Academic and non-academic selection criteria in predicting medical school performance

LOUISE C. URLINGS-STROP[1], KAREN M. STEGERS-JAGER[1], THEO STIJNEN[2] & AXEL P.N. THEMMEN[1,3]
[1]Erasmus MC, The Netherlands, [2]Leiden University Medical Centre, The Netherlands, [3]Erasmus MC, The Netherlands

Abstract

Background: A two-step selection procedure, consisting of a non-academic and an academic step, was recently shown to select students with a 2.6 times lower risk of early dropout and a higher clerkship Grade Point Average (GPA) than lottery-admitted controls.

Aim: To determine the relative contribution of the non-academic and academic steps to differences found in student performance.

Method: Lottery-admitted students ($n = 653$) and three groups of selection procedure participants were compared on early dropout rate and clerkship GPA: (1) all participants ($n = 1676$), (2) participants who passed step 1, and (3) participants who passed step 2.

Results: Selection procedure participation resulted in a 4.4% lower dropout rate than lottery admission and this difference increased to 5.2% after step 1 and to 8.7% after step 2. Clerkship GPA was significantly higher for participants who passed step 1 than for their lottery-admitted controls. This difference remained significant after the rejection of students on academic criteria in step 2.

Conclusion: The lower dropout rate of selected students is related to both self-selection of participants before the start of the selection procedure and the academic part of the selection procedure. The higher clerkship GPA of selected students is almost exclusively related to the non-academic selection criteria.

Introduction

Medical schools are faced with limited student places and large numbers of applicants. Therefore, student selection is an internationally widespread practice. Most medical schools have traditionally relied on academic criteria in admission procedures, such as the undergraduate grade point average (uGPA) and the Medical College Admission Test (MCAT) (Parry et al. 2006; Julie 2007). Recent reviews of the literature by Salvatori (2001), McGaghie (2002) and Siu and Reiter (2009) have shown that the uGPA has a moderate predictive value for subsequent academic performance, with correlations of 0.40–0.50. Similarly, the MCAT has an acceptable predictive value for pre-clinical performance, obtaining correlations of 0.31–0.54 with GPAs in third year of the medical school (Wiley & Koenig 1996; Julian 2005). However, it is more difficult to predict future clinical performance during clerkships (Basco Jr. et al. 2000; Hamdy et al. 2006). Given an explained variance of $<10\%$, the relationship between uGPA and performance during clerkships is much weaker (Peat et al. 1982; Veloski et al. 2000; Baars et al. 2009). Similarly, the MCAT has a moderate to low predictive value for clerkships, with an explained variance in clinical performance of ~15% (Donnon et al. 2007).

Nowadays, there is a widespread agreement that medical students should be selected using not only academic but also non-academic criteria, such as professional, communication, ethical reasoning and interpersonal skills (Kulatunga-Moruzi & Norman 2002; Siu & Reiter 2009; Patterson & Ferguson, 2010; Prideaux et al. 2011). The method most frequently used to measure such skills is the interview, sometimes accompanied by letters of reference or psychological tests. Unfortunately, predictive validity correlations for these measures rarely rise above 0.10 (Salvatori 2001; Albenese et al. 2003). More promising are the results of the multiple mini-interview (MMI) (Reiter et al. 2007), which was found to be predictive for the clinical decision-making component of the Canadian national licensing examination (standardized $\beta = 0.35$, $p < 0.05$). Despite the growing attention for non-academic selection criteria, little is known about the relationship between non-academic and academic qualities of students in explaining student performance (Eva et al. 2009).

In the Netherlands, selection takes place partly on the basis of a national lottery that is weighted for school performance and partly on institutional selection procedures (up to 50%),

Practice points

- Non-academic selection criteria are related to better performance during clerkships.
- Participation in a non-obligatory selection procedure is associated with lower dropout rate in medical school.
- Both non-academic and academic selection criteria contribute to the selection of students with a lower chance of dropout during medical school.

Correspondence: Axel P.N. Themmen, Department of Internal Medicine, Erasmus MC, 3000 CA Rotterdam, The Netherlands. Tel: +31-10-7043340; fax: +31-10-7035430; email: a.themmen@erasmusmc.nl

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which presents the unique opportunity to compare the results of randomly admitted and selected students. In a previous study, we have reported a controlled experiment that examined whether students selected for medical school using a combination of academic and non-academic selection criteria had higher academic performance throughout medical school than those selected by lottery. In the first, non-academic step participants were assessed according to the quality and extent of their extracurricular activities before application, while the second, academic step consisted of a series of five tests on a medical subject representative of assessments in the first year of medical school.

The main outcomes of this experiment were that the relative risk for dropout in the first two years was found to be 2.6 times lower for selected students than for students admitted by lottery (Urlings-Strop et al. 2009) and that selected students had a significantly higher mean grade on their first five clerkships (Urlings-Strop et al. 2011).

The successive use of non-academic and academic measures within this experiment creates the opportunity to examine the utility of both types of measures in predicting pre-clinical and clinical performance. Therefore, the aim of this retrospective cohort study was to compare the relative importance of the non-academic and academic measures in explaining the differences in student performance found between selected students and their lottery-admitted controls.

Methods

Selection procedure

Since 2000, there have been three ways of gaining admittance to medical school in the Netherlands: the national weighted lottery procedure (L-group), a local selection procedure (S-group) and direct access for highest achievers (D-group). All applicants are able to gain access to medical school through a national weighted lottery procedure, in which the chance of selection rises with the pre-university GPA (pu-GPA). Before the draw, students are placed in categories based on their pu-GPA (ranging from 5.5 to 10.0): 5.5–6.5, 6.5–7.0, 7.0–7.5 and 7.5–8.0, with lottery weights of 3, 4, 6 and 9, respectively. Direct access is given to students with a pu-GPA $\geq$ 8.0. This D-group was excluded from the analyses.

Applicants are assigned to the medical school of their choice according to the availability. Those who take part in the lottery can also choose to apply to a local selection procedure, which precedes the lottery.

The local selection procedure at Erasmus MC consists of two steps. In the first, mainly non-academic step, participants are assessed according to the quality and quantity of their extracurricular activities before application. Extracurricular activities include experience or jobs in health care, experience in management and organization, or special talents in sports, music or science. Evidence such as letters of recommendation and references to support their statements was mandatory. To guarantee reliability of the scoring in step 1, two scorers independently assessed each application. Where scores differed, the project leader (LCUS) reviewed and corrected the scores.

The second, mainly academic, step consisted of five cognitive tests on a medical subject preceded by informative classes, which were taken over four consecutive days at Erasmus MC Medical School and contained questions on logical reasoning, scientific thinking, epidemiology and pathology, anatomy and philosophy. Scoring of steps 1 and 2 was independent, both in terms of the persons scoring and in the scoring technique employed. In both selection steps, participants obtained a score and a successive ranking. An absolute threshold was applied in each step, independent of the result of the previous step or the number of participants that met the threshold. When the target number of selected students was not met, more students were admitted through the lottery system. A more extensive description of the cohorts and the selection procedure has been provided previously (Urlings-Strop et al. 2009).

Students rejected after the first or second selection step, marked as R_1 and R_2, respectively, were reverted to the national weighted lottery procedure in the same year. The group of lottery-admitted students at Erasmus MC consisted of L_0 students (=admitted through lottery alone) expanded with L_1 and L_2 students; i.e., students who were admitted through lottery from the rejected R_1 and R_2 groups.

Participants

Data used in this study were obtained for students from four consecutive cohorts (2001–2004) who were admitted to Erasmus MC by lottery (L-group) or by the local selection procedure (S-group). In Figure 1, the quantitative aspects of the selection procedure are shown. Of the initial 2287 applicants for the selection procedure, 611 (27%) withdrew voluntarily before the first step, i.e., they did not return the application form. Data on these candidates were not recorded; therefore, these students were excluded from further analyses. Of the remaining 1676 participants, 771 (46%) were rejected in the first step (R_1) and 304 (18%) in the second step (R_2), overall 64%. Almost 13% withdrew during the selection procedure despite having passed to the next step, leaving 389 students (23%), who were selected and therefore admitted to our medical school (S-group). In the same period, 938 students were admitted by lottery. Of these, 652 (69.5%) were admitted by lottery alone (L_0), 161 were admitted by lottery after rejection in the first step (L_1) and 125 after rejection in the second step (L_2).

Procedure

First, the scores of the participants in steps 1 and 2 were compared to explore the degree of mutual independence. Next, to gain insight in the individual steps of the selection procedure, we compared student performance of lottery-admitted and selected students in the three distinctive stages of this procedure (Table 1). First, we compared all selection procedure participants ($S + R_1 + R_2$) with non-participants who were admitted by lottery (L_0). Second, we compared students who passed the first selection step ($S + R_2$) with

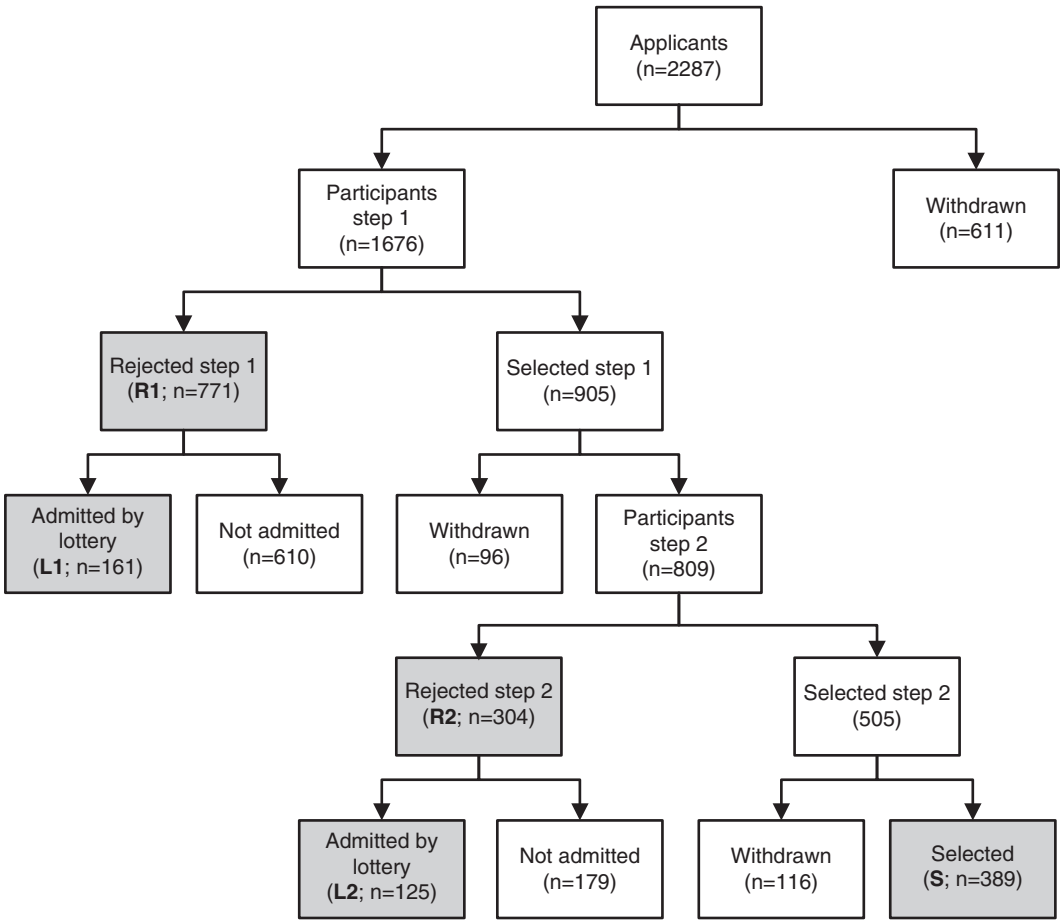

Figure 1. Quantitative aspects of the selection procedure.

Table 1. Statistical comparisons to measure the effect of separate steps in the selection procedure.

Participation		
Participants step 1	↔	*Non-participants*
$S+R_1+R_2$-group ($n=1464$)*		L_0-group ($n=652$)
Step 1 (non-academic)		
Selected step 1	↔	*Non-participants + rejected step 1*
$S+R_2$-group ($n=693$)#		L_0+L_1-group ($n=813$)
Step 2 (academic)	↔	*Non-participants + rejected step 1 and rejected step 2*
Selected step 2		
S-group ($n=389$)		$L_0+L_1+L_2$-group ($n=938$)

*Performance of R_1-group and R_2-group is estimated from performance of L_1-group and L_2-group, respectively.
#Performance of R_2-group is estimated from performance of L_2-group.

non-participants and students who were rejected in step 1 but readmitted by lottery (L_0+L_1). Third, we compared students who passed the second selection step and hence were selected for our medical school (S-group) with non-participants and students rejected in steps 1 and 2 but readmitted by lottery ($L_0+L_1+L_2=$L-group).

The L_1-group represents 21% of the R_1-group and the L_2-group represents 41% of the R_2-group. This means that 21% and 41%, respectively, were lottery admitted after a rejection in step 1 or step 2.

Student performance

The medical curriculum at Erasmus MC consists of a four-year pre-clinical phase followed by a two-year clinical phase. In the pre-clinical phase, examinations qualify the candidate for a fixed number of credits under the European Credit Transfer System (ECTS). One credit equals 28 hours of study; the study load per year is 60 credits. In the clinical phase, student performance is mainly assessed using a combination of patient-related assessment and oral examination. In addition, presentation on the wards is taken into account. Grades are awarded for each clerkship separately. The number of credits per clerkship depends on their duration in weeks.

Criteria for student performance were (1) percentage of early dropout; i.e., students who had failed to obtain 60 credits by the end of the second year and (2) GPA of the first five discipline specific clerkships (clerkship GPA); i.e., internal medicine, surgery, paediatrics, psychiatry and neurology. To ensure valid comparisons by ruling out possible confounding variables, all groups were contrasted on the pre-admission variables gender, age and pu-GPA (Urlings-Strop et al. 2011).

Statistics

The correlation between scores in the first and second selection steps and between the five tests employed in step 2 were analysed using Pearson's correlation coefficient.

The pre-admission variable 'gender' was analysed using chi-squared tests. Analysis of covariance (ANCOVA) was used for comparisons of age (covariates: year of entrance and weighted lottery category), and a *t*-test was used to compare pu-GPA between the selected students and their lottery-admitted controls. For each year of entrance, pu-GPAs were transformed into Z-scores. For comparisons concerning early dropouts, chi-squared tests were used. ANCOVA was used for comparisons of GPA of the first five clerkships. Again, year of entry and weighted lottery category were used as covariates.

We used the complex sample design of PASW statistics version 17.0 (SPSS, Inc., Chicago, IL, USA) to give student in groups R_1 and R_2 their correct weights. All data were derived from the university student administration systems, recorded in Excel 2011 workbooks and analysed with PASW statistics version 17.0.

Ethical considerations

At the time of research, ethical approval for studies concerning medical education was not required in the Netherlands. However, in order to adhere to the tenets of the Declaration of Helsinki, we took some precautions. Students' grades were extracted from the university administration system and delivered anonymously to the investigators. As data were collected as part of regular academic activities and only aggregate data are reported, individual consent was not necessary.

Table 2. Pre-admission variables of selected and lottery-admitted groups.

	Female (%)	Mean age at start (SE)	Mean *Z*-score of pu-GPA (SE)
Participation			
$S+R_1+R_2$-group*	61.0	19.42 (0.07)	−0.18 (0.04)
L_0-group	60.7	19.34 (0.06)	−0.11 (0.03)
Step 1			
$S+R_2$-group#	63.2	19.65 (0.11)	−0.21 (0.04)
L_0+L_1-group	60.4	19.31 (0.05)	−0.12 (0.03)
Step 2			
S-group	65.0	19.68 (0.09)	−0.17 (0.04)
$L_0+L_1+L_2$-group	60.5	19.34 (0.06)	−0.14 (0.03)

*Pre-admission characteristics of R_1-group and R_2-group are estimated from pre-admission characteristics of L_1-group and L_2-group, respectively.
#Pre-admission characteristics of R_2-group are estimated from pre-admission characteristics of L_2-group.

Results

Pearson's correlation coefficient for the scores on step 1 and step 2 was 0.13 ($p < 0.001$; $n = 693$), while correlations between the five tests used in step 2 vary between 0.11 and 0.35. There were no significant differences between the selected and lottery-admitted students with respect to gender, age and pu-GPA (Table 2).

There was a difference in the dropout rate between selection procedure participants and non-participants: the $S+R_1+R_2$-group had an estimated dropout rate of 11.2%, compared to 15.6% in the L_0-group (Table 3). However, this difference of 4.4%, which is half of the final 8.7%, was not statistically significant. After rejecting the R_1-group in step 1, the estimated percentage of dropouts in the $S+R_2$-group reduced with another 1.4–9.8%, while it decreased to 15.0% for the L_0+L_1-group. This resulting difference of 5.2% was significant ($F_{adj}(1,1326) = 5.94$, $p < 0.05$, $ES = 0.06$). The second selection step reduced the percentage of dropouts for the S-group with another 3.6% to the final 6.2%, while the dropout rate for the L-group remained about the same (14.9%). The final 8.7% difference in dropouts is again significant ($\chi^2(1) = 14.68$, $p < 0.001$, $ES = 0.11$).

The differences in GPA of the first five clerkships showed a different pattern (Table 3). There was no difference in clerkship GPA for selection procedure participants and non-participants. After step 1, the estimated clerkship GPA was significantly higher for the selected students ($S+R_2$-group) than for the lottery-admitted students (L_0+L_1-group) ($F_{adj}(1,827) = 13.57$, $p < 0.001$, $ES = 0.01$). This difference remained significant after the rejection of the R_2-group in step 2 ($F(1,822) = 12.30$, $p < 0.001$, $ES = 0.02$).

Table 3. Student performance of selected and lottery-admitted groups.

	Early dropout (%)				GPA clerkships		
	n	%	Δ (%)	Statistics	Mean (SE)	Δ Mean	Statistics
Participation							
$S+R_1+R_2$-group*	164	11.2	4.4	NS	7.86 (0.02)	0.02	NS
L_0-group	102	15.6			7.84 (0.02)		
Step 1							
$S+R_2$-group#	68	9.8	5.2	$p < 0.05$	7.94 (0.03)	0.11	$p < 0.001$
L_0+L_1-group	122	15.0			7.83 (0.02)		
Step 2							
S-group	24	6.2	8.7	$p < 0.001$	7.95 (0.03)	0.11	$p < 0.001$
$L_0+L_1+L_2$-group	140	14.9			7.84 (0.02)		

NS = Not significant
*Performance of R_1-group and R_2-group is estimated from performance of L_1-group and L_2-group, respectively.
#Performance of R_2-group is estimated from performance of L_2-group.

Discussion

This study indicates that the observed difference in dropout rate between selected and lottery-admitted students partly already existed before the start of the selection procedure and partly can be attributed to selection of participants on the basis of academic criteria in step 2. The significant difference in GPA for the first five clerkships almost completely appears to be an effect of the selection of participants on the basis of non-academic criteria in step 1.

A possible explanation for the difference in dropout rate between participants and non-participants is self-selection instigated by the selection procedure. At the start of the selection procedure, prospective applicants were informed of the required minimum quality and quantity of extracurricular activities. A quarter of the initial applicants did not return the application form. The remaining 75% participated in step 1 in which there were two thresholds: a minimum quality and a minimum quantity of extracurricular activities during the two years before application. Since rejection of 46% of the participants in step 1 did barely affect the dropout rate, it is improbable that the lower dropout rate is related to the degree of participation in extracurricular activities before application in itself. An alternative explanation is the motivation to enroll in the selection procedure as an additional chance to become a medical doctor. This latter suggestion is supported by several reports in the literature. A study of medical students in Brazil showed that autonomous motivation – which seems to be related to better quality of learning, increased persistence and effort in the studies – had close relationships with measures of self-regulation of learning and academic success in the context of a demanding medical programme (Sobral 2004). Also a study conducted in the Netherlands showed that selected medical school students were more profoundly committed to health care as illustrated by their health care-related extracurricular activities and study behaviour (Hulsman et al. 2007). Nonis and Wright (2003) concluded that personal characteristics such as achievement striving and optimism play a significant role in student performance. They found that average ability combined with high scores in achievement striving is likely to lead to better performance than high ability combined with lower scores in achievement striving. On balance, it is much easier to just join the lottery than taking the effort to seriously apply for the selection procedure. Recently, O'Neill et al. (2011a) found a protective effect on dropout of selection by (mostly non-academic) admission testing, which was independent of test scores, suggesting that partaking in such an admission test plays a more important role than the content of the admission test itself. In addition, these authors noted that assigning high priority to the medical school programme on the admission form also decreased the chance of dropout (O'Neill et al. 2011a). The finding in the present study that the dropout rate further decreased after rejecting applicants on the basis of academic criteria in step 2 was not surprising, since lower scores on academic admission tests are among the most consistent predictors of dropout on medical school (O'Neill et al. 2011b).

Unlike the findings with regard to dropout, there was no significant difference in clerkship GPA between participants and non-participants before selection. However, the selection of students in the first, non-academic, step appears to be almost completely responsible for the significant difference in clerkship GPA found for selected students; especially since the rejection of students on the basis of academic criteria in step 2 hardly influenced clinical GPA for the selected students. It is not easy to explain why students selected on the basis of their participation in extracurricular activities during pre-university education receive higher clinical grades. It might be that the extra effort, ability and organization needed to participate in extracurricular activities in addition to regular schoolwork identify those students who are better able to deal with the demands of medical school (Wright & Tanner 2002). Participation in extracurricular activities may also favour the development of relevant non-academic qualities and skills that will contribute to better clinical performance. Such non-academic skills, for example those determined using the MMI instrument, have been shown to predict performance outcomes during clerkships and on licensing examinations (Reiter et al. 2007; Eva et al. 2009) and it would, therefore, be of interest to further study the relationship between participation in extracurricular activities and the characteristics determined by MMIs.

There appears to be some overlap between skills associated with extracurricular involvement and skills associated with higher clinical grades. Huang and Chang (2004) found that gains in academic skills, communication skills and interpersonal skills were associated with intra- and extracurricular involvement. In an attempt to establish student characteristics important for clerkship grading, Wimmers et al. (2008) found – using a survey among clinical teachers – that 'academic abilities', 'patient workup', 'interpersonal skills' and 'professional qualities' were of most importance.

The differential effects of step 1 and step 2 on the outcomes of the selection procedure correspond to their expected independency based on content, which was further confirmed by their relatively low inter-correlation. The effects of self-selection and of step 2 of the procedure on the decrease in the dropout rate, and of step 1 on clerkship GPA are lessons learned and could be used to improve and direct selection procedures in the future. To enhance the effect of self-selection the level of difficulty for application may be increased.

A possible limitation of this study is the representation of R_1 and R_2 by L_1 and L_2, respectively. However, after rejection in one of the selection steps, participants reverted to the national lottery pool of ~3500 applicants and were divided over the four lottery categories. Subsequently, after running the lottery, those selected from each category were assigned to the medical school of their first choice or, if not available, of their second or third choice. It is therefore very likely that L_1 and L_2 are random samples of R_1 and R_2. In addition, the low correlation between the scores on step 1 and step 2 may result from (a lack of) reliability of the measures used. However, we have optimized the reliability of the scoring in step 1 by reducing inter-rater variability and in step 2 by statistical evaluation of the administered tests.

In conclusion, the presence of the lottery procedure enabled us to examine, in a controlled study, the contribution

of non-academic and academic selection steps to the performance differences found between selected and lottery-admitted students. It was shown that the significantly lower dropout rate was related to self-selection of participants and to the academic selection step. The significantly higher clinical GPA was related to non-academic student characteristics as indicated by the quality and quantity of participation in extracurricular activities before admission to medical school.

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Notes on contributors

LOUISE C. URLINGS-STROP, M.D., was a PhD student at Erasmus MC Desiderius School and is now a resident at Sint Franciscus Gasthuis, Rotterdam, The Netherlands.

KAREN M. STEGERS-JAGER, Ph.D., is a Research Associate at Erasmus MC Desiderius School, Rotterdam, The Netherlands.

THEO STIJNEN, Ph.D., is a Professor of Medical Statistics and Head of the Department of Medical Statistics and Bio-informatics, Leiden University Medical Centre, Leiden, The Netherlands.

AXEL P.N. THEMMEN, Ph.D., is a Professor of Experimental Endocrinology and Medical Education at Erasmus MC, Rotterdam, The Netherlands.

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