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Reliability of predictors of study success in medicine

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Die Zuverlässigkeit von Prädiktoren des Studienerfolgs im Medizinstudium

Zusammenfassung. *Ziel der Studie:* Überprüfung der Reliabilität von Prädiktoren des Studienerfolgs im reformierten Wiener Medizinstudium (MCW), welche in einer prospektiven Studie des Jahrgangs 2002/03 gefunden wurden. Wir berichten die Ergebnisse eines Re-Tests an einer ebenfalls unselektierten Stichprobe des folgenden Jahrgangs 2003/04.

Methode: In einem Vergleich erfolgreicher mit nicht erfolgreichen Studierenden an der Medizinischen Universität Wien hatten wir (im Rahmen einer prospektiven, in den ersten Tagen des Studiums vorgenommenen Befragung) vier Faktoren gefunden, die für den Erfolg prädiktiv sind. Diese Befunde wurden am folgenden Jahrgang unter denselben methodischen Voraussetzungen einer Überprüfung unterzogen, nachdem zuvor a) die Repräsentativität der Stichproben überprüft worden, und b) die P-Werte einer Adjustierung unterzogen worden war.

Ergebnisse: Nach der Adjustierung der P-Werte nach Finner's Methode konnten die vier Erfolgsprädiktoren (männliches Geschlecht, deutsche Muttersprache, Schulleistungen, Lernkapazität) bestätigt werden. In der Stichprobe des Jahrgangs 2003/04 erwiesen sich 18 von 22 Items erneut als signifikant.

Schlussfolgerung: Die Mehrzahl der von uns gefundenen Erfolgsprädiktoren kann als gesichert erachtet werden.

Schlüsselwörter: Curriculum, Medizinstudium, Studierende, prospektive Studie, Geschlecht, Zulassung, Studienerfolg.

Summary. *Aim:* Examination of the reliability of predictors for study success found in a prospective study in the year 2002/03. We report the results of a retest in an unselected students' sample taken from the following academic year 2003/04.

Methods: In a comparison of successful and unsuccessful students in their first year at the Medical University of Vienna, four predictors for study success had been found (using a questionnaire in a prospective design). In a re-examination of this study, after testing for representativeness, all P values were first subjected to adjustment for multiple testing. Secondly, the items were retested in a student sample drawn in 2003/04 using the same procedures.

Results: After Finner's adjustment for multiple testing, the four predictors (male sex, German mother tongue, performance at school, learning capacity and learning style) were confirmed. In the students' sample of 2003/04, eighteen out of 22 items remained significant.

Conclusion: The majority of the prognostic factors found are reliable.

Key words: Curriculum, higher education, medical students, prospective study, sex, student selection, undergraduate, study success.

Introduction

In most European countries access to a medical degree course is limited. Particularly in countries with consistent graduation processes, access is linked to school marks (numerus clausus) [1, 2]. In those countries where universities select the students themselves, access is often linked to cognitive factors, but also to non-cognitive factors such as personality, learning styles, references, interviews [3–5] or ethnicity [6, 7].

Austria is the only country in Europe with formally unrestricted access to university, requiring only that a student successfully passes his/her final school examinations (or a comparable qualification). There is considerable fluctuation in the number of freshmen at the Medical University of Vienna, with about 1300 beginners (ranging from 890 to 2500 during the last twenty years). Due to the fact that the number of new students can neither

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be foreseen nor can it be influenced by the university, the selection process takes place at the end of the first year of study. To pass into the second year, a summative examination (SIP) has to be taken, which consists of 230 multiple choice questions from all 6 thematic modules of the first year. To pass this test, in 2002/03 50 % and in 2003/04, 60 % of the questions of each module had to be answered correctly. In the academic year 2002/03, only about 20 % of the beginners passed the examination at first go at the end of the first year of study. Another 20 % passed at their second attempt prior to the second academic year. Due to lack of capacity, only a total of 600 students are accepted for the second academic year. Should more than 600 students pass the test, those with the lowest number of accurate answers are put on the waiting list for a guaranteed place the following year.

These unique circumstances made it possible to investigate predictive factors in an unselected sample of students. If such factors could be detected, they could prove valuable for pre-study counselling and also for future selection processes. Furthermore, from the results of such studies, the accuracy of selection processes used in other countries at large could be assessed [8].

In a previous study we examined first-year students of an entirely reformed curriculum. By comparing two groups of students (a group of very successful vs. a group of students who had been unsuccessful in that they had failed the first-year exam twice), we found three decisive factors for success (male sex, German mother tongue, and an assessment of school marks in chemistry, physics, English, mathematics as well as class repetitions) and were able to identify aspects of study motivation, of learning style and the date of enrollment as being predictive for success at the SIP [9].

Another possible approach would be to compare all those who passed into the second academic year with those who did not. This way, again a rise in the absolute number of students examined and an amelioration in representativeness are achieved. In this comparison, all factors found in the first study plus learning capacity were found to be predictive [10].

For this study, we test the hypotheses drawn from Haidinger et al. [10] within the same general methodical framework. The sample consists of a group of students who began in the following year (2003/04).

Methods

The methods employed are already published elsewhere [8]. In brief, during the first days of the new academic year (October 2003) students attending the opening lectures were asked to fill out a structured questionnaire containing 67 items in order to collect information involving the following 11 factors: socio-demographic data – age, sex, native language, employment status, education and parents' social situation, performance at school; economic situation; living conditions; social integration; study motivation; learning capacity and learning styles; health impairment; contentment and ability to cope with stress; access to information; date of enrollment (by registration number).

At the end of the first year, the data from the questionnaire were correlated to the results of the compulsory test after the first academic year as we had done the year before. We compared those who had passed the examination with those who had failed (in June and/or September).

Adjustment and multiple testing

The results from our second study (all those successful compared with all who had failed [10]) were re-examined twice. Firstly the P values of all variables were adjusted according to the Finner procedure [11, 12], and secondly they were compared to the adjusted factors of the following academic year. We used Finner's method, which is an advancement on Bonferroni's single-step procedure, to adjust P values for multiple testing.

Sample and representativeness

Because of the high number of freshmen, first semester lectures are held in four parallel groups. Although the students are not obliged to attend lectures, about 80 % of them do so. At the time of the study, N = 1201 students were registered (i.e. they had enrolled by September 30, 2003, 24:00 hours). Of these, N = 839 (69.85 %) filled in the questionnaire. Since there are formal time limits set for the end of October, another 210 students ("latecomers") were admitted [13], but because of our prospective design demanding testing at the earliest point in time, these were not included in our study. Our results therefore are based on a total population of N = 1201.

For representative purposes, we tested our sample against this total population (excluding "latecomers"):

(1) In terms of sex-distribution our sample (66.6 % females) does not differ from the total population (65.6 % females, $P = 0.332$).

(2) In terms of academic success the students in our sample are somewhat more successful but statistically non-significant ($P = 0.148$). Moreover "latecomers" differ highly from our total population in terms of sex ($P < 0.001$) and academic success ($P < 0.001$). "Latecomers" more often are male and perform worse.

(3) With regard to comparability with the results of our previous study, it must be noted that the limit of 50 % correct answers in the multiple choice test for passing into the next academic year was raised to 60 %.

Results

a) P-Value adjustment

The statistically significant predictors: male sex, success at school (mathematics, physics, chemistry, English, mean of these four subjects, class repetition), German mother tongue, study motivation, learning capacity and learning style, which we reported previously [10] remained significant even after the adjustment of P values. The variable „health impairment" did not stay significant.

b) Reliability

The comparison of the adjusted P values of the year 2002/03 with those of the year 2003/04 left 18 of the originally 22 variables significant (Table 1). Only three variables (concerning learning style and date of enrolment) could not be confirmed with the data from the new sample.

Table 1. Predictive determinants after Finner's adjustment of P values in the students' sample of the study years 2002/03 and their re-examination in the sample of 2003/04

		2002/03			2003/04		
Sociodemographic variables		Successful *No. (%)*	Unsuccessful *No. (%)*	*Adjusted P (Finner)*	Successful *No. (%)*	Unsuccessful *No. (%)*	*Adjusted P (Finner)*
Sex	Female	175(42)	242(58)	0.0274	155(28)	404(72)	0.0045
	Male	110(54)	94(46)		111(40)	169(60)	
German mother tongue	yes	261(47)	295(53)	0.0159	226(35)	429(65)	0.0072
	no	37(32)	80(68)		40(22)	144(78)	
School Performance		*No.(mean)*	*No.(mean)*		*No.(mean)*	*No.(mean)*	
Mathematics		280(2.19)	356(2.76)	< 0.0001	248(2.04)	520(2.67)	< 0.0001
Physics		269(1.76)	333(2.16)	< 0.0001	219(1.60)	437(2.09)	< 0.0001
Chemistry		273(1.69)	330(2.12)	< 0.0001	223(1.63)	442(2.15)	< 0.0001
English		281(2.02)	353(2.52)	< 0.0001	242(1.83)	524(2.43)	< 0.0001
Sum of school marks		266(1.91)	324(2.4)	< 0.0001	204(1.77)	418(2.32)	< 0.0001
Number of class repetitions		293(0.06)	365(0.13)	0.0424	266(0.04)	566(0.15)	0.0130
		No.(mean)	*No.(mean)*		*No.(mean)*	*No.(mean)*	
Secure financial situation for the normal duration of studies (in mm)		296(16)	372(21)	0.0274	267(21)	565(24)	0.0215
Study motivation		*No. (%)*	*No. (%)*		*No. (%)*	*No. (%)*	
Reason for choosing medicine enjoy acquiring knowledge	yes	236(49)	247(51)	0.0011	227(36)	406(64)	0.0001
	no	62(33)	128(67)		41(19)	171(81)	
		No.(mean)	*No.(mean)*		*No.(mean)*	*No.(mean)*	
Academic success is very important to me (in mm)		297(10)	375(14)	0.0074	268(10)	574(13)	0.0072
I would be very/not at all upset if I were not able to complete my medical studies (in mm)		296(14)	373(18)	0.0188	267(10)	561(15)	0.0048
I feel that my course of studies is doable (in mm)		297(17)	374(25)	< 0.0001	268(19)	575(23)	0.0215
		No. (%)	*No. (%)*		*No. (%)*	*No. (%)*	
I already have clear ideas about my future specialisation	yes	147(38)	238(62)	0.0009	132(27)	350(73)	0.0048
	no	147(53)	128(47)		132(39)	208(61)	
Learning capacity, learning style		*No.(mean)*	*No.(mean)*		*No.(mean)*	*No.(mean)*	
It has always been easy/difficult for me to learn (in mm)		293(21)	372(32)	< 0.0001	267(27)	570(34)	0.0001
I am not/very bothered by having to learn large amounts of material (in mm)		295(31)	370(38)	< 0.0001	266(37)	562(43)	0.0159
In order for me to master the material I have to learn I need to understand it completely/to learn it by rote (in mm)		295(16)	371(20)	0.0274	266(17)	570(20)	0.0278
I am very nervous/not at all nervous before exams (in mm)		296(39)	372(33)	0.0419	267(37)	566(32)	0.0400
I prefer to learn under a strict schedule/at my own pace (in mm)		296(54)	371(45)	0.0036	264(50)	568(50)	0.7573
The curriculum should provide more orientation and structure/freedom (in mm)		295(36)	370(30)	0.0274	265(38)	572(34)	0.1845
I am impaired/not impaired by nervousness at exams (in mm)		295(64)	372(53)	< 0.0001	266(60)	571(66)	0.7932
Date of enrolment (mean rank)		115(111)	130(134)	0.0493	210(296)	427(330)	0.0786

Discussion

We were able to prove that firstly the predictors of study success found in a previous study were not the product of a high number of variables and of multiple testing, because most of them withstood the sharpened and most powerful adjustment by Finner's method, and secondly, that most of the determinants could be affirmed in the sample of the following study year.

We observed that out of 6 items concerning learning capacity and learning style the two items pertaining to learning capacity stayed significant, while out of those regarding learning style, 3 out of 4 items could not be

validated. This leads to the conclusion that learning capacity is more important for academic success than learning style.

As to the date of enrolment, we found evidence in the literature regarding the influence of this factor on study success (14) and we were able to confirm this in our first study. In this second survey, this determinant plays a minor role, at least in mastering the new curriculum. We point out that the true "latecomers" (students enrolling after September 30) are not part of our sample. If we had included these "latecomers" (see sample and representativity), we would have reached statistical significance, too ($P < 0.001$).

The results concerning school marks confirm the findings of others [2, 14, 15]. The well known fact that pupils with good school marks make successful students justifies their use as access criteria. Best prediction is achieved by means of all school marks [2] of the final school year. The combination of school marks and the TMS admission test [16] enhances the predictability a little (from r=0.47 to r=0.54). Its advanced Swiss version, the EMS [17] reaches a prognostic value of r=0.53 for the study of medicine. Overall, the validity achievable remains unsatisfactory [18].

German mother tongue is also a plausible factor for success. Again we state that improvements in pre-study language competence are necessary. In our view, it would be important for both economic reasons and to motivate non-German speaking students to clearly state that an excellent command of the German language is a prerequisitive for success in SIP 1.

The sex-difference is surprising for it is a fact that girls in general perform better at school and at university (e. g. Vienna University of Economics and Business Administration [14]). Moreover, our own data show females getting better school marks. Our data, also observed in the recent admission test at the Medical University of Graz [19] (where the ratio of females sank from 56 % applicants to 47 % admitted), seem to reveal a politically undesirable trend, which contradicts §§ 2, 41, and 44 of the Austrian University Act 2002 (equal opportunities for women and men).

Concerning the influence of sex on study-success we generated hypotheses based on qualitative interviews of students and sources in literature. We suppose that serious differences between men and women exist in terms of learning style, which we have not yet been able to address. Students' statements match the findings in literature that, generally speaking, women are less secure in terms of doability and the demands made on them. To master this uncertainty, girls try to learn meticulously already at school while boys tend to learn more strategically [20–22, overview in 7].

Regarding these differences in learning style it is not surprising that girls generally perform better at school [7]. Further investigation is needed because within the framework of the Vienna medical curriculum significantly fewer females pass the exam despite better school performance and despite its high predictive value for academic success.

To analyse the influence of the Vienna medical curriculum we will compare our findings to data of other medical schools. Furthermore we will test the effects of sex-specific learning styles.

We conclude that the main determinants (male sex, German mother tongue, school marks, aspects of study motivation and learning style) are confirmed predictors of success at the Medical University of Vienna. Concerning the factors learning style, health impairment and date of enrolment, the hypotheses have to be revised.

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