LOUISE C. URLINGS-STROP

DEVELOPING A TOOL FOR SELECTION FOR MEDICAL SCHOOL

A search for academic and non-academic parameters to predict future medical school performance

Developing a Tool for Selection for Medical School

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Louise Christine Urlings-Strop

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Developing a Tool for Selection for Medical School
A search for academic and non-academic parameters to predict
future medical school performance

Het ontwikkelen van een selectieprocedure voor de geneeskundeopleiding
Een zoektocht naar academische en niet-academische vaardigheden
die studiesucces tijdens de geneeskundeopleiding voorspellen

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Voor alle toekomstig studenten die Geneeskunde willen studeren
'If you really want to do something, you'll find a way. If you don't, you'll find an excuse.'
Jim Rohn

Voor Hidde en Jitske
'Waar je talenten en de behoefte van de wereld elkaar kruisen, ligt je roeping'
Aristoteles

Voor mijn ouders
'Men weet niet hoe de bomen groeien. Men kan er niets aan doen'

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CHAPTER 1

Introduction

INTRODUCTION

Globally medical schools are faced with a limited number of student places and manifold applicants. Therefore, student selection is an internationally widespread practice. Medical schools aim to offer the places available only to those applicants with the highest probability of a successful medical training and subsequent career, in view of the high expense and significant societal relevance of training competent medical doctors. To reach this goal, several selection procedures have been developed (Kreiter & Axelson, 2013) although the evidence that these procedures indeed do identify either better achieving students (Salvatori, 2001; Siu & Reiter, 2009) or ultimately competent professional doctors is limited (Benbassat & Baumal, 2007). Let alone that misbehaviour in the future can be excluded (Papadakis, Teherani, et al., 2005).

Most medical schools have traditionally relied on academic criteria in admission procedures, such as prior academic attainment and aptitude tests (Julie, 2007; Parry, Mathers, et al., 2006). Reviews of the literature have shown that prior academic attainment has a moderate predictive value for subsequent academic performance, with correlations of 0.40–0.50 (McGaghie, 2002; Salvatori, 2001; Siu & Reiter, 2009). Similarly, aptitude tests have an acceptable predictive value for pre-clinical performance, showing correlations of 0.31–0.54 with Grade Point Averages (GPAs) in third year of the medical school (Julian, 2005; Wiley & Koenig, 1996). However, it proved to be to be more difficult to predict clinical performance during clerkships (Basco Jr., Gilbert, et al., 2000; Hamdy, Prasad, et al., 2006). Given an explained variance of less than 10%, the relationship between prior academic attainment and performance during clerkships is much weaker (Baars, Wimmers, et al., 2009; Peat, Woodburry, et al., 1982; Veloski, Callahan, et al., 2000). Aptitude tests have a low to moderate predictive value for clerkships, with an explained variance in clinical performance of approximately 15% (Donnon, Paolucci, et al., 2007).

The decrease in predictive value of prior academic attainment and aptitude tests with increasing time prior to medical school admission has also been shown for schools with undergraduate entry in the Netherlands and Germany (Stegers-Jager, Steyerberg, et al., 2015; Trost, Nauels, et al., 1998). Additionally, selection on prior academic attainment is known to have an adverse impact on the percentage of selected candidates from non-traditional applicants including those from minority or lower social-economic backgrounds (Cleland, Dowell, et al., 2012).

In the last decades medical schools have included other student attributes than prior academic attainment or aptitude tests in their selection procedures, since the basis of performance in medical school appeared to be multifactorial with intellectual ability as well as other, non-academic, attributes playing an important role (Collins, White, et al., 1995), resulting in two types of predictors: academic predictors with prior academic attainment and aptitude tests as their best representative, and non-academic predictors, such as ability-based tests or the multiple mini interview (Benbassat & Baumal, 2007; Kreiter & Axelson, 2013; Prideaux, Roberts, et al., 2011). The rationale behind the addition of these so-called non-academic attributes to selection is that, next to strong cognitive abilities, medical doctors need other skills and competences, such as communication, collaboration, and professional integrity (Hojat, Erdmann, et al., 2013). Furthermore, certain personality characteristics such as conscientiousness have a positive bearing on student performance during medical school (Ferguson, James, et al., 2003; Lievens, Coetsier, et al., 2002). However, not all skills and characteristics can be assumed to be 'teachable' and some may need to be present at the start of medical school (Patterson, Knight, et al., 2016). Therefore, there is a need for sophisticated tools to assess such non-academic characteristics for the purpose of selecting medical students (Collin, Violato, et al., 2009; Ferguson, James, et al., 2002; Kulatunga-Moruzi & Norman, 2002; Siu & Reiter, 2009).

With the aim to add these characteristics to the selection procedure and thereby enhance the predictive validity of the interview, the multiple mini-interview (MMI) was developed: an admission procedure resembling an objective structured clinical examination with multiple short-interview stations (Eva, Rosenfeld, et al., 2004). Although the results of only small groups of students have been presented, the MMI has shown promising results in predicting clerkship and licensing examination results (Pau, Jeevaratnam, et al., 2013; Reiter, Eva, et al., 2007). Another selection method developed is Situational Judgment Testing (SJT) in which an applicant is provided with scenarios and subsequently asked to judge the appropriateness of reactions to the difficult situations that may be encountered during medical school (De Leng, Stegers-Jager, et al., 2016). Tested in a large Belgian cohort over four years a video-based SJT proved to be able to predict final medical school examinations and doctor certification performance but had little, although significant, added value over de cognitive tests (i.e. 2.2% for doctor performance) (Lievens, 2013).

An intuitively appealing applicant characteristic that has been proposed to be used for selection is motivation for medical school and the medical profession as a career choice. However, motivation is difficult to assess reliably and instruments that gauge motivation in most cases rely on self-report. An alternative way of determining motivation is evaluating motivated behaviour, i.e. extracurricular activities during pre-university education (puECAs) (O'Neill, Hartvigsen, et al., 2011; Schripsema, van Trigt, et al., 2014). Such extra-curricular activities are carried out by a person as a result of the intrinsic motivation and the willingness to learn specific tasks, thereby satisfying the interest and ambition of the person performing the task and showing that an applicant exceeds the requirements of admission to medical school and is willing to go the extra mile. Therefore, it has a high authenticity in describing a person. Astin proposed an involvement theory where involvement was defined as active participation in all kinds of (extra)curricular and social activities (Astin, 1999 (originally published 1984)). Highly involved students had a lower risk to drop out. He and Pike reported that involvement in a variety of curricular and co-curricular activities was directly related to augmented general abilities (Astin, 1975; Pike, 2000). Huang and Chang found that improvements of academic, communication and interpersonal skills were associated with intra- and extracurricular involvement (Huang & Chang, 2004).

In the light of best evidence medical education (Harden, Grant, et al., 1999) the validity of a selection method should be tested using an adequate control group; ideally a group of randomly admitted students. This was made possible by the three ways of gaining admittance to medical school in the Netherlands since 2000: a) direct access for highest achievers, b) a national weighted lottery procedure, and c) a local selection procedure.

Students with a pu-GPA ≥ 8.0 (ranging from 5.5 to 10.0) are granted direct access. All other qualified applicants are able to gain access to medical school through a national weighted lottery procedure, in which the chance of admittance rises with increasing pre-university GPA (pu-GPA). Although weighted and thereby biased by academic attainment, the lottery approaches randomly admittance fairly good. Applicants are assigned to the medical school of their choice according to availability. Those who take part in the lottery can also choose to apply to a local selection procedure. These selection procedures precede the lottery so rejected applicants can subsequently participate in the lottery. It is this unique co-existence of the national lottery and a local selection procedure that provides two perfectly comparable groups.

Only a few medical schools implemented a local selection procedure in the first years after the introduction in 2000. Ten Cate et al. described the selection procedures used in two Dutch medical schools (ten Cate & Hendrix, 2001; ten Cate, Hendrix, et al., 2002). In one school selection was based on cognitive abilities, in the other selection relied on assessment of non-cognitive abilities such as motivation and views on the medical profession. Both medical schools selected 24 students. After one year of follow up, a comparison of the results of the selected students with those of 341 lottery-admitted students revealed that selected students obtained only a slightly higher mean grade on written examinations. Based on these findings the two medical school decided to stop using their selection procedures due to lack of discriminative value above the national lottery and they stuck to that conclusion in later years (Lutke Schipholt & Lijftogt, 2010; Reijn, 2006). A third medical school selected 56 students using a three-step procedure (Hulsman, van der Ende, et al., 2007) and compared its outcomes with those of 446 lottery-admitted controls in two year-cohorts. The selection procedure involved the writing of an essay, cognitive tests and an examination of social skills. After one year of follow-up, no difference in academic achievement was found between selected students and lottery controls. All three medical schools never published results of subsequent years. Only recently the faculty of medical sciences of the University of Groningen reported the results of a multifaceted selection process which is partly based on the selection method described in this thesis (Schripsema, van Trigt, et al., 2014).

OUTLINE OF THIS THESIS

In the Netherlands - as described above - admission takes place partly on the basis of a national lottery that is weighted for academic attainment and partly on local selection procedures. The latter gradually increasing since 2001 up to maximally 50% (Ten Cate, 2007). This dual system presented the unique opportunity to compare the results of randomly admitted and selected students and thereby establishing the added value of selection procedures. In 2001 a two-step selection procedure was developed at Erasmus MC addressing non-academic (i.e. motivated behaviour) as well as academic skills. These non-academic skills were assessed using motivation through the determination of a candidates' active involvement in extracurricular activities. The second step tested the candidates academic skills in a medical school context.

The first study presented in *chapter 2* provides an elaborate description of the newly designed selection procedure. The objective of this study was to determine whether a combination of two selection steps, one assessing academic and one assessing non-academic abilities, would lead to the admission of students whose achievement in medical school is better than that of students who had been admitted by weighted lottery. Four consecutive cohorts were entered into the study and the follow up of each cohort was 2-4 years. The main outcome measures were dropout rate, study rate (credits per year) and mean grade per first examination attempt per year.

The study presented in *chapter 3* extended the comparison of selected and lottery-admitted students into the clinical phase of medical school to answer the question whether the selection procedure predicted student achievement in the clinical phase. The clinical phase are years 5 and 6 of medical school and directly come after the first four pre-clinical years. Follow-up of these cohorts was 5.5–8.5 years. The main evaluation parameter was the mean grade (GPA) obtained for the clinical phase clerkships.

The successive use of non-academic and academic criteria in the selection procedure creates the opportunity to examine the value of both types in predicting preclinical and clinical performance. In *chapter 4* the relative contribution of the non-academic and academic selection criteria to differences found in student performance, i.e. dropout rate and clerkship GPA, was descibed.

In *chapter 5* the relationship between selection using puECAs and clinical achievement is further examined by testing the hypothesis that candidates' puECAs predict their involvement in ECAs during medical school and that persistence in ECAs leads to better clinical achievement. If true, this would further support the choice of using puECAs as a non-academic selection tool in medical school selection procedures.

Finally, in *chapter 6*, the results of these studies are summarized and discussed in the light of the current scientific knowledge and currently used selection systems. Areas requiring further research are identified and discussed briefly and practical implications for the use of selection criteria at the various stages of the medical education program are described.

THE DUTCH APPROACH

The discussion about how to allocate student to medical school in the Netherlands started back in the sixties. In the preceding decades the number of students that started each year at the six medical schools approximately met the capacity of the schools. Moreover, the number of medical doctors that successfully accomplished the study met the demand for doctors required by society. However, in 1963-64, due to the baby boom after de 2nd world war, a significantly higher number of freshmen started medical school, which led to overcrowded lecture halls and training facilities, and as a result the medical schools claimed to be unable to meet the quality standards for medical education (Nota naar aanleiding van de ontwikkelingsplannen van de de universiteiten en hogescholen voor het tijdvak, 1963-1966, 1965). At the same time the Academic Council ('Academische Raad', predecessor of the 'Vereniging van Samenwerkende Nederlandse Universiteiten') published their report 'Artsenbehoefte en artsenvoorziening 1963-1982' in which they estimated the number of doctors required for health care in the Netherlands given a population of 15 million people (Godefroy, 1966). This was significantly higher than the medical schools were able to deliver at that time. Restriction of places and consequently creating a shortage of doctors was not considered an option in Parliament. Instead the Minister of Education advised the establishment of a new Faculty of Medicine, which was founded in Rotterdam in 1965 and is currently known as the Erasmus MC (Nota naar aanleiding van de ontwikkelingsplannen van de de universiteiten en hogescholen voor het tijdvak, 1963-1966, 1965).

In the following years the number of applicants continued to rise more than expected. The initial response of the medical schools was to increase the requirements of their propaedeutic (1st year) exam in order to decrease the number of students in later years. In 1972 an 'emergency law' was proposed to implement some kind of entrance selection to restrict the overwhelming numbers of students. Direct access was given to all applicants with a pre-university Grade Point Average (pu-GPA) ≥ 7.5 (on a scale of 1–10, where 1 = poor and 10 = excellent) and a lottery for the remaining applicants (Voorzieningen van tijdelijke aard met betrekking tot de inschrijving van studenten aan de Nederlandse universiteiten en hogescholen (Machtigingswet inschrijving studenten), 1972). After two years, this type of selection was terminated as a result of the debate about a presumed inequality for those hard working but not meeting this pu-GPA and the inevitable lawsuits of those not meeting these standards (Karstanje, 1981; Wilbrink & van der Vleugel, 1974). The surplus of applicants for the available places remained. Not even the establishment of an eighth medical school founded in 1975 in Maastricht could solve this problem. Universities lobbied hard for a system in which they would be able to enlist only the best students and the Christian Democrat parties in the coalition government backed that proposal. However, the State Secretary for Education Klein, of the social democratic Labour Party, fiercely opposed this and held on to the unweighted lottery, as preferred from the egalitarian social democratic perspective. After intense debate in Parliament a compromise was reached in the form of a weighted lottery (Toelatingscriteria numerus fixus-studierichtingen voor het studiejaar 1975-1976. Brief van de Staatssecretaris van Onderwijs en Wetenschappen, 1975), which has been in use ever since.

In weighted lottery the chance of selection rises along with the pu-GPA. There are four different lottery categories defined as: 7.5 ≤ pu-GPA < 8.0; 7.0 ≤ pu-GPA < 7.5; 6.5 ≤ pu-GPA < 7.0, and 5.5 ≤ pu-GPA < 6.5. The ratio by category for admission by lottery is, respectively, 9 : 6 : 4 : 3. After selection by lottery, and if enough places are available, applicants are assigned to the medical school of their first choice.

During the 80s and 90s the law which regulates the weighted lottery as well as the registration of students was renewed every year, despite the discussion about entrance selection on other criteria. This cyclical process was finally interrupted in 1997, when a brilliant candidate with a pu-GPA of 9.6 failed three consecutive times to get admitted to medical school (van Walsum, 1998). This created the opportunity for proponents of other admission criteria to widen the discussion. The 1997 report 'Weighing weighted lottery' (Commissie Toelating Numerus Fixusopleidingen, 1997) commissioned by the Dutch government showed that a pu-GPA of eight or higher had a predictive value for student achievement at medical school. Moreover, the notion that individual characteristics might play a role at study success gained support and was gradually accepted. Also, the politically motivated controversy waned over selection procedures based on merit, motivation or on specific criteria that have a proven predictive value regarding professional success or success in medical education (Drenth, 1998).

Ultimately, in 1999 Dutch law was changed and since then students with a pu-GPA of eight or higher were exempted from the lottery admission system and directly admitted to the medical school of their choice. In addition, medical schools were allowed to select 50% of the remaining number of allotted students by their own criteria and methods (Wet van 3 april 1999 tot wijziging van de Wet op het hoger onderwijs en wetenschappelijk onderzoek, houdende aanpassingen in het systeem van selectie voor opleiding waarvoor een toelatingsbeperking is vastgesteld. [Dutch Act of Higher Education and Sientific Research], 1999). With this an opportunity arose for individual medical schools to design their own selection procedure. From 2017 onward, medical schools must select all students using a school-specific procedure.

(A detailed description of the rich Dutch history and debate about lottery and selection can be found at benwilbrink.nl/projecten/loten_nf.htm (also in English))

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CHAPTER 2

Selection of medical students: a controlled experiment

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ABSTRACT

Objectives – We aimed to discover, through a controlled experiment, whether cognitive and non-cognitive assessment would select higher- achieving applicants to medical school than selection by lottery.

Methods – We carried out a prospective cohort study to compare 389 medical students who had been admitted by selection and 938 students who had been admitted by weighted lottery, between 2001 and 2004. Main outcome measures were dropout rates, study rate (credits per year) and mean grade per first examination attempt per year. Study rates in the 4 pre-clinical years of medical school were used to categorize students' performance as average or optimal.

Results – Pre-admission variables did not differ between the two groups. The main outcome of the selection experiment was that relative risk for dropping out of medical school was 2.6 times lower for selected students than for lottery-admitted controls (95% confidence interval 1.59–4.17). Significant differences between the groups in the percentage of optimally per- forming students and grade point average for first examination attempts were found only in the 2001 cohort, when results favoured the selected group. The results of the selection process took into account both the assessment procedure involved and the number of students who withdrew voluntarily.

Conclusions – This is the first controlled study to show that assessing applicants' non-cognitive and cognitive abilities makes it possible to select students whose dropout rate will be lower than that of students admitted by lottery. The dropout rate in our overall cohort was 2.6 times lower in the selected group.

INTRODUCTION

Because the number of applicants to medical school exceeds the number of places available, the selection of students is internationally widespread. Various national and local procedures are used (Medical School Admission Requirements (MSAR) 2008–2009: United States and Canada, 2007; Parry, Mathers, et al., 2006). The literature on selection shows that selection procedures tend to be based on two different principles: selection of those students who perform best, or selection of well-defined subgroups.

Various methods are used to identify best-performing students, including: undergraduate grade point average (uGPA) scores; pre-admission grades in specific basic science subjects; the Medical College Admission Test (MCAT); the Scholastic Assessment Test (SAT); interviews; written submissions, and psychological tests (DeVaul, Jervey, et al., 1987; Eva & Reiter, 2004; Nayer, 1992; Norman, 2004; Powis, 1998). Ideally, the validity of these different methods should be tested using a control group of randomly admitted students. However, such control groups are not available because admission procedures select overall cohorts per academic year. As a surrogate, correlations are therefore sought either between the scores of the selection method (or methods) and performance at medical school, or between these scores and the outcome of medical licensing examinations. Recent reviews of the literature by Salvatori (2001) and McGaghie (2002) 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 Year 3 of medical school (Julian, 2005; Wiley & Koenig, 1996). All other selection methods, including interviews (which are widely used (Kreiter, Yin, et al., 2004)), have low correlations with academic performance (Salvatori, 2001).

It is much easier to verify the efficiency of the second method of selecting students, which is by subgroup, categorized, for example, on the basis of age group, ethnicity, social background or educational back- ground (such as those defined by university graduates versus school leavers). Comparisons of such selected groups with controls admitted under the conventional admission method show no significant difference in performance in medical school or subsequent medical practice (Kay-Lambkin, Pearson, et al., 2002; McManus, 1998; Rolfe, Ringland, et al., 2004).

Some authors believe that selection processes overall very much resemble a lottery, and that the random selection of students for admission ultimately results in levels of student achievement similar to those produced by any of the existing selection procedures (DeVaul, Jervey, et al., 1987; Norman, 2004; Sheldrake, 1975). However, it has also been shown that certain characteristics, such as ability, motivation, ambition and conscientiousness, have, at the very least, a moderately positive bearing on student achievement (Ferguson, James, et al., 2003; Lievens, Coetsier, et al., 2002).

In the Netherlands, central selection takes place on the basis of a lottery that is weighted for academic attainment. In recent years it has become obvious that a pre-university education GPA (pu-GPA) of ≥ 8 (on a scale of 1–10, where 1 = poor and 10 = excellent) has a high predictive value for student achievement (Commissie Toelating Numerus Fixusopleidingen, 1997). It has also become accepted that individual characteristics play some part in study success (Begeleidingscommissie Decentrale Toelating, 2003). Since 1999, students with a pu-GPA ≥ 8 have therefore had unrestricted direct access to medical school, and medical schools have been allowed to select a maximum of 50% of their students on the basis of characteristics other than pu-GPA.

This situation presented a unique environment in which to perform an experiment in which a selection procedure could be designed, implemented and compared with the weighted lottery procedure. In the 2001–2002 academic year, we therefore started a selection experiment. The underlying hypothesis was that if, through their extracurricular activities, students display greater ability, motivation or ambition to achieve than their peers, they will not only perform better at medical school, but will continue to do so afterwards.

The objective of this experiment was to use controlled techniques to determine whether a combination of selection steps, based on the assessment of cognitive and non-cognitive abilities, would lead to the admission of students whose achievement in medical school would turn out to surpass that of students who had been selected by weighted lottery. This paper presents the first results of this experiment (i.e. those collated after 4 years of applying these selection steps).

METHODS

Admission of students

Pre-university education in the Netherlands lasts 6 years. Final examinations cover a number of subjects, four of which (biology, physics, chemistry and mathematics) are obligatory for admission to medical school. The GPA achieved in the final examinations is based on a combination of school examinations and state examinations, with each accounting for 50%. To graduate from pre-university education and enter the lottery procedure, the candidate must attain a pu-GPA of ≥ 5.5 (on a scale where 1 = poor and 10 = excellent).

Since 2001–2002, there have been options for admission to medical school through a local selection procedure (S-group), through the national lottery system (L-group), and through unrestricted direct access (D-group) (figure 1). To qualify for unrestricted direct access, an applicant must have a pu-GPA of ≥ 8. All other applicants have to take part in the weighted lottery, in which the chance of selection rises along with the pu-GPA. There are four different lottery categories defined as: 7.5 ≤ pu-GPA < 8.0; 7.0 ≤ pu-GPA < 7.5; 6.5 ≤ pu-GPA < 7.0, and 5.5 ≤ pu-GPA < 6.5. The ratio by category for admission by lottery is, respectively, 9 : 6 : 4 : 3. After selection by lottery, and if enough places are available, applicants are assigned to the medical

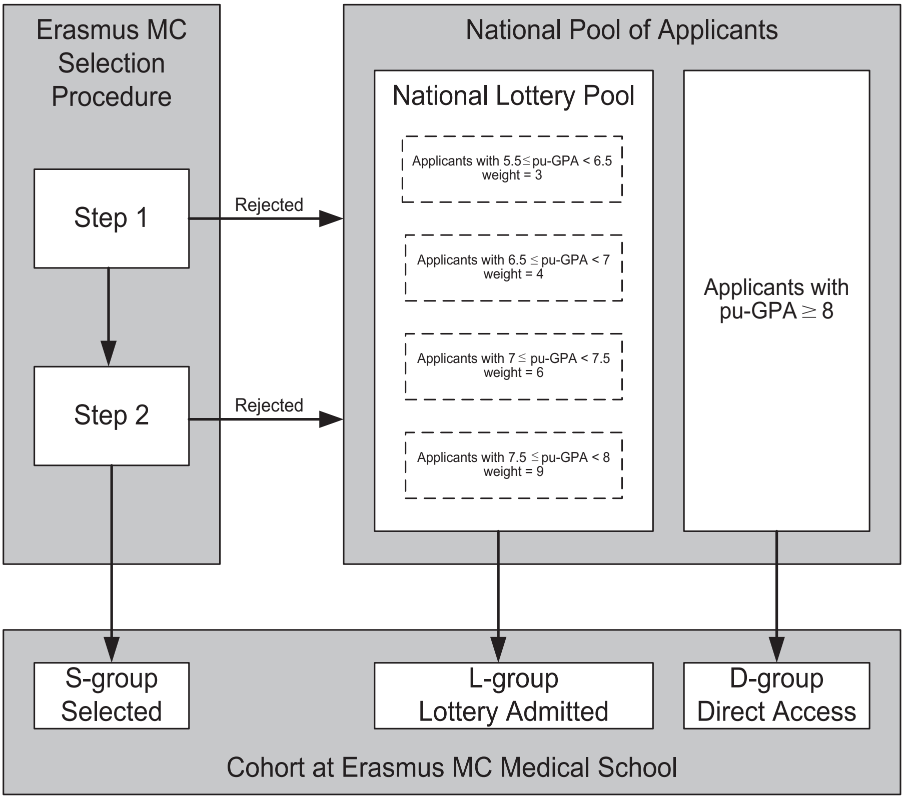

Figure 1 – Diagram showing the parallel selection and lottery procedures at ErasmusMC Medical School, Rotterdam
pu-GPA = pre-university education Grade Point Average

school of their first choice. Applicants who take part in the lottery can also choose to apply using a local selection procedure, which precedes the lottery.

Selection procedure at Erasmus MC Medical School

For logistical reasons in 2001, the maximum number of students to be selected was set at 15% of the maximal admissible number of 276. In 2002 it was set at 30% of 335, and in 2003 and 2004 at 50% of 410.

A two-step procedure was designed. In the first step, applicants were assessed according to the quality and extent of their extracurricular activities before application. Only activities that had lasted for > 2 years and had been carried out during the 3 years immediately prior to application were taken into account.

These activities were divided into five categories:
1. activities in health care;
2. activities in management and organization;
3. activities related to a talent (such as music, sport or science);
4. (extracurricular) academic education, and
5. additional pre-university education.

Applicants specified their extracurricular activities on a structured application form. The provision of evidence such as letters of recommendation and references to support their statements was mandatory. Per category, a minimum quality level was determined beforehand. If the activity met the quality criteria, the extent of that activity was calculated in hours per year; a minimum of 160 hours per year over 2 consecutive years was required. The total number of hours over 2 years was recoded into an individual score, and a ranking established. Except in 2001, all applicants who were ranked above the mean in the first step of selection were invited to proceed to the second. In the first academic year, a fixed number of 60 applicants were invited for the second selection step.

The second step consisted of five cognitive tests on a medical subject. These were performed over 4 consecutive days at Erasmus MC Medical School and contained questions on logical reasoning, scientific thinking, epidemiology and pathology, anatomy and philosophy. Three tests consisted of multiple-choice questions and two of open-ended questions. Applicants were scored per test using a scale of 1–10, where 1 = poor and 10 = excellent. A score of ≥ 5.5 was considered satisfactory. To be selected for admission, a student needed to pass four of five tests and achieve an average score across the five tests of ≥ 5.5.

Criteria for student achievement

The current medical curriculum at Erasmus MC consists of a 4-year pre-clinical phase followed by a 2-year clinical phase. The pre-clinical phase includes five modules, each lasting 2–6 weeks, as well as 6 thematic blocks each lasting 15–19 weeks, and electives amounting to a total of 29 weeks. Between them, the modules and thematic blocks include 29 examinations. Each examination qualifies 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.

We had no minimum requirements for the number of credits per year. However, it has been shown that 96% of the students at Erasmus MC who failed to obtain 60 credits by the end of the first 2 years of study failed to complete medical education (Splinter, 2005). Such students were therefore considered as dropouts. For the remaining students, achievement was specified by study rate (number of credits per year) and GPA at the first examination attempts per year. The credits and grades were derived from the university student administration system.

Statistical analysis

Four consecutive cohorts were entered into the study. Each cohort was followed for at least 2 years. The pre-admission variable 'gender' was analysed using chi-squared statistics with Mantel–Haenszel test for stratification by year of entrance and weighted lottery category. Analysis of covariance (ANCOVA) was used for comparisons of age, and a *t*-test was used to compare pu-GPA between both groups.

As approximately 50% of our students obtain the maximum of 60 credits each year, the use of study rate as a parameter for achievement leads to a non- normal distribution of the population. This non- normal distribution is increased by the identification of dropouts. Students were therefore divided into three categories: dropouts with < 60 credits after 2 years of study; optimal performers with the maximum study rate of 60 credits after each year, and average performers with a study rate of < 60 credits per year. A Mantel–Haenszel stratification test was used for comparisons between selected and lottery admitted groups concerning dropouts and optimal and average performers. The strata were year of entrance at medical school and weighted lottery category. Grade point averages in both groups were compared using student *t*-tests.

Data were derived from the university student administration systems, recorded in EXCEL 2003 workbooks and analysed using SPSS for Windows Version 15.0 (SPSS for Windows, 2006).

RESULTS

Selection procedure: quantitative aspects

Table 1 shows the different stages of the selection procedure that led 8.1% students to be selected in 2001, 13.4% in 2002, 21.1% in 2003 and 21.1% in 2004. The sizes of these components are also shown. The number of applicants increased from 393 in 2001 to 736 in 2004. The total number of places available increased from 275 in 2001 to 410 in 2003 and subsequent years.

Table 1 – *Quantitative aspects of the selection procedure*

	Cohort									
	2001		**2002**		**2003**		**2004**		**Total**	
Procedure	***n******	**(%)†**	***n****	**(%)†**	***n****	**(%)†**	***n****	**(%)†**	***n****	**(%)†**
Central registration	393		536		622		736		2287	
Withdrawn before first step	109	(27.7)	172	(32.1)	135	(21.7)	195	(26.5)	611	(26.7)
Step 1	284	(72.3)	364	(67.9)	487	(78.3)	541	(73.5)	1676	(73.3)
Rejected	216	(55.0)	153	(28.5)	172	(27.7)	230	(31.3)	771	(33.7)
Invited to participate in step 2	68	(17.3)	211	(39.4)	315	(50.6)	311	(42.3)	905	(39.6)
Withdrawn before second step	14	(3.6)	19	(3.5)	47	(7.6)	16	(2.2)	96	(4.2)
Step 2	54	(13.7)	192	(35.8)	268	(43.1)	295	(40.1)	809	(35.4)
Rejected	13	(3.3)	87	(16.2)	91	(14.6)	113	(15.4)	304	(13.3)
Selected	41	(10.4)	99	(18.5)	176	(28.3)	181	(24.6)	497	(21.7)
Withdrawn/lottery admitted elsewhere	9	(2.3)	28	(5.2)	45	(7.2)	26 ‡	(3.5)	108	(4.7)
Selected Group	32	(8.1)	71	(13.2)	131	(21.1)	155	(21.1)	389	(17.0)

* Number of applicants who participated in a particular step of the procedure
† Percentage of centrally registered candidates
‡ Withdrawn only

In 2001 and 2002, we limited the maximum number of students admitted by selection for logistical reasons. After the first assessment in 2001, this led to the rejection of an aberrantly high percentage of applicants. In the remaining 3 years, a mean of 44.5% of registered applicants was rejected. In 2003 and 2004, selection was performed according to the strict criteria described in the Methods section. About a quarter of the initial applicants withdrew voluntarily before the first selection step. Further- more, each year approximately 9% of the applicants did not respond to the invitation to enter the next phase.

Table 2 shows the sizes of the D-, S- and L-groups per cohort. As the goal of the experiment was to investigate whether a procedure could be developed to select students who would perform better than those admitted by weighted lottery alone, we compared only selected and lottery-admitted groups (S- and L-groups).

Table 2 – *Cohort Composition*

	2001		2002		2003		2004		Total	
Cohort	***n***	**(%)**	***n***	**(%)**	***n***	**(%)**	***n***	**(%)**	***n***	**(%)**
Total cohort	272		332		405		403		1412	
D-group	19	(7.0)	19	(5.7)	20	(4.9)	27	(6.7)	85	(6.0)
S-Group	32	(11.8)	71	(21.4)	131	(32.3)	155	(38.5)	389	(27.5)
L-Group	221	(81.2)	242	(72.9)	254	(62.7)	221	(54.8)	938	(66.4)

D-group = direct access group; S-group = selected group; L-group = lottery group

Pre-admission variables

Pre-admission variables per cohort are shown in Table 3. Overall, 65% of the S-group consisted of women, compared with 60.5% of the L-group. After controlling for year of entrance and weighted-lottery category, we found that this difference was non-significant ($\chi^2_{(1)} = 3.01$, $p = 0.083$).

Table 3 – *Pre-admission variables: gender, mean age, and mean pre-university grade point average*

		2001	(SD)	2002	(SD)	2003	(SD)	2004	(SD)
Gender, % female	S-group	71.9		74.6		60.3		63.2	
	L-group	61.5		58.3		56.3		66.5	
Mean age, years	S-group	20.82*	(2.40)	20.05	(2.35)	19.85	(2.77)	19.31	(1.75)
	L-group	19.79	(2.07)	19.67	(2.43)	19.48	(1.92)	19.37	(2.04)
Mean pu-GPA, Z-score	S-group	-0.23	(0.82)	-0.12†	(0.83)	-0.18	(0.81)	-0.16	(0.81)
	L-group	-0.16	(0.81)	-0.15	(0.85)	-0.10	(0.85)	-0.13	(0.88)

* Significantly higher than corresponding L-group ($t[251] = 2.569$, $p = 0.011$)
† Significantly more than corresponding L-group, ($\chi^2_{(1)} = 6.25$, $p = 0.012$)
SD = standard deviation; D-group = direct access group; S-group = selected group; L-group = lottery group; pu-GPA = pre-university grade point average

Mean age, adjusted for year of entrance and weighted-lottery category, was 19.69 years in the S-group and 19.34 years in the L-group. The S-group was 4.1 months older, which was significant ($F_{(1, 1259)} = 9.960$, $p = 0.002$). However, the partial $r = 0.08$, which was very low. Although both covariance's were significant, their effect sizes were very low: year of entrance was $t(1259) = 2.740$, $p = 0.006$, $r = 0.26$; weighted-lottery category was $t(1259) = 9.402$, $p = 0.000$, $r = 0.08$.

For each year of entrance, pu-GPAs were transformed into Z-scores. The pu-GPA was -0.17 for the S-group and -0.14 for the L-group ($t[1261] = -0.568$, $p = 0.570$). Adjusting for year of entrance revealed no different means.

Student achievement per cohort

Table 4 shows the achievements of the S- and L-groups specified as dropouts, optimal study rate and GPAs at the first examination attempts. Four cohorts were included in the study. All cohorts had a minimum follow-up of 2 years and two had a follow- up of 4 years. A Mantel–Haenszel stratification test showed a highly significant difference between the percentage of dropouts in the S- and L-groups ($\chi^2_{(1)}$ = 14.68, p = 0.000). The S-group had a relative risk for dropout 2.58 times (95% confidence interval [CI] 1.59–4.17) lower than that of the controls. The percentages of optimally performing students in both groups were almost identical and did not statistically differ in any of the 2002–2004 cohorts. By contrast, the percentages in the two groups in the 2001 cohort did differ, but this was statistically significant only in the second year ($\chi^2_{(1)}$ = 4.17, p = 0.041). After stratification for year of entrance and lottery category with Mantel–Haenszel chi-squared tests, the S-group did not outperform the L-group in terms of optimal performance in any of the academic years.

Finally, there were no significant differences between the two groups in GPAs at the first examination attempts, except in the 2001 cohort during the first academic year.

DISCUSSION

In 2001, a controlled experiment was instigated to investigate whether medical students selected on the basis of a combination of non-cognitive extracurricular activities and cognitive abilities would perform significantly better in medical school than students admitted by lottery.

Although there was no evidence for the existence of methods that might select students who would perform better in medical school, there were several reasons for this experiment (Norman, 2004). One major reason was the co-existence in the Netherlands of a central weighted lottery with a local selection system. This provided a unique environment in which to perform controlled experiments. Another important reason was that, in the absence of a selection system of proven efficacy, a lottery system should not be accepted as a valid solution. Both the lottery and this unproven procedure have been described as unfair to medical school applicants, as neither includes any truly objective criteria for predicting future performance (Zwick, 2006).

Table 4 – *Achievement in the selected and lottery groups*

Cohort		2001			2002			2003			2004			Statistics		
		n	(%)		*n*	(%)		*n*	(%)		*n*	(%)		RR	95% CI	*p*
Dropouts																
	S-group	2	(6.3)		2	(2.8)		11	(8.4)		9	(5.8)		2.58	1.59-4.17	0.000
	L-group	37	(20.4)		17	(11.2)		26	(14.6)		22	(14.0)				
Optimal Performance																
After 1 year	S-group	22	(73.3)		52	(75.4)		72	(60.0)		96	(65.8)		1.31	0.98-1.75	0.065
	L-group	110	(62.5)		143	(66.5)		125	(57.6)		121	(63.7)				
After 2 years	S-group	23	(76.7)		46	(66.7)		40	(33.3)		81	(55.5)		1.18	0.89-1.56	0.244
	L-group	100*	(56.8)		147	(68.4)		77	(35.5)		95	(50.0)				
After 3 years	S-group	14	(46.7)		32	(46.4)		40	(33.3)			--		0.90	0.64-1.26	0.532
	L-group	71	(40.3)		109	(50.7)		87	(40.1)			--				
After 4 years	S-group	13	(43.3)		26	(37.7)			--			--		1.38	0.84-2.26	0.206
	L-group	48	(27.3)		78	(36.3)			--			--				
		n	GPA	SD	*n*	GPA	SD	*n*	GPA	SD	*n*	GPA	SD			
Mean Grades																
Year 1	S-group	30	6.78†	0.88	69	6.48	0.81	120	6.24	0.66	146	6.18	0.64			
	L-group	176	6.29	0.80	215	6.42	0.74	217	6.22	0.64	190	6.25	0.72			
Year 2	S-group	30	6.63	1.12	69	6.59	0.83	120	5.91	0.75	145	5.99	0.75			
	L-group	167	6.29	0.88	215	6.44	0.83	217	5.98	0.71	182	6.10	0.77			
Year 3	S-group	30	6.38	1.03	66	6.49	0.73	109	6.08	0.81	--	--	--			
	L-group	175	6.20	0.76	213	6.30	0.81	206	6.06	0.73	--	--	--			
Year 4	S-group	30	6.33	1.03	68	6.32	0.93	--	--	--	--	--	--			
	L-group	170	6.03	0.89	203	6.25	0.82	--	--	--	--	--	--			

* Significantly more than corresponding percentage of optimals in the L-group ($\chi^2_{(1)} = 4.20$, $p = 0.040$)

† Significantly higher than corresponding GPA in the L-group, ($t[204] = 3.04$, $p = 0.003$)

RR = Relative Risk, calculated on the basis of the Mantel-Haenszel common odds ratio estimate, stratified for year of entrance and lottery category; CI = 95% confidence interval; D-group = direct access group; S-group = selected group; L-group = lottery group; pu-GPA = pre-university grade point average; SD = standard deviation

Our choice of selection criteria was based on the hypothesis that pre-university students who have distinguished themselves from their peers in their extracurricular activities, but not in higher GPAs, might have characteristics that will lead them to perform better in medical school than controls admitted on the basis of a lottery. Because no literature was available to support this, we felt that a second selection step, based on cognitive abilities, might be needed (Kulatunga-Moruzi & Norman, 2002; Zwick, 2006). Selection on the basis of pu-GPA was not allowed.

The main outcome of the selection experiment in four consecutive cohorts was the finding that the relative risk for dropping out of medical school was 2.6 times lower in selected students than in controls admitted by lottery. Except in the 2001 cohort, there were no significant differences between the percentages of students who performed optimally in either group. In the 2001 cohort, there were differences in all academic years, although this reached statistical significance only in the second academic year. Similarly, neither were there any significant differences during the first academic year between the S- and L- groups in terms of GPAs achieved at first examination attempts, with, once again, the exception of the 2001 cohort. It seems reasonable to postulate that the outcome of our selection was a product mainly of the procedure, but also, to a certain extent, of self-selection by the applicants themselves, the latter because some applicants were rejected, and some withdrew voluntarily throughout the entire course of the selection procedure. Means of 47% of applicants were rejected and 35.6% withdrew. Eventually, 17% were selected. The majority of applicants who withdrew (26.7%) did so before the start of the first step of the assessment after they had received the application form. Of the remaining 9%, approximately half withdrew because the lottery had allocated them a place at another medical school, which they then accepted.

The differences we observed in student achievement could not be explained by the pre-admission characteristics 'gender' and 'pu-GPA'. Although selected students were significantly older (by 4 months), this is unlikely to be a reasonable explanation. So how can we explain why a highly significant decrease in dropout rate was not accompanied by differences in GPA at the first examination attempt or by differences in the 'optimal' and 'average' study-rate categories? The most likely explanation is that our selection process excluded most of the potential dropouts who would normally have been admitted under the lottery procedure.

Students at risk of dropping out have three main characteristics: relatively low performance in pre-university education (Cohen-Schotanus, Muijtjens, et al., 2006; Ferguson, James, et al., 2002); lower prior qualifications for academic study, and poorer social integration at university (Arulampalam, Naylor, et al., 2007; Smith & Naylor, 2001; Tinto, 1992). Retrospective analysis at our medical school seems to indicate that students who are at risk of dropping out fall into three groups, consisting of: those who lack both motivation and ability; those with high motivation but inefficient study methods, and able students who get off to a slow start (Stegers-Jager & Splinter, 2008). Future comparisons of dropouts in the S- and L-groups may provide information about the type of potential dropouts who are excluded by the selection procedure.

In future research we will analyse qualitative aspects of the selection procedure and also the applicability of the procedure to other medical schools and other academic programs, such as those in law and economics. As well as comparing the performances of the S- and L-groups during clinical rotations, we will also compare levels of participation in extracurricular activities at medical school and seek to determine whether a higher level of participation in extracurricular activities in pre-university students, such as in 2001, is related to better achievements in study rate and GPA.

In conclusion, this is, to our knowledge, the first study to show that it is possible to select students who will perform better in the pre-clinical phase of medical school than their lottery-admitted controls. In this study, our main finding was that the dropout rate in these students was 2.6 times lower than in lottery-admitted students. We believe that these data may provide a starting point for examining the relationships between personal characteristics and academic achievement.

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CHAPTER 3

Selected medical students achieve better than lottery-admitted students during clerkships

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ABSTRACT

Objectives – A recent controlled study by our group showed that the dropout rate in the first 2 years of study of medical students selected for entry by the assessment of a combination of non-cognitive and cognitive abilities was 2.6 times lower than that of a control group of students admitted by lottery. The aim of the present study was to compare the performance of these two groups in the clinical phase.

Methods – A prospective cohort study was performed to compare the performance of 389 medical students admitted by selection with that of 938 students admitted by weighted lottery between 2001 and 2004. Follow-up of these cohorts lasted 5.5–8.5 years. The main outcome measures were the mean grade obtained on the first five discipline-specific clerkships by all cohorts and the mean grade achieved on all 10 clerkships by the cohorts of 2001 and 2002.

Results – Selected students obtained a significantly higher mean grade during their first five clerkships than lottery-admitted students (mean ± standard error [SE] 7.95 ± 0.03, 95% confidence interval [CI] 7.90–8.00 versus mean ± SE 7.84 ± 0.02, 95% CI 7.81–7.87; $P < 0.001$). This difference reflected the fact that selected students achieved a grade of ≥ 8.0 1.5 times more often than lottery-admitted students. An analysis of all mean grades awarded on 10 clerkships revealed the same results. Moreover, the longer follow-up period over the clerkships showed that the relative risk for dropout was twice as low in the selected student group as in the lottery-admitted student group.

Conclusions – The selected group received significantly higher mean grades on their first five clerkships, which could not be attributed to factors other than the selection procedure. Although the risk for dropout before the clinical phase increased somewhat in both groups, the actual dropout rate proved to be twice as low in the selected group.

INTRODUCTION

The number of applicants to medical school exceeds the number of places available. Therefore, student selection is an internationally widespread practice. Various methods are used to select the best performing students. The most common methods are the undergraduate grade point average (uGPA) and the Medical College Admission Test (MCAT) (Medical School Admission Requirements (MSAR) 2008–2009: United States and Canada, 2007; Parry, Mathers, et al., 2006). The uGPA has the greatest bearing on student achievement in medical school (Baars, Wimmers, et al., 2009; Cohen-Schotanus, Muijtjens, et al., 2006). Most studies suggest that it explains 15–25% of variance in achievement during the pre-clinical phase (Baars, Wimmers, et al., 2009; Salvatori, 2001).

However, results have shown that it is much more difficult to predict future clinical performance during clerkships (Basco Jr., Gilbert, et al., 2000; Hamdy, Prasad, et al., 2006). Given an explained variance of < 10%, the relationship between uGPA and achievement during clerkships is much weaker (Baars, Wimmers, et al., 2009; Peat, Woodburry, et al., 1982; Veloski, Callahan, et al., 2000). Most probably, the decrease in the strength of the relationship is caused by the substantial change in the learning environment – including in methods of assessment – at the transition from the pre-clinical to the clinical phase (Prince, Van De Wiel, et al., 2000). Similarly, the MCAT has a moderate to low predictive value for clerkships, with an explained variance in achievement of approximately 15% (Donnon, Paolucci, et al., 2007).

Both the uGPA and MCAT represent cognitive domains. Of non-cognitive measures, the most frequently used is the interview, sometimes accompanied by letters of reference or psychological tests, although predictive validity correlations rarely rise above 0.10 (Albenese, Snow, et al., 2003; Salvatori, 2001). To enhance the predictive validity of the interview, the multiple mini-interview (MMI) was developed; this is an admission procedure resembling an objective structured clinical examination with multiple short-interview stations. Although the results of only small groups of students have been presented, the MMI has shown promising results in predicting clerkship and licensing examination results (Reiter, Eva, et al., 2007). It is therefore unsurprising to identify a need for other criteria, especially those that are non-cognitive, with which to assess personal qualities for the purposes of selecting medical students (Collin, Violato, et al., 2009; Eva, Reiter, et al., 2004; Ferguson, James, et al., 2002).

Since 2000, medical schools in the Netherlands have been allowed to select up to 50% of their students based on characteristics other than pre-university GPA (pu-GPA). ten Cate & Hendrix (2001) and ten Cate, Hendrix, et al. (2002) have described the selection procedures used in two medical schools. In one of these, selection was based on cognitive abilities; in the other, selection relied on assessment of non-cognitive abilities such as motivation and views on the medical profession. An analysis carried out after 1 year of follow-up found that selected students obtained a slightly higher mean grade on written examinations. Both medical schools selected 24 students, whose results were compared with those of 341 lottery-admitted students. Hulsman, van der Ende, et al. (2007) used a three-step procedure. They selected 56 students and compared their outcomes with those of 446 lottery-admitted controls in two cohorts. The selection procedure referred to in this study involved the writing of an essay, cognitive tests and an examination of social skills. After 1 year of follow-up, no difference in academic achievement was found between selected students and controls.

From 2001, we performed a controlled experiment to find out whether students selected for medical school using a combination of cognitive and non-cognitive assessments would achieve more than those selected by lottery. The first four cohorts consisted of a total of 389 selected students and 938 lottery-admitted controls. In short, the main outcome of this prior study was the relative risk for dropout in the first 2 years, which we found to be 2.6 times lower for selected students than it was for students admitted by lottery (Urlings-Strop, Stijnen, et al., 2009). The four cohorts of selected and lottery-admitted students who entered medical school between 2001 and 2004 were followed to track their achievements in the clinical phase. The present paper reports the comparison of their clinical achievements.

The existence of the lottery-admitted group next to the selected group provided a unique opportunity to compare the results of randomly admitted versus selected students. This is the first study to compare the clinical achievements of selected students and controls.

METHODS

Selection procedure

Since 2000, there have been three ways of gaining admittance to medical school in the Netherlands: a local selection procedure (S-group); the national lottery system (L-group), and an unrestricted direct access (D-group). Applicants taking part in the lottery can also choose to apply for a local selection procedure, which precedes the lottery. The local selection procedure at Erasmus MC medical school and the weighted lottery system in the Netherlands have already been described (Urlings-Strop, Stijnen, et al., 2009). Direct access is given to students with a pu-GPA of ≥ 8.0.

Clinical curriculum

The medical curriculum consists of a 4-year (168-week) pre-clinical phase followed by a 2-year (84-week) clinical phase. The clinical phase consists of two parts which involve a fixed sequence of clinical rotations. A period of 15 weeks of general clinical training precedes 69 weeks of discipline-specific clerkships. The general clinical training includes 4 weeks of introduction followed by three short clerkships in internal medicine, surgery and paediatrics of 4, 4 and 3 weeks, respectively. Student achievement in each of these three clerkships is judged as 'insufficient', 'sufficient' or 'good'. The aim of the general clinical training is to teach the student the following competencies: history taking; physical examination; differential diagnosis; additional diagnostic procedures, and therapy planning (Splinter & Verwoerd, 2000). Because of the non-discriminatory power of this grading, these results were not included in further analysis.

Discipline-specific clerkships include 11 different rotations in internal medicine, surgery, paediatrics, psychiatry, neurology, gynaecology, dermatology, otorhinolaryngology, ophthalmology, family medicine and public health, respectively, followed by 15 weeks of elective clerkships. However, performance in both the public health and elective clerkships is not graded. The durations of the 10 clerkships on which performance is graded are 8, 8, 3, 5, 5, 5, 3, 3, 3 and 4 weeks, respectively. Some of these are preceded by a week of introductory courses. At the end of each clerkship, the student's performance is assessed using a combination of patient-related assessment and oral examination and rewarded with a grade between 5 (unsatisfactory) and 10 (excellent). In addition, overall clinical performance is assessed by a supervisor during each clerkship.

Participants

Students are eligible to start the clinical phase when they have completed all obligatory modules and all examinations. On the date selected to qualify for entry to this study (1 April 2010) 78.3% of students in the 2001 and 2002 cohorts had passed all 10 clerkships and 65.8% of those in the 2001–2004 cohorts had completed the first five discipline-specific clerkships. Students who were not eligible to start the clinical phase and who had obtained no grades in the pre-clinical phase for more than a year were considered as late dropouts; students who had failed to complete the first year of study within 2 years were considered as early dropouts. The mean grade for the 10 discipline-specific clerkships in the cohorts of 2001 and 2002 and that for the first five clerkships in all four cohorts was used as the criterion representing clinical achievement.

Statistical analysis

For all students, pre-admission data on age, gender and pu-GPA were collected, as well as start date and the number of clerkships completed by 1 April 2010. Within each cohort, pu-GPAs were translated into Z-scores in order to diminish cohort differences. Data on gender and the percentage of students who had begun clerkships, as well as on overall dropout rate and grades obtained on the clerkships, were analysed using the chi-squared test or Mantel–Haenszel test with stratification by year of entrance and weighted lottery category if appropriate. Analysis of covariance (ANCOVA) was used for comparisons of grades obtained. Again, year of entry and weighted lottery category were used as covariates.

All data were derived from the university student administration system, recorded in EXCEL 2003 workbooks and analysed using PASW for Windows Version 17.0 (SPSS, Inc., Chicago, IL, USA).

Ethical considerations

In the Netherlands, ethical approval for studies concerning medical education is not required. However, in order to adhere to the tenets of the Declaration of Helsinki, we took some precautions. Members of the medical faculty, who were not involved in this research, were authorised by the examination committee to extract the students' grades from the university administration system and deliver them in an anonymised form to the investigators.

RESULTS

As 65.8% of the 2001–2004 cohorts had completed at least five clerkships and 78.3% of the 2001 and 2002 cohorts had completed all 10 clerkships, the mean grades for five and 10 clerkships were used to compare the clinical achievement of selected and lottery-admitted students. An almost ideal correlation of 0.89 was found between the mean grade achieved on the first five clerkships and the mean grade obtained on all 10 clerkships by the 443 students in the cohorts of 2001 and 2002. This indicated that former achievement could be considered representative of overall clinical achievement. For the purposes of clarity, data for both the four cohorts of 2001–2004 and the two cohorts of 2001 and 2002 are shown in Tables 1–3, but only data for the four cohorts of 2001–2004 are discussed.

Table 1 summarises quantitative data from the start of medical education up to the completion of either five or 10 clerkships. In the four cohorts of 2001– 2004, 389 students were selected (S-group) and 938 students were admitted by lottery (L-group).

Table 1 – *Quantitative characteristics of the cohorts of 2001-2004 and the cohorts of 2001 and 2002 after 5.5 - 8.5 years of follow-up, respectively*

	Cohorts of 2001-2004				Cohorts of 2001-2002			
	S-group		L-group		S-group		L-group	
	n	**(%)**	***n***	**(%)**	***n***	**(%)**	***n***	**(%)**
Started medical school	389		938		103		463	
Early drop-out in first 2 years	24	(6.2)	140	(14.9)	4	(3.9)	72	(15.6)
Qualified to complete pre-clinical phase	365		798		99		391	
Late drop-out	12	(3.1)	20	(2.1)	0	(0.0)	10	(2.2)
Not yet completed pre-clinical phase	15	(3.9)	23	(2.5)	1	(1.0)	0	(0.0)
Eligible to start clerkships	338	(86.9)	755	(80.5)	98	(95.1)	381	(82.3)
Completed pre-clinical but stopped	16	(4.1)	27	(2.9)	2	(1.9)	3	(0.6)
Completed < 5* / 10† clerkships	80	(20.6)	97	(10.3)	9	(8.7)	22	(4.8)
Completed ≥ 5* / 10† clerkships	242	(62.2)	631	(67.2)	87	(84.5)	356	(76.9)

* For the cohorts of 2001-2004
† For the cohorts of 2001 and 2002
S-group = selected students; L-group = lottery admitted students

Of the 365 selected students and 798 lottery-admitted students who completed the pre-clinical phase, 12 and 20 students, respectively, dropped out in subsequent years, although they completed the first year, which led to overall dropout rates of 9.3% in the S-group and 17.1% in the L-group. After controlling for cohort and weighted lottery category, this differ- ence remains significant ($\chi^2_{(1)} = 10.11$, $p < 0.001$). The risk for both early and late dropout during the entire pre-clinical phase remained twice as large in the L-group as it was in the S-group.

Despite a follow-up of ≥ 5.5 years, 15 students in the S-group (3.9%) and 23 in the L-group (2.5%) had not yet completed the pre-clinical phase. The difference between the groups is not significant. Having completed the pre-clinical phase, 338 students in the S-group (86.9%) and 755 students in the L-group (80.5%) were eligible to start the clerkships. Sixteen (4.1%) students in the former group and 27 (2.9%) in the latter did not actually start this phase. Of these 16 S-group students, 13 were involved in a PhD programme; of the 27 L-group students, 17 were enrolled in PhD programmes, one was studying law and one was studying public health. No such activities could be confirmed for the 11 remaining students.

Eighty (20.6%) students in the S-group and 97 (10.3%) in the L-group in the four cohorts of 2001– 2004 had started the clerkships but had not yet completed five of them. Thus, data on the mean grade achieved on five clerkships were available for 242 (62.2%) students in the S-group and 631 (67.2%) in the L-group. Using the Mantel–Haenszel stratification test (strata = year of entrance), the difference between the groups in the percentage of students at this stage proved non-significant ($\chi^2_{(1)} = 0.23$, $p > 0.05$). The percentage of students who were eligible to start clerkships but had not completed at least five discipline-specific clerkships was 24.7% in the S-group and 13.2% in the L-group ($\chi^2_{(1)} = 2.97$, $p < 0.001$).

Pre-admission variables in the S- and L-groups in successive stages of study are shown in Table 2. There is a significant difference between the groups in the percentage of women at all stages, except at the start of medical school, when comparing gender over all four cohorts. Between the start of medical school and the completion of five clerkships, the percentage of women increased by 6.5% in the S-group and 4.2% in the L-group. These data indicate the positive selection of women during the pre-clinical phase. The variable 'mean age at start' remained the same during this period. However, the S-group was significantly older than the L-group, although the difference was usually < 6 months.

No significant difference in pu-GPA was observed between the S- and L-groups at any stage. Pre- university GPA increased slightly from the start through the five clerkships, indicating a positive selection during the pre-clinical phase. Because of the significant difference in gender and age, these variables were added as a covariate to the ANCOVA when the mean grades of the clerkships were assessed.

During the clinical phase, a total of 4365 grades were given for the first five clerkships. For administrative reasons, 40 grades (0.9%) were missing. An ANCOVA was used to compare the mean grades obtained by both groups on these first five clerkships, taking into account the cohort in which the students had started their study and their weighted lottery category. The first variable had no significant bearing on the mean grade, but the latter was significantly related ($F_{(1,827)} = 27.17$, $p < 0.001$). Mean ± standard error (SE) grades were 7.95 ± 0.03 (95% confidence interval [CI] 7.90–8.00) in the S-group and 7.84 ± 0.02 (95% CI 7.81–7.87) in the L-group ($F_{(1,822)} = 12.30$, $p < 0.001$). The effect size for this mean difference in GPA was small (0.015).

Table 2 – *Pre-admission variables at the start of medical school and after completion of at least five clerkships for the cohorts 2001-2004 and of 10 clerkships for the cohorts of 2001 and 2002*

		Cohorts of 2001-2004				**Cohorts of 2001 and 2002**			
		At start of medical school		**Finished ≥ 5 clerkships**		**At start of medical school**		**Finished 10 clerkships**	
Gender, % female									
	S-group	65.0		71.5†		73.8‡		78.0§	
	L-group	60.5		64.7		59.8		64.1	
Mean Age, years (SD)									
	S-group	19.69¶	(0.09)	19.74**	(0.12)	20.01††	(0.18)	20.02‡‡	(0.18)
	L-group	19.34	(0.04)	19.32	(0.07)	19.52	(0.08)	19.37	(0.06)
Mean pu-GPA* (SD)									
	S-group	-0.17	(0.01)	-0.04	(0.02)	-0.17	(0.03)	-0.09	(0.03)
	L-group	-0.14	(0.01)	-0.04	(0.01)	-0.15	(0.01)	-0.07	(0.02)

* Z-score
† Differs significantly from corresponding L-group ($\chi^2_{(1)}$ = 4.01, $p < 0.05$)
‡ Differs significantly from corresponding L-group ($\chi^2_{(1)}$ = 7.10, $p < 0.01$)
§ Differs significantly from corresponding L-group ($\chi^2_{(1)}$ = 8.24, $p < 0.01$)
¶ Differs significantly from corresponding L-group ($F_{(1,1259)}$ = 9.96, $p < 0.01$)
** Differs significantly from corresponding L-group ($F_{(1,824)}$ = 9.56, $p < 0.01$)
†† Differs significantly from corresponding L-group ($F_{(1,532)}$ = 6.28, $p < 0.05$)
‡‡ Differs significantly from corresponding L-group ($F_{(1,392)}$ = 10.32, $p < 0.001$)
S-group = selected students; L-group = lottery admitted students; SD = standard deviation; pu-GPA = pre-university grade point average

The addition of gender and age as covariates to the ANCOVA when mean grades were assessed showed no difference in means.

To explain the difference in mean grades between the S- and L-groups, the grades were divided into two categories, comprising: (i) grades of > 5.5 to< 8.0, and (ii) grades of ≥ 8.0. The first category represents grades of 6.0 (below average, but just good enough to continue) and 7.0 (average); the second category represents grades of 8.0 (good) and 9.0 (very good). In 7.5% of cases, grades were rounded up to a whole number. Table 3 shows the distribution of grades. Overall, over 70% of the grades were ≥ 8.0. However, S-group students obtained grades of ≥ 8.0 significantly more often than L-group students ($\chi^2_{(1)}$ = 30.17, $p < 0.001$). The probability of achieving a grade ≥ 8.0 was 1.5 times higher for selected students than it was for lottery- admitted students.

Table 3 – *Number of students achieving grades of < 8.0 or ≥ 8.0*

	Cohorts of 2001-2004		Cohort of 2001 and 2002	
	S-group*	**L-group**	**S-group†**	**L-group**
	n (%)	**n (%)**	**n (%)**	**n (%)**
5.5 < grade < 8	256 (21.5)	933 (29.8)	174 (20.0)	1043 (29.3)
Grade ≥ 8	936 (78.5)	2200 (70.2)	695 (80.0)	2516 (70.7)

* The S-group obtained a grade of ≥ 8 more often ($\chi^2_{(1)} = 30.17$, $p < 0.001$)
† The S-group obtained a grade ≥ 8 more often ($\chi^2_{(1)} = 30.20$, $p < 0.001$)
In the cohorts of 2001-2004, the mean grade was 7.95 (SE = 0.03, 95% CI = 7.90-8.00) in the S-group and 7.84 (SE = 0.02, 95% CI = 7.81-7.87) for the L-group ($F_{(1,822)} = 12.30$, $p < 0.001$).
In the cohorts of 2001 and 2002, the estimated mean grade is 8.00 (SE = 0.04, 95% CI = 7.93-8.07) in the S-group and 7.84 (SE = 0.02, 95% CI = 7.81-7.87) for the L-group ($F_{(1,414)} = 15.25$, $p < 0.001$).
S-group = selected students; L-group = lottery admitted students; SE = standard error; CI = confidence interval

DISCUSSION

In this study, we report the mean grades of selected (S-group) and lottery-admitted (L-group) students in the cohorts of 2001–2004 on the first five discipline-specific clerkships and in the 2001 and 2002 cohorts on all 10 discipline-specific clerkships. The S-group obtained a higher mean grade than the L-group on the first five as well as all 10 clerkships. The difference is small, yet significant, and reflects the fact that S-group students obtained mean grades of ≥ 8.0 1.5 times more often than L-group students. The mean grade on the first five clerkships of 443 recently graduated students (2001 and 2002 cohorts) showed a high correlation ($r = 0.89$) with the overall mean grade. These data suggest that our findings may be extrapolated to the overall clinical achievement of all students in the four cohorts of 2001–2004. This is an important finding because the literature reports correlations between selection methods such as the MCAT or pu-GPA and subsequent clinical performance as low and often not significant (Salvatori, 2001; White, Dey, et al., 2009).

In order to find out whether the observed difference in clinical achievement was related to selection before admission to medical school, pre-admission variables and selective steps after admission (but before the start of clerkships) were compared between the S- and L-groups. The early dropout rate in the S-group was significantly lower than in the L-group. In addition, although the overall risk for dropout declined, it remained twice as low in the S-group as in the L-group, representing a highly significant difference between both groups. The percentage of students who were still in the process of completing the pre-clinical 4-year phase of education after ≥ 5.5 years was small and did not differ significantly between the two groups. All students are expected to eventually complete the pre-clinical phase, as did all students in the cohorts of 2001 and 2002.

The percentage of students eligible to start the clerkships was higher in the S-group than in the L-group, mainly as a result of the difference in pre-clinical dropout rates. The difference was not significant. Similarly, the percentage of students who had completed five of 10 clerkships did not differ significantly between the two groups. However, the percentage of students who were eligible to begin clerkships but either stopped or started later and were therefore able to complete fewer than five clerkships before the qualifying date of 1 April 2010 was significantly higher in the S-group. University personnel records identified only those students who had completed the pre-clinical phase and started on a PhD programme or a different course of study at our university. This accounted for only 13 (3.3%) students in the S-group and 19 (2.0%) students in the L-group. Thirty of these had started on a PhD programme and two had embarked on an additional course of study; these numbers were roughly equally divided between the two groups. It was common for students to choose to postpone the start of the clerkships and related commitments to patient care in favour of other activities, such as travel abroad. However, we do not know whether the frequency of such non-study-related activities was higher among selected students than among lottery-admitted students. Nevertheless, it is highly probable that students who postponed the start of the clerkships had completed the pre-clinical phase in an optimal and nominal way.

Comparison of the pre-admission variables of gender, mean age and pu-GPA showed an increase in the percentage of women between the start of medical school and the completion of five or 10 clerkships. The increase was almost identical in both the S- and L-groups and indicated the positive selection of women during the pre-clinical phase. Mean age at the start of medical school remained the same during the period of study and indicated the absence of a relationship between this pre-admission variable and student achievement in the pre-clinical phase. Finally, pu-GPA in the S- and L-groups increased slightly during the period between the start and completion of clerkships, indicating the positive selection of students with a higher pu-GPA. More importantly, no significant difference in pu-GPA was observed between the S- and L-groups at any stage between the start of medical school and graduation after the completion of clerkships. Therefore, the observed difference in clinical achievement between the S- and L-groups appears to be related to the selection of students before admission.

The difference in mean grades on clerkships between the S- and L-groups is small because the distribution of grades was limited to four possibilities: 6.0, 7.0, 8.0 or 9.0. More than 70% of students obtained grades of 8.0 or 9.0. The difference in mean grades was caused by the fact that the probability of achieving a grade of ≥ 8.0 was 1.5 times greater for selected students than for lottery-admitted students. This is a significant and relevant difference.

Grades for clinical achievement in the four cohorts of 2001–2004 were based on subjective global performance ratings (GPRs) during the clerkships and a patient-related plus an oral examination at the end. The GPR represents a global rating awarded by a supervisor and covers the student's performance on a number of clinically relevant competencies over a certain period of time (Daelmans, van der Hem-Stokroos, et al., 2005). Recently, Wimmers, Kanter, et al. (2008) tried to establish which competencies were important for clerkship grading by administering a survey to clinical teachers at 17 teaching hospitals at which our students undertake their clerkships. The survey consisted of items on 21 different student characteristics, which clinical teachers were asked to rank in order of their importance to clerkship grading. Using structural equation modelling, a four-factor structure was found to define a competence profile for clerk- ship grading. The factors were 'cognitive abilities', 'patient workup', 'interpersonal skills' and 'professional qualities'. The first two factors were considered significantly more important by grading teachers than the other two, and indicated that grading was mainly determined by knowledge, the quality of the patient file and problem-solving abilities (Wimmers, Kanter, et al., 2008). Unfortunately, a more precise description of how much of the grading reflected pure cognitive or non-cognitive accomplishments cannot be given. This is an assessment method used not only in the Netherlands, but also worldwide (Kasselbaum & Eaglen, 1999) and, despite efforts to implement more modern forms of assessment, clinical examinations remain of questionable reliability and validity (van der Vleuten, 2000). It should be kept in mind that both groups sat the same examinations and supervisors had no knowledge of whether a student had been selected or lottery-admitted.

These data may be limited by the fact that not all eligible students in the four cohorts had completed the clinical phase. However, as the difference in mean clinical grade between the S- and L-groups was also found between the students in the cohorts of 2001 and 2002, most of whom had completed 10 clerkships, and as the mean grade on the first five clerkships was highly correlated (r = 0.89) to the mean grade on all 10 clerkships, the addition of more results will probably not change the outcome in any significant manner.

Another possible limitation is the subjective assessment method. Subjectivity is the main reason why the grades are abnormally distributed so that > 70% of students obtained grades in the highest categories of 8.0 and 9.0. Such grades are much higher than the pu-GPA (6.9) and the mean grade in the pre-clinical phase of training (6.1) achieved by the same cohort of students. The abnormal distribution limits distinction among the clinical competencies of the students and results in a small difference between the mean grades of the S- and L-groups. Both groups were subject to the same supervisors, global performance ratings and examinations. Supervisors and examiners were completely unaware of whether a student had been selected or lottery-admitted.

In conclusion, follow-up periods of 5.5–8.5 years of selected and lottery-admitted students in the cohorts of 2001–2004 revealed that selected students obtained a significantly higher mean grade on clerk- ships than lottery-admitted students. This difference in mean grade probably indicates differences in knowledge, quality of patient files and problem-solving abilities. The observed difference appears to relate to selection before admission. Reports on factors that have some predictive value for clinical achievement are rare (Donnon, Paolucci, et al., 2007; Meredith, Dunlap, et al., 1982; Reiter, Eva, et al., 2007). Our findings in the controlled setting of the national lottery system represent a strong stimulus for further research on other characteristics, which may select students with specific clinical competencies. However, such an effort is only worthwhile if such competencies are valued, taught and measured in medical school. For such research, we must first investigate the existence of any cause–effect relationship among our selection methods.

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CHAPTER 4

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

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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) (Julie, 2007; Parry, Mathers, et al., 2006). Recent reviews of the literature by Salvatori (2001), McGaghie (2002) and Siu & 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 (Julian, 2005; Wiley & Koenig, 1996). However, it is more difficult to predict future clinical performance during clerkships (Basco Jr., Gilbert, et al., 2000; Hamdy, Prasad, et al., 2006). Given an explained variance of <10%, the relationship between uGPA and performance during clerkships is much weaker (Baars, Wimmers, et al., 2009; Peat, Woodburry, et al., 1982; Veloski, Callahan, et al., 2000). Similarly, the MCAT has a moderate to low predictive value for clerkships, with an explained variance in clinical performance of ~15% (Donnon, Paolucci, 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 skills, communication skills, ethical reasoning and interpersonal skills (Kulatunga-Moruzi & Norman, 2002; Patterson & Ferguson, 2010; Prideaux, Roberts, et al., 2011; Siu & Reiter, 2009). 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 (Albenese, Snow, et al., 2003; Salvatori, 2001). More promising are the results of the multiple mini-interview (MMI) (Reiter, Eva, 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, Reiter, 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%), which presents the unique opportunity to compare the results of randomly admitted and selected students. In a previous study, we have reported a

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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, Stijnen, et al., 2009) and that selected students had a significantly higher mean grade on their first five clerkships (Urlings-Strop, Themmen, et al., 2011).

The successive use of non-academic and academic measures within this experiment creates the opportunity 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 ≥ 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, Stijnen, 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

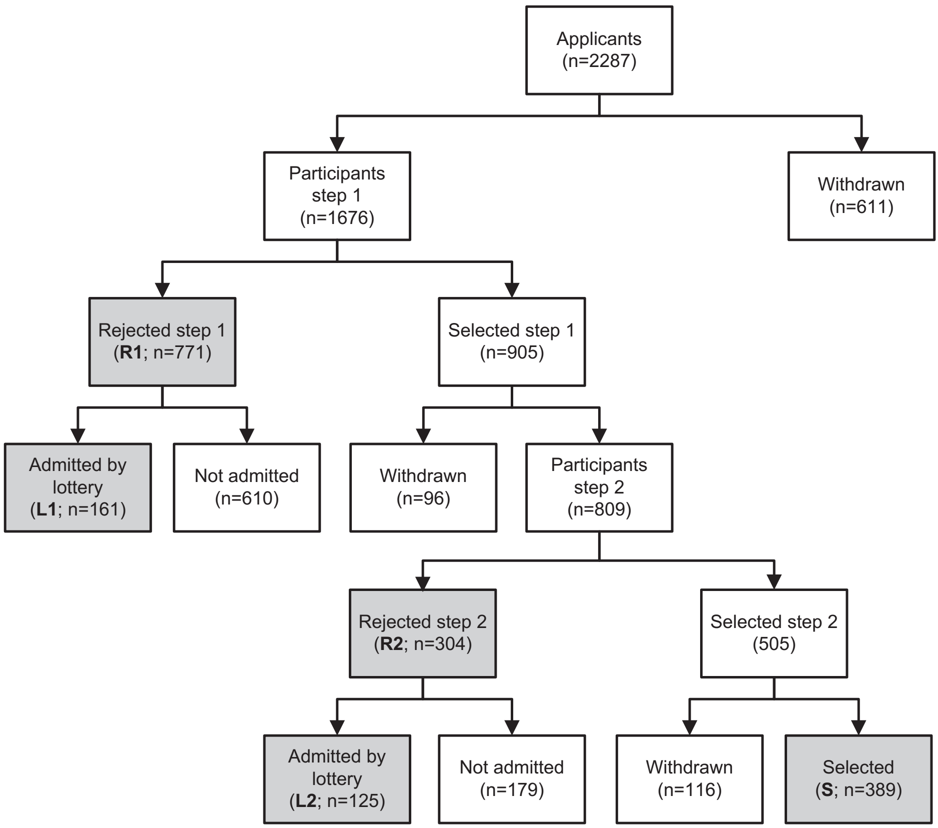

Figure 1 – Quantitative aspects of the selection procedure

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 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)

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)		
Selected step 2	↔	Non-participants + rejected step 1 and rejected 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

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, Themmen, 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.

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 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.

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

	Female %	Mean age at start (SE)		Mean Z-score of pu-GPA (SE)	
Application					
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

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 form performance of L_1-group and L_2-group, respectively

† Performance of R_2-group is estimated from performance of L_2-group

This resulting difference of 5.2% was significant (adjusted $F_{(1,1326)} = 5.94$, $p < 0.05$, 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) (adjusted $F_{(1,827)} = 13.57$, $p < 0.001$, 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).

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 enrol 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 extra- curricular activities and study behaviour (Hulsman, van der Ende, et al., 2007). Nonis & 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, Wallstedt, et al., 2011) 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, Wallstedt, et al., 2011). 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, Hartvigsen, et al., 2011).

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 (Eva, Reiter, et al., 2009; Reiter, Eva, et al., 2007) 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 & 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, Kanter, 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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CHAPTER 5

The relationship between extracurricular activities assessed during selection and during medical school and performance

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ABSTRACT

Several medical schools include candidates' extracurricular activities in their selection procedure, with promising results regarding their predictive value for achievement during the clinical years of medical school. This study aims to reveal whether the better achievement in clinical training of students selected on the basis of their extracurricular activities could be explained by persistent participation in extracurricular activities during medical school (msECAs). Lottery-admitted and selected student admission groups were compared on their participation in three types of msECAs: (1) research master, (2) important board positions or (3) additional degree programme. Logistic regression was used to measure the effect of admission group on participation in any msECA, adjusted for pre-university GPA. Two-way ANCOVA was used to examine the inter-relationships between admission group, participation in msECAs and clerkship grade, with pre-university GPA as covariate. Significantly more selected students compared to lottery-admitted students participated in any msECA. Participation in msECAs was associated with a higher pre-university GPA for lottery-admitted students only, whereas participation in msECAs was associated with higher clerkship grades for selected students only. These results suggest that persistent participation in extracurricular activities of selected students favours better clinical achievement, supporting the inclusion of ECAs in the selection procedure. More insight in the rationale behind participation in extracurricular activities during medical school may explain differences found between lottery-admitted and selected students.

INTRODUCTION

Places in medical school are scarce and medical education and training are expensive for providers and learners. Therefore, medical schools aim to offer the places available only to those applicants with the highest probability of successful medical training and subsequent career. To reach this goal, medical schools have developed several selection procedures, including interviews, admission tests and other measures of personal competencies (Kreiter & Axelson, 2013), although the evidence that these procedures indeed do deliver better achieving students (Salvatori, 2001; Siu & Reiter, 2009), let alone better professional doctors (Papadakis, Teherani, et al., 2005) is limited. Whereas traditionally the focus in selection has been on academic indicators, there is increasingly more attention for non-academic attributes that are considered important for success in clinical practice (Patterson, Knight, et al., 2016). As with all selection tools, it is critical to explore the reliability and validity of approaches to selecting for non-academic, or personal qualities.

A parameter frequently used in student selection procedures is prior academic attainment, such as the grade point average for the final undergraduate examinations (uGPA). uGPA shows a strong relationship with student achievement in medical school (Siu & Reiter, 2009) but explains just 16–25% of the variance in pre-clinical achievement (Salvatori, 2001) and less than 10% in clinical achievement (Benbassat & Baumal, 2007; Veloski, Callahan, et al., 2000). This decrease in predictive value of prior academic attainment by increasing time from medical school admission has also been shown for schools with undergraduate entry in the Netherlands and Germany (Stegers-Jager, Themmen, et al., 2015; Trost, Nauels, et al., 1998). Additionally, setting high academic grades as a threshold for entering medicine has an adverse impact for non-traditional applicants including those from minority or lower social-economic backgrounds (Cleland, Dowell, et al., 2012).

It has been shown that certain characteristics, such as ability, motivation, ambition and conscientiousness, have, at the very least, a moderately positive bearing on student performance (Ferguson, James, et al., 2003; Lievens, Coetsier, et al., 2002). The Multiple Mini Interview as well as Situational Judgement Tests, more recently developed to embed non-academic skills into the selection procedure, showed favourable results even for clinical performance (Lievens, 2013; Pau, Jeevaratnam, et al., 2013), although it is not easy to validate the use of such tests for selection purposes due to the absence of control groups (Kulatunga-Moruzi & Norman, 2002). Thus, performance in medical school appears to be multifactorial with intellectual ability as well as personality and motivation playing an important role (Collins, White, et al., 1995), resulting in two types of predictors; academic predictors with prior academic attainment as their best representative, and non-academic predictors which remain a less well explored area.

An alternative way of operationalizing non-academic skills is examining applicants' extracurricular activities during pre-university education (puECAs) (O'Neill, Hartvigsen, et al., 2011; Schripsema, van Trigt, et al., 2014; Urlings-Strop, Stegers-Jager, et al., 2013). An advantage of this method is that it is not based on a 'single' test administration but that it reflects a student's development over the last couple of years, hence increasing its authenticity. (Astin, 1999 (originally published 1984)) proposed an involvement theory where involvement was defined as active participation in all kinds of (extra)curricular and social activities. Highly involved students had a lower risk to drop out (Astin, 1975). Pike (2000) reported that involvement in a variety of curricular and co- curricular activities was directly related to growth in general abilities. Huang & Chang (2004) found that improvements of academic, communication and interpersonal skills were associated with intra- and extracurricular involvement. Using puECAs for selection to medical school showed encouraging results in preventing dropout (O'Neill, Hartvigsen, et al., 2011; Urlings-Strop, Stijnen, et al., 2009), and predicting pre-clinical (Schripsema, van Trigt, et al., 2014) (Schripsema et al. 2014) and clinical achievement (Urlings-Strop, Stegers-Jager, et al., 2013; Urlings-Strop, Themmen, et al., 2011). This latter finding raised the question why students selected on the basis of their participation in extracurricular activities during pre-university education receive higher grades in clinical training.

In the Netherlands students for medical school are in part admitted by lottery and in part selected by a medical school-specific selection procedure (Ten Cate, 2007). This situation presents a unique control group of randomly (lottery-) admitted students compared with those selected by a school-specific procedure which at our medical school combined non- academic (puECAs) and academic (cognitive tests) criteria (Urlings-Strop, Stijnen, et al., 2009). We hypothesized that selected students who had completed their pre-university education with the same GPA as their lottery admitted controls but had shown the ambition and ability to participate in pre-university extracurricular activities, use this same ambition and ability to continue performing extracurricular activities at medical school. The aim of the current study is to examine whether students who were selected on the basis of their puECAs persisted in their ECAs during medical school (msECAs) and whether this persistent participation in msECAs explains their better achievement in the clinical years of medical school. If so, this would further support the choice of using puECAs as a non-academic selection tool in medical school selection procedures.

METHODS

Selection procedure

Since 2000, there have been three ways to gain admittance to medical school in the Netherlands: a school-specific selection procedure (S); the national lottery system (L), and direct access for students with a pu-GPA above 8.0 (D). This D-group was excluded from the analyses. The local selection procedure at Erasmus MC Medical School consists of two steps. In the first step, applicants are assessed according to the quality and quantity of extracurricular activities before application in one or more of the following five categories: (1) activities in health care, (2) activities in management and organisation, (3) activities related to the development of a (individual) talent e.g. for music, sport or science; (4) (extracurricular) academic education; and (5) additional subjects during pre-university education. In the second, academic step, applicants take five tests on a medical subject preceded by informative classes. These locally developed tests focus on the subjects' logical reasoning, scientific thinking, epidemiology and pathology, anatomy and mathematics. Applicants who are ranked above the mean in the first step of selection are invited to proceed to the second step. In the second step applicants need to pass four of the five tests and to achieve an average score across the five tests of ≥ 5.5 (on a 10-point scale, 1 = poor, 10 = excellent). When the target number of students to be selected is not met, more students are admitted through the lottery system. A more extensive description of the selection procedure has been provided previously (Urlings-Strop, Stijnen, et al., 2009).

Curriculum

The undergraduate medical curriculum at Erasmus MC Medical School has been described previously (Urlings-Strop, Themmen, et al., 2011). The medical curriculum at the time of the study consisted of a 4-year pre-clinical phase followed by a 2-year clinical phase. The clinical phase consisted of a period of 15 weeks of general clinical training and 69 weeks of discipline-specific clerkships comprising 10 different rotations. At the end of each clerk- ship, the student's performance was assessed using a combination of patient-related assessment and oral examination and rewarded with a grade between 5 (unsatisfactory) and 10 (excellent).

Variables

Participation in msECAs

A first outcome measure of this study was participation in extracurricular activities during medical school (msECAs). Three types of extracurricular activities were considered: (1) completing a research master program, (2) conducting important administrative or organisational functions at Erasmus MC Medical School and (3) enrolling in an additional degree course at Erasmus University Rotterdam. All students were allowed to participate in one or more of these types of extracurricular activities, although entry criteria applied (e.g. for the research masters, see below) and in some cases places were limited (e.g. for the board positions). These three types of msECAs were chosen as they could reliably be measured and required a substantial time investment of the students.

Research masters – Erasmus MC Medical School offers motivated and talented students a scholarship for one of the four officially accredited Research Master programmes: clinical epidemiology, neuroscience, molecular medicine and clinical research. The requirement for enrolling the programme is obtaining the 60 credits of the first year at the end of that year. The study load of these programmes is 120 credits for two years, running parallel to the regular medical curriculum.

Board positions – Students can apply for a position in the board of the medical student union, membership of the curriculum committee, membership of the faculty council, and membership of the university council. Students fulfil a position in one of these participatory decision-making committees mostly for the duration of one academic year, although in some cases for two or more years. They can fulfil these positions during the second through fourth year of the pre-clinical curriculum.

Additional degree – Some students choose to enrol in an additional fulltime degree course at Erasmus University Rotterdam such as law or philosophy, running parallel to the medical curriculum and lasting four years with a study load of 60 credits per year. All students are allowed to apply for an additional course at any time during the pre-clinical curriculum.

Participation in at least one of these three types of msECAs was coded as yes on this dichotomous variable.

Clerkship GPA

A second outcome measure of this study was clerkship GPA. Clerkship GPA was calculated as the mean of the grades obtained on the 10 discipline specific clerkships. Grades were given on a 10-point scale (1 = poor, 10 = excellent) and 5.5 was the cut-off pass/fail mark.

Pre-university GPA

As pre-university GPA (pu-GPA) is known to be associated with performance at medical school, it was included in the analyses as a confounder/covariate. Pre-university GPA represents a students' mean grade obtained during the final year of pre-university education. Final grades in the Netherlands are based on school examinations (50%) and the national examination (50%). Within each cohort, pu-GPAs were translated into Z-scores in order to diminish cohort differences.

Participants and procedure

During the four years of the experiment (2001–2004), 389 students were selected (S-group) and 938 students were admitted by lottery (L-group). Of the S-group and L-group, 338 (86.9%) and 755 (80.5%) were eligible to start clerkships respectively (Urlings-Strop, Themmen, et al., 2011). Follow-up for all students was at least 5.5 years allowing sufficient opportunity to take part in any of the msECAs. Over the years 2001 through 2009, we collected information about student participation in one of the three classes of msECAs. Information about participation in a Research Master programme or an additional degree course was derived from the Erasmus University Rotterdam student administration systems. Proof of membership of the students' union and curriculum committee was obtained through the Erasmus MC annual reports, members of the university council through the Erasmus University Rotterdam annual reports and members of the board of the student fraternity from their yearbooks.

Students' grades were obtained from the university administration system and delivered anonymously to the investigators. Participants in this study did not suffer any adverse consequences of being a subject in this study. According to Dutch law, this study was exempt from ethical approval requirements.

Statistical analysis

First, we assessed associations between admission group and participation in any and in specific types of msECAs using Chi squared tests. To reveal whether the kind of puECA of the S-group was associated with participation in msECAs, we evaluated the participation in msECAs for each puECA-category used in the selection procedure separately.

A P value of < 0.05 was considered statistically significant. Effect sizes (ES) were calculated directly from Chi squared tests with ES ≈ 0.10 indicating a small effect, ES ≈ 0.30 a medium effect, and ES ≈ 0.50 a large effect (Hojat & Xu, 2004).

Second, we used logistic regression to calculate an odds ratio (OR) for the effect of admission group on participation in msECA, adjusted for pu-GPA. To assess whether pu-GPA had the same association with participation in msECA for selected and lottery admitted students, the interaction term 'admission group' x 'pu-GPA' was included in the model that also included admission group and pu-GPA as main effects.

Third, to examine the inter-relationships between admission group, participation in msECAs and clerkship grade we used a two-way analysis of covariance (ANCOVA) with admission group and participation in msECAs as independent variables and pu-GPA as covariate. Simple effects analysis was used to study the effect of participation in msECA for each of the two admission groups. Again, a *p*-value of < 0.05 was considered significant. In addition, effect sizes, partial eta squared ($\eta 2$), were obtained with values of 0.01, 0.06 and 0.14 indicating small, medium or large effects, respectively (Cohen, 1988).

Analyses were performed using IBM SPSS Statistics for Windows Version 21.0.

RESULTS

On the qualifying date (1 January 2015), 1087 (99.6%) of the 1093 eligible students from cohorts 2001–2004 had completed all ten discipline-specific clerkships. Overall, 174 (16.0%) of these students participated in one of the three defined types of msECAs (Table 1). This percentage was almost twice as high for the S-group (23.7%) compared to the L-group (13.0%). S-group students in particular more often completed a Research Master or fulfilled a board position. For students in the S-group participation in msECA was not associated with a particular puECA category (Table 2).

Table 1 – *Students participation in extracurricular activities (msECAs) per admission group*

	N	msECA		Research Master		Board position		Additional course	
		n	**(%)**	***n***	**(%)**	***n***	**(%)**	***n***	**(%)**
S-group	338	80	(23.7)	60	(17.8)	18	(5.3)	4	(1.2)
L-group	749	94	(13.0)	73	(9.7)	14	(1.9)	14	(1.9)
Total	1087	174	(16.0)	133	(12.2)	32	(2.9)	18	(1.7)
Test value (χ^2)			21.41		13.90		9.74		0.67
p value			<0.0001		<0.001		0.002		NS
ES			0.14		0.11		0.09		

S-group = selected students; L-group = lottery admitted students; msECA = extracurricular activities performed during medical school.

Table 2 – *Pre-admission ECA (puECA) category and participation in ECAs at medical school (msECA) of the S-group students*

puECA category	Performed msECA *n*	(%)
Working experience in health care	6	(35.3)
Management/organisational function	15	(25.0)
Development of talent	16	(25.4)
(Extracurricular) academic education	13	(27.7)
Extra subject at pre-university education	30	(20.4)
Total	80	(23.7)

ECA = extracurricular activities performed during pre-university education (puECA) or during medical school (msECA).

Both admission group and pu-GPA were significant predictors of participation in msECAs (Table 3). However, we found a statistically significant differential effect of admission group by pu-GPA (Table 3, Figure 1). The effect of pu-GPA on participation in msECA was prominent for L-group students but absent for S-group students. Specifically, with a pu-GPA below 1.0 (z-score) L-group students were much less likely to participate in msECAs than students in the S-group with a similar pu-GPA. Although the interaction effect suggests that with a high pu-GPA (z > 1.0) the L-group students were more likely to participate in msECAs than the S-group students with a similar GPA (Figure 1), additional analyses revealed that for the relatively small number of students with a high pu-GPA (*n* = 125; 12.1%) there was no statistically significant difference in participation rate between S-group and L-group students ($\chi^2_{(1)} = 0.123$, $p = 0.73$).

Table 3 – *Multiple Logistic Regression Model – Predictors of participation in msECAs*

Independent variable*		*n*	OR	95% CI	*p* value
Admission group	Selected	326	2.71	1.87–3.93	<0.001
	Lottery	709	1.00†		
pu-GPA	Continuous	1035	2.69	1.99–3.62	<0.001
Admission group x pu-GPA			.361	0.23–0.56	<0.001

msECA = extracurricular activities performed during medical school; pu = pre-university; GPA = grade point average; OR = Odds Ratio; CI = confidence interval
* Model Chi-square = 68.553, $p < 0.001$, Nagelkerke $R^2 = 0.11$
† Reference group

The two-way ANCOVA regarding differences in the effect of participation in msECAs on clerkship GPA for students in the S-group and the L-group showed significant main effects of both participation in msECAs ($F_{(1, 1030)} = 9.88$, $p < 0.01$, partial $\eta^2 = 0.009$) and admission group ($F_{(1,1030)} = 20.72$, $p < 0.001$, partial $\eta^2 = 0.020$). The

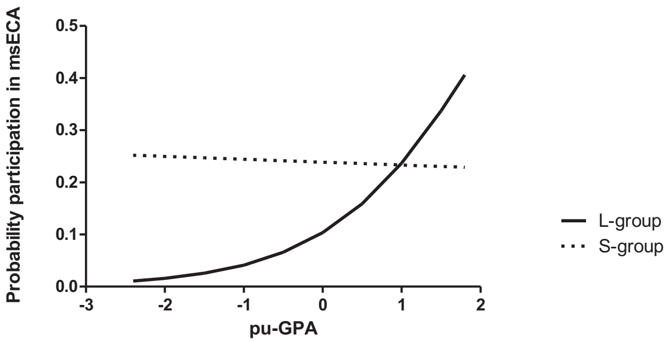

Figure 1 – Interaction effect between pu-GPA and admission group on the probability of participation in msECA.
S-group = selected students; L-group = lottery-admitted students; pu-GPA = pre-university grade point average; msECA = extracurricular activities performed during medical school

msECA participants had higher grades than non-participants and selected students had higher grades than lottery-admitted students. However, there also was a significant interaction effect between participation in msECAs and admission group ($F_{(1,1030)}$ = 8.50, p < 0.01, partial η^2 = 0.008), indicating that participation in msECAs has a different association with clerkship GPA for selected than for lottery-admitted students. Specifically, S-group students that participated in msECAs had significantly higher clerkship grades than S-group non-participants, while this difference did not exist among L-group students (see Table 4 and Figure 2).

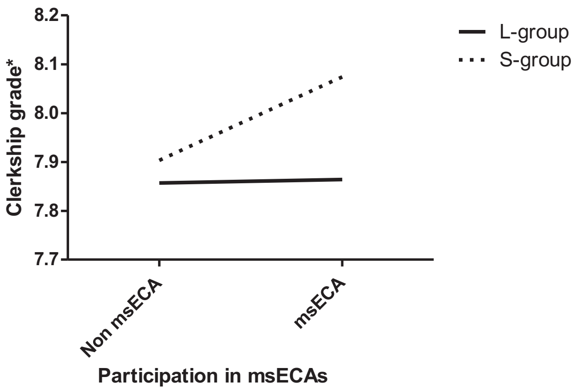

Figure 2 – Interaction effect between participation in msECA and admission group on clerkship grade.
S-group = selected students; L-group = lottery admitted students; msECA = extracurricular activities performed during medical school.
* Estimated marginal means of clerkship grade, covariate evaluated at the value pre-university GPA= -0.07 (mean)

Table 4 – *Clerkship GPA by admission group and participation in msECA*

	Clerkship GPA (SE)				Statistics msECA vs non msECA	
	msECA		**Non msECA**		***F***	***p* value**
Admission Group						
S-group	8.07*	(0.036)	7.90*	(0.020)	16.58	<0.001
L-group	7.86*	(0.035)	7.86*	(0.013)	0.03	NS

GPA = grade point average; SE = standard error; S-group = selected students; L-group = lottery-admitted students; msECA = extracurricular activities performed during medical school
* Covariate evaluated at the value pre-university GPA = -0.07 (mean)

DISCUSSION

This study indicates that persistent activities of students selected on extracurricular activities explain their better achievement during the clinical years of medical school. Selected students not only participate more often in extracurricular activities during medical school than lottery-admitted students, their participation is also not associated with their pu-GPA, whereas lottery-admitted students tend to only participate if they have a high pu-GPA. Finally, participation in extracurricular activities is associated with higher clerkship grades for selected students but not for lottery-admitted students.

The finding that students selected on extracurricular activities before medical school participated more often in extracurricular activities during medical school than their lottery-admitted comparisons was according to our expectations based on the principle of behaviour consistency: the best predictor of future behaviour is past behaviour in similar situations (Ouellette & Wood, 1998; Stegers-Jager, Themmen, et al., 2015). However, to our knowledge this is the first study to report on the persistence of extracurricular activities after admission despite the fact that several medical schools have used extracurricular activities as a selection criterion (O'Neill, Hartvigsen, et al., 2011; Schripsema, van Trigt, et al., 2014; Urlings-Strop, Stijnen, et al., 2009). Interestingly, participation in extracurricular activities during medical school was not associated with the type of extracurricular activities employed before medical school. Apparently, it is rather the intention or ambition to perform extracurricular activities in general than a specific type of extracurricular experience that influences the decision to participate in extracurricular activities at medical school (Huang & Chang, 2004).

One of the most striking outcomes is that for selected students the decision to participate in extracurricular activities during medical school does not depend on their pu-GPA whereas it does for lottery-admitted students, despite the absence of differences in pu-GPA or pre-clinical achievement between the two admission groups (Urlings-Strop, Stijnen, et al., 2009; Urlings-Strop, Themmen, et al., 2011). A possible explanation, as suggested previously by Schripsema, van Trigt, et al. (2015), is that the selected students have better time management skills than lottery-admitted students with similar pre-university GPAs. These skills not only enable them to participate in the time-consuming selection procedure during their pre-university examinations, but also to participate in extracurricular activities during medical school. Another possible explanation has to do with students' self-efficacy, i.e., their belief in their ability to succeed in specific situations. As the most powerful source of self-efficacy beliefs is past performance (Bandura, 1997), it can be expected that students who were able to participate in extracurricular activities next to their pre-university education are more confident that they will be able to do so successfully during medical education than students who did not have this positive past experience.

Another striking finding is that participation in extracurricular activities is associated with higher clerkship grades, but only for selected students. Lottery-admitted students do not seem to benefit from their participation in extracurricular activities, at least not with respect to their clerkship grades. A first possible explanation is that the rationale for participation in extracurricular activities is different for selected than for lottery-admitted students. A theory that appears promising in explaining voluntary participation is Higgins' regulatory focus theory (Higgins, 1997; Higgins, 1998). Following this theory, it might be that S-group students participate in extracurricular activities because they 'want to' (promotion focus), while L-group students participate because they feel they 'have to' (prevention focus). This might have been particularly so in the first years of our selection procedure when applicants were less aware of the requirements for admission. As described by Lucieer, Stegers-Jager, et al. (2016) it might be that in more recent years—since the requirements for admission have become more transparent—applicants invest time in extracurricular activities just because they want to enter medical school. Possible differences in regulatory focus between lottery-admitted and selected students and their relationship with clerkship grades may be an interesting area for further research.

As we have suggested previously, participation in extracurricular activities may favour the development of relevant non-academic qualities and skills that will contribute to better clinical performance (Urlings-Strop, Stegers-Jager, et al., 2013). Indeed, another medical school that included puECAs in their procedure concluded that selected students had better skills in terms of collaboration, communication, reflection, ethical decision making and professional behaviour during the first three years of medical school (Schripsema, van Trigt, et al., 2014). These competencies in particular were rated important for the clerkship years by clerkship directors (Windish, Paulman, et al., 2004).

The observation that lottery-admitted students do not improve their clinical achievement after participating in msECAs suggests that early or long-term, persistent participation is required to acquire competencies that are multi-usable in other settings (Huang & Chang, 2004). Selected students and lottery-admitted students who participate in extracurricular activities during medical school may be different types of students. It might be that selected students always (both before and after admission) look for additional activities, irrespective of their pu-GPA, whereas only the lottery-admitted students with higher pu-GPA—with probably also better pre-clinical achievement (Benbassat & Baumal, 2007)—participate in msECAs. Apparently, the personality types represented by the selected students are rated more favourably in the subjective grading in clinical training (Kasselbaum & Eaglen, 1999). It might be interesting to explore in further studies whether selected students score higher on personality traits such as extraversion and agreeableness that may be beneficial for their future professional practice (Lievens, Coetsier, et al., 2002) and as such might also be rated higher by clinical examiners.

The strengths of this study are its large sample size and the long-term follow-up. In addition, the availability of the lottery-admitted students gave us the unique opportunity to compare the participation in msECAs and its relationship with clinical achievement for students selected on puECAs with those of randomly admitted students. This enabled us to note the differential effect of pu-GPA on participation in msECA for lottery-admitted and selected students and the differential effect of participation in msECA on clinical achievement.

This study also has some limitations. The number and diversity of msECAs was limited to those that could be reliably measured, i.e. accredited research masters, official board functions and/or an additional degree course and are therefore probably underestimated. Furthermore, time-consuming msECAs were chosen on purpose, since one of the requirements at the selection of medical students was a minimum number of 4 h per week during at least 2 years spent in participation in puECAs before medical school. Only students that passed the first year successfully could apply for a research master, although grades were not a selection criterion for these masters. Additionally, no data was available about participation in puECAs of the lottery-admitted students. However, as we were still able to compare the msECAs for both admission groups, this absence will probably not affect the conclusions of our study. Finally, this study was performed in one medical school. Further replication studies are required to establish whether our results can be generalised to other populations.

The present study has some practical implications for medical school selection procedures. A first implication for medical schools is to include the assessment of puECAs in the selection procedure, since these may predict participation in msECAs in turn leading to better clinical achievement. Apparently using puECAs enables medical schools to attract and select students who are willing and able to continue performing extracurricular activities, and consequently also have a higher chance of better clinical grades. The fact that for selected students participation in msECAs was not related to their pu-GPA suggest that using puECAs in selection enables medical schools to identify those applicants with a lower pu-GPA who have a high chance of good clinical achievement. In other words, the use of puECAs as a selection criterion seems to have additional value to the use of pu- GPA. As an added benefit—contrary to our expectations and those of others—selection on puECAs has recently been shown not to disadvantage non-traditional applicants from minority or lower social-economic backgrounds (Stegers-Jager, Steyerberg, et al., 2015), whereas selection on pu-GPA does (Cleland, Dowell, et al., 2012). However, it might still be that self- selection instigated by the use of puECAs as a criterion in the selection procedure is stronger for non-traditional applicants than for traditional applicants at other medical schools. Additionally, as suggested above, there is a risk that when requirements of puECA participation for admission become more transparent, applicants may choose to participate in puECAs because they feel they have to do so to have a chance to enter medical school, and not because they want to ((Lucieer, Stegers-Jager, et al., 2016) and Higgins' regulatory focus theory (Higgins, 1997; Higgins, 1998)). Therefore, it would be interesting to search for tools to assess the underlying student traits that lead to persistent msECAs associated with better clinical achievement.

A second practical implication of this study is that medical school should offer sufficient possibilities for extracurricular activities for students, since participation in msECAs may lead to better clinical achievement. Although it might be tempting to strongly stimulate participation of all students, it is — in view of the lack of an effect of msECA participation for lottery-admitted students — questionable whether this will lead to the desired results. As stated above, the effect of msECA participation on clinical achievement may depend on an underlying trait of the participating student, rather than being an effect of the participation itself.

In conclusion, the results of our study suggest that persistent participation in extracurricular activities endorsed better clinical achievement for selected students, supporting the inclusion of ECAs in the selection procedure. More insight in the rationale behind participation in extracurricular activities during medical school may explain differences found between lottery-admitted and selected students.

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CHAPTER 6

General discussion

GENERAL DISCUSSION

Selecting the doctors of the future – those possessing the capabilities and motivation to flourish both as a student and as a physician later on – is a continuous challenge. A variety of selection procedures have been applied ranging from (weighted) lottery to interviews to admission tests and other assessments of personal competencies (Kreiter & Axelson, 2013). Evidence that these procedures do indeed deliver better achieving students (Salvatori, 2001; Siu & Reiter, 2009), let alone better professional doctors (Papadakis, Teherani, et al., 2005) is limited. The introduction of medical school-specific procedures in addition to the national lottery system in the Netherlands created opportunities for experiments providing evidence-based conclusions and recommendations; a strategy also recommended by Cook, Bordage, et al. (2008). This thesis describes an experiment regarding selection of students hypothesizing that selection would identify students that will perform better than those who are randomly admitted. A two-step selection procedure was developed and used to select students, consisting of a non-academic (i.e. extracurricular activities) and an academic step (i.e. curriculum sample test and cognitive ability tests). Academic performance of selected students was compared with that of students admitted by lottery. The four studies in this thesis add to the existing literature by 1) comparing pre-clinical and clinical performance of selected versus lottery-admitted students (chapters 2 and 3), 2) determining the relative contribution of the non-academic and academic steps (chapter 4) and 3) exploring the relation between extracurricular activities assessed during selection and during medical school and performance (chapter 5).

MAIN FINDINGS

Our main findings are that students selected by the two-step selection procedure had a significantly lower risk for dropping out of medical school compared to controls admitted by lottery. Additionally, those selected obtained a higher mean grade than the lottery admitted students in their clinical years. Noticeable is the absence of difference in pre-university Grade Point Average between both groups. Thus, the observed difference in clinical achievement between the selected and lottery admitted groups seems not to be related to achievement during pre-university education. Instead the selection procedure seems to sort out those that have the capability to perform better during the important clinical stage of medical school. The study on the relative contribution of each of the two steps to the differences observed in student performance revealed that the significantly higher clinical grades were attributable to participation in extracurricular activities before admission to medical school. The observed difference in dropout rate partly already existed before the start of the selection procedure, probably due to some kind of self-selection by those who, after they requested it, not returned the application form. And partly could be attributed to selection of participants based on academic criteria that made up the second selection step. The fourth study suggested that persistent activities during medical school of students selected on extracurricular activities explain their better achievements in the clinical phase.

In this chapter, these main findings will be evaluated by discussing the two conceptual frameworks underpinning the two-step selection experiment, i.e. extracurricular activities and the curriculum sample test. Because several years have passed since we initially developed our selection procedure, some thoughts about the changing medical school selection environment over the years are also appropriate.

EXTRACURRICULAR ACTIVITIES

The selection procedure we developed assessed extracurricular activities performed in the last three years of pre-university education. Assessing extracurricular activities is neither new nor specific for the medical field. Job application forms used in personnel selection use at least partly activities undertaken out of context of the job but relevant to the skills needed for the job. By assessing both the quality and the quantity of extracurricular activities performed over the preceding three years before application, we aimed to increase the authenticity of the admission procedure. Unlike the personal statement and single tests, which are more of a snapshot, long-term extracurricular activities reflect the applicant's development over several years. These activities were self-reported and guided by supporting documents by the applicants using a highly structured application form and thoroughly assessed using predefined guidelines.

Our hypothesis was that students, by participating in extracurricular activities, display greater ability, motivation or ambition to achieve than their peers, and subsequently perform better at medical school, and will continue to do so afterwards. One of the most remarkable results presented in this thesis (chapter 3) is that our selected students obtained higher grades in the clinical curriculum compared to their lottery admitted counterparts. Remarkable because the predictive value of selection tools decreases over time (Patterson, Knight, et al., 2016). This almost completely turned out to be an effect of the selection based on non-academic criteria and selected students' persistent extra-curricular activities in the years thereafter during medical school (chapter 5).

The use of extracurricular activities performed during pre-university education for selecting students for medical school showed encouraging results in preventing dropout (O'Neill, Hartvigsen, et al., 2011), and predicting pre-clinical (Schripsema, van Trigt, et al., 2014) and clinical achievement (chapter 3). Explaining why students selected on their participation in extracurricular activities during pre-university education receive higher clinical grades is challenging in view of the years that have elapsed between the pre-university extracurricular activities and the grades obtained in the clinical phase of medical school. Moreover, at first sight the content of both parameters appears to be quite different.

The answer lies perhaps in the fact that performing extracurricular activities in addition to regular schoolwork reveals character traits that students also need when dealing with the requirements of medical school. More specifically, when performing these activities, students probably learn the skills and enhance their non-academic qualities that have been shown to be necessary for clinical performance (chapter 2, 3, Wright & Tanner 2002). Schripsema, van Trigt, et al. (2014) also included pre-university extracurricular activities in their selection procedure and concluded that selected students had better skills in terms of collaboration, communication, reflection, ethical decision making and professional behaviour during the first three years of medical school. These competencies in particular were also rated important for the clerkship program by clerkship directors (Windish, Paulman, et al., 2004). Selection based on these, non-academic, competencies have been shown to predict performance outcomes during clerkships and on licensing examinations, for example by using the Multiple Mini Interview instrument, (Eva, Reiter, et al., 2009; Reiter, Eva, et al., 2007). It would, therefore, be of interest to further study the relationship between participation in extracurricular activities and the characteristics determined by MMIs.

The overlap between skills associated with extracurricular involvement and skills associated with higher clinical grades might be explained by the involvement theory from Astin (1999 (originally published 1984)). In this theory, involvement was defined as active participation in all kinds of (extra)curricular and social activities to which a highly involved student devotes considerable energy. The greater the student's involvement, the greater the students learning capacity and personal development will be. Pike (2000) reported that involvement in a variety of curricular and co-curricular activities was directly related to growth in general abilities such as communication skills, interpersonal skills and critical thinking. Also, conversely, improvements of academic, communication and interpersonal skills were associated with intra- and extracurricular involvement (Huang & Chang, 2004). Again, these interpersonal and communication skills were shown to correlate with success in the clinical setting (Haight, Chibnall, et al., 2012; Hojat, Erdmann, et al., 2013).

Remarkably, participation in extracurricular activities during medical school was associated with a higher pre-university GPA for lottery-admitted students only, whereas this was associated with higher clerkship grades for selected students only (chapter 5). These results indicate that persistent participation in extracurricular activities of selected students favours better clinical achievement. Ferguson, James, et al. (2003) also demonstrated that the amount of information given in a personal statement, mostly covering motivation and hobbies, was positively related to clinical performance. The observation that lottery-admitted students do not improve their clinical achievement after participating in extracurricular activities during medical school suggests that early or long-term, persistent participation is required to acquire competencies that are multi-usable in other settings (Huang & Chang, 2004). Alternatively, selected students and lottery-admitted students who participate in extracurricular activities during medical school may be different types of students: selected students always (both before and after admission) look for additional activities, irrespective of their pu-GPA, whereas only the lottery-admitted students with higher pu-GPA – with probably also better pre-clinical achievement – participate in extracurricular activities at medical school. Apparently, the personality types represented by the selected students are rated more favourably in the subjective grading in clinical training (Kasselbaum & Eaglen, 1999). Further research could be directed at which non-academic qualities and skills clerkship assessors consider important for clerkship grading and use in the evaluation of students. Once established, the challenge is then to translate these qualities and skills to more generalized traits that could be used in selection procedures.

In conclusion, the use of extracurricular activities in the selection for medical school as an operationalization of non-academic skills is at least profitable in terms of clinical performance, although the underlying comprehensive traits still need to be elucidated. The next step is to examine whether those selected are indeed better doctors. In addition, according to the involvement theory, it may be interesting to investigate whether tempting those students that would otherwise not benefit (i.e. those with lower grades and not used to participate in this kind of activities) to participate in extracurricular activities would also lead to better performance in clinical skills.

CURRICULUM SAMPLE TEST

Those students selected in the first selection step – appraised on quality and quantity of the extracurricular activities performed – were allowed to join a three-day class at the university including tests. This second selection step was designed as a curriculum sample in a medical school context. To prepare for this curriculum sample, applicants were provided with a reader about the medical topic chosen for that sample (e.g., HIV or diabetes). Over three consecutive days they attended lectures and took five tests on subjects related to the topic. The tests were developed by 1st year medical school faculty and focused on logical reasoning, scientific thinking, epidemiology and pathology, anatomy and philosophy – all subjects that are frequently addressed in the medical curriculum. We showed that, using the above described curriculum sample (or 'work sample'), the lower dropout rate of selected students was clearly associated with passing this step of the selection procedure, irrespective of pre-university GPA (chapter 5).

Studies in the personnel selection domain have also shown that selection based on the candidates' prior accomplishments and achievements is positively correlated to job performance. To illustrate, Hough (1984) reported that government attorneys wanted to be selected and promoted on the basis of their record, their prior accomplishments, and achievements. The author found that the accomplishment record was not related to the traditional psychological measures but did correlate with job performance. Thus, these findings suggest what psychologists have long advocated, i.e. the best indicator of future performance is past performance, thereby backing the behavioural-consistency model described by Wernimont & Campbell (1968). This model has in later years been translated into a work sample tests (e.g. (Callinan & Robertson, 2000; Hunter & Hunter, 1984; Schmidt & Hunter, 1998). A work sample test is used to assess an applicant's ability and skills required for a specific job and is often used as a tool in employee selection. The content of a work sample should be closely related to the content of the required work-related competencies. This can be achieved by focusing on behavioural indicators that are identified with and required for a successful overall job performance (Callinan & Robertson, 2000; Ployhart, 2006). These kinds of tests are traditionally thought to be among the most valid predictors of job performance (Schmidt & Hunter, 1998). Roth, Bobko, et al. (2005) in their review and meta-analysis tempered this conclusion a little bit. They found the correlation of work sample testing and later measures of job performance to be .32, which is lower than the value of .54 found in an earlier, often cited, meta-analysis by Hunter & Hunter (1984). This is due mainly to the exclusion of studies with small sample sizes, adding studies from later years – since earlier studies found higher correlations – and leaving out studies with methodological problems.

Recently, De Visser, Fluit, et al. (2017) employed a curriculum sample in their selection of medical school students. They set up an online course and exam, both mimicking the course and examinations of the medical school curriculum as closely as possible. Selected students both significantly dropped out less often and more often obtained the obligatory credits necessary to start the second year (De Visser, Fluit, et al., 2017). These results were irrespective of pre-university GPA, similarly to the results concerning dropout reported in this thesis. The curriculum sample test is not solely used for selection by medical schools. For example, Visser, Van der Maas, et al. (2012) used a curriculum sample for selecting first year psychology students. Applicants followed a one-week course and studied a chapter of a first-year psychology course book. At the end of the week applicants took a test on the course. In line with the findings in this thesis, the authors concluded that selected students dropped out less often after correction for pre-university GPA. In addition, students selected using this curriculum sample test obtained higher grades in the first year and more often completed their bachelor's degree within four years. These results were attributed purely to this selection test (Visser, Van der Maas, et al., 2012). Lucieer, Stegers-Jager, et al. (2015) conducted an experiment using an adapted form, a sham procedure, of the selection procedure described in this thesis. Selecting all applicants of one cohort solely on the first, non-academic, step followed by the selection of the subsequent years' cohort exclusively on the second, academic, step allowed the comparison of the relative contribution of both phases. Their results show that indeed, the curriculum sample selection step contributed primarily to first year study success of selected students. After analysis of six consecutive cohorts Stegers-Jager, Themmen, et al. (2015) found that the most recent past performance – either before or during medical school – is the main predictor of future performance during pre-clinical training.

When designing a work sample as a selection tool, an important issue to consider is that it should be relevant to the specific role it is designed for (Meijer & Niessen, 2015; Patterson, Zibarras, et al., 2016). Or, more dedicated to medicine: select those students that fit the medical curriculum a specific school offers. Medical schools have different profiles, in the Netherlands some schools emphasize their specific educational principles (such as Maastricht University with its problem-based learning), others accentuate their research profile (Erasmus MC) or offer multiple (research) masters thereby widening the possibilities of medical students beyond the basic curriculum (Erasmus MC, Groningen University). If a medical school has designed the work sample to fit its specific profile, it is also necessary that the school publicly shares this specific profile to allow the selection of the 'the best performing' student, in the context of its specific curriculum. If the profile is not publicized the risk exists that 'right' candidates, i.e. those fitting the profile, do not even apply. A recent study on student approaches to medical school choice of Wouters, Croiset, Schripsema, et al. (2017) underlines the necessity of transparency of the medical school selection aims. They found that only 10% of the students choose a medical school based on its curriculum. Indeed, most candidates apply for a specific medical school because of the attractiveness of the city where it is located and the selection procedure it runs. The authors appeal to medical schools to provide proper information about their program in order to achieve the desired student-curriculum fit.

Summarizing, a selection procedure based on a curriculum sample test should create conformity between selection, curriculum and assessment (Meijer & Niessen, 2015; Ployhart, 2006) and should be perfectly aligned with the curriculum that is selected for as recommended by Prideaux, Roberts, et al. (2011). A point of debate and subject for further research on curriculum sample tests as selection tools for medical school is that social skills, integrity and ethics are not taken into account, whereas these are perceived as important traits for medical doctors (Patterson, Ferguson, et al., 2008). It can be concluded from this thesis as well as from the literature that a curriculum sample test has proven its value in selecting students with lower chances to drop out of medical school. Nonetheless, it should be stressed that these benefits depend on alignment of the curriculum sample to the medical school curriculum and on transparent communication about the goals of the selection procedure, allowing applicants to make an informed choice to which medical school to apply to.

CHANGING ENVIRONMENT

Several years have passed since we initially developed our selection procedure. During these years, we selected for intrinsic motivation, operationalized through motivated behaviour, i.e. extracurricular activities. Our choice to use these extracurricular activities has worked well since both a decrease in dropout and an increase in higher clinical grades was noted (chapter 3). There is a potential drawback by continuing the use of extracurricular activities. In the early years, the selection procedure and its requirements to take part were not yet widely known among applicants, although adequate need to know information was provided. Thus, applicants had not undertaken their extracurricular activities considering a possible future selection procedure, but because such activities were attractive to them. Over the years, this could have changed. Nowadays, applicants may choose a strategic approach and cherry pick only those activities that would help them to get into medical school. Because they feel they should, not because they want to, and this strategy potentially influences their motivation to perform (Lucieer, Stegers-Jager, et al., 2015). It may be that having and demonstrating this kind of extrinsic motivation instead of an intrinsic motivation, does not necessarily translate into having and demonstrating the capacity or the ability to develop the required qualities that are critical for higher performance in the clinical phase. This is elaborated in chapter 5 in which we considered it likely that this persistence or determination in pursuing these extracurricular activities - the intrinsic motivation - correlates positively with better clinical achievement for selected students.

Furthermore, it is not clear that an extrinsic motivation for extracurricular activities will lead to persistent activities during medical school. It might be that this behaviour is only exhibited for the explicit purpose of qualifying for entry into medical school. Further research to appropriately assess the influence of extrinsic motivation would be needed.

Additionally, commercial coaching agencies increasingly offer guidance to applicants in the form of preparation programs for the selection procedures. This recent development introduces a socio-economic dimension since these often quite expensive services are more available to those applicants who can afford it. These commercial coaching services are a new phenomenon in the Netherlands but are much more common in Anglo-Saxon countries such as Australia. In that country over half of the applicants was reported to use these commercial coaching services. However, this has not translated into a better performance in the selection tests, except for the non-verbal reasoning elements. (Griffin, Carless, et al., 2013; Griffin, Harding, et al., 2008). Thus, coaching does not have the intended effect because it cannot compensate for the absence of sustained practice, but non-verbal reasoning appears to be coachable and learnable through pattern recognitions (Griffin, Carless, et al., 2013). It also means that it is necessary to adapt the selection procedure in such a way to ensure that these kind of preparation programs pose as little unwanted influences as possible.

Coaching should not be confused with providing applicants with adequate information about the selection procedure, since the procedure also depends on applicants who know how they are selected and what they are selected for. It also provides applicants the opportunity to make a fair assessment if they qualify for the criteria, and finally it provides the selecting institution with selectable applicants – after all, you cannot select volleyball players for a game of basketball. Giving representative information to students about the selection procedure intents to improve the composition of the group of applicants (Benbassat & Baumal, 2007).

Currently, Erasmus MC is the only medical school in the Netherlands that organizes a dedicated instruction day for applicants. During this day applicants are all given the same information and details of the procedure. This results in a level playing field, for both the applicants as well as Erasmus MC, because applicants who realize at the end of the day that they do not qualify for the selection criteria are able to withdraw their application. This seems even more meaningful knowing that high school students know very little about how the selection procedure for medical school works (Wouters, Croiset, Isik, et al., 2017).

Another recent development is increased scrutiny of professional behaviour demonstrated by medical professionals. There have been various media reports of misconduct or unprofessional behaviour by doctors, and this has influenced the debate about selection in that it should not be limited to including the best performing students but also excluding those future doctors that, despite good academic performance, do not qualify when it comes to the high standards for non-academic personal qualities (Niessen & Meijer, 2016; Powis, 2015). The selection procedure should focus on both academic grades and personal qualities (Norman, 2004) but cannot be expected to, or guarantee, that applicants are excluded who would become doctors who will be mentioned in the headlines when it comes to misconduct or unprofessional behaviour. They can successfully complete a selection procedure and subsequent medical school while behaving unprofessionally at the same time, but most students that showed unprofessional behaviour did not have a disciplinary action throughout their career (Papadakis, Teherani, et al., 2005).

It remains challenging to definitively link the admission procedure to good clinical performance or at least to what patients perceive as good clinicians – the latter measured through patients' satisfaction surveys (Basco, Gilbert, et al., 2000). Even more challenging is objectively sorting out applicants who do not meet the personal qualities essential for good clinicians. Adding an element of professional integrity to the selection procedure can help, for example with an integrity-based Situational Judgment Test, for detecting these unwanted behavioural qualities (De Leng, Stegers-Jager, et al., 2017; Husbands, Rodgerson, et al., 2015). This could be subject of further research. As a way of last resort, Dutch law (Wet Versterking Besturing, 2010) provides the possibility of an iudicium abeundi; the examination committee can prevent a registration based on behaviour or statements of a student that makes him or her unsuitable for medical practice (Bonke & Van Luijk, 2010). Although theoretically promising, practically this procedure has proven to be rather problematic for example in having to establish an evidentiary file that is able to withstand judicial scrutiny – an applicant who has his or her registration ended has the right to appeal this decision.

LIMITATIONS OF SELECTION PROCEDURES

An often-heard critique when it comes to selection is the suggestion that it limits diversity at medical school (Cleland, Dowell, et al., 2012; Wouters, Croiset, Isik, et al., 2017). This is an important issue since (minority) patients feel best at ease with someone who shares the same background (Perloff, Bonder, et al., 2016). Additionally, when students have to deal with a more diverse student population during their studies, it is assumed to increase their understanding for these (minority) groups and later on for their patients (Cleland, Dowell, et al., 2012; Cohen-Schotanus, Muijtjens, et al., 2006). In an attempt to widen access to medical school for e.g. ethnic minorities and those from lower social economic status, various initiatives have been launched (Abbasi, 1998; James, Ferguson, et al., 2008; Johnsons, 1971). In the Netherlands this striving to equal access to all eligible for medical school was one of the reasons for introducing a lottery system for entrance to medical school (chapter 1). The lottery was anonymous and based on grades only, so it was assumed to be fair and to lead to equal access for all these under-represented groups unless they were already underrepresented during pre-university education. It was feared that selection based on extracurricular activities would induce or exacerbate inequality since minority students were believed to be less inclined to work on 'CV-building'. However, this fear is unwarranted. Stegers-Jager, Themmen, et al. (2015) showed, using a slightly adapted selection procedure as described in this thesis (applicants run through both steps), that minority subgroups were not disadvantaged although self-selection in terms of the decision not to return the application form cannot be ruled out. This is in line with a Danish study in which also no effect was found on diversity of the student population using a selection procedure that included extracurricular activities (O'Neill, Vonsild, et al., 2013).

Another limitation is the possibility of self-selection applied by the candidates since participation in the selection procedure offers candidates an additional chance in addition to the lottery. Joining the lottery is far less demanding than the effort asked for taking part in the selection procedure. As a result, only highly motivated students take part in the selection procedure. Nonis & Wright (2003) found that just this high-performance level in combination with only moderate grades leads to better performance than vice versa. This degree of motivation at least protects them from dropout (chapter 4; (O'Neill, Hartvigsen, et al., 2011)). So, this kind of self-selection turned out to be desirable by making the applicant pool more dedicated. Another, rather positive, effect of self-selection turned out to be the selection of those having the personality traits that seems profitable for future doctors. Schripsema, van Trigt, et al. (2016) found that their selected students had higher scores on conscientiousness which in turn in other studies proved to affect results in medical school (Ferguson, Sanders, et al., 2000; Lievens, Coetsier, et al., 2002). Another example of a self-selection for selection procedures is the perception among minority groups that they have a (substantially) lower chance of successfully completing the selection procedure. Whereas most applicants consider the usage of a selection procedure and the specific city where the university of their choice is located to be the most important drivers in their decision to enroll or apply, this is slightly less important for (non-)Western minority groups (Wouters, Croiset, Schripsema, et al., 2017). It is conceivable that applicants from minority groups do not even bother to apply at a medical school that uses a selection procedure because they perceive to have no chance at admission. To what extent this plays a role in deciding or determining where to apply for medical school should be a subject of further research.

CLOSING REMARKS

Although the studies in this thesis show that a successful selection procedure for medical school has been developed, there remain some important medical school student skills that are not addressed in the current procedure, such as socials skills and integrity. The introduction of other methods such as the multiple mini interview (MMI) and situational judgment testing (SJT) to medical school selection widens the selection instruments to include these skills in the selection procedure. Both methods present applicants with work-related situations and subsequently assess their responses to these situations. The work-related situations reflect the roles that applicants are likely to encounter in training and practice during medical education (Eva, Rosenfeld, et al., 2004; Patterson, Zibarras, et al., 2016; Ployhart, 2006) and include social skills and integrity. Both methods proved to be reliable and valid for selecting medical students, even though the development of these tests is complex (Patterson, Knight, et al., 2016; Reiter, Eva, et al., 2007).

The challenge for the future lies in optimizing, further calibrating and ultimately strengthening selection procedures. Preferably this augmentation should be preceded by an answer to the question which set of skills a medical school wants to add to a medical doctor and allocated on the demands from society and the specific curriculum designed to achieve this. This specific profile and subsequent curriculum should be clear for each school as well as its future students. On the one hand this creates an opening to develop an optimal selection procedure fitted to the schools' profile. On the other hand, it gives future students the opportunity to make an informed choice which medical profile suits them best. For example, when offering a problem-based learning curriculum; some feel attracted to it and others do not. Also, for the university offering such a program, it is beneficial to select those who have the greatest chance to succeed.

Although the 2009 Framework for Undergraduate Medical Education in the Netherlands (Van Herwaarden, Laan, et al., 2009) offers the medical school an educational outline and end terms, the challenge for medical schools is to choose a profile and publicize this profile. This will result in more variety between medical schools that leads to future doctors that are not only skilled to practice medicine but also have other, additional, abilities valuable for their job and patient care. Results presented in this thesis showed that a selection procedure uniquely designed for a medical school with a marked research profile, reflected in the provision of additional extracurricular activities in the form of a research master's program, indeed endorsed these activities. A tailored selection procedure for this specific profile, using motivated behaviour by means of extracurricular activities followed by a curriculum sample test reduces the dropping out rate of the selected students and in the end, favours a better clinical performance.

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CHAPTER 7

Summary

SUMMARY

Worldwide places in medical school are scarce and medical education and training are expensive for providers and learners. Therefore, medical schools aim to offer the places available only to those applicants with the highest probability of successful medical training and subsequent career. To reach this goal, medical schools have developed several selection procedures, including interviews, admission tests and other measures of personal competencies (Kreiter & Axelson, 2013), although the evidence that these procedures indeed do deliver better achieving students (Salvatori, 2001; Siu & Reiter, 2009), let alone better professional doctors (Papadakis, Teherani, et al., 2005) is limited. Uniquely in the Netherlands, to downsize the applicant pool, selection was organised nationally based on a lottery that is weighted for academic attainment. Whereas traditionally the focus in selection has been on academic indicators, there is increasingly more attention for non-academic attributes that are considered important for success in clinical practice (Patterson, Knight, et al., 2016). As with all selection tools, it is critical to explore the reliability and validity of approaches to selecting for non-academic, or personal qualities.

Current research about selection procedures used throughout the world and over the years indicates that these methods do not deliver the desired results (DeVaul, Jervey, et al., 1987; Papadakis, Teherani, et al., 2005; Stegers-Jager, Themmen, et al., 2015). There was no evidence for the existence of methods that might select students who would perform better in medical school (Norman, 2004). However, in the absence of a selection system of proven efficacy, a lottery system should not be accepted as a valid solution. Both the lottery and the unproven procedures have been described as unfair to medical school applicants, as neither includes any truly objective criteria for predicting future performance (Zwick, 2006). The Dutch situation in which access to medical school was granted by lottery and the possibility to select up to 50% of the students by a selection procedure provided a unique opportunity to form a control group of randomly admitted students to compare with those selected. We used this dual system to develop an evidence-based selection procedure addressing non-academic (i.e. motivation) as well as academic skills. The former evaluated motivation through the determination of candidate active involvement in extracurricular activities, the latter by tests concerning the study skills of candidates in a medical school context.

The local selection procedure at Erasmus MC Medical School consists of two steps. In the first step, applicants are assessed according to the quality and quantity of extracurricular activities before application in one or more of the following five categories: (1) activities in health care, (2) activities in management and organisation, (3) activities related to the development of a (individual) talent e.g. for music, sports or science; (4) (extracurricular) academic education; and (5) additional subjects during pre-university education. In the second, academic step, applicants take five tests on a medical subject preceded by informative classes. These locally developed tests focus on the subjects logical reasoning, scientific thinking, epidemiology and pathology, anatomy and mathematics.

MAIN FINDINGS

The objective of the study presented in *Chapter 2* was to use controlled techniques to determine whether a combination of selection steps, based on the assessment of academic and non-academic abilities, would lead to the admission of students whose achievement in medical school would turn out to surpass that of students who had been selected by weighted lottery. We introduced our two-step selection method. 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. Four consecutive cohorts were admitted partly by selection and partly by lottery. All cohorts in this study had a minimum follow-up of 2 years and two had a follow up of 4 years. The main outcome was that the relative risk for dropping out of medical school was 2.6 times lower in selected students than in controls admitted by lottery. Grossly there were no significant differences between the percentages of students who performed optimally (i.e., those obtaining the maximum of 60 credits each year) in either group. The differences we observed in student achievement could not be explained by the pre-admission characteristics 'gender' and 'pre-university GPA (pu-GPA)'. Selected students were 4 months older, which is significant although thought not clinically relevant.

Since this dropout rate was reduced by this selection procedure, we questioned whether the selected students also outperformed the lottery admitted students in the clinical phase. Therefore, the aim of the study presented in *Chapter 3* was to compare the performance of selected and lottery admitted students in the clinical phase. The overall risk for dropout before the start of the clerkships declined, however it remained twice as low in the selected group compared to the lottery admitted group.

After at least 5.5 years of study, almost three quarter of the students completed at least five clerkships. This mean grade of five clerkships turned out to correlate very well to mean grade of all clerkships, indicating that the former achievement could be considered representative for overall clinical achievement. Therefore, mean grades of selected and lottery-admitted students in the four (yearly) cohorts on the first five discipline specific clerkships and on all 10 discipline-specific clerkships in the first two cohorts were evaluated. Those selected obtained a higher mean grade than the lottery admitted students on the first five as well as all 10 clerkships. The probability of achieving a grade of ≥ 8.0 was 1.5 times greater for selected students than for lottery-admitted students. Of notice is the absence of difference in pre-university Grade Point Average between both groups at any stage between the start of medical school and graduation after the completion of clerkships. Therefore, the observed difference in clinical achievement between the selected and lottery admitted groups appears to be related to the selection of students before admission.

To assess the relative importance of both steps in explaining the differences in student performance found between selected students and their lottery admitted controls the study reported in *Chapter 4* was conducted. We investigated the relative contribution of the first non-academic and second academic selection step to the differences found in student performance during medical school. It was shown that the observed difference in dropout rate between this groups partly already existed before the start of the selection procedure (i.e. self-selection) and partly can be attributed to selection of participants based on academic criteria in the second, 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.

The aim of the study presented in *Chapter 5* was to examine whether students who were selected based on their pre-university Extra Curricular Activities (puECAs) persisted in their ECAs during medical school (msECAs) and whether this persistent participation in msECAs explains their better achievement in the clinical phase. Thereby supporting the choice of using puECAs as a non-academic selection tool in medical school selection procedures. It turned out that persistent activities of students selected on extracurricular activities apparently favours their better clinical achievement. Selected students not only participate more often in extracurricular activities during medical school than lottery-admitted students, their participation is also not associated with their pu-GPA, whereas lottery-admitted students only participate if they have a high pu-GPA. Also, participation in extracurricular activities is associated with higher clerkship grades for selected students but not for lottery-admitted students. Thereby supporting the choice of using puECAs as a non-academic selection tool in medical school selection procedures.

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CHAPTER 8

Samenvatting

SAMENVATTING

De studie geneeskunde is populair, niet alleen in Nederland. Wereldwijd overtreft het aantal aanmeldingen nagenoeg altijd het aantal beschikbare plaatsen. De studie is kostbaar, zowel om aan te bieden als om te volgen. Medische faculteiten zijn erop gericht deze schaarse plaatsen bij voorkeur beschikbaar te stellen aan diegenen met de grootste kans op het succesvol afronden van de medische opleiding en zij die bij voorkeur een veelbelovende carrière als arts tegemoet gaan. Om dit doel te bereiken, hebben medische faculteiten diverse selectieprocedures ontwikkeld, zoals het afnemen van interviews, het afnemen van toelatingstesten en diverse andere testen die de mate van aanwezigheid van individuele competenties meten (Kreiter and Axelson 2013). Het bewijs dat deze methoden studenten opleveren die inderdaad beter presteren (Salvatori 2001, Siu and Reiter 2009), laat staan betere, meer professionele artsen (Papadakis, Teherani et al. 2005) is beperkt. Uniek in wereld is het Nederlandse nationale systeem van gewogen loting; hoe hoger je gemiddeld eindexamencijfer, hoe groter je kans om ingeloot te worden. Traditioneel ligt in met name Westerse landen de focus voor selectie op academische vaardigheden. Aan het einde van de 20e eeuw krijgen de niet-academische vaardigheden meer aandacht en worden deze in toenemende mate belangrijk geacht om te bezitten om als dokter succesvol te zijn (Patterson, Knight et al. 2016). Zoals ook geldt voor selectiemethoden die academische vaardigheden testen, is het van cruciaal belang om ook wanneer geselecteerd wordt middels methoden welke niet-academische vaardigheden testen, de betrouwbaarheid en validiteit van deze methoden te onderzoeken.

Het huidige onderzoek naar selectiemethoden die wereldwijd en in de loop van de jaren zijn gebruikt, geeft aan dat deze methoden maar zelden de gewenste resultaten opleveren (DeVaul, Jervey et al. 1987, Papadakis, Teherani et al. 2005, Stegers-Jager, Themmen et al. 2015). Het is Norman (2004) die durft te concluderen dat er geen bewijs is voor het bestaan van selectiemethoden die inderdaad studenten selecteren die beter presteren tijdens de studie geneeskunde. Hoewel er daarmee een gebrek is aan selectiemethoden met een bewezen werkzaamheid, is het instellen van een (gewogen) loting ook geen wenselijke oplossing. Zowel de loting als de vooralsnog onbewezen selectiemethoden worden door aankomend studenten als oneerlijk ervaren aangezien geen van beide echt objectieve criteria bevat die toekomstige prestaties als arts voorspellen (Zwick 2006). De Nederlandse situatie waarin de toegang tot medische faculteit wordt verleend door de loting en de mogelijkheid om tot 50% van de studenten te selecteren via een selectieprocedure bood een unieke kans om een controlegroep van willekeurig toegelaten studenten te vormen en hen te vergelijken met de door de selectieprocedure geselecteerde studenten. Onderzoek in dit proefschrift maakt gebruik van dit duale systeem om een op wetenschappelijk bewijs gebaseerde selectieprocedure te ontwikkelen die zowel niet-academische (zoals motivatie) als academische vaardigheden in zich heeft.

De selectieprocedure zoals ontwikkeld in het ErasmusMC bestond uit twee stappen. In de eerste stap is een afgeleide gebruikt van motivatie door naar de betrokkenheid bij extracurriculaire activiteiten tijdens de laatste twee jaar op de middelbare school of eventueel al gevolgde vervolgopleiding te vragen. Deze activiteiten moesten voldoen aan een vooraf opgestelde maak van kwaliteit en kwantiteit. Daarnaast moesten zijn gedaan zijn in een van de volgende vijf categorieën: (1) activiteiten in de gezondheidszorg, (2) activiteiten in een bestuur en/of organisatie, (3) activiteiten gerelateerd aan een uniek talent zoals op het gebied van sport, wetenschap of muziek, (4) een extra vak gevolgd op de middelbare school of (5) extra activiteiten gedaan tijdens een eerdere (academische) vervolgopleiding. In de tweede stap van de selectieprocedure werden de academische (studie)vaardigheden getest door middel van een driedaagse studieperiode op de faculteit inclusief college en toetsten rondom een medisch onderwerp. De in het ErasmusMC ontwikkelde toetsen behandelden logisch redeneren, wetenschappelijk denken, epidemiologie, pathologie, anatomie en (medisch) rekenen.

BELANGRIJKSTE BEVINDINGEN

Het doel van de in *hoofdstuk 2* gepresenteerde studie was om op gecontroleerde wijze vast te stellen of de combinatie van de selectiestappen, gebaseerd op de beoordeling van hun academische en niet-academische vaardigheden, zou leiden tot de toelating van studenten wiens prestaties tijdens de studie geneeskunde die van studenten toegelaten via de gewogen loting zou overtreffen. De gebruikte selectieprocedure wordt beschreven: in de eerste, niet-academische stap werden de kandidaten beoordeeld op de kwaliteit en de omvang van hun extracurriculaire activiteiten gedaan tijdens de middelbare school, terwijl de tweede, academische stap bestond uit een reeks van vijf tests rondom een medisch onderwerp. Deze laatste week is representatief voor het eerste jaar van de studie geneeskunde. Vier opeenvolgende cohorten werden gedeeltelijk toegelaten via selectie en deels door de gewogen loting. Alle cohorten in deze studie hadden een minimale follow-up van 2 jaar en twee hadden een follow-up van 4 jaar. Het belangrijkste resultaat was dat het relatieve risico om in de eerste twee jaar uit te vallen 2,6 keer lager was voor geselecteerde studenten dan voor studenten toegelaten door de loting. Er was geen significant verschil in het percentage studenten dat optimaal studeerde in beide groepen (het maximumaantal van 60 studiepunten per jaar behaalden), noch haalden ze hogere cijfers. Dit verschil in uitval kon niet worden verklaard door de variabelen 'geslacht' en 'gemiddeld eindexamencijfer'. Geselecteerde studenten waren weliswaar significant ouder, echter dit is maar 4 maanden wat niet klinisch relevant wordt geacht.

Nu de uitval lager is onder geselecteerde studenten was het de vraag of de geselecteerde studenten dit zouden vasthouden in de klinische fase. Daarom was het doel van de studie gepresenteerd in *hoofdstuk 3* het vergelijken van de prestaties van geselecteerde en ingelote studenten in de klinische fase. Het bleek dat het risico om uit te vallen voor het begin van de klinische fase weliswaar daalde, maar het bleef in de geselecteerde groep tweemaal zo laag in vergelijking met de ingelote groep.

Na ten minste 5,5 jaar studie voltooide bijna driekwart van de studenten tenminste vijf coschappen. Dit gemiddelde cijfer van deze vijf coschappen bleek goed overeen te komen met het gemiddelde cijfer van alle tien coschappen. Daarmee kan het cijfer voor de eerste vijf coschappen als representatief voor de gehele klinische fase worden beschouwd. Dit gemiddelde cijfer van de coschappen van geselecteerde en ingelote studenten werd geëvalueerd waaruit bleek dat de geselecteerde studenten een hoger gemiddeld cijfer behaalden dan de ingelote studenten. De kans op het behalen van een cijfer ≥ 8,0 was 1,5 keer groter voor geselecteerde studenten dan voor studenten die zijn toegelaten via de loting. Opvallend is de afwezigheid van verschil in gemiddeld eindexamencijfer tussen beide groepen in elke fase tussen de start van de studie geneeskunde en het afstuderen na de coschappen. Daarmee lijkt het gevonden verschil in klinische prestaties tussen de geselecteerde en ingelote studenten gerelateerd te zijn aan de selectie van studenten vóór het starten van de studie.

Om het relatieve belang van beide stappen bij het verklaren van de verschillen in prestaties tussen geselecteerde en ingelote studenten te verklaren, werd het in *hoofdstuk 4* gerapporteerde onderzoek uitgevoerd. We onderzochten de relatieve bijdrage van de eerste niet-academische en tweede academische selectiestap tot de verschillen in de prestaties van studenten geneeskunde. In deze studie is aangetoond dat het waargenomen verschil in uitval tussen de geselecteerde en ingelote groep gedeeltelijk al bestond voor de start van de selectieprocedure (zelfselectie) en gedeeltelijk kan worden toegeschreven aan selectie op basis van academische criteria in de tweede selectiestap. Het significant hogere cijfer in de klinische fase kan vooral verklaard worden met de niet-academische vaardigheden, uitgevraagd in de tweede selectiestap. Dit betrof deelname aan extra curriculaire activiteiten van een zekere kwaliteit en kwantiteit vóór toelating tot de studie geneeskunde.

Het doel van de studie gepresenteerd in *hoofdstuk 5* was om te onderzoeken of studenten die werden geselecteerd op basis van hun extracurriculaire activiteiten op de middelbare school (ECAms), het ook volhouden om extracurriculaire activiteiten te blijven doen tijdens de studie geneeskunde (ECAg). En vervolgens of dit ook hun betere prestaties in de klinische fase verklaart. Waarmee dit de keuze zou ondersteunen voor het gebruik van ECAms als niet-academisch selectiemiddel bij selectieprocedures voor medische faculteiten. Deze studie laat zien dat het blijven doen van ECAg van studenten die zijn geselecteerd op ECAms hun betere prestaties tijdens de klininische fase verklaren. Geselecteerde studenten nemen niet alleen vaker deel aan ECAg dan studenten die zijn toegelaten door loting, hun deelname is ook niet geassocieerd met hun gemiddeld eindexamencijfer, terwijl ingelote studenten alleen deelnemen aan een ECAg als ze een hoog gemiddeld eindexamencijfer hebben. Verder wordt deelname aan extracurriculaire activiteiten weliswaar geassocieerd met hogere cijfers in de klinische fase voor geselecteerde studenten; dit is niet het geval voor ingelote. Dit ondersteunt het de keuze voor het gebruik van ECAms als een niet-academisch onderdeel bij selectieprocedures voor medische faculteiten.

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Publications & presentations

PUBLICATIONS & PRESENTATIONS

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PhD portfolio

PHD PORTFOLIO

	Year	Workload (ECTS)
PhD training		
General Courses	2006 – 2011	
Regression Analysis		1,5 ECTS
Survival Analysis		1,5 ECTS
Structural Equation Modeling		2 ECTS
SPSS AMOS		2 ECTS
masterclass 'creative thinking'		1 ECTS
English Biomedical Writing and Communication		3 ECTS
Presentations		
Oral presentations (12x)	2003 – 2008	12 ECTS
Poster presentations (1x)	2008	0,5 ECTS
Workshops/symposia (21x)	2004 – 2010	21 ECTS
Award		
Urlings-Strop L.C., Themmen A.P.N., Stijnen T., Splinter T.A.W. Prestaties van geselecteerde versus ingelote studenten in de preklinische en klinische fase. Paper gepresenteerd tijdens het NVMO-congres te Egmond aan Zee, november 2008. **Award for Best Scientific Paper.**		
(Inter)national conferences		
International conferences (5x)	2004 – 2008	5 ECTS
National conferences/seminars (6x)	2003 – 2009	3 ECTS
Other activities		
General board member and president of Promeras (Association for PhD students at Erasmus MC)	2007 – 2009	

Appendix

About the author

ABOUT THE AUTHOR

Louise Christine Strop was born on April 16, 1977 in Dokkum, the Netherlands. In 1994 she graduated from secondary school (HAVO) at 'De Lage Waard' in Papendrecht and subsequently obtained her VWO diploma in 1995 at 'Luzac College' in Rotterdam. Her wish was to study medicine but due to the lottery system she could not start until 2000. In the meantime, she enrolled in Health Policy and Management (BMG) at the Erasmus University in Rotterdam. Since 1996 she attended nursing college. Finally, in 2000 she started medical school at the Erasmus University in Rotterdam. Already during her studies, she worked as a student assistant at the 'Opleidingsinstituut Geneeskunde' (OiG) which ultimately resulted in the PhD trajectory this thesis is the result of. First under the supervision of prof.dr. T.A.W. Splinter and in later years prof.dr. A.T.N. Themmen. From the beginning she was involved in the development of the selection procedure for medical students at Erasmus University.

Since 2011 she is a Medical Doctor and started her training as Pulmonary Physician, first at the department of Internal Medicine at the Sint Franciscus Gasthuis in Rotterdam (supervisor drs. A.P. Rietveld) and subsequently the department of Pulmonary Medicine (supervisors dr. A. Rudolphus and dr. J.C.C.M. in 't Veen) at the same hospital. In 2016 she started a fellowship Intensive Care Medicine at the department of Intensive Care Medicine at OLVG, Amsterdam (supervisor prof.dr. P.H.J. van der Voort). She is a Pulmonary Physician since July 1, 2017 and an Intensivist since July 1, 2018.

Louise is married to Bart Urlings and together they have a son, Hidde (2005) and a daughter, Jitske (2006) and live in Berkel en Rodenrijs.

Dankwoord

I can no other answer make but thanks,
And thanks

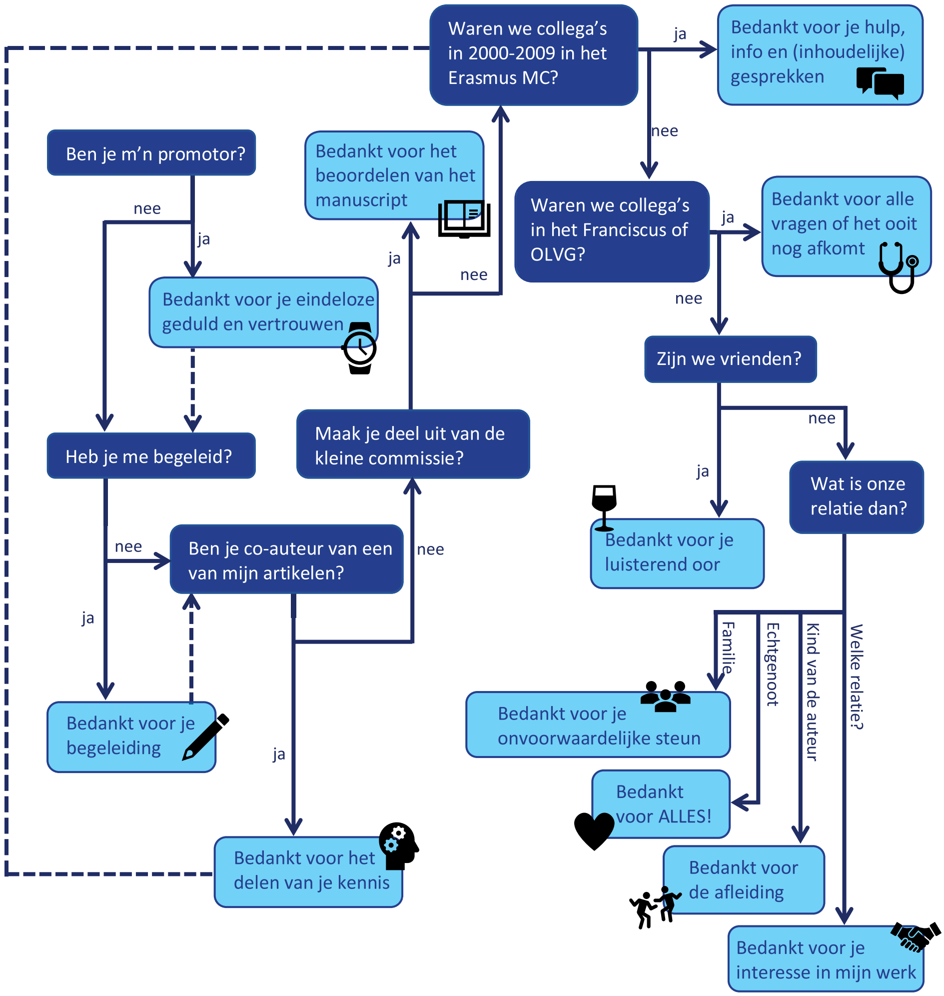
- William Shakespeare: Twelfth Night, Act III, Scene III -

DANKWOORD

Als na zoveel jaren eindelijk het boekje daar ligt, kan het niet anders dan dat er in de tussenliggende jaren veel is gebeurd. In al die jaren heb ik zoveel mensen leren kennen, zijn er zoveel mensen geweest die me geholpen hebben en ben ik aan zoveel mensen dank verschuldigd dat het onmogelijk is iedereen bij naam te noemen. Er zijn zovelen geweest die een bijdrage hebben geleverd aan dit proefschrift, sommigen inhoudelijk, anderen doordat ze me aanspoorden, weer anderen doordat ze me onvoorwaardelijk steunden. Alles benoemen, in welke volgorde dan ook, zou meer bladzijden beslaan dan een dankwoord lang kan zijn. Daarnaast draagt dat het risico dat ik iemand vergeet, wat onvergeeflijk zou zijn. Immers, ik ben eenieder voor elke rol die hij of zij heeft vervuld in het vervolmaken van dit proefschrift oprecht dankbaar. Daarom verwijs ik, naast naar het citaat van Shakespeare op voorgaande pagina, graag naar figuur 1.

Toch is er één persoon die wel bij naam genoemd mag worden: prof.dr. T.A.W. Splinter. Hij was de inspirator achter het project ‘decentrale selectie’. Diegene die zijn nek uit stak om ‘selectie aan de poort’ van de grond te krijgen. Eigenwijs en eigengereid, met een groot hart voor medisch onderwijs. Ted, jij was een bevlogen man die door oprechte interesse altijd wilde weten hoe het echt zat en om die reden altijd meer vragen stelde dan wie dan ook kon beantwoorden. Het zette aan tot kritisch denken en het maken van nieuwe figuren en tabellen, steeds weer zoeken naar nieuwe relaties en verbanden tussen alle variabelen. Dat gaf inzicht en voer voor nieuwe discussies. Je wens ‘selectie aan de poort’ in Nederland tot een succes te maken en met degelijk onderzoek te staven hebben geleid tot het inmiddels afschaffen van de loting. Wie had dat ooit gedacht!

Louise



Figuur 1 – Dankwoord-diagram. Gelieve hier te vinden wie waarvoor wordt bedankt.

Appendix