996-2012. Our models allowed for the clustering of applications within applicant. We were unable to identify cases where applicants had applications in different years but we do not anticipate the number of applicants making repeated annual applications to be high. Applicants will choose schools they wish to apply to for a variety of reasons including their perception of whether a university is 'easy' or 'hard' for them to get into [26, 27]. Central to this will be the selection processes used by the school and its usual examination grade requirements [28]. We have not been able to take this aspect of choice into account in our modelling.

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 [22]. For the majority of applicants, at the time they make their application to medical school, they have yet to sit their final school examinations. Medical schools therefore make their offer decisions on the basis of the grades the student is

predicted to get (as made by their teachers). In these analyses, educational attainment was measured using the actual grades gained. If a school's prediction 'over-estimates' a student's actual performance then the student may receive offers ahead of another student whose grades have been more appropriately predicted, even though both students may gain the same actual grades. Alternatively, under-prediction may see able students not being made offers despite meeting the educational requirements in their eventual examination results. It has been reported that Independent and Grammar schools predict their pupils' grades more accurately than other types of schools and are the least likely to over-estimate in their prediction [29]. Thus, if erroneous prediction is influencing offer likelihood we would expect it to bias against any advantage for Independent and Grammar schools.

One challenge in undertaking longitudinal analyses in this field is that of 'grade inflation'. In 1996 the proportion of A'levels awarded the top grade (Grade A) was ~15% [30]. However with the Examination Boards moving from norm referencing to criterion referencing, this had increased steadily and substantially to ~27% by 2012. In consequence it has become more difficult for medical schools to differentiate the most academically able students to whom they wish to make offers. Our calculation of a z-score should account for this as it looks at how different attainment is above and below the mean for that year.

We used parental occupation as a proxy for socio-economic status, and this was pre-coded for us by UCAS using standard protocols. However, 10.4% of applicants did not provide sufficient information on parental occupation to enable classification (Table 1). We have previously commented on the challenges faced in ascribing socio-economic status using

parental occupation and concluded that data is most likely to be missing for applicants who are mature students (aged 21 years and older) non-White, and who live in deprived areas [31]. To minimise this potential bias we limited our study population to those aged less than 21 years. More subtle biases may arise as a result of misinformation provided by applicants in light of a perception during the study period that universities were seeking to discriminate positively in favour of students from more disadvantaged backgrounds [32, 33].

We adjusted for a range of variables previously associated with the likelihood of admission to medical school. However, we recognise that admission is a complex assessment of suitability and there may be factors we have not been able to capture which may come into play.

Interpretation of Findings

The impact of the expansion programme in changing the likelihood of offers for all applicants, and in attenuating the offer likelihood between some demographic applicant groups is a striking finding. In short, not only was it 'easier' to get into medical school, but the selection process also appeared to be 'fairer' for some applicants. Two factors may explain these observations; first the schools needed to hit their increased quotas but the numbers of applicants for medicine had yet to increase proportionally in relation to the expanded number of places. Students to whom an offer would not have been made previously might now be expected to be successful as selection criteria might be lowered. If this were the case, might we expect the differentials in relation to educational attainment to be the variable most affected – that is, students might now be accepted who had 'dropped' a grade, or may have been made offers which were slightly lower – and indeed

our data does suggest some attenuation of the effect of educational attainment in 1999-2001. Another explanation is that the four 'new' medical schools opened as part of the expansion programme made it clear that they wanted to do things a little differently to the existing schools, not least the manner in which they selected future students [34]. However their size relative to the total number of medical school places suggests impact on the global scale would be too small to register the changes seen in our data.

It is notable that medical schools are increasingly adopting a variety of novel tools as they seek to enhance the objectivity of their selection methods [16, 17]. Advocates of aptitude testing have argued that tools such as the UKCAT may reduce offer inequity, with recent work from Tiffin suggesting that if the tool is used as a 'threshold test' – i.e. a certain pre-determined test score must be attained in order for the medical school to consider an application – only the UKCAT score and academic attainment remain independent predictors of the likelihood of receiving an offer [22]. The use of UKCAT is now widespread. First used in 2006, 25 of the 31 UK medical schools were using it in 2009 and others have since adopted it or plan to adopt it [35]. However, not all schools use UKCAT as a 'threshold test'. It is possible that the loss of the advantage for female applicants and the increase in advantage of candidates from grammar and independent schools may reflect the increased use of the UKCAT. The test has been reported to favour male applicants and also those from a higher socioeconomic class or from independent or grammar schools - although these findings are not consistently observed [20, 36, 37]. While the proportion of applicants from non-White minority groups remains much higher than in the population as a whole, the apparent disadvantage that they experience when applying to study medicine remains, and is largely unexplained. This observation seems no less relevant than when first made as

a consequence of McManus and colleagues' early work in this area in the late 1980s and 1990s [8-11]. Arguments that aptitude tests have a positive impact on equity therefore require substantiation across the range of demographic variables through further analysis from multiple admission cohorts.

Policy Implications and Future Research Directions

In 2009, the UK Government commissioned a Panel on Fair Access to the Professions whose report 'Unleashing Aspiration' set out a series of recommendations to improve access to university for training in medicine, law and other professions for students from disadvantaged groups [14]. The Forward to the most recent progress report on these recommendations however suggested that [38]:

> *" … medicine lags behind other professions both in the focus and in the priority it accords to these issues. It has a long way to go when it comes to making access fairer, diversifying its workforce and raising social mobility. There is no sense of the sort of galvanised effort that the Neuberger Report induced in law. That is regrettable, not least because when it comes to both gender and race, medicine has made impressive progress over recent years. Its success in recruiting more female doctors and doctors from black and minority ethnic backgrounds indicates that with the right level of intentionality the medical profession can also throw open its doors to a far broader social intake than it does at present. The profession itself recognises that the skills which modern doctors require include far greater understanding of the social and economic backgrounds of the people they serve. That is a welcome recognition. It now needs to be matched by action. Overall, medicine has made far too little progress and shown far too little interest in the issue of fair access. It needs a step change in approach.*

While criticising medicine's success in widening access in general, the statement goes on to imply that the only remaining issue in ensuring 'fair access' relates to that of socio-economic background, with the increased numbers of female and non-white students providing *prima*

facia evidence that for other demographic characteristics, the battle has been won. We argue that simple reporting of the demography of student cohorts says nothing about the fairness of access for the demography of any student cohort is a product both of the characteristics of those applying for a place and the biases, if any, of the selection process.

Our findings suggest that a persistent advantage remains for some demographic factors. We have noted that we may have not controlled for unknown confounders in our analysis and it is possible that the novel methods used by medical schools are deliberately selecting for skills such as empathy, resilience, ethical awareness and so forth for which we have not been able to account. If this is the case, then the data presented here should merely stimulate a re-focusing of the research question; that is, why are the qualities deemed necessary to practice medicine distributed non-randomly across different demographic groups? This raises new questions as to what we mean when we talk about 'fairness' and 'equity' and opens a tricky political Pandora's Box; an issue thoughtfully tackled by Eva in a recent editorial [39]. Our findings also suggest that during the expansion period of medical school places, the importance of 'good' educational attainment in terms of the likelihood of receiving an offer, lessened; that is, it would appear that the entry qualifications of those entering medical school dropped. The expansion thus produced a cohort of doctors who entered medical school in the late 1990s / early 2000s and who appear, en masse, to have poorer educational attainment than earlier and later cohorts. This offers the opportunity to explore further the validity of measures of educational attainment made at 18 years of age as predictors for doctors' professional performance.

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Diagrams, Tables and Figures

Figure 1: Derivation of sample: N= no. of applicants (no. of applications)

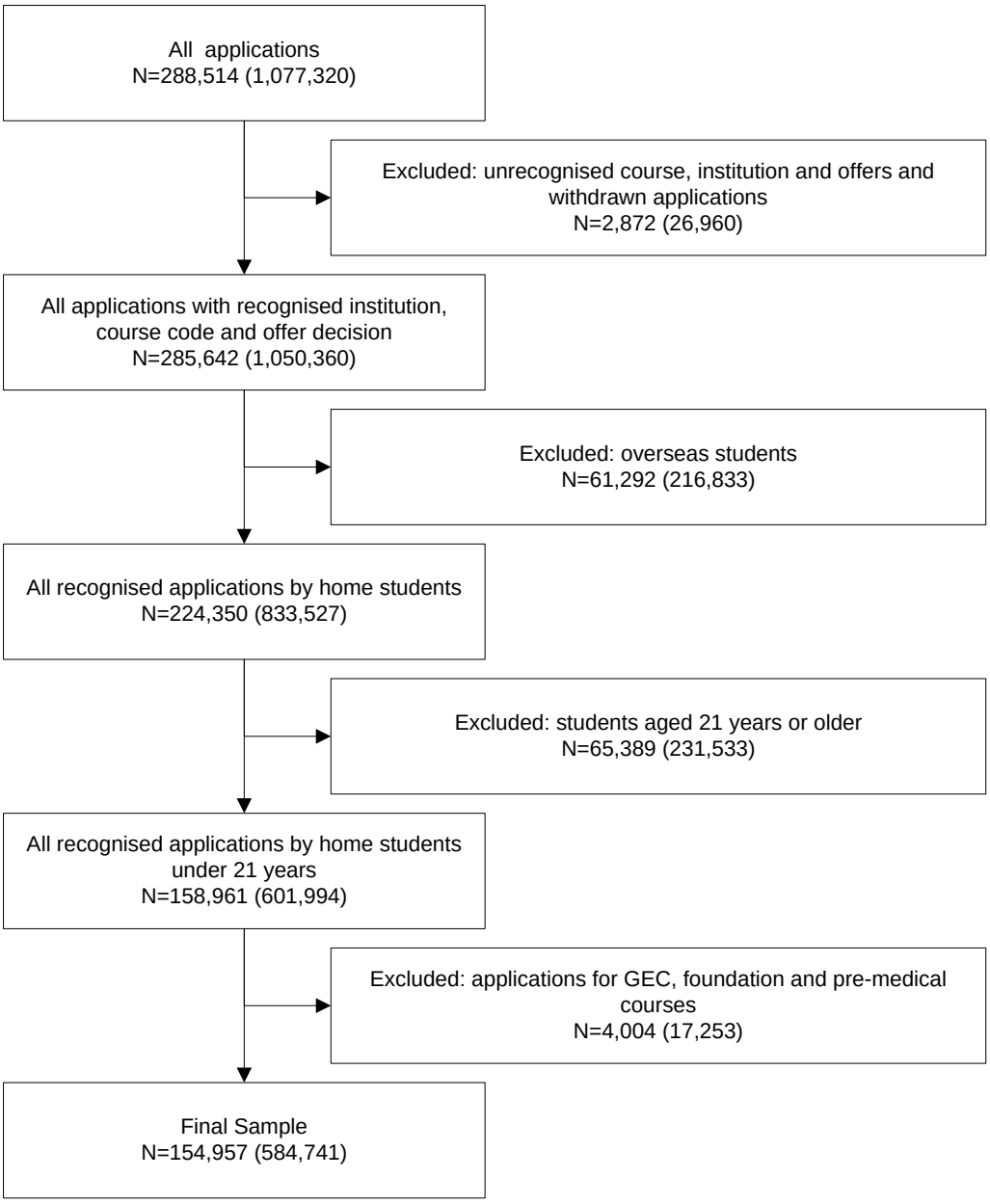


Table 1: Characteristics of Applicants

	All applicants (n=154,957)	Not offered a place (n=66,383)	Offered a place* (n=88,574)	Accepted** (n=84,018)
Year:				
1996	8,027 (5.2)	3,690 (5.6)	4,337 (4.9)	3,992 (4.8)
1997	8,089 (5.2)	3,697 (5.6)	4,392 (5.0)	4,124 (4.9)
1998	7,936 (5.1)	3,410 (5.1)	4,526 (5.1)	4,209 (5.0)
1999	7,275 (4.7)	2,688 (4.1)	4,587 (5.2)	4,307 (5.1)
2000	6,653 (4.3)	1,878 (2.8)	4,775 (5.4)	4,461 (5.3)
2001	6,578 (4.3)	1,488 (2.2)	5,090 (5.8)	4,741 (5.6)
2002	7,345 (4.7)	1,959 (3.0)	5,386 (6.1)	4,973 (5.9)
2003	8,153 (5.3)	2,440 (3.7)	5,713 (6.5)	5,249 (6.3)
2004	9,811 (6.3)	3,912 (5.9)	5,899 (6.7)	5,536 (6.6)
2005	10,680 (6.9)	5,218 (7.9)	5,462 (6.2)	5,205 (6.2)
2006	10,708 (6.9)	5,064 (7.6)	5,644 (6.4)	5,426 (6.5)
2007	10,471 (6.8)	4,891 (7.4)	5,580 (6.3)	5,366 (6.4)
2008	10,385 (6.7)	4,795 (7.2)	5,590 (6.3)	5,411 (6.4)
2009	10,194 (6.6)	4,730 (7.1)	5,464 (6.2)	5,314 (6.3)
2010	10,884 (7.0)	5,475 (8.3)	5,409 (6.1)	5,266 (6.3)
2011	11,121 (7.2)	5,869 (8.8)	5,252 (5.9)	5,111 (6.1)
2012	10,647 (6.9)	5,179 (7.8)	5,468 (6.2)	5,327 (6.3)
Sex:				
Male	68,596 (44.3)	30,958 (46.6)	37,638 (42.5)	36,041 (42.9)
Female	86,361 (55.7)	35,425 (53.4)	50,936 (57.5)	47,977 (57.1)
Ethnicity*:**				
White	94,519 (61.0)	34,448 (51.9)	60,071 (67.8)	56,810 (67.6)
Mixed	4,355 (2.8)	2,032 (3.1)	2,323 (2.6)	2,200 (2.6)
Other	3,759 (2.4)	2,072 (3.1)	1,687 (1.9)	1,621 (1.9)
Black Caribbean	584 (0.4)	380 (0.6)	204 (0.2)	192 (0.2)
Black African	5,262 (3.4)	3,775 (5.7)	1,487 (1.7)	1,388 (1.7)
Black Other	354 (0.2)	236 (0.4)	118 (0.1)	108 (0.1)
Pakistani	9,839 (6.4)	6,133 (9.2)	3,706 (4.2)	3,557 (4.2)
Bangladeshi	2,536 (1.6)	1,598 (2.4)	938 (1.1)	884 (1.1)
Indian	16,552 (10.7)	7,621 (11.5)	8,931 (10.1)	8,638 (10.3)
Chinese	3,561 (2.3)	1,501 (2.3)	2,060 (2.3)	1,987 (2.4)
Other Asian	7,820 (5.1)	4,124 (6.2)	3,696 (4.2)	3,548 (4.2)
Not known	5,816 (3.8)	2,463 (3.7)	3,353 (3.8)	3,085 (3.7)
Parental Occupation**:**				
Higher managerial and professional	60,167 (38.8)	21,081 (31.8)	39,086 (44.1)	37,359 (44.5)
Lower managerial and professional	39,934 (25.8)	17,042 (25.7)	22,892 (25.9)	21,580 (25.7)
Intermediate occupations	14,362 (9.3)	6,252 (9.4)	8,110 (9.2)	7,642 (9.1)
Lower supervisory and technical	3,928 (2.5)	2,015 (3.0)	1,913 (2.2)	1,806 (2.2)
Routine†	3,675 (2.4)	2,161 (3.3)	1,514 (1.7)	1,402 (1.7)
Semi-routine‡	9,993 (6.5)	5,463 (8.2)	4,530 (5.1)	4,282 (5.1)
Small employers and own account	6,729 (4.3)	3,389 (5.1)	3,340 (3.8)	3,146 (3.7)
Not stated	16,169 (10.4)	8,980 (13.5)	7,189 (8.1)	6,801 (8.1)
School Type:				
Grammar and Independent	68,313 (44.1)	23,132 (34.9)	45,181 (51.0)	43,093 (51.3)
Other	83,754 (54.1)	41,629 (62.7)	42,125 (47.6)	39,702 (47.3)
Not known	2,890 (1.9)	1,622 (2.4)	1,268 (1.4)	1,223 (1.5)
Attainment§:				
Good attainment	91,995 (59.4)	29,273 (44.1)	62,722 (70.8)	60,906 (72.5)
Poor attainment	56,588 (36.5)	33,093 (49.9)	23,495 (26.5)	20,963 (25.0)
Not known	6,374 (4.1)	4,017 (6.1)	2,357 (2.7)	2,149 (2.6)

*Applicant has received at least one offer from their applications submitted to UCAS.

**Applicants enter medical school on a traditional course (25 additional students were accepted to medical school on a traditional course but their application to the specific institution and course is not seen in the UCAS records. 827 applicants when to medical school on non-traditional courses; 7 GEC; 208 Pre-medical; and, 612 foundation course students).

*** Data aggregated in the analyses White; Black (Black Caribbean, Black African; Black Other); Asian (Pakistani; Bangladeshi; Indian; Chinese; Other Asian); and Other (Mixed; Other)

**** Data aggregated in the analyses as Higher Managerial and Professional (HMP) and non-Higher Managerial and Professional (all other occupational groups; non-HMP).

†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 2: Unadjusted and adjusted modelling of application outcome and application characteristics. *fully adjusted for all variables shown in table. † Reference is 1996; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. *(Wald statistics)*

	Unadjusted Analysis			Adjusted Analysis*		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Year†:			*(<0.001)*			*(<0.001)*
1997	0.93	(0.88, 0.99)	0.016	0.93	(0.88, 0.98)	0.005
1998	1.02	(0.96, 1.08)	0.538	1.08	(1.02, 1.14)	0.005
1999	1.27	(1.20, 1.35)	<0.001	1.33	(1.26, 1.41)	<0.001
2000	2.16	(2.04, 2.30)	<0.001	2.20	(2.08, 2.33)	<0.001
2001	2.98	(2.80, 3.16)	<0.001	2.94	(2.78, 3.11)	<0.001
2002	2.71	(2.56, 2.87)	<0.001	2.65	(2.50, 2.80)	<0.001
2003	2.40	(2.26, 2.54)	<0.001	2.26	(2.14, 2.39)	<0.001
2004	1.43	(1.35, 1.51)	<0.001	1.34	(1.27, 1.42)	<0.001
2005	0.93	(0.88, 0.98)	0.012	0.92	(0.87, 0.97)	0.002
2006	0.95	(0.90, 1.00)	0.055	0.89	(0.84, 0.94)	<0.001
2007	0.99	(0.94, 1.05)	0.757	0.92	(0.87, 0.97)	0.002
2008	1.10	(1.04, 1.16)	0.001	0.98	(0.93, 1.04)	0.502
2009	1.09	(1.03, 1.15)	0.003	0.99	(0.93, 1.04)	0.582
2010	0.89	(0.85, 0.95)	<0.001	0.79	(0.75, 0.84)	<0.001
2011	0.81	(0.77, 0.86)	<0.001	0.72	(0.69, 0.76)	<0.001
2012	0.91	(0.86, 0.97)	0.002	0.82	(0.78, 0.86)	<0.001
Sex‡:						
Female	1.28	(1.26, 1.31)	<0.001	1.21	(1.19, 1.24)	<0.001
Ethnicity¥:			*(<0.001)*			*(<0.001)*
Asian	0.53	(0.51, 0.54)	<0.001	0.64	(0.62, 0.65)	<0.001
Black	0.24	(0.22, 0.25)	<0.001	0.43	(0.40, 0.46)	<0.001
Other	0.58	(0.56, 0.61)	<0.001	0.69	(0.66, 0.72)	<0.001
Parental Occupation§:						
Higher managerial and professional (HMP)	1.53	(1.50, 1.56)	<0.001	1.26	(1.24, 1.29)	<0.001
School Type¶:						
Grammar and Independent	1.73	(1.70, 1.76)	<0.001	1.25	(1.23, 1.28)	<0.001
Attainment:						
z-score	2.57	(2.54, 2.60)	<0.000	2.40	(2.37, 2.43)	<0.001

Figure 2: Adjusted ORs for offer by year –Reference is 1996, male, White ethnicity, non-HMP parental occupation, non-grammar or independent school type and attainment z-score of 0. Figure displays ORs on log scale.

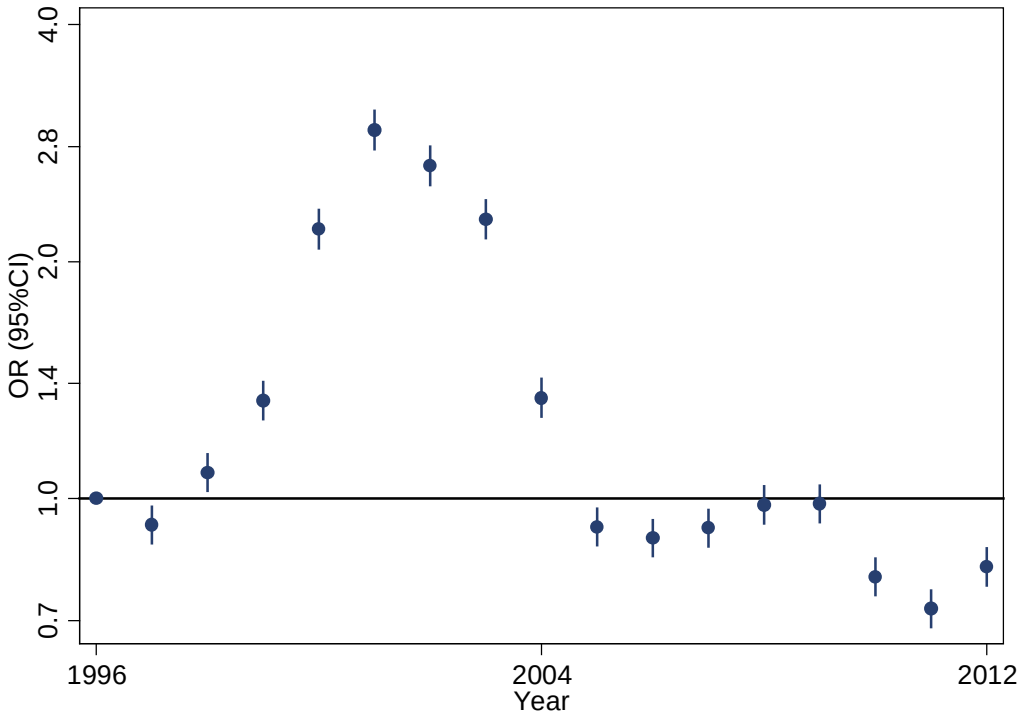


Figure 3: Adjusted ORs for offer by year and gender–Reference is 1996, male, White ethnicity, non-HMP parental occupation, non-grammar or independent school type and attainment z-score of 0. Figure displays ORs on log scale.

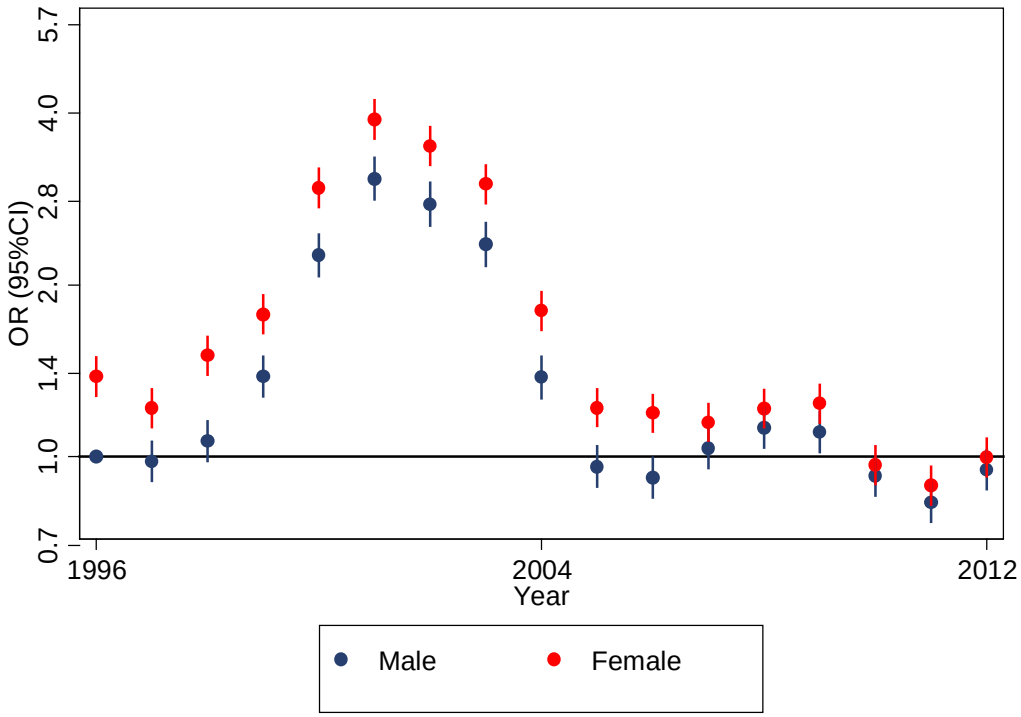


Figure 4: Adjusted ORs for offer by year and ethnicity–Reference is 1996, male, White ethnicity, non-HMP parental occupation, non-grammar or independent school type and attainment z-score of 0. Figure displays ORs on log scale.

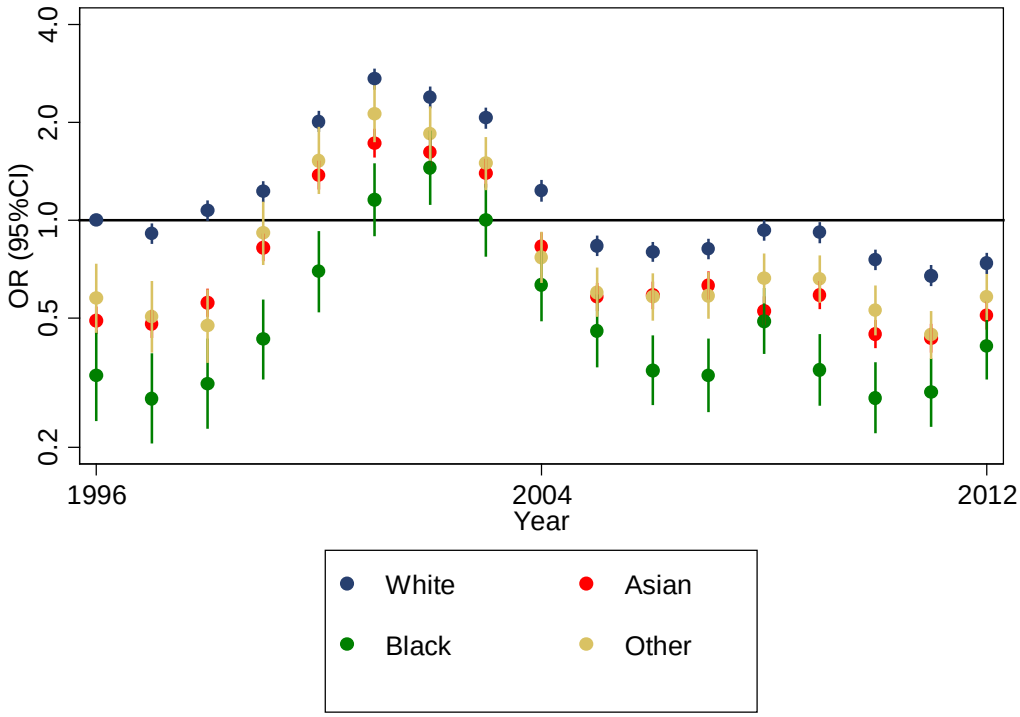


Figure 5: Adjusted ORs for offer by year and parental occupation–Reference is 1996, male, White ethnicity, non-HMP parental occupation, non-grammar or independent school type and attainment z-score of 0. Figure displays ORs on log scale.

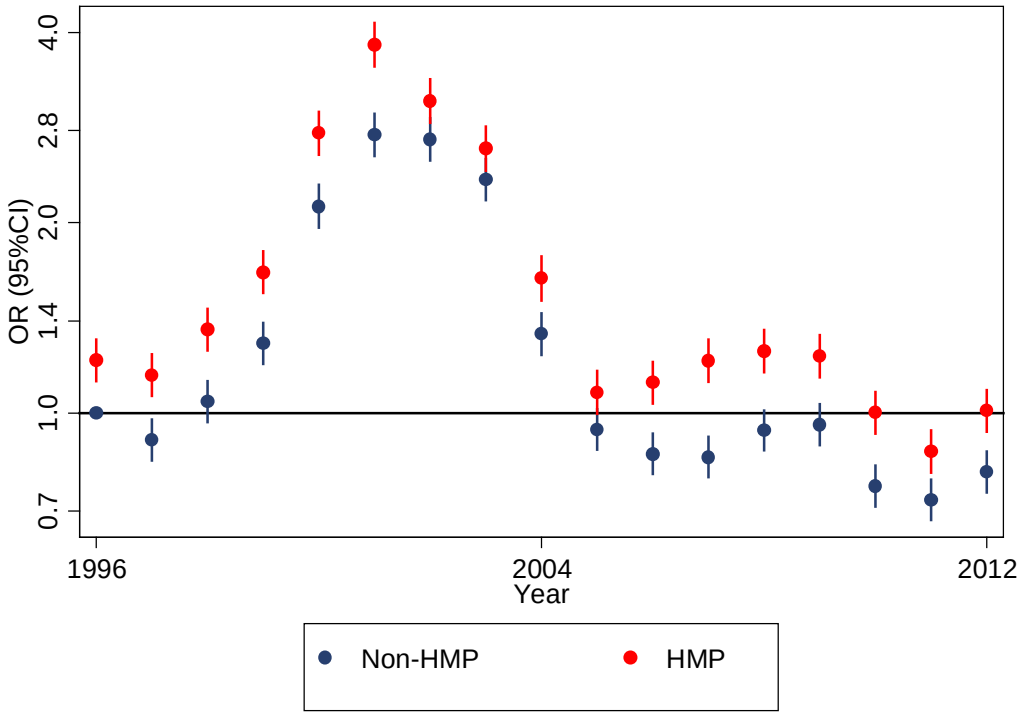


Figure 6: Adjusted ORs for offer by year and school type–Reference is 1996, male, White ethnicity, non-HMP parental occupation, non-grammar or independent school type and attainment z-score of 0. Figure displays ORs on log scale.

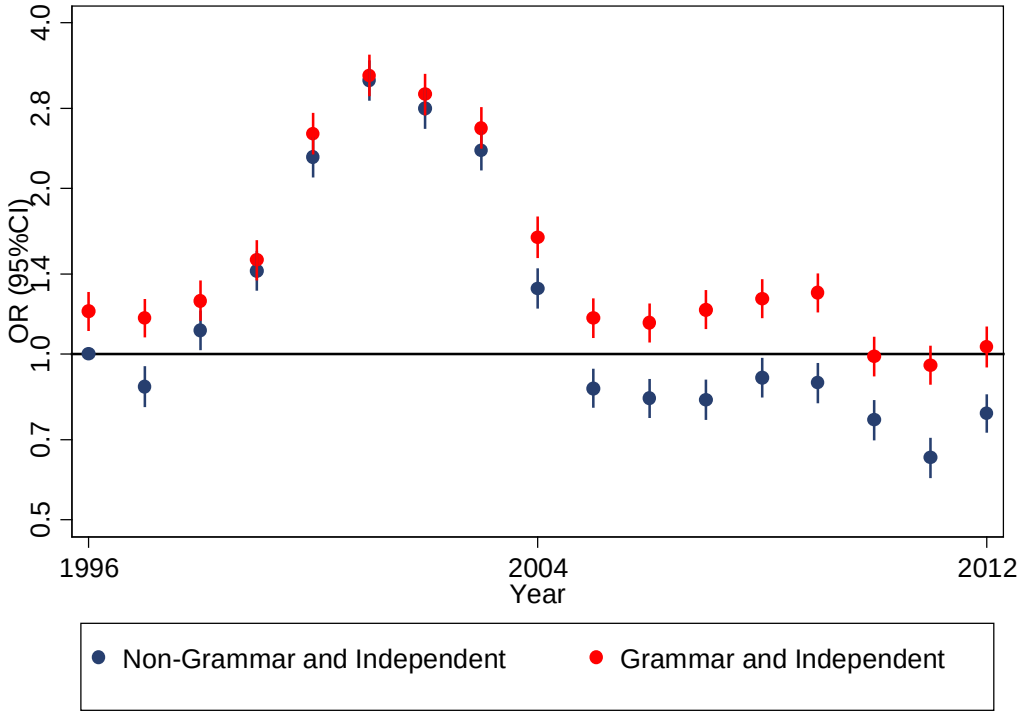
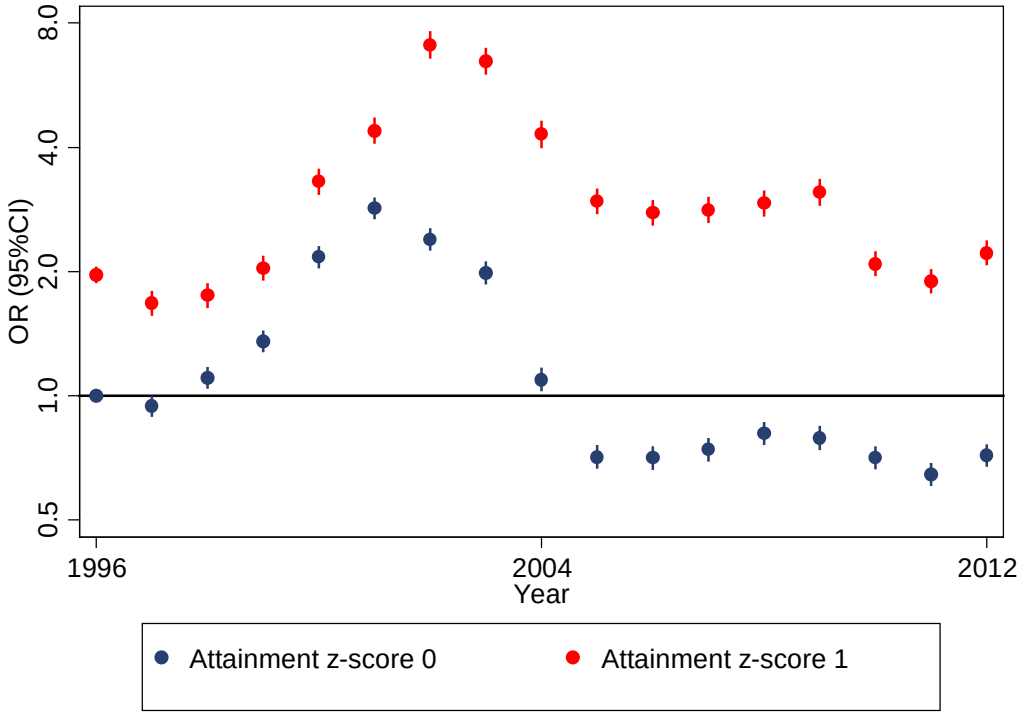


Figure 7: Adjusted ORs for offer by year and attainment–Reference is 1996, male, White ethnicity, non-HMP parental occupation, non-grammar or independent school type and attainment z-score of 0. Figure displays ORs on log scale.



Supplementary Materials

Table S1: Results of adjusted modelling of sex and year with main effects and interactions. † Reference is 1996; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. *(Wald statistics)*

		OR	95% CI	p-value
Main effects:				
Year†:				*(<0.001)*
1997		0.98	(0.91, 1.06)	0.640
1998		1.06	(0.98, 1.15)	0.122
1999		1.38	(1.27, 1.50)	<0.001
2000		2.25	(2.07, 2.45)	<0.001
2001		3.07	(2.81, 3.34)	<0.001
2002		2.77	(2.54, 3.01)	<0.001
2003		2.35	(2.16, 2.56)	<0.001
2004		1.38	(1.27, 1.50)	<0.001
2005		0.96	(0.89, 1.04)	0.338
2006		0.92	(0.85, 1.00)	0.038
2007		1.04	(0.96, 1.12)	0.394
2008		1.12	(1.04, 1.22)	0.004
2009		1.10	(1.02, 1.20)	0.016
2010		0.93	(0.86, 1.00)	0.056
2011		0.83	(0.77, 0.90)	<0.001
2012		0.95	(0.88, 1.03)	0.196
Sex‡				
Female		1.38	(1.28, 1.49)	<0.001
Ethnicity¥				*(<0.001)*
Asian		0.64	(0.62, 0.65)	<0.001
Black		0.43	(0.41, 0.46)	<0.001
Other		0.69	(0.66, 0.72)	<0.001
Parental Occupation§				
HMP		1.26	(1.24, 1.29)	<0.001
School Type¶				
Grammar and Independent		1.26	(1.23, 1.28)	<0.001
Attainment z-score		2.40	(2.37, 2.43)	<0.001
Interactions:				
Year:	**Sex:**			*(<0.001)*
1997	Female	0.90	(0.81, 1.00)	0.050
1998	Female	1.02	(0.92, 1.14)	0.690
1999	Female	0.93	(0.84, 1.04)	0.202
2000	Female	0.95	(0.85, 1.06)	0.381
2001	Female	0.92	(0.82, 1.03)	0.146
2002	Female	0.92	(0.82, 1.02)	0.129
2003	Female	0.92	(0.83, 1.03)	0.159
2004	Female	0.95	(0.85, 1.06)	0.340
2005	Female	0.92	(0.82, 1.02)	0.125
2006	Female	0.94	(0.84, 1.04)	0.251
2007	Female	0.80	(0.72, 0.89)	<0.001
2008	Female	0.78	(0.70, 0.87)	<0.001
2009	Female	0.81	(0.73, 0.91)	<0.001

2010	Female	0.76	(0.68, 0.84)	<0.001
2011	Female	0.77	(0.70, 0.86)	<0.001
2012	Female	0.76	(0.68, 0.85)	<0.001

Table S2: Results of adjusted modelling of ethnicity and year with main effects and interactions. † Reference is 1996; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. *(Wald statistics)*

		OR	95% CI	p-value
Main effects:				
Year†:				*(<0.001)*
1997		0.91	(0.85, 0.97)	0.004
1998		1.07	(1.00, 1.14)	0.037
1999		1.22	(1.15, 1.30)	<0.001
2000		2.01	(1.89, 2.15)	<0.001
2001		2.72	(2.55, 2.91)	<0.001
2002		2.39	(2.23, 2.55)	<0.001
2003		2.06	(1.93, 2.20)	<0.001
2004		1.23	(1.15, 1.32)	<0.001
2005		0.83	(0.78, 0.89)	<0.001
2006		0.80	(0.75, 0.85)	<0.001
2007		0.82	(0.77, 0.87)	<0.001
2008		0.93	(0.87, 0.99)	0.026
2009		0.92	(0.86, 0.98)	0.007
2010		0.75	(0.71, 0.80)	<0.001
2011		0.68	(0.63, 0.72)	<0.001
2012		0.74	(0.69, 0.79)	<0.001
Sex‡				
Female		1.21	(1.19, 1.24)	<0.001
Ethnicity¥				*(<0.001)*
Asian		0.49	(0.45, 0.54)	<0.001
Black		0.33	(0.24, 0.45)	<0.001
Other		0.58	(0.45, 0.73)	<0.001
Parental Occupation†§				
HMP		1.26	(1.24, 1.29)	<0.001
School Type¶				
Grammar and Independent		1.25	(1.23, 1.28)	<0.001
Attainment z-score		2.40	(2.37, 2.43)	<0.001
Interactions:				
Year:	**Ethnicity:**			*(<0.001)*
1997	Asian	1.07	(0.94, 1.22)	0.281
1998	Asian	1.06	(0.93, 1.20)	0.374
1999	Asian	1.37	(1.21, 1.55)	<0.001
2000	Asian	1.39	(1.22, 1.58)	<0.001
2001	Asian	1.29	(1.13, 1.47)	<0.001
2002	Asian	1.38	(1.21, 1.57)	<0.001
2003	Asian	1.37	(1.21, 1.57)	<0.001
2004	Asian	1.37	(1.21, 1.56)	<0.001
2005	Asian	1.42	(1.25, 1.61)	<0.001
2006	Asian	1.49	(1.32, 1.69)	<0.001
2007	Asian	1.57	(1.38, 1.78)	<0.001
2008	Asian	1.15	(1.01, 1.31)	0.033
2009	Asian	1.30	(1.15, 1.48)	<0.001

2010	Asian	1.20	(1.06, 1.37)	0.005
2011	Asian	1.30	(1.15, 1.48)	<0.001
2012	Asian	1.41	(1.24, 1.60)	<0.001
1997	Black	0.94	(0.60, 1.46)	0.769
1998	Black	0.88	(0.57, 1.37)	0.579
1999	Black	1.06	(0.70, 1.60)	0.790
2000	Black	1.04	(0.68, 1.58)	0.856
2001	Black	1.28	(0.86, 1.91)	0.228
2002	Black	1.83	(1.22, 2.74)	0.003
2003	Black	1.46	(0.98, 2.19)	0.064
2004	Black	1.55	(1.04, 2.31)	0.033
2005	Black	1.65	(1.11, 2.47)	0.014
2006	Black	1.30	(0.88, 1.93)	0.189
2007	Black	1.23	(0.82, 1.84)	0.317
2008	Black	1.58	(1.08, 2.33)	0.019
2009	Black	1.14	(0.76, 1.69)	0.524
2010	Black	1.13	(0.76, 1.69)	0.531
2011	Black	1.32	(0.89, 1.94)	0.168
2012	Black	1.67	(1.14, 2.46)	0.009
1997	Other	0.96	(0.69, 1.35)	0.824
1998	Other	0.77	(0.54, 1.08)	0.134
1999	Other	1.29	(0.94, 1.78)	0.116
2000	Other	1.32	(0.95, 1.83)	0.102
2001	Other	1.36	(1.00, 1.85)	0.050
2002	Other	1.34	(1.00, 1.81)	0.053
2003	Other	1.26	(0.94, 1.70)	0.128
2004	Other	1.09	(0.81, 1.46)	0.578
2005	Other	1.25	(0.94, 1.67)	0.126
2006	Other	1.26	(0.95, 1.68)	0.110
2007	Other	1.25	(0.94, 1.65)	0.129
2008	Other	1.23	(0.92, 1.65)	0.155
2009	Other	1.25	(0.94, 1.66)	0.125
2010	Other	1.22	(0.91, 1.63)	0.184
2011	Other	1.14	(0.86, 1.52)	0.367
2012	Other	1.37	(1.04, 1.81)	0.030

Table S3: Results of adjusted modelling of parental occupation and year with main effects and interactions. † Reference is 1996; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. *(Wald statistics)*

		OR	95% CI	p-value
Main effects:				
Year†:				*(<0.001)*
1997		0.91	(0.84, 0.98)	0.010
1998		1.04	(0.97, 1.12)	0.272
1999		1.29	(1.19, 1.39)	<0.001
2000		2.12	(1.96, 2.29)	<0.001
2001		2.75	(2.55, 2.97)	<0.001
2002		2.71	(2.51, 2.92)	<0.001
2003		2.34	(2.17, 2.52)	<0.001
2004		1.33	(1.24, 1.44)	<0.001
2005		0.94	(0.88, 1.01)	0.109
2006		0.86	(0.80, 0.93)	<0.001
2007		0.85	(0.79, 0.92)	<0.001
2008		0.94	(0.87, 1.01)	0.093
2009		0.96	(0.89, 1.03)	0.264
2010		0.77	(0.71, 0.83)	<0.001
2011		0.73	(0.68, 0.79)	<0.001
2012		0.81	(0.75, 0.87)	<0.001
Sex‡				
Female		1.21	(1.19, 1.24)	<0.001
Ethnicity¥				*(<0.001)*
Asian		0.64	(0.62, 0.65)	<0.001
Black		0.43	(0.40, 0.46)	<0.001
Other		0.69	(0.66, 0.72)	<0.001
Parental Occupation§				
HMP		1.21	(1.12, 1.31)	<0.001
School Type¶				
Grammar and Independent		1.25	(1.23, 1.28)	<0.001
Attainment z-score		2.40	(2.37, 2.43)	<0.001
Interactions:				
Year:	**Parental Occupation:**			*(<0.001)*
1997	HMP	1.05	(0.94, 1.16)	0.417
1998	HMP	1.07	(0.96, 1.19)	0.198
1999	HMP	1.07	(0.96, 1.19)	0.228
2000	HMP	1.08	(0.96, 1.20)	0.200
2001	HMP	1.15	(1.02, 1.28)	0.017
2002	HMP	0.95	(0.85, 1.06)	0.347
2003	HMP	0.92	(0.83, 1.03)	0.152
2004	HMP	1.01	(0.90, 1.13)	0.873
2005	HMP	0.94	(0.85, 1.05)	0.291
2006	HMP	1.07	(0.96, 1.19)	0.223
2007	HMP	1.17	(1.05, 1.30)	0.004
2008	HMP	1.10	(0.99, 1.22)	0.083
2009	HMP	1.06	(0.95, 1.18)	0.311

2010	HMP	1.08	(0.97, 1.20)	0.179
2011	HMP	0.98	(0.88, 1.10)	0.751
2012	HMP	1.03	(0.93, 1.15)	0.170

Table S4: Results of adjusted modelling of school type and year with main effects and interactions. † Reference is 1996; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. *(Wald statistics)*

		OR	95% CI	p-value
Main effects:				
Year†:				*(<0.001)*
1997		0.87	(0.81, 0.95)	0.001
1998		1.11	(1.02, 1.19)	0.010
1999		1.42	(1.31, 1.53)	<0.001
2000		2.28	(2.11, 2.47)	<0.001
2001		3.14	(2.91, 3.40)	<0.001
2002		2.80	(2.58, 3.03)	<0.001
2003		2.34	(2.17, 2.53)	<0.001
2004		1.32	(1.22, 1.42)	<0.001
2005		0.87	(0.80, 0.94)	<0.001
2006		0.83	(0.77, 0.90)	<0.001
2007		0.83	(0.76, 0.89)	<0.001
2008		0.91	(0.84, 0.98)	0.014
2009		0.89	(0.82, 0.96)	0.003
2010		0.76	(0.70, 0.82)	<0.001
2011		0.65	(0.60, 0.70)	<0.001
2012		0.78	(0.72, 0.84	<0.001
Sex‡				
Female		1.21	(1.19, 1.24)	<0.001
Ethnicity¥				*(<0.001)*
Asian		0.63	(0.62, 0.65)	<0.001
Black		0.43	(0.40, 0.46)	<0.001
Other		0.69	(0.66, 0.72)	<0.001
Parental Occupation§				
HMP		1.26	(1.24, 1.29)	<0.001
School Type¶				
Grammar and Independent		1.20	(1.11, 1.29)	<0.001
Attainment z-score		2.41	(2.38, 2.44)	<0.001
Interactions:				
Year:	**School Type**			*(<0.001)*
1997	Grammar and Independent	1.11	(1.00, 1.24)	0.052
1998	Grammar and Independent	0.94	(0.85, 1.05)	0.301
1999	Grammar and Independent	0.87	(0.78, 0.97)	0.014
2000	Grammar and Independent	0.92	(0.82, 1.03)	0.151
2001	Grammar and Independent	0.85	(0.76, 0.95)	0.005
2002	Grammar and Independent	0.89	(0.79, 0.99)	0.032
2003	Grammar and Independent	0.92	(0.82, 1.03)	0.131

2004	Grammar and Independent	1.03	(0.93, 1.16)	0.546
2005	Grammar and Independent	1.12	(1.01, 1.25)	0.036
2006	Grammar and Independent	1.15	(1.03, 1.27)	0.012
2007	Grammar and Independent	1.22	(1.09, 1.36)	<0.001
2008	Grammar and Independent	1.16	(1.04, 1.29)	0.006
2009	Grammar and Independent	1.22	(1.09, 1.36)	<0.001
2010	Grammar and Independent	1.09	(0.98, 1.21)	0.116
2011	Grammar and Independent	1.23	(1.10, 1.37)	<0.001
2012	Grammar and Independent	1.10	(0.57, 0.70)	0.071

Table S5: Results of adjusted modelling of attainment z-score and year with main effects and interactions. † Reference is 1996; ‡ Reference is Male; ¥ Reference is White; § Reference is non-HMP; ¶ Reference is non-Grammar and Independent. *(Wald statistics)*

		OR	95% CI	p-value
Main effects:				
Year†:				*(<0.001)*
1997		0.94	(0.90, 0.99)	0.031
1998		1.10	(1.05, 1.17)	<0.001
1999		1.35	(1.28, 1.43)	<0.001
2000		2.17	(2.05, 2.29)	<0.001
2001		2.84	(2.70, 3.01)	<0.001
2002		2.39	(2.26, 2.53)	<0.001
2003		1.98	(1.87, 2.10)	<0.001
2004		1.09	(1.03, 1.16)	0.003
2005		0.71	(0.67, 0.75)	<0.001
2006		0.71	(0.67, 0.75)	<0.001
2007		0.74	(0.70, 0.78)	<0.001
2008		0.81	(0.76, 0.86)	<0.001
2009		0.79	(0.74, 0.84)	<0.001
2010		0.71	(0.67, 0.75)	<0.001
2011		0.64	(0.61, 0.68)	<0.001
2012		0.72	(0.68, 0.76)	<0.001
Sex‡				
Female		1.21	(1.19, 1.24)	<0.001
Ethnicity†				*(<0.001)*
Asian		0.64	(0.63, 0.66)	<0.001
Black		0.46	(0.43, 0.49)	<0.001
Other		0.70	(0.67, 0.73)	<0.001
Parental Occupation†				
HMP		1.23	(1.21, 1.25)	<0.001
School Type†				
Grammar and Independent		1.24	(1.21, 1.26)	<0.001
Attainment z-score		1.96	(1.89, 2.04)	<0.001
Interactions:				
Year:				*(<0.001)*
1997	Attainment z-score	0.90	(0.86, 0.96)	<0.001
1998	Attainment z-score	0.81	(0.76, 0.85)	<0.001
1999	Attainment z-score	0.77	(0.72, 0.81)	<0.001
2000	Attainment z-score	0.78	(0.73, 0.82)	<0.001
2001	Attainment z-score	0.78	(0.74, 0.83)	<0.001
2002	Attainment z-score	1.51	(1.41, 1.61)	<0.001
2003	Attainment z-score	1.66	(1.55, 1.78)	<0.001
2004	Attainment z-score	2.00	(1.86, 2.16)	<0.001
2005	Attainment z-score	2.12	(1.97, 2.29)	<0.001
2006	Attainment z-score	2.00	(1.86, 2.15)	<0.001
2007	Attainment z-score	1.94	(1.80, 2.09)	<0.001
2008	Attainment z-score	1.84	(1.71, 1.98)	<0.001
2009	Attainment z-score	2.01	(1.85, 2.17)	<0.001

2010	Attainment z-score	1.50	(1.41, 1.60)	<0.001
2011	Attainment z-score	1.50	(1.40, 1.60)	<0.001
2012	Attainment z-score	1.58	(1.48, 1.68)	<0.001