

CHAPTER 3

A multi-site study on medical school selection, performance, motivation and engagement

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Abstract

Introduction We examined whether: (i) medical students admitted based on top pre-university grade point averages (top-pu-GPAs), a voluntary selection procedure, or lottery; (ii) students who participated in selection and students who had not participated; and (iii) students admitted through different selection procedures show differences in performance, motivation and engagement.

Methods Year-1 (pre-clinical) and Year-4 (clinical) students from three medical schools, which apply different selection procedures, completed a survey, including standard validated questionnaires measuring quality of motivation (Academic Self-regulation Questionnaire), strength of motivation (Strength of Motivation for Medical School-Revised) and engagement (Utrecht Work Engagement Scale–Student). Performance data were comprised of GPA and course credits in Year-1 and clerkship performance in Year-4. Regression analyses were performed.

Results The response rate was 35%; 387 Year-1 and 273 Year-4 students participated. Top-pu-GPA students outperformed selected students. Selected Year-1 students reported higher strength of motivation than top-pu-GPA students. Analyses showed no differences in quality of motivation and engagement between the admission groups. Participation in selection was associated with higher engagement and better clerkship performance in Year-4. GPA, course credits and strength of motivation in Year-1 differed between students admitted through the different selection procedures.

Conclusions Top performing students in pre-university education perform best in the medical study. A voluntary selection procedure seems favourable to lottery because it appears to attract engaged students who perform better in the clinical phase of the study. However, no significant differences between selected and lottery-admitted students were found. The type of selection procedure may be less important.

Introduction

Admission into medical school is highly competitive, and available places are generally allocated through selection¹⁻³. By applying selection procedures, medical schools aim to admit motivated students who will perform well in their studies⁴. Research shows that academic records, multiple mini-interviews (MMIs), aptitude tests, situational judgement tests and selection centres are among the most effective selection tools³. A recent review has indicated the need for the investigation of combinations of selection tools, rather than selection tools in isolation, as well as the need for multi-site studies³. The aim of this study was to investigate the associations of various admission processes, various combinations of selection tools and participation in a voluntary selection procedure (as opposed to refraining from participation) with student performance across different medical schools. In addition, we investigated associations with motivation and engagement because these variables are deemed important for the learning and performance of students⁵⁻⁷.

Motivation concerns the reasons people act in certain ways. These reasons can originate from within the person or from external factors. According to the self-determination theory (SDT), autonomous motivation (AM) is seen when one does something out of genuine interest or because of a positive valuation of the activity. On the contrary, controlled motivation (CM) is seen when one experiences internal or external pressure⁸. AM is associated with better learning, academic performance, and well-being^{5,9-15}. Student engagement also contributes to better learning and academic performance in (medical) students^{7,16-18} and has a negative relationship with burnout¹⁹. Engagement is defined as *“a positive, fulfilling, and work-related state of mind that is characterized by vigour, dedication, and absorption”*¹⁹.

Because each medical school usually applies a single selection pathway for the admission of all students, admissions pathways are rarely compared in research. A three-step admission system implemented by the Dutch government has enabled researchers to make such comparisons. In the first step, applicants with a pre-university grade point average of 8 or higher on a scale ranging from 1-10 (top-pu-GPA) are offered admission. In the second step, applicants are selected using a multi-tool selection procedure. Dutch medical schools can develop their own selection procedure, providing that students are not selected solely based on academic records. Participation in the usually time-consuming selection procedure is voluntary. When rejected, applicants automatically become enrolled in the third step, a lottery weighted for pu-GPA; this step is also open to

applicants who refrained from participation in selection²⁰.

Research on students admitted through the various selection pathways has produced mixed results, and the findings have often lacked significance. Top-pu-GPA students consistently outperform selected and lottery-admitted students²¹. Comparisons between selected and lottery-admitted students are less conclusive. In some studies, selected students outperformed lottery-admitted students with regard to Year-1 GPA²²⁻²⁴ (although, in one study this was in only one out of the four cohorts under study²⁵), course credits obtained in Year-1^{22;24}, dropout^{22;24-26}, professional behaviour²¹ and clerkship performance^{26;27}. Other studies, however, have reported no differences in Year-1 GPA^{22;28}, course credits obtained in Year-1²², Year-1 course completion in one year^{24;29}, dropout rates^{21;22}, performance on Year-3 OSCE's²² and clerkship performance¹⁴ between selected and lottery-admitted students. One of these studies found mixed results with respect to selection based on cognitive criteria or non-cognitive criteria²². In addition to these mixed results, studies focusing on the motivation of students admitted through different pathways are few in number. Some studies found higher strength of motivation among selected students as compared to lottery-admitted and top-pu-GPA students^{28;30;31}, while others did not find significant differences³². Even fewer studies have taken into account the quality of motivation. In a Dutch study, selected students reported more AM than lottery-admitted students¹², whereas in a more recent study, no differences in AM and CM were found³¹. Moreover, recently selected students reported higher strength of motivation, AM and CM than students who were selected years before, suggesting a temporary increase in motivation because of selection. Engagement has not yet been studied in relation with selection. In summary, the results are inconclusive. Whenever differences are found, applying selection seems favourable over applying lottery, although the differences are usually small.

Regarding participation in selection, it has been argued that applicants who invest the time and effort necessary for participation in selection may perform better than those who refrain from it²¹. However, the evidence of this is scarce. Some researchers have benefited from the fact that the lottery-admitted group consists of students who had and students who had not participated in selection, and they have taken this into account as a factor in their research. Selected students outperformed students who had not participated in selection on knowledge tests^{21;24}. In Year-1 and Year-2, selected students and students who had participated in selection obtained more course credits than students who had not participated, while in Year-3, no significant differences were found. Selected students

obtained the highest level of professional behaviour judgement more often than both groups of lottery-admitted students. There are indications of lower dropout rates among students who had participated, but due to a low overall dropout rate, these findings did not reach significance²¹. Similar findings were reported in a Danish study³³. Another Dutch study showed that performance of lottery-admitted students that had participated in selection did not differ from selected students with regards to dropout and course credits, while selected students outperformed both lottery-admitted groups in the pre-clinical phase in terms of GPAs²⁴. Regarding clerkship performance, no significant differences were found between the two lottery groups²⁶. Thus, only a little evidence supports the hypothesis that students who have participated in selection outperform those who have not. Motivation, as reflected in the preparation for selection, has been suggested as one reason why students who have participated might perform better^{21,31,34}, but this assumption has not yet been investigated.

Because selection procedures are usually costly, identifying which type of procedure is the most effective in selecting students with the most desirable characteristics can inform policy decisions. The mere presence of an effort-intensive selection procedure may be more important than the specific characteristics of the procedure. The single-institution nature of previous research has resulted in a dearth of studies comparing different selection procedures. In a study comparing students selected using cognitive criteria and students selected using non-cognitive criteria within one medical school, no differences were found with regard to dropout and performance during the pre-clinical and clinical phases of medical study²². The present study includes multiple institutions applying different selection procedures, enabling comparisons across medical schools.

The following research questions guided our study (see Table 1):

1. Are different admission groups (i.e., admission based on selection, lottery and top-pu-GPA) associated with differences in motivation, engagement and pre-clinical and clinical performance?
2. Is participation in selection associated with differences in motivation, engagement and pre-clinical and clinical performance?
3. Are different selection procedures associated with differences in motivation, engagement and pre-clinical and clinical performance?

Our hypotheses were:

1. Top-pu-GPA students outperform selected and lottery-admitted students, and selected students outperform lottery-admitted students in pre-clinical and/or clinical education, while selected students outperform and report higher AM and engagement than lottery-admitted and top-pu-GPA students.
2. Students who participated in selection outperform and report higher AM and engagement than students who did not participate in selection.
3. Different types of selection procedures do not result in differences in motivation, engagement and pre-clinical and clinical performance.

Methods

Study design

This was a multi-site cross-sectional study using an online survey (Net Questionnaire) comprised of personal data and standard, validated questionnaires. The indicators of academic performance of the participating students were retrieved from student administrative databases.

Setting

This study was carried out at three Dutch medical schools: VUmc School of Medical Sciences Amsterdam (VUmc), Academic Medical Center Amsterdam (AMC), and University Medical Center Groningen (UMCG). Medical study in the Netherlands consists of three years of pre-clinical education, followed by three years of clinical education, after which students obtain their medical degrees. Although small local differences may exist, we expect the curricula to be largely comparable because medical curricula across the Netherlands are all vertically integrated, student-centred²⁰ and driven by nationally standardized end terms³⁵. An overview of the characteristics of the selection procedures of the different medical schools is provided in Table 2.

Table 1 Overview of the research questions and hypotheses

1) Are different admission processes (i.e. admission based on selection, lottery, and top-pu-GPA) associated with differences in motivation, engagement and pre-clinical and clinical performance?	
Academic performance	Motivation and engagement
Top-pu-GPA > selection and lottery Selection > lottery	Selection > top-pu-GPA and lottery
2) Is participation in selection associated with differences in motivation, engagement and pre-clinical and clinical performance?	
Academic performance	Motivation and engagement
Participation in selection > no participation in selection	Participation in selection > no participation in selection
3) Are different selection procedures associated with differences in motivation, engagement and pre-clinical and clinical performance?	
Academic performance	Motivation and engagement
Procedure A = procedure B = procedure C	Procedure A = procedure B = procedure C

Participants

In the 2013-2014 academic year, students were invited via e-mail (with two reminders) to participate in this study. The sample consisted of Year-1 students for the pre-clinical phase and Year-4 students for the clinical phase of medical study. For every ten participants, a gift card of €25 was awarded through random selection. Participation was voluntary, and informed consent was received.

Outcome measures

An overview of the collected data is provided in Table 3. The outcome measures were academic performance, motivation and engagement.

Academic performance Three measures were defined to represent academic performance in Year-1: course credits, GPA and professional behaviour. *Course credits* (European credits) obtained in the respective study year were used. At all medical schools, the maximum number of course credits per year was 60. *GPA* in the first year was comprised of the average of the first attempts on all knowledge tests. For VUmc, AMC and UMCG, respectively, six, five, and four tests were included. For *professional*

behaviour, unsatisfactory, satisfactory or good judgments on professional development were examined. Similar to other researchers, we chose the achievement of *good clerkship performance* as an indicator of performance in Year-4²⁹. Good clerkship performance was defined as receiving a grade of 8 or higher out of 10 for at least half of the clerkships. The final clerkship grade is a single grade that includes an assessment of professional behaviour. Year-4 was composed of six clerkships at VUmc and AMC and four clerkships at UMCG.

Motivation Two measures were defined to represent motivation: strength of motivation and type of motivation (AM and CM). We used the concept of motivation put forth by STD³⁶. AM and CM were measured with the 16-item Academic Self-regulation Questionnaire³⁷. Scores ranged from 1 (not important at all) to 5 (very important).

Table 2 Differences of the selection procedures of the three universities

	VUmc	AMC	UMCG
Selection procedure	<p><i>Procedure A</i> Two phases: 1) Portfolio including previous academic records and extracurricular activities. Students meeting the set threshold were invited to participate in the second phase. 2) Lectures followed by assessment of academic skills, measured with tests about medical subjects and study skills.</p> <p>(http://www.med.vu.nl/nl/opleidingen/bachelor-geneeskunde/decentrale-selectie/index.aspx)</p>	<p><i>Procedure B</i> Two phases: 1) Cognitive tests and portfolio including previous academic records and extracurricular activities. 2) Lecture followed by an academic test and three-station MMI (Year-1) or interview (Year-4).</p> <p>(https://www.amc.nl/web/Onderwijs/Aankomend-student/Geneeskunde/Decentrale-selectie-1.htm)</p>	<p><i>Procedure C</i> Two phases: 1) Portfolio (comprising sections on pre-university education, extracurricular activities, and reflection) and academic and non-academic tests. The highest scoring applicants were invited to participate in the second phase. 2) Patient lecture followed by assignments (related to the lecture, writing an essay, and scientific reasoning) and a four-station MMI assessing communication skills, collaboration skills and reflection.</p> <p>(http://www.rug.nl/umcg/education/medicine/selection_admission_requirements_and_deficiencies)</p>
Places assigned through selection	<p>Year-1: 60% of 350 places Year-4: 50% of 350 places</p>	<p>Year-1: 75% of 350 places Year-4: 50% of 350 places</p>	<p>Year-1: 100% of 410 places Year-4: 50% of 410 places</p>

Relative autonomous motivation (RAM) was calculated by subtracting the CM subscale score from the AM subscale score. Strength of motivation was measured with the 15-item Strength of Motivation for Medical School-Revised questionnaire^{32,38,39}. Scores ranged from 1 (strongly disagree) to 5 (strongly agree).

Table 3 Data collected for each student

Type of data	Description
Gender	Male or female
Age	- For first year students categorized as < 19 and 19 ≤ - For fourth year students categorized as < 23 and 23 ≤
Admission group	Based on pu-GPA, lottery or selection
Participation in selection	Whether students had participated in selection or not (selected students and students admitted through lottery after being rejected in selection)
Pre-university GPA	Average of pre-university education grades (10 point scale: 1 = very poor; 10 = excellent)
University	VUmc, AMC, or UMCG
Ethnicity	1 Dutch 2 Turkish/Moroccan/African 3 Surinamese/Antillean 4 Asian 5 Western 6 Other
First generation university student	Whether both students' parents had not attended university (research university or university of applied sciences)
Medical doctor as a parent	Whether either one of the student's parents was a medical doctor
Area growing up	City or village/small town
Living situation	With/without parents
Study progress in Year-1	Number of obtained course credits
Academic performance in respective study year	- GPA at first attempts on knowledge tests in Year-1 - Whether or not a student obtained an 8 or higher (scale 1 – 10) for at least half of the clerkships in Year-4
Professional behaviour in Year-1	Whether or not a student received an unsatisfactory professional behaviour judgment in Year-1
Motivation	- Strength of motivation (SMMS-R) - Type of motivation; autonomous motivation, controlled motivation and relative autonomous motivation (SRQ-A)
Engagement	Engagement (UWES student version)

Engagement The total score on the nine-item Utrecht Work Engagement Scale – Students (UWES-S-9)¹⁸ represented students' engagement. Students rated their level of engagement across the domains of vigour, absorption and dedication. Scores ranged from 0 (never) to 6 (always).

Independent variables

To answer the three research questions, three independent variables were defined: *admission group* (selection, lottery, and top-pu-GPA), *selection participation* (participation and no participation in selection) and *selection procedure* (selection procedures A, B and C for the selection procedures at VUmc, AMC and UMCG, respectively).

Confounders

We investigated whether the variables age, gender, university, first-generation student, doctor parent, ethnicity, area of growing up, living situation and pu-GPA needed to be included as confounders in the final models, along with the independent variables. Ethnicity was defined using the definition of Statistics Netherlands (CBS; www.cbs.nl), which states that a person belongs to an ethnic minority group if at least one of his or her parents was born outside the Netherlands. These variables were indicated as possible confounders because previous research showed the importance of students' background characteristics in performance and motivation^{9;29;40}.

Statistical analysis

For linear and dichotomous outcome variables, respectively, linear and binary logistic regression modelling was performed. First, we performed univariate regression analyses. Next, for every regression model, we investigated whether variables needed to be included as confounders in the final model based on a change in the regression coefficient of 10% or more and a significant association with the outcome variable⁴¹. Wherever appropriate, we used the Bonferroni procedure for multiple comparison correction. Pu-GPA was not considered as a possible confounder in the analyses in which the different admission groups (top-pu-GPA, selection and lottery) were compared, because the top-pu-GPA group was, by definition, the group with the highest pu-GPAs. Analyses were performed using IBM SPSS Statistics for Windows Version 20.0 (IBM Corp., Armonk, NY, USA).

Results

First, we provide the descriptives and the reliability tests of the used scales. Next, we report the results for each research question separately.

The 666 participants (response rate $\approx 35\%$ across all three universities) included 387 Year-1 students and 273 Year-4 students. The gender distribution (74.3% female) was representative of that in Dutch medical schools²⁰. Participants who enrolled in a graduate entry programme ($n = 6$) and participants admitted under special circumstances ($n = 17$) were excluded from the analyses. Seventy-six students (12%) were admitted based on top-pu-GPA, 75 students (12%) enrolled through a lottery without having participated in a selection procedure, 82 students (13%) were admitted through a lottery after being rejected in selection and 395 students (61%) were admitted through selection. We considered the admission pathway distribution in our sample to be a fair reflection of the population, based on the places assigned through selection at each medical school. Of the Year-1 participants 62.5%, 70.3% and 92.4% at VUmc, AMC and UMCG, respectively, were admitted through selection. Of the Year-4 participants 44.2%, 45.0% and 40% at VUmc, AMC and UMCG, respectively, were admitted through selection. A further breakdown by study year is provided in Table 4.

The Cronbach's alpha values for reliability for the UWES-S-9, AM, CM and the SMMS-R were 0.90, 0.82, 0.84 and 0.79 respectively.

Table 5 summarizes the means and standard deviations of all variables. The results of the regression analyses for Year-1 and Year-4 students and Pearson correlations between linear and dichotomous variables are depicted in Tables 6, 7 and 8, respectively. The incidence of unsatisfactory judgments for professional behaviour was too low (1.4%) to conduct further analyses.

Admission group

Year-1: Students with top-pu-GPAs obtained higher GPAs than selected students ($B = 0.526$, $p < 0.01$). Selected students reported higher strength of motivation than students with top-pu-GPAs ($B = 2.581$, $p < 0.05$, respectively). Analyses showed no significant associations between admission group and course credits, engagement, AM, CM and RAM.

Year-4: Students with top-pu-GPAs were more likely to show good performance during their clerkships than selected students (Odds Ratio (OR) 1.218, $p < 0.1$). Analyses showed no significant associations between admission group and engagement, strength of motivation, AM, CM and RAM.

Summary: These findings partly support our hypothesis that top-pu-GPA students would outperform other students, while selected students would report higher AM and engagement than top-pu-GPA and lottery-admitted students. Top-pu-GPA performed best, and selected students reported higher strength of motivation, but only in Year-1. Selected students did not show better quality of motivation and engagement than the other students.

Participation in selection

Year-1: Analyses showed no significant associations between participation in selection and GPA, obtained course credits, engagement, AM, CM, RAM and strength of motivation.

Year-4: Students who had participated in selection were more likely to show good performance during their clerkships (odds ratio 2.883, $p < 0.01$) and reported significantly higher engagement ($B = 0.317$, $p < 0.05$) than student who had not participated. Analyses showed no significant associations with the motivation measures.

Summary: Our hypothesis that students who participated in selection would outperform others and show better motivation and engagement was not supported for Year-1, because there were no differences in this regard. Our hypothesis was supported for Year-4 students.

Type of selection procedure

Year-1: Analysis showed significant associations between type of selection procedure and GPA, obtained course credits and strength of motivation. Selection C was associated with more course credits than selection procedure A ($B = 3.404$, $p < 0.05$). Procedure B was associated with higher GPAs than Procedures A ($B = 1.248$, $p < 0.01$) and C ($B = 0.995$, $p < 0.01$). In addition, Procedure B was associated with higher strength of motivation than Procedures A ($B = 2.770$, $p < 0.01$) and C ($B = 1.170$, $p < 0.1$). Analyses showed no significant associations with AM, CM, RAM and engagement.

Table 4 Breakdown descriptives per study year

Study year (n)	Females (n, %)	Average age (in years)	University			Admission group (n, %)			
			VUmc	AMC	UMCG	Top-pu-GPA	Selection	Lottery	
								With participation in selection	Without participation in selection
Year-1 (n = 387)	283 (73.3 %)	18.8	120	128	132	49 (13.0 %)	287 (74.4 %)	41 (10.8 %)	
								25 (6.5 %)	16 (4.1 %)
Year-4 (n = 273)	190 (73.9 %)	22.8	52	60	145	27 (10.5 %)	108 (42.0 %)	116 (45.2 %)	
								59 (23.0 %)	57 (22.2 %)

Note: because not all data were available for all students, not all percentages add up to 100%

Table 5 Descriptives

	n	Year-1						Year-4												
		Female	Age	ENG	AM	CM	RAM	SMIMS	GPA	Course credits	n	Female	Age	ENG	AM	CM	RAM	SMIMS	good clerkship performance	
		Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)	
Participation																				
No	16	81.3%	21.0 (3.4)	4.4 (1.0)	4.2 (0.5)	2.0 (0.4)	2.3 (0.7)	53.4 (7.5)	6.5 (0.9)	51.0 (15.3)	59	67.8%	23.5 (2.6)	3.7 (0.9)	4.1 (0.5)	2.0 (0.8)	2.1 (1.1)	51.6 (7.6)	67.9%	
Yes	315	76.8%	18.8 (1.3)	4.3 (0.8)	4.3 (0.4)	2.0 (0.7)	2.3 (0.8)	55.5 (6.9)	7.1 (1.1)	56.5 (9.4)	165	77.0%	22.6 (1.6)	4.1 (0.9)	4.2 (0.4)	1.9 (0.7)	2.3 (0.8)	52.3 (6.2)	85.9%	
A	75	76.0%	18.2 (0.6)	4.4 (0.8)	4.3 (0.5)	1.9 (0.6)	2.4 (0.8)	54.2 (7.3)	6.5 (0.9)	54.9 (11.3)	23	82.6%	23.1 (2.4)	4.3 (0.8)	4.2 (0.4)	1.8 (0.7)	2.3 (0.9)	53.0 (6.5)	91.3%	
B	90	75.6%	19.3 (1.5)	4.4 (0.9)	4.4 (0.4)	2.1 (0.7)	2.3 (0.8)	57.6 (6.2)	7.8 (1.2)	56.2 (9.2)	27	74.1%	22.9 (1.3)	4.0 (0.8)	4.1 (0.4)	1.9 (0.7)	2.3 (0.8)	52.0 (7.9)	92.3%	
C	122	77.9%	18.5 (0.9)	4.2 (0.9)	4.2 (0.4)	2.0 (0.6)	2.3 (0.8)	54.9 (6.2)	6.8 (0.8)	58.7 (5.8)	58	75.9%	22.5 (1.6)	4.1 (0.8)	4.2 (0.4)	1.9 (0.7)	2.3 (0.8)	52.6 (5.4)	82.5%	
Top-pu-GPA	49	59.2%	18.1 (0.6)	4.3 (0.9)	4.2 (0.6)	2.1 (0.8)	2.1 (1.0)	52.5 (7.5)	7.8 (0.9)	58.5 (8.6)	27	63.0%	21.7 (1.0)	3.7 (0.9)	4.0 (0.4)	2.2 (0.6)	1.8 (0.6)	47.9 (7.9)	96.0%	
Lottery	41	78.0%	20.1 (2.7)	4.3 (0.9)	4.2 (0.5)	2.1 (0.7)	2.1 (0.9)	54.9 (6.9)	6.9 (1.3)	51.2 (15.1)	116	72.4%	22.9 (2.2)	3.9 (0.9)	4.1 (0.5)	1.9 (0.7)	2.2 (0.9)	51.7 (6.9)	76.1%	
Selection	287	76.7%	18.7 (1.2)	4.3 (0.8)	4.3 (0.4)	2.0 (0.6)	2.3 (0.8)	55.6 (6.8)	7.0 (1.1)	56.9 (8.7)	108	76.9%	22.7 (1.7)	4.1 (0.8)	4.2 (0.4)	1.9 (0.7)	2.3 (0.8)	52.5 (6.3)	86.8%	

ENG = Engagement

AM = Autonomous Motivation

CM = Controlled Motivation

RAM = Relative Autonomous Motivation

SMIMS = Strength of Motivation for Medical School

Table 6 Results regression analyses Year-1

Year-1	Engagement		AM	CM		RAM	Strength of motivation		Course credits	GPA	
	B	B		B	B		B	B			
No participation in selection[§]	(0.122) 0.064	(-0.094) -0.105	(-0.042) -0.014	(-0.022) 0.052	(-2.149) -0.458	(-5.535**) -1.528	(-0.594*) 0.046				
A (VUmc)	(0.175) 0.030	(0.048) 0.009	(-0.044) -0.017	(0.083) 0.027	(-0.652) -1.060	(-3.858***) -3.404**	(-0.339**) -0.253				
B (AMC)	(0.170) -0.086	(0.143**) 0.033	(0.110) 0.146	(0.012) -0.048	(2.791*) 1.710*	(-2.521) -2.262	(0.947***) 0.995***				
Admission group[‡]	(-0.071) 0.114	(-0.123) -0.062	(0.058) 0.058	(-0.161) -0.070	(-3.053**) -2.581**	(1.553) 3.022	(0.738***) 0.526***				
Lottery	(0.017) 0.084	(-0.084) -0.086	(0.136) 0.136	(-0.214) -0.215	(-0.664) 0.491	(-5.726***) -4.004	(-0.105) 0.124				

In parentheses: unadjusted for confounders; without parentheses: final model

[§]Reference group: participation in selection

[¶]Reference group: UMCG

[‡]Reference group: selection

* p < 0.1; ** p < 0.05; *** p < 0.01

^{‡‡} We applied the Bonferroni procedure for multiple comparison correction

Table 7 Results regression analyses Year-4

Year-4	Engagement		AM		CM		RAM		Strength of motivation		Good clerkship performance	
	B		B		B		B		B		ODDS	
No participation in selection ^s	(-0.415***) -0.317**		(-0.107) 0.015		(0.131) 0.131		(-0.254) -0.176		(-0.662) 0.470		(0.347***) 0.347***	
Procedure ^{†‡}												
A (VUmc)	(0.186) 0.244		(-0.034) -0.056		(-0.044) -0.045		(0.032) -0.002		(0.461) 0.124		(0.448) 0.448	
B (AMC)	(-0.053) 0.064		(-0.058) -0.082		(0.000) 0.055		(0.003) -0.096		(-0.548) 1.502		(0.392) 0.392	
Admission group ^{ER}												
Top-pu-GPA	(-0.370*) 0.005		(-0.182) 0.041		(0.317) 0.317		(-0.468**) -0.325		(-4.620***) -2.124		(1.096) 1.218*	
Lottery	(-0.224*) -0.136		(-0.064) 0.019		(0.064) 0.064		(-0.140) -0.077		(-0.831) 0.017		(0.899**) 0.918	

In parentheses: unadjusted for confounders; without parentheses: final model

^sReference group: participation in selection

[†]Reference group: UMCG

* p < 0.1; ** p < 0.05; *** p < 0.01

[‡] We applied the Bonferroni procedure for multiple comparison correction

Table 8 Pearson correlations linear and dichotomous variables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Selection Participation	Gender	Age	First generation student	Doctor as parent	Area growing up	Living situation	pu-GPA	Engagement	AM	CM	RAM	Strength of motivation	Gpa Year-1	Course credits Year-1	Good clerkship performance
-	0.050	-0.386**	-0.103*	-0.066	-0.016	-0.039	0.074	0.159**	0.119**	-0.014	0.078	0.118**	0.108	0.115*	0.202**
-	-	-0.025	0.001	-0.060	0.127**	0.066	-0.049	-0.005	0.100*	-0.053	0.084*	0.085*	-0.041	0.110*	0.026
-	-	-	0.086*	0.058	0.097*	0.374**	-0.104**	-0.098*	-0.053	-0.029	-0.014	-0.082*	0.007	-0.134**	-0.141*
-	-	-	-	-0.176**	0.091*	-0.057	-0.131**	-0.040	-0.027	0.056	-0.049	-0.021	-0.002	-0.030	0.055
-	-	-	-	-	-0.115**	0.089*	0.119**	-0.076	-0.080*	0.023	-0.072	-0.048	0.126*	-0.001	0.006
-	-	-	-	-	-	0.080*	-0.052	0.041	-0.030	-0.036	0.005	-0.007	0.018	0.019	0.063
-	-	-	-	-	-	-	-0.064	-0.177**	-0.106**	0.004	-0.062	-0.070	-0.031	-0.003	-0.054
-	-	-	-	-	-	-	-	-0.084*	-0.094*	0.002	-0.047	-0.135**	0.434**	0.241**	0.145*
-	-	-	-	-	-	-	-	-	0.609**	-0.086*	0.389**	0.499**	0.002	0.084	0.146*
-	-	-	-	-	-	-	-	-	-	-0.063	0.584**	0.524**	0.032	0.118*	0.122
-	-	-	-	-	-	-	-	-	-	-	-0.847**	-0.060	0.046	-0.004	-0.159*
-	-	-	-	-	-	-	-	-	-	-	-	0.332**	-0.018	0.063	0.196**
-	-	-	-	-	-	-	-	-	-	-	-	-	0.075	0.048	0.090
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.313**	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Year-4: Analyses showed no significant associations between type of selection procedure and clerkship performance, engagement, AM, CM, RAM and strength of motivation.

Summary: Our hypothesis that students admitted through the three different selection procedures would not show differences was supported for Year-4 and only partly supported for Year-1. In Year-1, type of motivation and engagement were similar among students selected through the different procedures. Procedure B was more efficient in selecting students with higher GPAs and strength of motivation than Procedures A and C, and Procedure C was more efficient in selecting students who obtained more course credits.

Discussion

The multi-site nature of this study enabled the investigation of different admission processes and participation in a voluntary selection procedure while controlling for institutional effects. In addition, we studied the selection procedures used at different medical schools in relation to the performance, motivation and engagement of medical students in the pre-clinical and clinical phases of study. Students who excelled in pre-university education performed better in the pre-clinical and clinical phases of medical study and showed lower strength of motivation than selected students in the pre-clinical phase. This is in accordance with previous research^{3,28;30;31;42-44}. Selected students did not outperform lottery-admitted students in the pre-clinical and clinical phase of the study, which is in concordance with some previously reported findings^{14;22;28}. However, findings differ greatly across studies and may be ascribed to the increased proportion of places allocated through selection, reducing the performance gap between selected and lottery-admitted students. Inconsistencies in the findings also indicates that selection research is difficult to replicate because the context varies in the different studies and the same selection tools are also used in different ways in different contexts⁴⁵. Moreover, differences are usually small, which may explain why they do not always reach significance. As in previous research²⁸, the selected students across the three medical schools reported higher strength of motivation than top-pu-GPA students in the pre-clinical phase of the study. However, no differences were found regarding type of motivation and engagement. This was unexpected and perhaps due to the restricted range, which means that students scored at the top end for engagement and autonomous motivation and at the bottom end for controlled motivation. The mean engagement score in our sample (M=4.17), for example, clearly exceeds the score of the norm group of social sciences students (M=3.18)⁴⁶.

Students' high AM and engagement can be maintained throughout the medical study by designing the curriculum so that it supports students' autonomy and self-efficacy⁴⁷⁻⁵⁰. This also highlights the challenge that selection committees are confronted with, namely selecting the best candidates from a pool of seemingly equally suitable candidates.

Our hypothesis that students who had participated in a voluntary selection procedure would outperform and show higher AM and engagement than students who had not participated was only partly supported. Among students in the clinical phase, participation was related with clerkship performance and engagement but not with motivation. One possible explanation could be that the motivation of all students was increased by the transition from pre-clinical to clinical education. Indeed, patient contact stimulates students' motivation⁹. Students who previously chose to participate in a selection procedure, for which coping with stress and being able to combine studies with other activities are important, may become energized by and cope better with the pressure of clerkships. This may explain differences in their engagement and performance. Students who had participated in selection have been found to be more emotionally stable and conscientious than students who did not³⁴. Among students in the pre-clinical phase, no differences were found. This was somewhat surprising because in previous research, students who participated outperformed students who had not²¹. However, they only outperformed students who had not participated in terms of course credits, not in terms of other outcomes measures, which suggests that the two groups of students may not be very different from one another. Again, the increased proportion of students admitted through selection may have resulted in a change in the behaviour of applicants. Due to reduced chances of being admitted through lottery, participation in selection may have become more appealing to a wider range of applicants, reducing differences between the groups. Also, the group that had not participated in selection was rather small; this might explain why the differences did not reach significance.

We did not expect to find differences between students admitted through different selection procedures. Findings among the students in the clinical phase supported this. This must be interpreted with caution, however. Relatively small group sizes might have resulted in insufficient power to detect smaller effects. Among the students in the pre-clinical phase, we found some differences. Of course, the medical school context, as a whole, should be considered when interpreting these results⁴⁵. The three medical schools train their students to meet the same end terms. However, small differences in curricular structures and assessment and grading programs can influence study results. Students

selected at the medical school using Procedure B showed higher GPAs and strength of motivation than students selected at the medical schools that use Procedures A and C, while students selected at the university using Procedure C obtained more course credits. Procedures B and C contain more cognitive measurements than Procedure A, during both phases, which may explain the better academic performance of students selected at the medical schools using those two procedures because previous academic performance is the best predictor of future academic performance^{3;42-44}. The findings seem to suggest that potential differences between the students selected at the three medical schools fade over the course of medical study. Another explanation may be that the characteristics of the three medical schools (selection procedure, curriculum and location) appeal to different types of students. Two of the three medical schools in our study are located in the same city. It would be interesting to know how students with the desire to study medicine in this particular city decide which medical school to apply to. We intend to examine students' reasons for applying to a certain medical school in future research.

Further research questions - We plan to conduct longitudinal research that should reveal whether students' performance, motivation and engagement develop differently throughout medical study. A next important step in selection research is to follow up on the various groups of students after graduation.

Limitations

Possible limitations include selection bias and response bias. Selection bias, in this study, refers to the issue that not all Dutch universities are included. However, because the universities included represent a variety of selection procedures, we believe our choice to be justified. Because the questionnaire was offered digitally, we were able to approach all students from the proposed cohorts, which decreased the influence of selection bias at the student level. A response bias is likely because we do not know how non-responders would have answered the motivation and engagement questions. Some groups in our sample were relatively small. We have taken this into account in the interpretation of the findings. The top-pu-GPA group is consistently small because only 4% of all pre-university graduates in the Netherlands achieve this.

Conclusion

Top performing students in pre-university education perform best in the medical study. A voluntary time-consuming selection procedure seems favourable to lottery because it appears to attract engaged students who perform better in the clinical phase of the study. However, this effect seems to disappear when more places in medical school are allocated through selection. Moreover, differences between selected and lottery-admitted students did not reach significance. The results suggest that the type of selection procedure may be less important. Differences are small due to good overall performance, motivation and engagement levels.

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