Ethnic and social disparities in performance on medical school selection criteria

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CONTEXT Medical schools in Western societies seek measures to increase the diversity of their student bodies with respect to ethnicity and social background. Currently, little is known about the effects of different selection procedures on student diversity.

OBJECTIVES This prospective cohort study aimed to determine performance differences between traditional and non-traditional (i.e. ethnic minority and first-generation university candidates) medical school applicants in academic and non-academic selection criteria.

METHODS Applicants in 2013 (n = 703) were assessed on academic and non-academic selection criteria. They also completed a questionnaire on ethnicity and social background. Main outcome measures were 'not selected' (i.e. failure on any criteria), 'failure on academic criteria' and 'failure on non-academic criteria'. Odds ratios (ORs) with 95% confidence intervals (CIs) were estimated by logistic regression analysis for ethnic subgroups (Surinamese/Antillean, Turkish/Moroccan/African, Asian, Western) compared with Dutch applicants, adjusted for age, gender, additional socio-demographic variables (first-generation immigrant, first-generation university applicant, first language, medical doctor as parent) and pre-university grade point average (pu-GPA). Similar analyses were performed for first-generation university applicants.

RESULTS Compared with Dutch applicants, Surinamese/Antillean applicants underperformed in the selection procedure (failure rate: 78% versus 57%; adjusted OR 2.52, 95% CI 1.07–5.94), in particular on academic criteria (failure rate: 66% versus 34%; adjusted OR 3.00, 95% CI 1.41–6.41). The higher failure rate of first-generation university applicants on academic criteria (50% versus 37%; unadjusted OR 1.66, 95% CI 1.18–2.33) was partly explained by additional socio-demographic variables and pu-GPA. The outcome measure 'failure on non-academic criteria' showed no significant differences among the ethnic or social subgroups.

CONCLUSIONS The absence of differences on non-academic criteria was promising with reference to increasing social and ethnic diversity; however, the possibility that self-selection instigated by the selection procedure is stronger in applicants from non-traditional backgrounds cannot be ruled out. Further research should also focus on why cognitive tests might favour traditional applicants.

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INTRODUCTION

Worldwide, medical schools increasingly strive to achieve greater diversity among their students with respect to ethnicity and social background.[1–4] The rationales for widening access to medicine are based on the aims of achieving social equality and improved health care provision by ensuring that future doctors are representative of the societies they serve.[1] We aimed to study whether non-traditional applicants, such as ethnic minority and first-generation university applicants, have similar chances of being admitted to medical school as applicants from more traditional backgrounds. Although it is argued that varying selection practices may influence which applicants gain entry to medical school,[1] evidence on the effects of different types of selection criteria on student diversity is still scarce.[2] In this study, we focused on the relationships between the applicants' ethnic and social backgrounds and their performance on different types of selection criteria.

Non-traditional students are still under-represented in medical schools, despite several initiatives – in particular in the USA and the UK – aimed at widening access.[1,5] The factors reported to limit the widening of access include financial (cost of a medical career), social (medical school is 'not for the likes of me'[6]) and structural (e.g. non-inclusive admission practices) constraints.[1] In addition, the gap in educational attainment between non-traditional students and traditional students, which originates in early (school) life, remains to be addressed.[1]

One of the suggested ways to attract and widen access to medical school for non-traditional students involves the use of criteria other than grades for selection. The rationale is that the use of grades has been shown – especially in the UK – to introduce a significant socio-economic bias.[1] One of the alternatives to grades-based selection is the use of aptitude tests, such as the UK Clinical Aptitude Test (UKCAT), the Medical School Admission Test (MCAT) and the Undergraduate Medicine and Health Sciences Admission Test (UMAT). Another alternative is the use of non-academic selection criteria such as professionalism, communication and ethical reasoning skills,[3] measured by methods such as multiple mini-interviews (MMIs)[7] and situational judgement tests (SJTs).[8]

So far the introduction of these so-called attributes-based admission criteria as an alternative to grades-based selection has shown mixed results with respect to student diversity. Although Cleland *et al.*,[1] in their recent review, concluded that aptitude tests are 'better' at widening access than grades, personal statements and references, other recent studies have indicated that socio-demographic factors remain strong determinants of performance in the MCAT, UKCAT and UMAT.[4,9,10] O'Neill *et al.* also failed to see significant changes in the diversity of students after the introduction of attributes-based selection criteria.[2]

There is some evidence that written SJTs have a lower level of adverse impact in ethnic minority groups than do written tests of cognitive ability,[8] which is encouraging, but means that there are still ethnicity-based differences in SJT performance. A recent Canadian study showed that the MMI was unable to neutralise the diversity-limiting effect of the use of grades as a criterion for selection to interview.[10] This problem, that personal attributes or other skills are often only considered once grade requirements have been met, was also reported by Powis *et al.*[3] These mixed findings indicate a need for further studies that combine different types of selection criteria in order to be able to determine their respective effects on student diversity. Moreover, these studies should not use the different selection criteria sequentially, but concurrently, in order to assess their full potential in widening access.

In the Netherlands, students are selected for medical school either on the basis of a national lottery system that is weighted for school performance or on medical school-specific selection procedures. The medical schools themselves can decide on their selection criteria, but, so far, have not been allowed to use pre-university grades. As the proportion of students selected by medical school-specific procedures has increased in recent years and will continue to rise, interest in the issue of widening access has also increased in the Netherlands. Previously, we reported on a controlled experiment that showed the predictive value of a selection procedure combining academic and non-academic criteria for performance at medical school.[11–13]

The concurrent use of academic and non-academic criteria creates the opportunity to measure the effects of these different selection criteria on student diversity. Therefore, the aim of this prospective study was to determine whether performance differences occur between traditional and non-traditional medical school applicants on academic and

non-academic selection criteria and the extent to which these performance differences can be explained by age, gender, additional socio-demographic characteristics and pre-university grade point average (pu-GPA).

METHODS

Selection procedure

The local selection procedure at Erasmus MC Medical School in Rotterdam consists of two parts. In the first, non-academic part, participants are assessed according to the quality and quantity of their extracurricular activities before application based on information given on the application form. Extracurricular activities include (voluntary) jobs in health care, experience in management and organisation, or those that show special talents in sports, music or science. Evidence such as letters of recommendation and references to support their statements is mandatory.

The second part, which is academic, consists of five cognitive tests on medical subjects preceded by informative classes. Tests are taken over three consecutive days at Erasmus MC Medical School and contain questions on logical reasoning, scientific thinking, epidemiology and pathology, anatomy and calculus. Scoring of the non-academic and academic parts is independent in terms of both the persons scoring and the scoring techniques employed. In both selection parts, participants obtain a score and a successive ranking. In each part, an absolute threshold that is independent of the result of the other part and of the number of applicants meeting the threshold is applied. When the target number of students to be selected is not met, more students are admitted through the lottery system. Since 2012 all participants have undertaken both parts of the selection procedure. A more extensive description of the selection procedure has been provided previously.[11]

Participants and procedure

This study included all participants in the Erasmus MC Medical School selection procedure in 2013 (n = 750). During the on-site testing days, applicants were invited to complete a questionnaire that included items on factual aspects of their ethnicity and social background (Table 1). This part of the study was designed with the help and approval of the Dutch Data Protection Authority. Applicants were informed about the study, participation was voluntary, anonymity was guaranteed and applicants were ensured that answers on the questionnaire did not influence the outcome of the selection procedure. Data on performance on the selection procedure were derived from the university student administration system. Because data were collected

Table 1 Data recorded for each applicant

Source and type of data	Comment
By questionnaire	
Ethnicity	Dutch Turkish/Moroccan/African Surinamese/Antillean (Dutch Guyana) Asian (including Chinese) Western Other
First-generation immigrant	Ethnic minority applicants born outside the Netherlands
First language	Dutch or non-Dutch
First-generation university applicant	Applicants whose parents did not attend university (either a research university or a university of applied sciences)
Medical doctor as a parent	Parental profession as provided by the applicant was used to determine whether or not he or she had at least one parent who was a medical doctor
From university student administration	
Gender	
Age	At admission
Pre-university grade point average	Mean grades obtained during the final year of pre-university education (10-point scale: 1 = very poor, 10 = excellent) Final grades were based on school examinations (50%) and the national examination (50%) Not available for all applicants
Not selected	Scored below threshold on at least one part of the selection procedure
Failed on non-academic criteria	< 30 points on extracurricular activities
Failed on academic criteria	Average test score < 5.5 or scores of < 5.5 on two or more of five tests

as part of regular academic activities, individual consent was not necessary.

Variables

According to Statistics Netherlands (www.cbs.nl), an individual belongs to an ethnic minority group if at least one of his or her parents was born outside the Netherlands. Based on the countries of birth of their parents, ethnic minority applicants were classified into five ethnic subgroups: Surinamese/Antillean; Turkish/Moroccan/African; Asian; Western, and 'Other'[14,15] (Table 1). The 'Other' category included only a small number of applicants and its data were therefore excluded from the statistical analyses.

Gender and age are known to be associated with a better chance of making a successful application and were therefore included.[4,16] Pre-university GPA was included in the analyses as a continuous variable. As pu-GPA was not available for applicants with a foreign or a non-standard Dutch pre-university education, a categorical variable – 'missing pu-GPA' – was added to the analyses. Admission criteria for applicants with a foreign pre-university education are similar to those for applicants with a Dutch pre-university education: diplomas should be of a comparable level and certain subjects are required. Entrance examinations include examinations in Dutch, English, chemistry, biology, physics and mathematics.

Three measures were defined as representing failure on the selection procedure: not selected; failure on non-academic selection criteria, and failure on academic selection criteria. 'Not selected' refers to failure on at least one of the selection criteria.

Statistical analysis

We assessed associations between ethnicity and the other independent variables using chi-squared tests for categorical variables and analysis of variance (ANOVA) for pu-GPA and age. We used logistic regression to calculate an odds ratio (OR) for the effect of ethnicity and for the effect of social background on each of the three outcome measures. Odds ratios reflect the change in the probability of failing on the selection criteria relative to the probability of not failing on the selection criteria associated with each of the independent variables. An OR of > 1 reflects an increased likelihood of failure.

Statistical interaction terms were used to study the potentially differential effects of ethnicity by applicants' characteristics. For example, to assess whether ethnicity had the same associations with failure on academic selection criteria for men and women, we included the interaction term 'ethnicity × gender' in a model that also included ethnicity and gender as main effects.

We hypothesised that any differences in performance in the selection procedure might be explained by demographic or additional socio-demographic characteristics associated with ethnicity. These variables were sequentially considered in multivariable regression models for each of the three outcomes. Firstly, we adjusted for demographic characteristics (age and gender). Secondly, we adjusted for demographic and socio-demographic characteristics (first-generation immigrant, language spoken at home, first-generation university applicant, medical doctor as parent). Finally, we adjusted for demographic variables, socio-demographic variables and pu-GPA.

Analyses were performed using IBM SPSS Statistics for Windows Version 20.0 (IBM Corp., Armonk, NY, USA). We present 95% confidence intervals (CIs) for unadjusted and adjusted ORs, which indicate statistical significance if they do not include a value of 1.0.

RESULTS

Applicant characteristics

The questionnaire was completed by 703 applicants (94%), of whom 463 (66%) were Dutch and 240 (34%) were non-Dutch applicants. Asian applicants were older, were more often first-generation immigrants and their first language was more often not Dutch. Turkish/Moroccan/African applicants were more often first-generation university candidates and their first language was also more often not Dutch (Table 2). Both Asian and Western applicants more often had a missing pu-GPA.

Not selected

Dutch applicants were less likely to fail on any of the selection criteria (57%) compared with Surinamese/Antillean and Turkish/Moroccan/African applicants (78% and 70%, respectively) (Table 2). These differences correspond to unadjusted ORs of 2.73 (95% CI 1.27–5.84) for Surinamese/Antillean applicants and 1.77 (95% CI 1.01–3.08) for Turkish/Moroccan/

Table 2 Characteristics of 703 applicants to medical school (Erasmus MC Medical School Rotterdam) in 2013

	Dutch (*n* = 463, 66%)	Surinamese/ Antillean (*n* = 41, 6%)	Turkish/ Moroccan/ African (*n* = 66, 9%)	Asian (*n* = 81, 12%)	Western (*n* = 52, 7%)	p-value
Socio-demographic characteristics						
First-generation immigrant, *n* (%)	–	3 (7%)*	7 (11%)*	48 (60%)†	21 (40%)	< 0.001‡
First language not Dutch, *n* (%)	4 (1%)	5 (12%)*	57 (86%)†	73 (90%)†	25 (48%)*	< 0.001‡
First-generation university applicant (*n* = 694), *n* (%)	106 (23%)*	7 (17%)	39 (59%)†	25 (31%)	8 (15%)	< 0.001
Medical doctor as parent	75 (16%)	9 (22%)	1 (2%)*	9 (11%)	10 (19%)	0.01
Demographic and educational variables						
Male, *n* (%)	152 (33%)	13 (32%)	21 (32%)	29 (36%)	15 (29%)	0.95
Age, years, mean ± SD	19.28 ± 1.63	19.05 ± 1.14	19.54 ± 1.19	20.29 ± 4.15§	19.79 ± 2.04	0.001
Pu-GPA						
Missing¶, *n* (%)	25 (5%)*	7 (17%)	9 (14%)	13 (16%)†	10 (19%)†	< 0.001
Continuous, mean ± sd	6.92 ± 0.55	6.76 ± 0.51	6.76 ± 0.47	6.84 ± 0.50	6.95 ± 0.56	0.10
Dependent variables						
Not selected, *n* (%)	262 (57%)*	32 (78%)†	46 (70%)	55 (68%)	28 (54%)	0.01
Failed on non-academic criteria, *n* (%)	141 (31%)	14 (34%)	15 (23%)	24 (30%)	17 (33%)	0.69
Failed on academic criteria, *n* (%)	158 (34%)*	27 (66%)†	40 (61%)†	45 (56%)†	19 (37%)	< 0.001

SD = standard deviation; pu-GPA = pre-university grade point average.
* Percentage significantly lower than overall average.
† Percentage significantly higher than overall average.
‡ Category of Dutch excluded from analysis.
§ Significantly higher than for Dutch and Surinamese/Antillean applicants.
¶ Number of applicants with a foreign pre-university education: *Dutch* (*n* = 3); Surinamese/Antillean (*n* = 1); Turkish/Moroccan/African (*n* = 0); Asian (*n* = 2), and Western (*n* = 7).

African applicants (Table 3). The disparity for Turkish/Moroccan/African applicants was partly explained by their demographic characteristics (adjusted OR 1.63) and pu-GPA (adjusted OR 1.44).

Demographic and socio-demographic characteristics and pu-GPA failed to explain the difference for Surinamese/Antillean applicants.

There was no significant difference in the likelihood of being selected between first-generation university applicants and their traditional counterparts (Table 4).

No significant interaction effects were found. Details of the regression analyses are presented in Table S1.

Failure on non-academic selection criteria

There were no significant differences between ethnic or social subgroups in the chance of failure on the non-academic selection criteria (Tables 3 and 4).

Failure on academic selection criteria

Dutch applicants were less likely to fail on the academic selection criteria (34%) than were Surinamese/Antillean, Turkish/Moroccan/African and Asian applicants (66%, 61% and 56%, respectively) (Table 2). Unadjusted ORs were 3.72, 2.97 and 2.41 for Surinamese/Antillean, Turkish/Moroccan/African and Asian applicants, respectively (Table 3). The demographic variables failed to explain the differences for the three subgroups (adjusted ORs: 3.71, 3.00 and 2.52, respectively), whereas the socio-demographic variables partly accounted for the difference found for the Asian applicants only. Pre-university GPA explained the disparity for Turkish/Moroccan/African applicants to some extent. First-generation university applicants were more likely to

Table 3 Associations between ethnicity and failure on the selection procedure (n = 703)

	Not selected		Failed non-academic criteria		Failed academic criteria	
Characteristics	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Ethnicity effect unadjusted						
Dutch	1.0		1.0		1.0	
Surinamese/Antillean	**2.73**	1.27–5.84	1.18	0.60–2.33	**3.72**	1.90–7.30
Turkish/Moroccan/African	**1.77**	1.01–3.08	0.67	0.37–1.24	**2.97**	1.75–5.05
Asian	1.62	0.98–2.68	0.96	0.57–1.61	**2.41**	1.50–3.89
Western	0.90	0.50–1.59	1.11	0.60–2.05	1.11	0.61–2.02
Ethnicity effect adjusted for demographic variables*						
Dutch	1.0		1.0		1.0	
Surinamese/Antillean	**2.95**	1.37–6.38	1.36	0.66–2.79	**3.71**	1.89–7.28
Turkish/Moroccan/African	1.63	0.93–2.87	**0.51**	0.27–0.98	**3.00**	1.76–5.11
Asian	1.38	0.82–2.31	0.56	0.31–1.01	**2.52**	1.55–4.11
Western	0.78	0.43–1.41	0.82	0.41–1.64	1.12	0.61–2.03
Ethnicity effect adjusted for demographic* and socio-demographic† variables						
Dutch	1.0		1.0		1.0	
Surinamese/Antillean	**3.06**	1.35–6.91	1.52	0.72–3.18	**3.71**	1.83–7.53
Turkish/Moroccan/African	1.63	0.70–3.81	0.66	0.26–1.71	**2.28**	1.01–5.15
Asian	1.08	0.46–2.56	0.85	0.32–2.28	1.38	0.59–3.22
Western	0.69	0.34–1.41	1.08	0.48–2.41	0.79	0.38–1.66
Ethnicity effect adjusted for demographic* and socio-demographic† variables and pu-GPA						
Dutch	1.0		1.0		1.0	
Surinamese/Antillean	**2.52**	1.07–5.94	1.43	0.67–3.03	**3.00**	1.41–6.41
Turkish/Moroccan/African	1.44	0.59–3.52	0.62	0.24–1.61	2.26	0.96–5.33
Asian	1.07	0.43–2.67	0.79	0.29–2.14	1.60	0.66–3.91
Western	0.70	0.33–1.49	1.09	0.49–2.45	0.86	0.40–1.87

Figures in bold denote significant ORs ($p < 0.05$).
OR = odds ratio; 95% CI = 95% confidence interval; pu-GPA = pre-university grade point average.
* Age and gender.
† First-generation immigrant, first language, first-generation university applicant, medical doctor as parent.

fail on the academic part (50%) than non-first-generation university applicants (37%). This difference in percentage corresponds to an unadjusted OR of 1.66 (Table 4). The disparity was partly explained by socio-demographic variables (adjusted OR 1.49) and pu-GPA (adjusted OR 1.28).

DISCUSSION

This study found that both ethnicity and social background were independent predictors of selection for medical school. However, there were surprising differences in their relationships with the non-academic and the academic selection criteria. The results on the non-academic criteria were promising in terms of achieving fairness and equality, whereas ethnicity and social background were related to poorer performance on the cognitive tests. The ethnic and social disparities in performance could only partly be explained by age, gender, socio-demographic variables, including first-generation immigrant status and first language, and pu-GPA.

One of the most surprising outcomes is the finding that there were no significant differences among ethnic or social subgroups in the chance of failure based on extracurricular activities. This finding is

Table 4 Associations between social background and failure on the selection procedure (n = 703)

	Not selected		Failed non-academic criteria		Failed academic criteria	
Characteristics	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Social background effect unadjusted						
First-generation university applicant	1.30	0.92–1.85	0.80	0.55–1.17	**1.66**	1.18–2.33
Social background effect adjusted for demographic variables*						
First-generation university applicant	1.25	0.87–1.79	0.68	0.45–1.05	**1.65**	1.17–2.32
Social background effect adjusted for demographic* and socio-demographic† characteristics						
First-generation university applicant	1.22	0.83–1.79	0.82	0.51–1.30	**1.49**	1.03–2.17
Social background effect adjusted for demographic* and socio-demographic† characteristics and pu-GPA						
First-generation university applicant	1.03	0.69–1.55	0.74	0.47–1.15	1.28	0.86–1.91

Figures in bold denote significant ORs ($p < 0.05$).
OR = odds ratio; 95% CI = 95% confidence interval; pu-GPA = pre-university grade point average.
* Age and gender.
† Ethnicity, First-generation immigrant, first language, medical doctor as parent.

not in line with the findings of a recent Dutch study which investigated the chances of ethnic minority students of obtaining residency training places and revealed that one of the main obstacles for these students is that their curriculum vitae are not as good as those of Dutch students.[17] A possible explanation is that the gap in the quality of curriculum vitae widens throughout medical school. It may be that non-traditional students are less aware of the need to 'work on their CV' during medical school[17] or they may need to spend their 'spare' time in paid jobs in order to finance their studies more often than traditional students do.[14]

However, our findings were in line with those of O'Neill *et al.*,[2] who also found that the introduction of an attributes-based track, which included reference to extracurricular activities, had no effect – neither positive nor negative – on the social diversity of their student population. These authors explained the lack of positive findings by suggesting that their applicant pool was not sufficiently diverse.[2] Unlike the present study, O'Neill *et al.*[2] did not have access to data on unsuccessful applicants and therefore were unable to determine whether those from non-traditional backgrounds did not apply or were not selected. Although we also cannot rule out the possibility that the self-selection instigated by our selection procedure[12] is stronger in applicants from non-traditional backgrounds, we found nevertheless that the percentage of non-Western ethnic minority applicants in our selection procedure (27%) was much higher than the percentage of non-Western ethnic minority students who graduated from pre-university education in the Netherlands in 2012 with the subjects required for medical school (8%).[18] In other words, the social composition of our applicant pool does not imply that self-selection has played a major role.

In line with the results of earlier studies among medical school applicants,[4,9,10] ethnicity and social background were related to poorer performance on the cognitive tests.

However, we found distinctions among ethnic groups, which may point to different mechanisms for ethnicity-related disparities in cognitive test performance. The underperformance of Surinamese/Antillean applicants on the academic selection criteria could not be explained by socio-demographic factors and only to some extent by pu-GPA, whereas the disparate performance of applicants in the Turkish/Moroccan/African and Asian groups could be explained by social background factors. As we have suggested previously in this journal, this may be explained by the fact that Surinamese/Antillean applicants often speak Dutch at home.[15] As first language may be a proxy for cultural differences in communication rather than for language skill, cultural differences in communication between Dutch and Surinamese/Antillean applicants may be masked by the fact that they speak the same

language. Further research is required to explore other causes of poorer performance and should also consider sub-test scores.

Male gender was an independent predictor of a higher chance of being successful on the selection procedure (Table S1), mainly because it was associated with a lower chance of failing on the academic criteria, which is in line with the findings of others.[4,16] This finding provides further evidence for the suggestion by Tiffin *et al.*[19] that the use of aptitude tests such as the UKCAT may mitigate the long-standing disadvantage of males when applying for medical school. The additional socio-demographic factors were less important for performance on the selection procedure, except for the 'first-generation immigrant' factor, which was associated with lower performance on the academic selection criteria. Further studies are required to explore why these applicants underperform on cognitive tests even after adjustments for first language and (missing) pu-GPA.

A main predictor for success in the selection procedure was a higher pu-GPA, which not only resulted in a lower chance of failing on the academic selection criteria, but also reduced the likelihood of failing on the non-academic selection criteria. This latter finding is remarkable as it was expected that applicants who have spent a lot of time on extracurricular activities would as a consequence have a lower pu-GPA. However, others have already argued that success on non-academic criteria enables success on academic criteria and vice versa.[20] Put differently, there appears to be a positive correlation between academic and non-academic qualities.

The strengths of this study refer to its large sample size and the fact that the cohort included a large number of non-Dutch applicants, which gave us the opportunity to extend our analysis beyond a White/non-White comparison, to which most studies on ethnicity and admittance to medical school are restricted. In addition, we were able to overcome the limiting effect of one type of selection criteria (e.g. grades[10]) on diversity as all applicants were assessed on both academic and non-academic criteria.

A first limitation of our study is that we had only limited data on non-applicants and therefore were unable to determine the effect of self-selection on the social composition of our applicant pool.[2] Nonetheless, we were able to compare successful and unsuccessful applicants as advised by Cleland *et al.*[1] In addition, as reported above, the percentage of non-Western minority applicants by far exceeded the percentage of non-Western pre-university graduates in the Netherlands. The percentage of first-generation university applicants was also higher than the percentage of first-generation university students in our student cohort of 2013 (26% versus 23%). This suggests that at least as many first-generation university applicants participated in the selection procedure as in the lottery, although we cannot rule out the possibility that a higher percentage of first-generation university candidates participated in the pu-GPA-weighted lottery but were less often admitted because of their lower pu-GPA.

A second limitation is that this study was performed in one cohort of applicants to one medical school. Future replicative studies are needed to establish whether the present results can be generalised to other populations. We would like to encourage others to also test the effects of both academic and non-academic selection criteria on student diversity.

This study has some practical implications for medical schools that aim to increase the diversity of their student populations. A first recommendation would be to include non-academic criteria in the selection procedure. Selection on the basis of the quality and quantity of extracurricular activities before application showed no bias with respect to ethnicity or social background. In addition, previous research has shown that success on our non-academic selection criteria was related to better performance during clerkships.[12] However, this previous study also revealed that success on the academic part of the selection procedure was related to a lower chance of dropout during medical school.[12] Therefore, academic criteria should also be included in selection procedures, preferentially in the form of aptitude tests because their adverse impact is lower than that of grades.[1]

A second recommendation would be to use different selection criteria concurrently and to further explore the impacts of different weightings of the criteria on student diversity. A recent UK study showed that how the UKCAT was used (in borderline cases, as a factor in admissions or as a threshold) influenced the social composition of the cohorts selected.[19] A related issue concerns whether or not an applicant must score highly on all selection criteria (non-compensatory) or whether high scores on some criteria can make up for low scores on others (compensatory).[1] Our findings suggest that if we had selected students based on non-academic criteria only, our student cohort would have been more diverse in terms of both ethnicity and social background. Currently, we are considering a

compensatory selection procedure in which applicants can compensate for lower scores on academic criteria with higher scores on non-academic criteria and vice versa. Although we still think that a certain threshold should be met in both sets of criteria, it is probable that such thresholds can be lowered when a concurrent compensatory method is used. Further research into the precise impacts of different weightings and compensation rules on the types of applicants selected for medical school is required.

In conclusion, the results on the non-academic selection criteria are promising in terms of increasing social and ethnic diversity; however, the possibility that self-selection instigated by the selection procedure is stronger in applicants from non-traditional backgrounds cannot be ruled out. Further research should also focus on why cognitive tests might favour traditional medical school applicants. In order to give all applicants a fair chance of admittance, medical schools must set up selection procedures that are diversity-neutral or at least take the diversity amongst applicants into account.

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REFERENCES

1 Cleland J, Dowell J, McLachlan J, Nicholson S, Patterson F. *Identifying Best Practice in the Selection of Medical Students*. London: General Medical Council 2012. http://www.gmc-uk.org/Identifying_best_practice_in_the_selection_of_medical_students.pdf_51119804.pdf. [Accessed 10 July 2014.]
2 O'Neill L, Vonsild MC, Wallstedt B, Dornan T. Admission criteria and diversity in medical school. *Med Educ* 2013;**47**:557–61.
3 Powis D, Hamilton J, McManus I. Widening access by changing the criteria for selecting medical students. *Teach Educ* 2007;**23**:1235–45.
4 Puddey IB, Mercer A. Socio-economic predictors of performance in the Undergraduate Medicine and Health Sciences Admission Test (UMAT). *BMC Med Educ* 2013;**13**:155.
5 Mathers J, Parry J. Why are there so few working-class applicants to medical schools? Learning from the success stories. *Med Educ* 2009;**43**:219–28.
6 Greenhalgh T, Seyan K, Boynton P. 'Not a university type': focus group study of social class, ethnic and sex differences in school pupils' perceptions about medical school. *BMJ* 2004;**328**:1541.
7 Reiter HI, Eva KW, Rosenfeld J, Norman GR. Multiple mini-interviews predict clerkship and licensing examination performance. *Med Educ* 2007;**41**:378–84.
8 Patterson F, Ashworth V, Zibarras L, Coan P, Kerrin M, O'Neill P. Evaluations of situational judgement tests to assess non-academic attributes in selection. *Med Educ* 2012;**46**:850–68.
9 James D, Yates J, Nicholson S. Comparison of A level and UKCAT performance in students applying to UK medical and dental schools in 2006: cohort study. *BMJ* 2010;**349**:c478.
10 Reiter HI, Lockyer J, Ziola B, Courneya CA, Eva K. Canadian Multiple Mini-Interview Research A. Should efforts in favour of medical student diversity be focused during admissions or farther upstream? *Acad Med* 2012;**87**:443–8.
11 Urlings-Strop LC, Stijnen T, Themmen APN, Splinter TAW. Selection of medical students: a controlled experiment. *Med Educ* 2009;**43**:175–83.
12 Urlings-Strop LC, Stegers-Jager KM, Stijnen T, Themmen AP. Academic and non-academic selection criteria in predicting medical school performance. *Med Teach* 2013;**35**:497–502.
13 Urlings-Strop LC, Themmen APN, Stijnen T, Splinter TAW. Selected medical students achieve better than lottery-admitted students during clerkships. *Med Educ* 2011;**45**:1032–40.
14 Hofman A, van den Berg M. Ethnic-specific achievement in Dutch higher education. *High Educ Eur* 2003;**28**:371–89.
15 Stegers-Jager KM, Steyerberg EW, Cohen-Schotanus J, Themmen APN. Ethnic disparities in undergraduate pre-clinical and clinical performance. *Med Educ* 2012;**46**:575–85.
16 Powis D, James D, Ferguson E. Demographic and socio-economic associations with academic attainment (UCAS tariff scores) in applicants to medical school. *Med Educ* 2007;**41**:242–9.
17 Leyerzapf H, Abma T, Naar een kleurrijk UMC. *Ervaringen van Arts-Assistenten en Opleiders op Medische Afdelingen. Eindrapport Onderzoek Naar Doorstroom van Artsen met 'Allochtone' Achtergrond Naar Specialisatie*. Amsterdam: VU Medical Centre Amsterdam 2012.
18 Statistics Netherlands (Centraal Bureau voor de Statistiek). VO; examenkandidaten en gediplomeerden, onderwijssoort in detail. www.cbs.nl. [Accessed 10 July 2014.]

19 Tiffin PA, Dowell JS, McLachlan JC. Widening access to UK medical education for under-represented socioeconomic groups: modelling the impact of the UKCAT in the 2009 cohort. *BMJ* 2012;**344**:e1805.
20 Eva KW, Reiter HI, Trinh K, Wasi P, Rosenfeld J, Norman GR. Predictive validity of the multiple mini-interview for selecting medical trainees. *Med Educ* 2009;**43**:767–75.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1. Regression analyses for effects of demographic and socio-demographic variables on each of three outcome measures for 703 applicants to medical school in 2013.

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